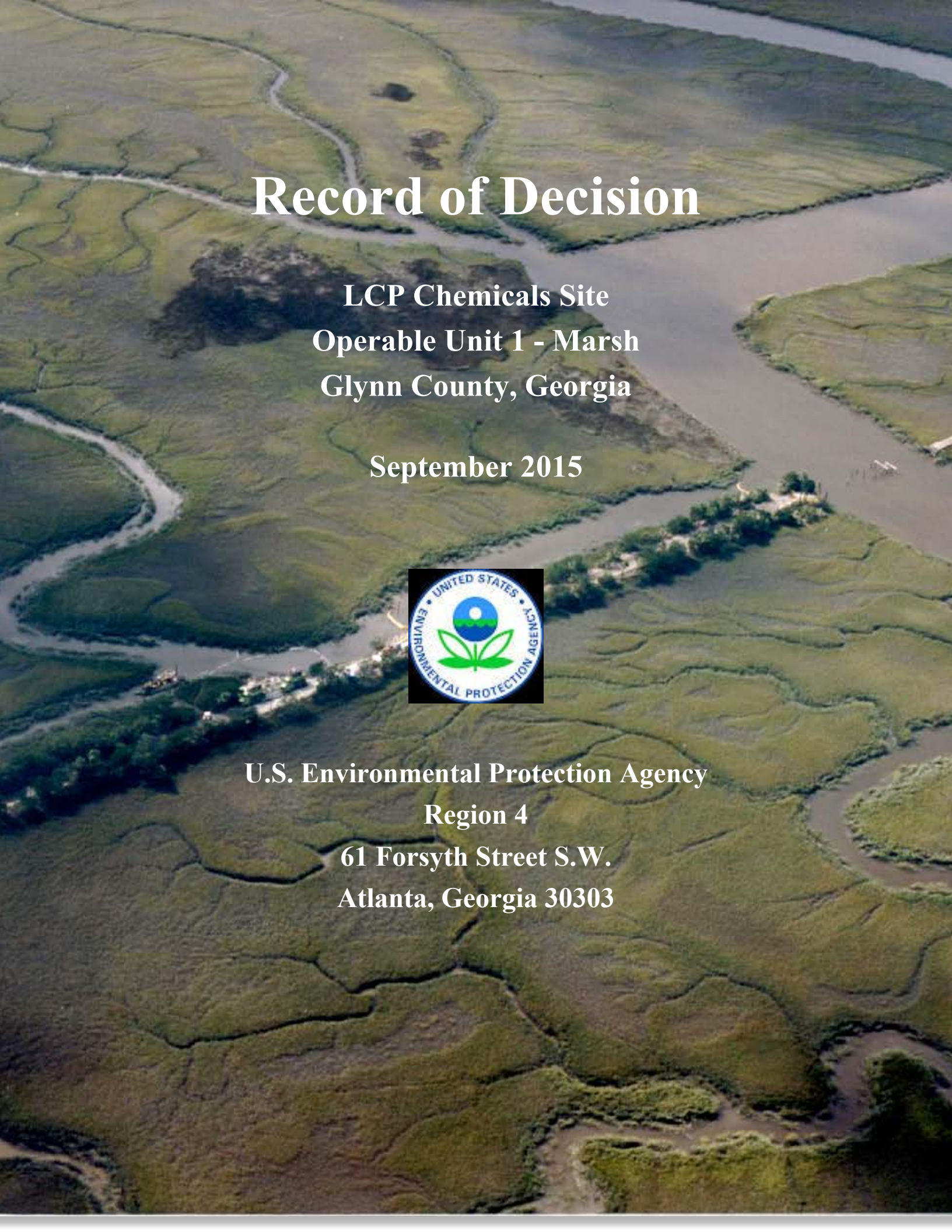


Record of Decision

LCP Chemicals Site
Operable Unit 1 - Marsh
Glynn County, Georgia

September 2015

U.S. Environmental Protection Agency
Region 4
61 Forsyth Street S.W.
Atlanta, Georgia 30303

RECORD OF DECISION

SUMMARY OF REMEDIAL ALTERNATIVES SELECTION

LCP CHEMICALS SITE
BRUNSWICK, GLYNN COUNTY, GEORGIA
OPERABLE UNIT (OU) 1 - MARSH

CERCLIS ID: GAD099303182

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA, GEORGIA

SEPTEMBER 2015

PART 1: DECLARATION

1.0 Site Name and Location

The LCP Chemicals Superfund Site (the Site), Operable Unit (OU) 1 is located at 4125 Ross Road, Brunswick, Glynn County, Georgia. The Site was entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database June 24, 1988 and the identification number of the Site in CERCLIS is: GAD099303182. The Site was listed on the National Priorities List (NPL) on June 17, 1996. Because the conditions at the LCP Chemicals Site are complex, the Site was organized into three OUs: OU1, the LCP Chemicals marsh; OU2, the Site's groundwater, including the surface and subsurface soil of the former mercury Cell Building Area; and OU3, the remaining Site's Uplands, excluding the mercury Cell Building Area. The LCP Chemicals marsh (OU1) occupies approximately 760 acres immediately northwest of Brunswick, Glynn County, Georgia. The property is bordered by a former Glynn County land disposal facility and a pistol firing range on the north, Ross Road on the east, the Turtle River and associated marshes to the west, and the Brunswick Cellulose plant to the south. The LCP Chemicals marsh consists of approximately 662 acres of flat, vegetated tidal marsh and 98 acres of tidal creeks. Former operations at the LCP Chemicals Site were located on 121 acres of upland area, east of the marsh.

2.0 Statement of Basis and Purpose

This decision document, presents the Selected Remedy for OU1 of the LCP Chemicals Site, Brunswick, Glynn County, Georgia, which was chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) 42 U.S.C. Section 9601 *et seq*., and to the extent practicable, the National Contingency Plan (NCP) 40 Code of Federal Regulations (CFR) Part 300. This decision is based on the Administrative Record (AR) for the LCP Chemicals Site (OU1), the Marsh.

The Georgia Environmental Protection Division (GAEPD) concurs with the Selected Remedy.

3.0 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

4.0 Description of Selected Remedy

Based on the information currently available, the U.S. Environmental Protection Agency (EPA) believes the selected remedy of dredging, *in situ* capping and thin-layer placement over the lower concentrations of contaminated sediment meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. In compliance with CERCLA Section 121(b), this

alternative will be protective of human health and the environment, comply with applicable, relevant and appropriate requirements (ARARs), be cost effective, will use permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable. Sediment removal, capping and covering of mercury, Aroclor 1268, lead and polycyclic aromatic hydrocarbon (PAH) contaminated sediment have been demonstrated to be reliable and provide an element of treatment to reduce mobility and toxicity (bioavailability) through physical isolation, stabilization, and chemical sequestration/immobilization of the contaminants under the caps.

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site whenever possible (NCP §300.430(a)(1)(iii)(A)). The LCP Chemicals marsh's mercury, Aroclor 1268 and otherwise contaminated sediment is not readily classifiable as principal threat wastes despite the inherent toxicity of mercury and Aroclor 1268 and demonstrated mobility which, in the case of the former, has contaminated surface water. Capping alternatives have been demonstrated to be reliable containment remedies for this type of contamination in submerged sediments.
The major components of the remedy include:

- Dredging approximately seven acres (~22,000 cubic yards [CY]) in the LCP Ditch and Eastern Creek to a target depth of 18 inches;
- Backfilling the dredged areas with ~14,000 CY of clean material;
- Replanting the disturbed vegetated marsh areas with native plants;
- Capping approximately six acres in Domain 3 Creek and Purvis Creek;
- Thin-layer placement on approximately 11 acres of marsh;
- Confirmation of co-location of dioxins/furans with Aroclor 1268;
- Dewatering dredged sediments on-site and disposing of them at licensed off-site facilities;
- Constructing staging areas and temporary access roads. This will likely require an additional disturbance of approximately seven acres;
- Restoring of disturbed areas;
- Monitoring in the short-term during the construction phase, including soundings and surveys to verify removal depths, depth verification measurements to document material placed, and/or material coverage assessments;
- Monitoring in the long-term the remedy's long-term effectiveness in enhancing ecosystem recovery and reducing risks to human health and the environment; and
- Institutional controls (ICs).

5.0 Statutory Determinations

The Selected Remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.
The remedy in this OU does not satisfy the statutory preference for treatment as a principal element of the remedy. The toxicity and mobility of mercury and Aroclor 1268

in sediments will be significantly reduced by physically and, depending on further evaluation during remedial design, possibly chemically isolating the contaminated sediments from the aquatic environment. *In-situ* caps, and in the case of lower concentrations, thin-layer placement is generally accepted as reliable containment for contaminated sediment.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review will be conducted every five years after initiation of remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

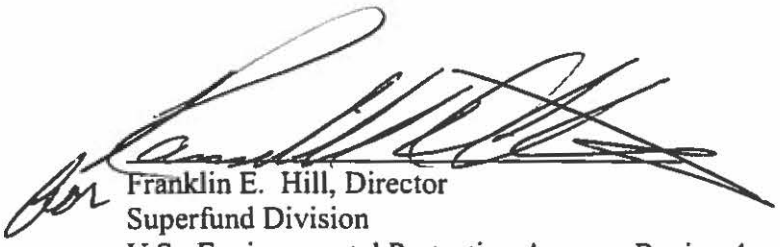
6.0 Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the AR file for this Site.

- ✓ Chemicals of concern (COCs) and their respective concentrations.
- ✓ Baseline risk represented by the COCs.
- ✓ Cleanup levels established for COCs and the basis for these levels.
- ✓ How source materials constituting principal threats are addressed.
- ✓ Current and reasonably anticipated future land use assumptions used in the baseline risk assessment (BRA) and Record of Decision (ROD).
- ✓ Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- ✓ Key factor(s) that led to selecting the remedy that demonstrate how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision.

7.0 Authorizing Signature

This ROD documents the selected remedy for sediments at the LCP Chemicals (OU1) Superfund Site. This remedy was selected by EPA with concurrence from GAEPD.



Franklin E. Hill, Director
Superfund Division
U.S. Environmental Protection Agency, Region 4

9/22/15
Date

RECORD OF DECISION

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ACRONYMS AND ABBREVIATIONS

AET	Apparent effect threshold
Allied	Allied Chemical Corporation
amsl	above mean sea level
AOC	Administrative Order on Consent
API	American Petroleum Institute
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirement
ARCO	Atlantic Refining Company
ATSDR	Agency for Toxic Substance and Disease Registry
AWQC	Ambient Water Quality Criteria
BERA	Baseline Ecological Risk Assessment
bls	below land surface
BMI	brine mud impoundments
BMP	best management practices
Bohicket	Bohicket-Capers Association
BRA	Baseline Risk Assessment
CalEPA	California Environmental Protection Agency
CBP	caustic brine pool
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CFS	cancer slope factor
cm^2	square centimeter
cm/s	centimeters per second
COCs	chemicals of concern
COPC	chemicals of potential concern
CP	conservation preservation
CSM	conceptual site model
CT	central tendency
CTE	central tendency exposure
CUL	cleanup levels
CY	cubic yards
Dixie	Dixie O'Brien Company
dw	dry weight
ECR	excess cancer risk
EJSEAT	Environmental Justice Strategic Enforcement Assessment Tool
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ER-L	effects range low
ER-M	effects range median

ACRONYMS AND ABBREVIATIONS - Continued

ERT	Emergency Response Team
FFDA	former facility disposal area
FS	Feasibility Study
ft	feet/foot
ft/sec	feet per second
GADNR	Georgia Department of Natural Resources
GAEPD	Georgia Environmental Protection Division
Geosyntec	Geosyntec Consultants
HI	hazard index
HQ	hazard quotient
HHRA	Human Health Risk Assessment
IC	institutional control
IRIS	Integrated Risk Information System
LCP	Linden Chemical and Plastic
LOAEL	lowest-observed-adverse-effect-level
LOE	line of evidence
LTM	long-term monitoring
LTMP	long-term monitoring plan
MeHg	methylmercury
mg/kg	milligrams per kilogram
ng/kg	nanograms per kilogram
ng/L	nanograms per liter
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no-observed-adverse-effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTR	National Toxics Rule
O&M	Operation and Maintenance
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzodioxins
PCDF	polychlorinated dibenzofurans
PELs	probable effect levels
pH	hydrogen ion concentration
ppm	parts per million
PRG	Preliminary Remedial Goals
PRPs	potentially responsible parties
PTI	PTI Environmental Services
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act

ACRONYMS AND ABBREVIATIONS - Continued

RD	Remedial Design
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SEC	sediment effect concentration
SIC	Standard Industrial Classification
Site	LCP Chemical Site
su	standard units
SWAC	surface-weighted average concentration
TCDD	tetrachlorodibenzodioxin
TCDF	tetrachlorodibenzofuran
TCLP	Toxicity Characteristic Leaching Procedure
TEC	toxic equivalence concentrations
TELs	threshold effect levels
TOC	total organic carbon
TRBE	Turtle River/Brunswick Estuary
TRV	toxicity reference factor
TSCA	Toxics Substances Control Act
UAO	Unilateral Administrative Order
UCL	upper confidence limit
WCC	Western Creek Complex

PART 2: THE DECISION SUMMARY

1.0 Site Name, Location, and Description

The LCP Chemical Site (the Site) is located at 4125 Ross Road, Brunswick, Glynn County, Georgia and is surrounded primarily by commercial and industrial property. For an area location map and general Site map see Figure 1. The Site occupies approximately 850 acres immediately northwest of Brunswick, Glynn County, Georgia (Figure 2). The property is bordered by a former County land disposal facility and a pistol firing range on the north, Ross Road on the east, the Turtle River and associated marshes to the west, and Brunswick Cellulose plant to the south. The LCP Chemicals marsh comprises about 760 acres of the property, consisting of approximately 662 acres of flat vegetated tidal marsh and 98 acres of tidal creeks. Former manufacturing operations at the Site were located on 121 acres of upland area, located east of the marsh. Figure 3 shows the key features of the uplands portion of the Site, while in operation. Various industries occupied the Site's uplands since the 1920s, including most recently mercury cell chlor-alkali plants.

The U.S. Environmental Protection Agency (EPA) and the Georgia Environmental Protection Division (GAEPD) have organized the work for the Site into three operable units (OUs): OU1 addresses the marsh; OU2 addresses the Site's groundwater, as well as the surface and subsurface soil associated with the former mercury Cell Building Area; and OU3 pertains to the remainder of the Site's Uplands. This is the first remedial action selected for any of the OUs. The EPA is the lead agency for the Site. GAEPD is the support agency. The remedial investigation (RI)/feasibility study (FS) has been funded by the potentially responsible parties (PRPs), as a result of a settlement.

2.0 Site History and Enforcement Activities

2.1 Site History and Sources of Contamination

The Atlantic Refining Company (ARCO) operated the Site as a petroleum refinery from 1919 until the mid-1930s, when a labor dispute forced its closure. Georgia Power Company purchased portions of the Site between 1937 and 1950, and operated electric power generating facilities. In 1941, the Dixie O'Brien Company (Dixie) purchased 10.5 acres of the Site, south of the Georgia Power parcels, where it formulated paints and varnishes. Dixie sold its land to the Allied Chemical Corporation (Allied) in 1955 and moved its operations across town.

In 1956, the Allied Chemical and Dye Corporation (now Honeywell) built and operated a chlor-alkali facility at the Site, principally for the production of chlorine gas, hydrogen gas, and caustic solution. The plant operated using the mercury cell process, which involved passing a concentrated brine solution between stationary graphite anodes and a flowing mercury cathode to produce chlorine gas, sodium hydroxide (caustic) solution, and hydrogen gas. Sodium hypochlorite (bleach) and hydrochloric acid were also produced in secondary reactions. For a time, the graphite anodes were impregnated with the polychlorinated biphenyl (PCB) Aroclor 1268 to extend their life.

In December 1979, LCP Chemicals (Georgia) acquired the Site. It continued using the same chlor-alkali process. Figure 4 shows the layout of the process piping as it conveyed initially untreated process liquids from the mercury cell building to the receiving basins in the marsh.

In July 1991, LCP Chemical's parent, Hanlin, initiated bankruptcy proceedings under Chapter 11. After a severe decline in plant maintenance and operations, the State of Georgia began administrative proceedings to revoke the company's air and water permits. When the State brought suit against the company in 1993, Allied intervened and attempted to negotiate a Consent Decree with the State for the purchase of the facility and transfer of all of its permits. In February 1994, following failed negotiations between Allied, Hanlin, and GAEPD, LCP Chemicals ceased all manufacturing activities at the Site. In 1998, the bankruptcy court approved Hanlin's conveyance of title to the Brunswick plant and the property to Allied. Allied acquired and merged with Honeywell, Inc., becoming Honeywell International, Inc. in 1999.

At the time LCP Chemicals ceased operations, mercury and Aroclor 1268 contamination was widespread throughout Domain 1 (see Figure 2 and Section 5.1 for a description of the marsh Domains) of the LCP Chemicals marsh and to a lesser extent in the other domains. In addition to the mercury and Aroclor 1268, lead, other metals, and polycyclic aromatic hydrocarbon (PAHs) also contaminated the domains closest to the Uplands. Mercury and Aroclor 1268 were detected in aquatic life at levels elevated enough to require a ban on commercial fishing in the area and a seafood consumption advisory for part of Turtle River and its creeks.

In June 17, 1996, the LCP Chemicals Site was place on the National Priority List (NPL) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or "Superfund." Groundwater contamination at the Site had been established based on the results of various investigations. In listing the Site on the NPL, the EPA found the following hazardous substances associated with the Site: mercury, Aroclor 1268, and other hazardous substances. Mercury and Aroclor 1268 contamination was caused by the operation of the mercury chlor-alkali plant during the period of 1956 to 1994.

In February 1994, after numerous investigations by the GAEPD and the EPA, GAEPD requested that the EPA initiate removal enforcement actions at the Site. According to the Action Memorandum signed in May 1994, the Site was a high priority for removal action. Section 2.3.2 and 2.3.3 provide detail on the 1990s removal actions.

A Unilateral Administrative Order (UAO) was issued to Allied, Hanlin and the former LCP Chemicals plant manager in March 1994 and then amended in March 1995 to add ARCO, Georgia Power, and the O'Brien Corporation (successor to Dixie) as respondents. The O'Brien Corporation failed to comply with the UAO and is defunct. Besides development of plans and schedules for the removal and proper disposal of waste and debris, the work to be performed under the 1995 UAO included the following: a) control the migration and/or releases of all hazardous substances, b) install and operate an oil/ water separation system, c) install a carbon adsorption unit for wastewater, d) drain, treat and dispose of the remaining caustic and sulfuric acid used to absorb the moisture in the chlorine, e) complete the abandonment of the water supply wells, f) develop a plan a schedule for the demolition and removal of the mercury cell buildings, g) develop a plan and schedule for sampling the subsurface soil beneath the mercury cell buildings and h) develop plans and schedules for the removal, treatment and proper disposal of all contaminated soil, debris, and sediment beneath the mercury cell buildings and other portions of the plants, which were removed.

The three remaining PRPs; Allied, Georgia Power, and ARCO, subsequently entered into a mixed funding Administrative Order on Consent (AOC) to conduct additional removal activities in November 1997. The removal, which involved excavation of 13 acres of contaminated marsh and select portions of the Eastern Creek and LCP Ditch (Main Canal) down to an average depth of one foot, backfilling of the marsh with clean soil to design grade and planting with cordgrass (*Spartina alterniflora*), was completed in July 1999. Figure 5 shows the extent of the work performed under the 1997 AOC.

The RI/FS for the LCP Chemicals marsh is being performed pursuant to an AOC, dated July 6, 1995, between ARCO, Allied, Georgia Power and the EPA. The PRPs agreed to perform the RI/FS concurrently with the removal work.

In May 2007, Honeywell, identified earlier as the successor to Allied, signed an AOC, agreeing to perform a time critical removal of a caustic brine pool (CBP) located in the

vicinity of the former mercury cell buildings. Figure 6 shows the extent of the CBP, as it is currently delineated.

2.2 Previous Investigations

Multiple parties performed investigations in the LCP Chemicals marsh to determine the scope of a removal action that was identified in the November 1997 AOC and performed in 1998-1999. The EPA conducted a three-phase sample investigation during 1995 in the marsh flats and the tidal channels, at the direction of the On-Scene Coordinator (OSC), for use in assessing the need for and scope of removal action in the marsh. Geosyntec Consultants (Geosyntec) performed limited sampling in the marsh over the period of 1995-1997, and PTI Environmental Services (PTI) performed additional sampling in 1996. The National Oceanic and Atmospheric Administration (NOAA) also performed a monitoring study in the marsh and tidal channels in 1997. A summary of these events is provided below.

2.2.1 EPA (1995)

The EPA conducted three sampling events in 1995. A major part of the EPA's sampling program was conducted along a grid, established immediately west of the Former Facility Disposal Area (FFDA, a former disposal area) and south of the B-Street causeway. Additional sampling in the outer reaches of the LCP Chemicals marsh (west of Purvis Creek) was also performed. In all, over 200 separate locations were sampled by EPA in 1995. These sampling events included other media samples such as biota and toxicological test samples in addition to sediment chemistry.

2.2.2 PTI Environmental Services (1996)

In 1996, PTI completed a sediment sampling event consistent with the event completed by the EPA in 1995, involving sampling at well over 100 separate locations across the LCP Chemicals marsh and adjacent area. This sampling event was completed, in part, to confirm the 1995 EPA results which lacked accurate position coordinates due to global position limitations during that period.

Sediment sampling was focused in the in the area between the marsh-upland border and Eastern Creek below the B-Street causeway. Additional sampling in the outer reaches of the LCP Chemicals marsh (west of Purvis Creek) was also performed but at a lower sampling density. This sampling event included other media samples such as biota and toxicological test samples, in addition to sediment chemistry.

2.2.3 Geosyntec Consultants (1995-1997)

Geosyntec performed more limited scopes of sampling in support of the other studies by EPA and PTI, prior to the removal action. Geosyntec conducted two sampling events in 1995. The first event, conducted in June 1995, involved sediment sampling at 17 locations in the marsh along the perimeter of the FFDA and two additional locations in the same vicinity. Later in September 1995, in support of the uplands removal action, described in detail in Section 2.3.3, Geosyntec sampled near-shore sediment at three

locations immediately west of each of two former American Petroleum Institute (API) separators (one north of B-Street and one south of B-Street). In 1996, three locations were sampled in the Dillon Duck area at the north end of the Site and two locations were sampled west of the FFDA in support of a removal action treatability test. A more comprehensive sampling was performed in 1997 involving sediment collection from 22 locations across the entire LCP Chemicals marsh.

2.2.4 NOAA 1997

In 1997, NOAA performed a sampling event involving eight locations across the LCP Chemicals marsh. The study focused on sediment sampling in the LCP Chemicals marsh south of the B-Street causeway and east of Purvis Creek. Biota and sediment samples were also collected for laboratory toxicity testing.

2.2.5 Sampling in Support of the 1998-1999 Marsh Removal Response Action

Between 1998 and 1999, approximately 13 acres of marsh flats (nearest the sources of historical facility discharges) were excavated, backfilled to restore grade, and re-vegetated with native marsh grasses. Dredging was also performed along a portion of the Eastern Creek and in select portions of the LCP Ditch (2,650 linear feet [ft]). Figure 5 shows the Marsh Removal Area and extent of dredging in the LCP Ditch and Eastern Creek. Sampling support for the marsh removal action included several separate events spanning the timeframe from 1997 (pre-removal planning) through 1999 (post removal).

2.3 Cleanup Activities Planned and Completed to Date

2.3.1 Background

During the period of active manufacturing at the Site, process and storm sewer discharges from the on-site operations entered the near-shore marsh at several locations along the Site shore. Most of the process/storm sewer lines were located in the southern portion of the Site, especially those serving the mercury cell plants (Figure 4).

One of the sewer lines is believed to have served areas in the former ARCO community (the community built by ARCO to support the refinery operation at the Site); it passed into the South API Separator and then into the marsh. This South API Separator tank once contained several feet of sludge characterized by elevated concentrations of mercury, Aroclor 1268, and other Site related constituents. The sludge was removed from the tank during the upland removal action completed in 1997 and the API Separator was closed in place.

Another pipeline is believed to have been present in the northern part of the Site uplands, connected to a second API Separator (the “North” tank) located along the marsh edge. Sludge was also removed from this API Separator and the tank was closed in place during the removal response action completed in 1997.

Two 36-inch diameter process sewer lines were associated with the mercury cells plants, directing process wastewater to the Outfall Canal and to the Outfall Pond. Overflow

from the settling pond went into the LCP Ditch. This process wastewater was discharged to the sewer lines without treatment during early industrial operations (up until the early 1970s) in accordance with standard industrial practices of that era. The chemical characteristics of this untreated wastewater can be inferred from the chemical characteristics of the first Brine Mud Impoundments (BMIs) constructed in the early 1970s (these impoundments received sludge from wastewater of the mercury cell plants operation). Sludge in BMI No. 1 contained mercury and Aroclor-1268 at concentrations over 1,000 milligrams per kilogram (mg/kg). Some of the mercury and Aroclor-1268 chemical contributions to the marsh area can be attributed to the composition of this wastewater discharge. A storm sewer line also drained into the Outfall Pond.

During the operation of the chlor-alkali plant, two mercury cell buildings housed approximately 100 mercury cells that were used in the production of chlorine gas, caustic solution and hydrogen gas. Beginning around 1970, wastewater was diverted via concrete sloping floors to a sump and then to the on-site wastewater treatment plant for treatment prior to off-shore permitted release. The two mercury cell buildings were demolished during the removal and the concrete slab was covered with soil to prevent future mercury emissions. The cover was planted with a Bermuda grass surface that is routinely maintained.

2.3.2 Source Control

Source control measures at the LCP Chemicals Site began with the construction of the mercury brine impoundments in 1970 and continues to the present time with the sparging (injection) of carbon dioxide into the caustic brine pool. Pursuant to a Preauthorization of CERCLA Section 111(a) Claim, the PRPs removed 13 acres of highly contaminated marsh flats which were nearest to facility discharges points. In this removal about 21,500 cubic yards (CY) of contaminated sediment and debris were removed and properly disposed of. In addition, 3,500 CY of contaminated sediment were excavated from 2,650 linear ft of the LCP Ditch and Eastern Creek. In total, 38,925 tons of material required off-site disposal. Of this amount, 13,400 tons were shipped as hazardous waste and 25,525 tons were shipped as non-hazardous material. Figure 5 shows the extent of the marsh removal work completed in the 1990s.

Eleven discrete disposal units were located on the western portion of the Site, where the Uplands meet the LCP Chemicals marsh. The eight closest to the marsh disposal areas are: 1) outfall pond and canal, 2) the FFDA, 3) the south gravity separator, 4) the north disposal area, 5) the south disposal area, 6) the BMIs, 7) the north gravity separator and 8) scrapyard and cell parts area. About 45,797 CY of Subtitle D Resource Conservation and Recovery Act (RCRA) non-hazardous waste and 45,118 CY of Subtitle C RCRA / Subtitle C Toxic Substances Control Act (TSCA) hazardous waste, and associated contaminated soil were removed from these eight areas and properly disposed of. The following is a brief description of the eight areas:

1) The "outfall pond" served as the central discharge point for almost all the outfalls at the Site and predated Allied's arrival in 1955. Along with the Outfall Canal, the

Outfall Pond was dredged, de-watered, and excavated in 1995. It was roughly 70 ft in diameter and 8-to-12 ft deep. Portions of the filtercake resulting from the cleanup activities failed the toxicity characteristic leaching procedure (TCLP) test for mercury and had PCB concentrations greater than 500 mg/kg.

2) The FFDA, also known in early EPA documents as the "Allied Disposal Area," was a landfill about four acres in size in the marsh, extending from the upland area. It included both hazardous and non-hazardous debris and contained spent mercury cell anodes, waste sludge and various other materials. Contaminants included mercury, PCBs, lead and various organic constituents. With each high tide, the FFDA became inundated with salt water from the marsh.
3) The "south gravity separator" was a concrete separator about 200 ft long and 40 ft wide. It was built in the southern portion of the Site within the footprint of the Altamaha Canal by ARCO's corporate predecessor at the Site. It received both sanitary sewage from the town of Arco and various petroleum waste streams from the refinery operations. The south gravity separator was connected to the marsh by pipe and the water contained therein rose and fell with the tides. What amounted to petroleum sludge in the separator also contained high levels of mercury, lead and PCBs.
4) The "north disposal area," also known as the "acid pits", was located immediately south of the north gravity separator. It was comprised of roughly a quarter acre of marsh and was filled with acid sludge from gasoline clarification. The sludge contained significant levels of lead which were highly acidic, and on warm days, would ooze up through the ground surface. It did not contain mercury or PCB contamination.
5) The "south disposal area," also known as the "tar pits," was about an acre in size and was located on the very southwest corner of the upland area of the Site. It was adjacent to the marsh and extended underneath the BMIs. It contained petroleum (perhaps tank bottoms) to a depth of 12-to-15 ft below land surface (bls). Contaminants included only PAHs and lead.
6) There existed four BMIs located at the Site that occupied a total of about three acres between the south disposal area and the FFDA. The first three BMIs were built by Allied in the mid-1970s as part of the plant's National Pollutant Discharge Elimination System (NPDES) wastewater treatment system; the fourth BMI was built by LCP Chemicals (GA) during the mid-1980s. The BMIs were located adjacent to the south gravity separator and partly over the Altamaha Canal, and were constructed in a petroleum-contaminated area. Material used to construct the BMIs included demolition debris and spent graphite anodes from the Solvay process. The brine mud (K071RCRA waste) contained mercury and PCBs above 500 parts per million (ppm); the material comprising the berms of the BMIs were contaminated with a combination of mercury, lead, PCBs and organic wastes.
7) The "north gravity separator" was essentially identical to its companion to the south in purpose, construction, and history; it too was located within the footprint of the Altamaha Canal. However, it is not thought to have contained mercury or PCB contamination.

8) During plant operations, the Scrap Yard was utilized for storage of used process equipment, used tanks, small storage sheds and miscellaneous trash and debris. The Cell Parts Area is an approximately 0.1 acre area on the south side of the Cell Parts Storage Warehouse, adjacent to the northeast side of the Scrap Yard. The warehouse was utilized to store chlor-alkali cell parts.

2.3.3 Uplands Removals

In total, about 130,120 CY of Upland (non-marsh) wastes and associated contaminated soils were removed and properly disposed of under EPA's Emergency Removal authority. About 45 percent of the yardage excavated was disposed of as Subtitle C (TSCA) waste. The remainder was disposed of in a Subtitle D landfill. Including the Upland areas discussed above, approximately 25 Upland areas were addressed during the 1990s removal. The Upland removal response activities included the following components: (i) characterization of the upland area of the Site; (ii) delineation of removal areas; (iii) removal and off-site disposal of impacted materials; (iv) post-excavation confirmation sampling to verify compliance with the removal action goals; (v) containment and treatment of contaminated water; (vi) permanent abandonment of water-supply wells; (vii) backfilling and grading of removal areas; and (viii) closure of the site sewer system. Cell Building Area removal action decommissioning activities began immediately following the chlor-alkali plant closure in February 1994. Other Upland removal activities commenced in July 1994 and were completed in June 1997. The depth of excavation at the upland portion of the site ranges from less than 1 ft (0.3 meters [m]) to approximately 13 ft (4 m). Figure 7 shows the extent of the Uplands removal, including the eight areas proximal to the LCP Chemicals marsh.

2.4 Enforcement Activities

In February 1994, after numerous investigations by the GAEPD and the EPA, GAEPD requested that the EPA initiate removal enforcement actions at the Site. According to the Action Memorandum signed in May 1994, the Site was a high priority for removal action. A UAO was issued in 1994 and then amended in 1995, to add PRPs. Three PRPs; Allied, Georgia Power, and ARCO, subsequently entered into an AOC, which included a Preauthorization of CERCLA Section 111(a) Claim, to conduct additional removal activities in August 1997. The removal was completed in July 1999. The RI/FS has been performed pursuant to an AOC, between ARCO, Allied, Georgia Power and the EPA. The PRPs agreed to perform the RI/FS concurrently with the removal work. In May 2007, Honeywell, identified earlier as the successor to Allied, signed an AOC, agreeing to perform a time-critical removal of a caustic brine pool located in the vicinity of the former mercury cell buildings.

3.0 Community Participation

Based on the Site's current Environmental Justice Strategic Enforcement Assessment Tool (EJSEAT) ranking, which is calculated by evaluating indicators related to health, the environment, environmental compliance and social demographics, the residents in the census tract where the Site is located were identified as among the top 30 percent of the State's most vulnerable citizens. Some of these residents may be fisherman considered high quantity consumers who eat approximately 73 meals of fish per year.

The EPA is continuing its efforts to promote community awareness and involvement with the Site. It has developed an electronic reading room for the Site that contains the documents which will support remedy selection and related information. The Site's remedial project managers have met with and made presentations before the members of the Glynn Environmental Coalition and participated in radio interviews about the Site. The Region also publishes the Brunswick Environmental Cleanup Newsletter to update the public on the cleanup progress at the LCP Chemicals Site and the three other Superfund sites in the Brunswick area.

On December 4, 2014, the EPA hosted a Proposed Plan meeting, during which the EPA presented a description of the proposed remedy and schedule for remedy implementation. Additionally, on February 26, 2015, EPA, in collaboration with GAEPD, the Agency for Toxic Substance and Disease Registry (ATSDR) and the Georgia Department of Health hosted an Availability Session to answer questions regarding the remedy and questions regarding the health effects of PCBs.

Site documents are available to the public in the Administrative Record (AR) repositories located at the EPA Region 4 Superfund Records Center (61 Forsyth Street, Atlanta, GA 30303) and these documents are also posted on the EPA Region 4 webpage (http://epa.gov/region4/foiapgs/readingroom/lcp_chemicals_site/). The EPA Region 4's local repository is located at the Brunswick-Glynn County Library, 208 Gloucester Street, Brunswick, GA 31520.

4.0 Scope and Role of the Operable Unit

As indicated above, the EPA and GAEPD have organized the work for the LCP Chemicals Site into three OUs: OU1 addresses the marsh; OU2 addresses the Site's groundwater, as well as the surface and subsurface soil associated with the mercury Cell Building Area; and OU3 pertains to the remainder of the LCP Chemical Site's Uplands. This is the first remedial action selected for any of the OUs.

The status of the two remaining operable units is as follows:

- The feasibility study for OU3 (the Uplands) is underway. The ROD for OU3 (the Uplands) is expected to be finalized during 2016; and
- Groundwork has begun for OU2, the Site's groundwater including the mercury Cell Building Area.

5.0 Site Characteristics

5.1 Physical Characteristics

The approximately 760 acre LCP Chemicals marsh is bordered to the west by Turtle River, to the north by Gibson Creek (a tributary to Turtle River) and the Brunswick Cellulose plant to the south. The principal feature of the LCP Chemicals marsh is Purvis Creek, which divides the marshlands roughly in half - north to south. Purvis Creek traverses most of the LCP Chemicals marsh, entering at the southwest corner of the marsh near the Salt Dock and ending at the northeast upland-marsh border. At high tide, Purvis Creek has a maximum depth of approximately 11 ft and a maximum width of 500 ft. Purvis Creek and its associated smaller channels are tidally influenced and are considered salt water. Tidal variation in the LCP Chemicals marsh occurs twice daily and can range in excess of 9 ft during a tidal cycle. Numerous smaller tidal channels exist in the LCP Chemicals marsh. Many of these channels were named during the development of the baseline ecological risk assessment (BERA), including the manmade LCP Ditch, the Eastern Creek, the Western Creek Complex (WCC), the Landfill Creek and the Dillon Duck (Figure 2). The LCP Ditch runs adjacent to the manmade causeway extending from the LCP Chemicals Uplands (OU3) to Purvis Creek. The Eastern Creek feeds into the LCP Ditch at approximately its midpoint and drains the eastern half of the LCP Chemicals marsh south of the causeway road.

Approximately 750 ft downstream from where the LCP Ditch enters Purvis Creek is the mouth of the WCC. The WCC is comprised of three principal channels and drains the western half of the LCP Chemicals marsh below the causeway. The Landfill Creek borders the old Glynn County landfill at the northern portion of the LCP Chemicals marsh, and is proximate to Dillon Duck. The physical breakup of the LCP Chemicals marsh by these physical features led to the development of “domains”, or areas of similar physical setting and contaminant characteristics in the BERA, as shown on Figure 2.

Domain 1 is 21 acres in size and bounded by the Uplands to the east, the LCP Ditch to the north and Eastern Creek to the west. Because this domain is located closest to LCP Chemical’s discharge/disposal areas, a removal of contaminated sediments took place in the eastern portion of Domain 1 in 1998-1999. Domain 2 is 115 acres in size and is bounded on the east by Domain 1, the south by Uplands and the west and north by Purvis Creek and the LCP Ditch. It contains the WCC. Domain 3 is 108 acres in size and is bounded to the south by the LCP Ditch, the east by the Uplands, and the west and north by Purvis Creek. Domain 4 is 417 acres in size and is the area west of Purvis Creek up to the Turtle River. Domain 4 is divided into an eastern and western portion by the surface water flow divide between creek and the river.

The Upland area east of the marshland is characterized by gently sloping terrain from approximately 5 ft above mean sea level (amsl) along the marsh/upland border to an elevation of approximately 15 ft amsl along Ross Road. This area of the Site is roughly divided in half by the east-west entrance road (B Street). Operations related to the chlor-alkali process were primarily located in the areas south of the entrance road and the area of the boiler house north of B Street, along with smaller isolated waste disposal areas

dispersed over the northern half of the Site. The location of the former chlor-alkali mercury cell buildings is currently covered with soil and fenced. Refinery operations were present over the western portion of the upland areas. The Dixie Paint operations were located on the south side of B Street. The southern border of the Site is defined by another rail spur that goes almost to the Turtle River before heading south onto the Brunswick Cellulose property. Figure 3 shows the features discussed above.

5.1.1 Surface Water Hydrology

The Turtle River and its associated tidal creeks and tributaries are not rivers and creeks in the traditional sense; rather, they are tidally influenced systems. The hydrodynamics within the Turtle River and its tributaries is governed by semi-diurnal tidal forces. Three tidal zones (termed "prisms") occur in these types of estuarine river systems, as well as within smaller tidal channels:

1. Headwater Zone (upper reaches) – water rises from the channel onto the marsh flats on the flood tide, and spills back into the channel on the ebb.
2. Middle Zone – water oscillates (with little mixing) back and forth with tides.
3. Lower Zone (mouth) – water leaves the river channel on each ebb tide and is replaced with "new" water on the subsequent flood tide (this phenomenon is termed "excursion").

During the flood tide, water feeds in from St. Simons Sound and into the Turtle River and into smaller tidal channel reaches. As the water level rises, it spills over the channel banks and across the broad vegetated marsh flats. This water spreads to the point of the "tidal node" where it meets flood tide waters from an adjacent channel. Waters then recede from the tidal node back into the channels during the ebb tide cycle. Ebb tides have slightly higher water velocity than the flood tide whereas the flood tide duration is slightly longer compared to ebb.

5.1.2 Marsh Sediment Classification

The marsh areas are underlain by soils of the Bohicket-Capers Association (Bohicket). The Bohicket soils consist of very poorly drained soils in a regular and repeating pattern. The landscape consists of level tidal marshes that border the Atlantic Ocean and extend a few miles inland along creeks and rivers. These soils formed in silty and clayey marine sediment. Bohicket soils make up 80 percent of the unit. Typically, the surface layer is dark gray silty clay loam about eight inches thick. The substratum is dark greenish-gray silty clay and clay to a depth of 65 inches or more. There are many fibrous grass roots throughout Bohicket soils have very low permeability. The sulfur content is two-to-three percent and a strong hydrogen sulfide odor is noticeable when the soil is disturbed. Bohicket soils are flooded by seawater twice each day.

The Bohicket soils in the LCP Chemicals marsh may not be as generally characterized. The sulfide content ranged from 2.8-to-3,300 mg/kg, with a mean of 297 mg/kg.

5.1.3 Physical Properties of Marsh and Channel Sediments

The sediment hydrogen ion concentration (pH) is neutral to slightly alkaline and ranges from 7.2 to 8.0 standard units (su). Total organic carbon (TOC) levels were high and ranged from 1,900 to 130,000 mg/kg on a dry weight basis (0.19- to-13 percent), with most samples in the 3 percent to 6 percent range. This reflects a typical wetlands environment with relatively slow decomposition of organic matter under submerged and partially anaerobic conditions, which leads to an accumulation of organic carbon in surface sediment. Iron oxide levels range from non-detect to 8,400 mg/kg (0.84 percent), with most samples being in the 0.3-to-0.4 percent range.

The channel sediments consisted mostly of clayey silt with very high moisture contents. The texture classification of these samples ranged from sandy clay loam to sandy clay-to-clay according to the United States Department of Agriculture soil texture triangle.

Mineralogical analysis was performed to identify major reactive soil components that may be controlling mercury and lead solubility. The mineralogical analysis identified quartz, pyrite, halite, clay (i.e., unspecified clay minerals), non-crystalline inorganics, and organics. The predominant minerals, by weight, were non-crystalline inorganics, which includes amorphous iron oxides and other precipitates, and quartz. A significant percentage by weight (generally 10-20 percent) of the sediment makeup was identified as organic matter.

5.1.4 Generalized Marsh Site Model

A cross-sectional view of the LCP Chemicals marsh, including the transition from the Uplands is provided in Figure 8. The dominant features of the cross section, from the surface down include a dense root mat, a low permeability marsh clay ($1.3x10^{-7}$ to $1.8x10^{-8}$ centimeters per second [cm/s]), the Satilla Sand aquifer, and at the base the partially cemented sandstone layer. The dense root mat zone exhibits high organic carbon content (5,300 to 80,000 mg/kg) and supports an active layer of *Spartina* grass. Below the root mat zone, the marsh clay extends several feet in depth (on average about 7-8 ft). Below the marsh clay is the Satilla Sand aquifer, which is composed primarily of fine-to-medium grained sand. Beneath the Satilla Sand is the semi-confining, variably cemented sandstone, estimated to be between 4 and 24 ft thick at the Site.

5.1.5 Marsh Stratigraphy

Figure 9 shows the clay thickness measured at these numerous locations throughout the marsh. At all but one near-shore location, the marsh clay thickness generally ranged from 5 to 10.5 ft; there was one location where the marsh clay was reported to be 20 ft thick. The one location that had less than 5 ft of clay was located at the marsh shore and had a thickness of 2.5 ft.

Figure 10 shows a number of stratigraphic cross-sections across the LCP Chemicals marsh, along the near-shore area. The stratigraphy is characterized by a downward sequence of mixed rootmat with sediment, a “muck” or very soft clay layer, a layer of

firm clay transitioning to sandy clay/clayey sand and then to the Satilla Sand aquifer (the surficial aquifer of the Site).

In undisturbed areas, the average TOC levels were generally above 2.5 percent, except at a few isolated locations; lower levels of 1- to- 2.5 percent and < 1 percent TOC occurred where the removal in Domain 1was conducted during the late 1990s. This is attributed to the borrow material used to backfill the marsh after remediation. A consistent distribution of average percent fine particulates also was observed; most locations in undisturbed areas had >75 percent fines, and all had >50 percent fines, consistent with mud flat channels. Less than 25-50 percent fines occurred in the removal areas of Domain 1, which also was attributed to the borrow material used to backfill the marsh.

5.2 Contaminant Transfer Conceptual Site Models

The Human Health Risk Assessment (HHRA) focused on potential human exposure to chemicals of potential concern (COPCs) detected in sediment and biota collected at, and adjacent to, the LCP Chemicals marsh (Environmental Planning Specialists, 2011). Exposure points are places or "points" where exposure could potentially occur. Exposure routes include the basic pathways through which COPCs may potentially be taken up by the receptor. The HHRA evaluated exposure to COPCs through consumption of fish, shellfish and clapper rail (an infrequently consumed game bird). Direct contact with contaminated sediment and surface water was also evaluated though the trespasser scenario. Figure 11 shows a diagram of the simplified conceptual site model (CSM) for the marsh trespasser and fish and clapper rail consumers.

An early ecological assessment conducted at the Site by the EPA Emergency Response Team (ERT, 1997) concluded that there were risks to ecological receptors inhabiting the LCP Chemicals marsh. An ecological CSM (Figure 12) provided a basis for evaluating contaminant migration pathways to ecological receptors. Elevated concentrations of mercury and Aroclor 1268 were detected in fish tissue samples from Turtle River, Gibson Creek, and Purvis Creek by the Georgia Department of Natural Resources (GADNR). During the mid-1990s, an ERT field study found mercury and Aroclor 1268 contamination in most abiotic and biotic samples. Mercury and Aroclor 1268 were found in fiddler crabs, blue crabs, killifish, marsh periwinkles, marsh grass, diamondback terrapins, clapper rail, brown shrimp, grasshoppers, spot, and rats. The highest concentration of mercury (330 mg/kg) was found in a terrapin liver sample. The highest concentration of Aroclor 1268 (3,500 mg/kg) was also found in a terrapin liver sample. Elevated levels of persistent organic pollutants, including Aroclor 1268, have been detected in bottlenose dolphins in the Turtle River/Brunswick Estuary (TRBE) (Pulster and Maruya, 2008).

Early indications from sediment toxicity testing by ERT (Winger *et al.* 1993) were that the contaminants at the Site were not acutely toxic to benthic invertebrates in 10-day tests conducted with brown shrimp, amphipods, and Japanese medaka embryos. However, hydrophobic organic compounds like Aroclor 1268 require time to accumulate in test organisms before they reach toxic levels. Subsequently, numerous chronic toxicity tests

were conducted to evaluate longer exposure periods (e.g., 28 days for amphipods and 2 months for grass shrimp).

The initial ecological assessment focused on the prevalent and bioavailable chemicals among other COCs identified at the Site. The most prevalent and bioavailable chemicals (mercury, Aroclor 1268, lead, and PAHs) were extensively monitored in abiotic media and biota. A Baseline Ecological Risk Assessment (BERA), conducted over a seven year period, utilized food-web models for various receptors to assess exposures (Black and Veatch, 2011). Multiple rounds of sediment toxicity testing on amphipods and grass shrimp have identified other chemical factors (e.g., organic carbon and sulfides) that affect bioavailability of these chemicals in sediment.

Two additional important contaminant pathways were also evaluated in detail. The first is that both mercury and Aroclor 1268 readily bioaccumulate and biomagnify via trophic transfer through the food web. This results in greater concentrations of these chemicals in the higher trophic levels (e.g., otters, herons and humans) than in invertebrates or marsh grasses. Second, methylation of mercury occurs in the marsh sediment and biota that results in the formation of methylmercury which is more toxic than inorganic mercury.

5.3 Nature and Extent of Contamination

The BERA evaluated data records (sediment biota and toxicity) generated in the course of the post-removal action Site characterization and monitoring events. The HHRA evaluated the post-removal sediment data collected between the years 2000 and 2007, excluding the creek sediment records, since the creeks were judged to be too soft to support the weight of an individual. Only fish tissue samples collected between the years 2002 to 2006, from the Purvis and Gibson Creeks and the middle portion of the Turtle River, were evaluated in the HHRA (Figure 23). Both the HHRA and the BERA screened all of the analytical records and evaluated their contribution to the computed risks. These assessments lead to the identification of COCs which include the following:

- Mercury
- Aroclor-1268
- Lead
- Total PAHs

5.3.1 Mercury in Sediment

The highest mercury concentrations, typically in the range of 10-to-100 mg/kg, are found in Eastern Creek, most notably in the southern half of the channel where the previous dredging was limited (due to the more restricted channel width and depth, as well as the meandering nature of the channel) and further south beyond the limits of where the dredging occurred in the removal action. In contrast, the average sediment mercury concentration in the reference stations was 0.07 mg/kg.

Two reference locations were used during the various ecological studies. One (Troup Creek) was located about 4.3 miles from the LCP Chemicals marsh, on the eastern side of the Brunswick Peninsula, and the other west of Sapelo Island, over 25 miles from the Brunswick area. The purpose of these reference locations was to collect data from areas presumed to have been uncontaminated with the LCP Chemicals Site, for the sake of comparison. Figure 13 shows the locations of the reference locations.

As shown in Figure 14, elevated mercury concentrations also occur in the LCP Ditch, most notably in the region where Eastern Creek joins this feature, with concentrations typically in the range of 5-to-25 mg/kg. A third area with elevated mercury concentrations is in the western segment of the WCC, where mercury concentrations are generally highest in the headwater portion of this channel, ranging from 5-to-16 mg/kg. With the exception of the areas proximal to the Uplands in Domain 1 as delineated above, in the marsh flats and tidal channels beyond these regions, including Purvis Creek, sediment mercury levels are typically at concentrations of less than 2-5 mg/kg, and lower yet in the marsh west of the tidal node which divides Domain 4 into “a” and “b” portions (Figure 1).

Methylmercury (MeHg) was measured at over 150 sediment sampling locations throughout OU1. The methylmercury in sediment ranged from below detection limits to 0.05 mg/kg, with a mean concentration of 0.005 mg/kg. Only a small fraction of the mercury in sediment was present as methylmercury. Because methylmercury readily bioaccumulates, it is more prevalent and toxic in biota tissue and toxic than elemental mercury. Figure 15 shows the locations of the sediment samples analyzed for methylmercury and the results.

5.3.2 Aroclor 1268 in Sediment

Sediment concentrations of Aroclor 1268 (the predominant PCB mixture in the LCP marsh) exhibit a spatial pattern generally consistent with that of mercury, with the highest sediment concentrations observed in the LCP Ditch and Eastern Creek (Figure 16). The western limb of the Western Creek Complex contains isolated detections of Aroclor 1268, with three sampling locations in the range of between 10-to-25 mg/kg. The Aroclor 1268 concentrations are noticeably higher compared to mercury at these locations, with many more sample locations in the range of 25-to-100 mg/kg or higher. Aroclor 1268 concentrations also tend to be a bit higher compared with mercury in Purvis Creek, in particular in the central portion of Purvis Creek where Aroclor 1268 is in the range of 5-to-10 mg/kg. Similar to mercury, the Aroclor 1268 concentrations are lowest in the marsh west of Purvis Creek. Aroclor 1268 was not detected above 0.13 mg/kg in the reference stations.

5.3.3 Lead in Sediment

Sample locations with the more elevated concentrations of lead occur in the Dillon Duck feature, the upper headwaters of Domain 3 Creek (located in the northern portion of the Site), and the former Glynn County landfill (Figure 17). Concentrations are typically in excess of 100 mg/kg in these locations, whereas elsewhere the concentrations are

consistently in the range of 10 mg/kg to 50 mg/kg. Lead was not detected above 22 mg/kg in the reference stations.

5.3.4 Total PAHs in Sediment

The contaminant distribution for total PAHs is consistent with other COCs previously described (Figure 18), with the more elevated conditions present in the tidal channel areas. The majority of the marsh flats (i.e., vegetated top of marsh) in the LCP Chemicals marsh are low to non-detect for PAHs. The average sediment total PAH concentration in the reference stations was 0.145 mg/kg.

5.3.5 Observed Sediment Aroclor 1268 and Mercury Vertical Distributions

Figures 19a through 19i show the Aroclor 1268 and mercury results from vertical profile sampling in both the channels in the LCP Chemicals marsh and the marsh "flats." Note that vertical sampling in an environment such as the marsh is difficult and the data from the deeper samples collected is likely to represent worse case conditions, since some degree of cross-contamination is a certainty.

Of the 26 cores collected to a depth of one foot below the marsh surface or less, non-detect levels were approached within the upper one foot sample interval in 18 cores. The remaining shorter profiles could not be used to identify the bottom of contamination at these locations because the data did not extend beyond one foot, where declines in mercury and Aroclor 1268 concentrations were observed in the deeper cores.

Among the three cores collected at deeper depths, concentrations were low or approaching non-detect at 1.6 ft or deeper. The LCP Ditch core showed decreasing concentrations that were less than 20 mg/kg mercury and less than 2 mg/kg Aroclor 1268 at 1.6 ft depth. The two Domain 3 locations were characterized by low chemical concentrations at all depths (less than 6 mg/kg mercury and less than 2 mg/kg Aroclor 1268).

Note that, in contrast to the vertical profiles completed in the marsh channels (Figures 19a through 19e), those completed in the marsh "flats" (Figures 19f through19i) almost uniformly show a decline to low mercury and Aroclor 1268 concentrations in the upper six inches of the profile. This implies that in the marsh "flats' the COCs are present in a relatively thin layer at the surface.

5.3.6 Observed Sediment PAH and Lead Vertical Distributions

Figures 20a through 20f show the lead and PAH results from vertical profile sampling of the channels and marsh flats. Total PAHs were not collected at all locations, but Domains 1 through 3 were represented. All of the Domain 1 cores were collected from the removal area (pre-removal) and had lead concentrations above 40 mg/kg. In the other locations, eight of the ten cores analyzed for lead were characterized by sediment concentrations below 40 mg/kg at all depths, and eight of the ten cores analyzed for PAHs were characterized by sediment concentrations below 4 mg/kg, except for one core

in taken in Purvis Creek, where the concentration was 17.4 mg/kg at eight inches below that creek bottom.

The distribution of COCs clearly points to the Eastern Creek, LCP Ditch and portions of Domain 3 Creek near the Site Uplands as major contaminant sources. In addition the Eastern Creek and LCP Ditch are more directly influenced by tidal action that can mobilize contaminants into Purvis Creek and beyond, much more so than contaminants in vegetated wetland marsh areas with very low tidal energy.

5.3.7 Observed Sediment Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs)

PCDDs and PCDFs are persistent chemicals in the environment. They tend to be very insoluble in water, adsorb strongly onto soils, sediments, and airborne particulates, are persistent in the environment, and bioaccumulate in biological tissues. These substances have been associated with a wide variety of toxic effects in animals. The association of PCDDs/PCDFs with the LCP Chemicals Site is due to the use of graphite anodes in the former chlor-alkali plant.

There exist about 48 sediment PCDD/PCDF results from LCP Chemicals marsh and surrounding areas sediment/soil samples. The general conclusion is that there exists a strong correlation between Aroclor 1268 and PCDD/PCDF concentrations.

In the marsh, sediment dioxin toxic equivalence concentrations (TECs) declined from an average of about 6,768 nanograms per kilogram (ng/kg) [range 2,640 to 12,761 ng/kg] in the vicinity of the removed FFDA to 138 ng/kg at dioxin station 111, located over half way down the LCP Ditch, at the confluence of the Eastern Creek with the LCP Ditch, to a TEC of 6.9 ng/kg at dioxin sampling station 117, where the LCP Ditch enters Purvis Creek, (Table 1 and Figure 21). This represents a 1,000 fold reduction of TECs from the removed source area (the former facility disposal area) to Purvis Creek. The EPA (2014) dioxins/furans memorandum provides details on the available data for dioxins and furans in the LCP Chemicals Marsh.

With exception of dioxin station 100, the Purvis Creek sediment dioxin TECs remain at single digit parts per trillion downstream of where the LCP Ditch enters Purvis Creek, until the confluence of Purvis Creek with the Turtle River. All the 1996 Turtle River sediment TECs remained in the single digit part per trillion range (Table 1) and many of the dioxin concentrations in Purvis Creek were similar to the Troup Creek and Crescent River reference stations.

The PCDD/PCDF and Aroclor 1268 sediment data presented in Table 1 show a strong relationship between Aroclor 1268 concentration and PCDD/PCDF concentration (correlation coefficient = 0.91). Similar relationships were found at the Onondaga Lake and Ninemile Creek Superfund sites in upstate New York.

5.4 Surface Water

The highest concentration of total mercury in the surface water of the major creeks in the LCP Chemicals marsh was 188 nanograms per liter (ng/L) in Eastern Creek (Table 2), which was less than the EPA's chronic ambient water quality criteria of 940 ng/L (saltwater) and 770 ng/L (freshwater). However, several surface water samples exceeded the Georgia in-stream water quality criteria for Coastal and Marine Estuary Waters of 25 ng/L for total mercury. Methylmercury concentrations in surface water in OU1 ranged from 0.15 to10 ng/L, which exceeded levels at reference locations (0.008 – 0.22 ng/L).

Aroclor 1268 was infrequently detected in creeks or at background reference locations and occasionally exceeded the Georgia in-stream water quality criteria for Coastal and Marine Estuary Waters of 0.03 and 0.000064 µg/L for total PCBs (including Aroclor 1268). Dissolved lead concentrations at the Site never exceeded water quality criteria. Figure 22 shows the locations of the surface water sampling stations.

Surface water concentrations of PCDD/PCDF collected in 2000 (approximately one year after the FFDA sediment removal) from the LCP Chemicals marsh were not very different from those found at the two reference stations (Troup Creek and Crescent River, Table 3).

5.5 Fish, Shellfish, Benthic Invertebrate and Other Biota Tissue

5.5.1 Mercury and Aroclor 1268

Body burdens of COCs in biota key to the functioning of the marsh system at the LCP Chemicals Site (i.e., cordgrass, Eastern oysters, grass shrimp, fiddler crabs, blue crabs, mummichogs, and various large finfish) were typically higher in the LCP Chemicals marsh, when compared to biota at reference locations. Table 4 shows the concentrations of mercury (assumed to be all methylmercury) and Aroclor 1268 in wholebody tissues collected from the LCP Chemicals marsh and from the Troup Creek reference area, as reported in the BERA. The significance of these concentrations in biota is described in the risk assessments and in the "Summary of Site Risks" section below.

The levels of methylmercury and PCBs (primarily Aroclor 1268) detected in fish fillets resulted in a fish consumption advisory for the TRBE issued by the GADNR from 1995 to the present.

5.5.2 PCDD/PCDF

A 1997 Turtle River ATSDR Health Consultation presented dioxin fish data from 1989 through 1994. The fish data presented in the report were acquired by Georgia-Pacific from two Turtle River stations, one immediately above the confluence of Purvis Creek with the Turtle River and the second near the confluence of the East River with the Turtle River. Fish tissue dioxin data for the Chattahoochee and Oconee Rivers, and the Sapelo Sound are also presented in the report for the sake of comparison. The Health Consultation concluded that fish PCDD/PCDF concentrations were higher in the Turtle

River than in reference areas; however, the dioxin levels found in fillet tissue were well below the Food and Drug Administration tolerance levels for dioxin in fish of 3 ng/kg. Table 5 presents the fillet and whole body PCDD/PCDF concentrations in fish collected at two stations upstream and downstream of the Brunswick Cellulose Mill, as well as at the Sapelo Sound reference station.

During the late 1990s a University of Michigan investigator analyzed organ and muscle tissue from clapper rail, mottled duck, boat-tailed grackle, red-winged blackbird, stripped mullet, yellow tail, sea trout, Atlantic croaker and blue crab caught in the marsh for PCDD/PCDF. All tissues were found to be uniformly below the detection limits of 10 ng/kg.

In 1998, the U.S. Fish and Wildlife Service collected killifish (Fundus heteroclitus) tissue from mid-way along the LCP Ditch. Along with other parameters, the whole body tissue was analyzed for dioxins/furans. Almost all PCDD/PCDF congeners were found to be below detection limits. Consequently, because the calculated TECs assume each congener is present at one-half the detection limit, the results are an overestimation of actual tissue levels. In addition, the concentrations of dioxin/furan in the whole fish tissue samples were taken from killifish collected from the LCP Ditch during the marsh removal which also represents worst case conditions.

6.0 Current and Potential Future Land and Water Uses

6.1 Land Uses

The LCP Chemicals Site is surrounded primarily by commercial and industrial property. As shown on Figure 3, it is bordered by a former Glynn County land disposal facility and a pistol firing range to the north, a tidal marsh and the Turtle River to the west, the Brunswick Cellulose plant to the south, and Ross Road on the east. The Glynn County Planning Commission Land Use Maps designates the area as industrial for both present and future use. The "useable" areas of the Site, the marshland from the east bank of Purvis Creek, and the Brunswick Cellulose property to the south are all zoned "Basic Industrial." The former Standard Industrial Classification (SIC) code for the property is 2812 (Chemicals and Allied Products, Alkalies and Chlorine), which falls within the GAEPD's regulatory definition of non-residential property (391-3-19-.02(2)(i)). Current and future off-site land use for commercial and industrial purposes is expected to remain unchanged.

6.2 Marsh and Creek Use

The LCP Chemicals marsh is zoned by Glynn County as a conservation preservation (CP) district. The intent of the CP designation is to preserve and/or control development areas of the County which: 1) serve as wildlife refuges, 2) possess natural beauty or are of historical significance, 3) are utilized for outdoor recreational purposes, 4) provide needed open spaces for the health and general welfare of the county inhabitants, or 5) are subject to period flooding.

Purvis Creek and associated streams within OU1 are considered Coastal and Marine Estuarine Waters and under the Georgia Water Use Classifications, Chapter 391-3-6-.03(14), and include the following use Classifications: Recreation, Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life and Coastal Fishing.

7.0 Summary of Site Risks

A baseline HHRA was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site assuming no remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The public health risk assessment followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and non-carcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment which support the need for remedial action is discussed below followed by a summary of the environmental risk assessment.

7.1 Human Health Risks

7.1.1 Identification of Contaminants of Concern

The contaminants of potential concern (COPCs) were selected to represent potential site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment.

The baseline HHRA identified a subset of the COPCs as presenting a significant current or future risk and are referred to as the COCs in this ROD. Table 6 presents the COCs and exposure point concentrations for each of the COCs detected in sediment, fish, shellfish and the clapper rail. The tables include the range of concentrations detected for each COC, as well as frequency of detection (i.e., the number of times the chemical was detected in the samples collected from the LCP Chemicals marsh), the exposure point concentration (EPC), and how the EPC was derived. The table indicated that mercury and Aroclor 1268 were most frequently detected COCs in the sediment and biota at the LCP Chemicals marsh. The 95 percent upper confidence limit (UCL) on the arithmetic mean was used as the EPC for mercury and Aroclor 1268. The HHRA quantitatively evaluated both cancer and non-cancer health hazards associated with potential current and/or future exposures to COCs present in sediment, fish, shellfish and clapper rail from the LCP Chemicals marsh, in the absence of any action to control or mitigate the chemicals. The HHRA was prepared to evaluate potential risks associated with exposure to elevated concentrations of mercury and Aroclor1268 in sediment; Aroclor-1268 and mercury in fish; Aroclor 1268 and mercury in shellfish; and Aroclor-1268 and mercury in the clapper rail.

7.1.2 Exposure Assessment

The receptors evaluated in the LCP Chemicals marsh baseline HHRA include the marsh trespasser, recreational fish consumer, high quantity fish consumer, shellfish consumer and the clapper rail consumer. Figure 11 is an illustration of the CSM used to determine reasonable exposure scenarios and pathways of concern. Note that the figure identifies the dermal contact with surface water as having been considered qualitatively. The marsh trespasser scenario assumed that a hypothetical individual visits the marsh on a regular basis and comes into contact with contaminated sediment and surface water over time beginning in adolescence and continuing into adulthood. The recreational fish consumer scenario evaluated exposure to recreational anglers who consistently consume fish and shellfish from the LCP Chemicals marsh over a long period of time (30 years for adults). This scenario uses data on the amount of recreationally-caught fish consumed by children, adolescents, and adults in the southeastern United States and assumes that all of that consumption would be from fish caught within Zones D, H, and I of the St. Simons Estuary (Figure 23).

The high quantity fish consumer scenario evaluated exposures to individuals who, based on the area-specific creel survey, consume more locally-caught fish than the typical recreational angler. The shellfish consumer scenario was used to evaluate potential exposure to COC in shellfish (e.g., white shrimp and blue crab) caught in areas of the marsh proximate to the LCP Chemicals Site. The clapper rail consumer scenario is used to evaluate potential exposure to COC in clapper rail caught in areas of the marsh proximate to the LCP Chemicals Site. According to United States Fish and Wildlife representatives, although the clapper rail is hunted, people do not commonly consume clapper rail. There are no data specific to clapper rail ingestion rates; therefore data for total wild game ingestion for children, adolescents, and adults was used, along with the conservative assumption that clapper rail obtained from the LCP Chemicals marsh comprised 10 percent of the total wild game ingestion. A summary of the results of the risk estimates is provided below in the “Risk Characterization” section.
Fish consumption rates used in the baseline HHRA were based on the following:

- The adult high quantity consumer scenario was assumed to consume, on average, 27 grams of finfish per day. Assuming a fish meal size of 0.3 pounds (135 grams), this translates to 73 meals/year, or approximately six meals per month (from Zones D, H and I), based on self-identified high-quantity consumers in an area-specific creel survey. Assuming a larger fish meal (0.5 pounds) fish meal size, this translates to about 43 meals per year, or a little less than four meals per month;
- The recreational adult consumer was assumed to consume, on average, about 16 grams of finfish per day. Assuming a fish meal size of 0.3 pounds, this translates to about 38 fish meals per year, or about three and a half meals of finfish per month. Assuming a larger fish meal size (0.5 pounds), this translates to about 26 meals per year, or about two meals per month. For shellfish consumption, the adult recreational fisher was assumed to catch and eat about 12 grams per day, on average. This translates to about one and a half meals per month for a 0.5 pound

meal or about two and a half meals of shellfish per month for a 0.3 pound meal size. These finfish and shellfish consumption quantities are based on upper-end of EPA defaults for recreational fishing in Southeast United States. The HHRA assumes that these consumption amounts are for fish caught in the same area; and

- The area-specific creel survey was the basis for the high quantity fish consumption rates used in the baseline HHRA, conducted by the federal ATSDR (U.S. Department of Human Health Services) and the Glynn County Health Department, which surveyed 211 Turtle River anglers. The creel survey covered racial/ethnic groups representative of area population. The NOAA fisheries information was used to assign site-specific weighting factors to the various species of fish caught and eaten. Based on the survey, Table 7 shows the average percentage of the various species of fish caught by coastal Georgia anglers between 2001 and 2005.

Fish filet tissue data used in the HHRA from the GADNR Zones D, H and I. Zone D is considered to be the middle of the Turtle River. Zones H and I are Purvis Creek and Gibson Creek, respectively. Figure 23 shows the GADNR Fish Consumption Guidelines Zones. The most recent fish fillet data (2011) shows that fish caught in Zone H (Purvis Creek) had the highest mercury and Aroclor 1268 concentrations in 56 percent of the species sampled. Hence, the HHRA estimated the risks posed by consuming fish from the most contaminated zones in the St. Simon estuary.

Because risk assessments are designed to be conservative so that risk management strategies can be protective of human health, as well as consistent with EPA policy and guidance, two types of exposure scenarios were analyzed in the HHRA to assess the range of potential risk: the reasonable maximum exposure (RME), which estimates the highest level of human exposure that could be reasonably expected to occur, and the central tendency (CT, or "typical") scenario. Cancer and non-cancer health hazards were assessed under both these scenarios.

Major assumptions about exposure frequency, duration, and other exposure factors that were included in the exposure assessment (e.g., exposure frequency (days per year), exposure duration (years), and body surface area (cm^2) for dermal exposure) were included in the HHRA.

7.1.3 Toxicity Assessment

Risk estimates for all COCs were based on the toxicity values, using cancer slope factors (CSFs) to assess potential carcinogenic effects and reference doses (RfDs) to assess potential non-cancer effects. The measures were primarily derived and published by EPA. The two contaminants responsible for the majority of the estimated site risks are mercury and Aroclor 1268.

Whenever possible, route-specific toxicity values were used. However, toxicity values for sediment dermal exposures have not yet been developed by the EPA; therefore, the oral toxicity values were used to derive adjusted toxicity values for use in assessing

dermal exposure. The hierarchy of sources to toxicity values recommended by the EPA was used to obtain toxic criterion, with the exception of Aroclor 1268.

For all exposure scenarios considered in the HHRA (sediment exposure, fish/shellfish consumption or clapper rail consumption), all mercury was assumed to be present as methylmercury. Methylmercury is a toxic metal compound with which a number of adverse human health effects have been associated in both humans and animals. Large amounts of data exist on neurotoxicity, particularly in developing organisms.

The Integrated Risk Information System (IRIS) contains values for the CFS for PCB mixtures and RfDs for Aroclor 1016 and Aroclor 1254 only. The RfD for Aroclor 1016 on the IRIS database was used as surrogate toxicity for Aroclor 1268, as detailed in the HHRA, because it is more similar on a toxicological basis to Aroclor 1016 than to Aroclor 1254.

PCBs are classified as probable human carcinogens, as a result of dose-response bioassays of Aroclor mixture performed in rodents. Studies on rhesus monkeys exposed to PCBs indicate a reduced ability to fight infections and resulted in reduced birth weight in offspring exposed in utero. Two slope factors were derived, one for high risk and persistent mixtures and the other for low risk and low persistence mixtures. To be conservative, the slope factor for high risk and persistence was used for dermal contact with Aroclor 1268, as well as that consumed in fish.

A summary of the toxicity criteria used and their sources for both cancer and non-cancer health effects are presented in Tables 8 and 9, respectively.

7.1.4 Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

where: risk = a unitless probability (e.g., 2E-05) of an individual's developing cancer.
CDI (cancer) = chronic daily intake averaged over 70 years (mg/kg-day).
SF = slope factor, expressed as (mg/kg-day)-1.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1E-06). An excess lifetime cancer risk of 1E-06 indicates that an individual experiencing the RME estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three. The EPA's generally acceptable risk range for site-related exposures is 1E-06 to 1E-04.

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life-time) with a RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic non-carcinogenic effects from all contaminants are unlikely. An HI > 1 indicates that site-related exposures may present a risk to human health. The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where: CDI = Chronic daily intake.
RfD = reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Hazards and Risks from Exposure to Sediment

For the current and future trespasser wandering in the LCP Chemicals marsh, the RME maximum non-cancer HI presented in the HHRA was 0.08, indicating no hazard (Table 10). The cancer risk from exposure to sediment was 1.0E-05, which is within EPA's acceptable risk range (Table 11).

Non-Cancer Hazards from Consumption of Fish and Shellfish

Non-cancer hazards from consumption of fish collected from zones D, H and I are summarized in Table 12 for the RME scenarios. For recreationally-caught finfish, the estimated HIs for the adult, adolescent and child are 3, 3, and 4, respectively. These HIs are greater than one and indicate that for the recreational fish consumer, the potential for adverse non-cancer effects could occur from exposure to contaminated recreationally-caught finfish containing mercury and Aroclor 1268.

For the high quantity fish consumer RME scenarios, the HIs were estimated to be 5, 4, and 8 for the adult, adolescent and child, respectively. These HIs also indicate that adverse non-cancer effects are expected to occur.

The estimated RME hazards from consumption of shellfish (blue crab and white shrimp) are summarized in Table 13. The HIs range from 0.7 for the adolescent to 4 for the child, suggesting the potential for adverse health hazards to adults and children from exposure to mercury and Aroclor 1268 in shellfish. In general, hazards from mercury in blue crab

are higher than from white shrimp; and conversely, hazards from Aroclor 1268 slightly higher from consumption of white shrimp than from blue crab.

Non-Cancer Hazards from Consumption of Clapper Rail
The estimated hazards from RME consumption of clapper rail are shown in Table 14. The HIs are greater than one and suggest that potential adverse effects could occur. Most of the hazards are related to Aroclor 1268 in clapper rail breast tissue.

Cancer Risks from Consumption of Fish and Shellfish
Table 15 provides lifetime cancer risk estimates for consumers of recreationally-caught and high-quantity consumption of finfish. These risk estimates are based on RME exposures and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of Aroclor 1268. The current lifetime cancer risk to the adult recreational finfish consumer at this Site is estimated to be 1.1E-04. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 1 in 10,000 of developing cancer as a result of site-related exposure to the COCs. For the high-quantity fish consumer RME scenario the lifetime cancer risk is higher at 2E-04.

For consumption of shellfish (blue crab and white shrimp) the RME lifetime cancer risk was estimated to be 5.8E-05 (Table 16). This risk level indicates that an individual would have an increased probability of about 6 in 100,000 of developing cancer as a result of site-related exposure to the COCs in shellfish.

Cancer Risks from Consumption of Clapper Rail
As summarized in Table 17, RME lifetime cancer risk from eating clapper rail harvested from Domain 1 is estimated to be 1.1E-04 or a probability of about 1 in 10,000.

Risk Summary
A summary of the hazards and risks is presented in Table 18. The HHRA describes the cancer risks and non-cancer health hazards associated with ingestion of fish contaminated with mercury and Aroclor 1268 from the LCP Chemicals marsh. Fish and shellfish ingestion is the primary pathway for exposure to COCs and for potential adverse health effects. Cancer risks and non-cancer health hazards calculated for consumption of LCP Chemicals marsh fish, shellfish and clapper rail exceeded the target risk level range, as follows:

- ***Non-cancer health hazards*:** The calculated RME non-cancer HIs ranged from 0.7 for consumption of shellfish to 8 for the child high quantity fish consumer. Adult recreational anglers would have a HI of 3 and the adult high-quantity fish consumer would have a HI of 5, both of which exceed EPA's acceptable level. Calculated central tendency exposure (CTE) hazards exceeding the acceptable level are for child consumption of fish and shellfish and the high quantity fish consumer. The calculated RME non-cancer HIs ranged from 1 for the adolescent

to 5 for the child. All of the CTE cancer risks were within acceptable levels for the clapper rail.

- ***Cancer risks***: Cancer risks are only associated with Aroclor-1268. The HHBRA calculated a RME excess cancer risks (ECR) of 2E-04 for the high quantity fish consumer and 1E-04 for the clapper rail consumer. An ECR of 6E-05 for consumption of shellfish is within EPA's acceptable range. All of the CTE cancer risks were within acceptable levels.

There were no unacceptable health hazards or risks associated with lead or PAHs. The only two contaminants that contribute to unacceptable human health risks are mercury and Aroclor 1268.

The Baseline HHRA also estimated fish and shellfish tissue concentrations that would be protective to humans at EPA's acceptable HI of 1.0 and cancer risk range of 1E-06 to 1E-04. For example, Table 19 compares the current average edible tissue concentrations from the Baseline HHRA with the calculated protective tissue goals for the adult RME high quantity fish/shellfish/clapper rail consumer at a HI of 1 and cancer risks at 1E-04. These numbers from the Baseline HHRA and those calculated as part of the State of Georgia fish consumption advisory for the TRBE can be used for future monitoring of fish tissue levels to determine if protective levels are achieved.

7.1.5 Uncertainties Related to the Baseline HHRA

Uncertainties are inherent in the quantitative risk assessment process due to environmental sampling design, assumptions regarding exposure, and the quantitative representation of chemical toxicity. To satisfy the EPA goal of ensuring that health risks are not underestimated, conservative assumptions were built into the HHRA so that resultant risk estimates are more likely to overestimate risks than to underestimate them. Examples of uncertainty in the OU1 Baseline HHRA where conservative assumptions were made relate to the exposure assumptions used to characterize the RME receptor scenarios, the COC concentrations in biota tissue used to estimate receptor intake, and the toxicity values used to characterize the potential cancer risks associated with Aroclor 1268. These assumptions are as follows:

- An individual trespasser would walk through the Site marsh once a week for 30 years (a total of 1,560 separate events), each time incidentally ingesting contaminated sediment;
- 100 percent of the fish and shellfish eaten by any individual would come from the areas in the immediate vicinity of the Site.
- A hunter would eat clapper rail obtained from the Site such that this source of clapper rail comprises 10 percent of the total wild game eaten.
- The potential carcinogenicity of Aroclor 1268 was evaluated using the upper-bound cancer slope factor for high risk/persistence PCBs. At least one review of

the available carcinogenicity data suggests the tumorigenic potency of Aroclor 1268 may be somewhat lower.

7.1.6 Qualitative Estimation of Risks Posed by PCDD/PCDF to Human Health

The HHRA for the marsh assumed six days per year reasonable maximum exposure intake frequency for direct human contact to the sediment. Using this site-specific exposure frequency, the dioxin-TEC protective for the human child is calculated as follows:

$$50 \text{ ng/kg} \times \frac{350 \text{ d/y}}{6 \text{ d/y}} = 2{,}900 \text{ ng/kg (for dioxin TEC in sediment)}$$

Based on the dioxin TECs presented in Table 1, all areas above this concentration of 2,900 ng/kg will be removed, thereby suggesting no risk to children from direct contact to sediment.

For fish consumption, using the EPA Fish Advisory Guidance (with an ingestion rate higher than OU1 HHRA ingestion rate for all receptors), the calculated screening level is 3 ng/kg (for dioxin TEC in fish fillets). The fish filet data associated with the 1997 Turtle River Health Consultation Report led ATSDR to the conclusion that the TEC levels were not of significant concern.

These sediment and fish fillet values are both based on a non-carcinogenic hazard quotient of one (HQ = 1) for the sensitive young child receptor, using the EPA IRIS RfD. They are also within the carcinogenic risk range of 1E-06 to 1E-04. Finally, University of Michigan investigators analyzed organ and muscle tissue from clapper rail, mottled duck, boat-tailed grackle, red-winged blackbird, stripped mullet, yellow tail, sea trout, Atlantic croaker and blue crab for tetrachlorodibenzodioxin (TCDD) / tetrachloro-dibenzofuran (TCDF). All were found to be uniformly below the detection limits of 10 ng/kg.

7.2 Ecological Risks

7.2.1 Ecological Communities in the LCP Chemicals Marsh

The tidal estuary of the Site is comprised of approximately 13 percent tidal creeks and 87 percent marsh composed of indigenous marsh grasses, predominantly smooth cordgrass (*Spartina alterniflora*).

OU1 generally consists of a community of *S. alterniflora* and occasional patches of black needle rush (*Juncus roemerianus*). Cordgrass is prevalent in the low marsh with plant diversity increasing towards the upland area such as in the Dillon Duck area.

The benthic salt marsh invertebrate community at the Site includes those organisms that live in the sediment of the marsh (benthic infauna) and on top of the sediment (epibenthic fauna). It also includes those organisms that live on the plants of the marsh (epiphytic fauna). Tidal influences and inundation are key factors that govern community structure

and function in the marsh system. Site-specific surveys and studies have described the important components of the invertebrate community as follows:

- Fiddler crabs (*Uca* spp.) are ubiquitous in salt marshes and appear to have a mutually beneficial interaction with marsh vegetation. Crab burrows increase plant production by moderating soil conditions and, in turn, marsh plants facilitate crab burrows by stabilizing the substrate.
- Grass shrimp (*Palaemonetes pugio*) are a major source of food for crabs and fish and facilitate nutrient cycling.
- Other invertebrates including infaunal, epifaunal, and epiphytic organisms are present at the Site. The benthic community is composed of barnacles, mysids, penaeid shrimp, ribbed mussels, marsh periwinkle, mud snails, eastern oysters, blue crabs, oligochaetes, polychaetes, and amphipods.

Fish inhabit the LCP Chemicals creek and marsh system, generally entering into the marsh area with incoming tides. Fish indigenous to the marsh include the mummichog, red drum, black drum, silver perch, spotted seatrout, striped mullet, Atlantic croaker, southern kingfish, spot, and sheepshead. Smaller fish, like mummichog, do not migrate and are a key component of the food web. Many other fish species migrate from the Site to nearby areas.

Finfish and shellfish predominantly reside in the creeks and make use of the marsh areas only during high tide conditions when the marsh is inundated. The use of different areas of the marsh by other aquatic organisms (e.g., mummichogs, shellfish, grass shrimp) depends on the proportion of time that each area is inundated. The location and duration of inundation depends on bank elevation. During low tide, vegetated marsh areas and creeks are predominantly exposed and water is present only in small portions of the creeks. Exposed marsh areas are used by organisms such as fiddler crabs, which emerge from their burrows to forage on organic carbon and algae.

Based on current understanding of tidal fluctuations, flooding in the marsh may only be fully inundated 5-to-20 percent of the time, which equates to approximately one-to-four hours a day, depending on the elevation at any particular point. Thus, tidal fluctuations are a critical factor in understanding the types of ecological exposures that occur for wildlife in the marsh as fish and other aquatic organisms move in and out of the marsh with tides.

There are many birds indigenous to the marsh and include grebes, herons, bitterns, ibises, geese, marsh ducks, vultures, hawks, ospreys, rails (including the clapper rail), stilts, plovers, sandpipers, gulls, pelicans, and songbirds. The wood stork (*Mycteria americana*), an endangered species, has been observed foraging in tidal creeks of the salt marsh and breeding at several colonies in the vicinity of Brunswick.

Mammals use the marsh and surrounding habitats for food and shelter even though there are major variable conditions in salt marshes that are related to tidal inundation and

salinity. Resident mammal species likely include shrews, bats, raccoon, river otter, and marsh rabbit. The West Indian manatee (*Trichechus manatus*) and the Atlantic bottlenosed dolphin (*Tursiops truncatus*), both of which are protected under the Marine Mammal Protection Act, have been observed in Purvis Creek.

The most common reptile in Atlantic coast salt marshes is the diamondback terrapin (*Malaclemys terrapin*). In addition, several species of threatened or endangered Atlantic sea turtles, the green turtle (*Chelonia mydas*), Kemp's ridley turtle (*Lepidochelys kempi*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), and leatherback turtle (*Dermochelys coriacea*), may visit the Site.

7.2.2 Problem Formulation

Problem formulation identifies the major factor to be considered in a BERA, including COPC characteristics, ecosystems and/or species potentially at risk, and ecological effects to be evaluated. It establishes the goals, breadth, and focus of the assessment, develops a conceptual model, and selects assessment endpoints, which are explicit expressions of the environmental value that is to be protected. In a HHRA, only one species (humans) is evaluated and the cancer and non-cancer effects are the usual endpoints. In contrast, a BERA involves multiple species that are likely to be exposed to differing degrees and respond differently to the same contaminant. Assessment endpoints focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the Site.

Assessment endpoints are the ecological resources whose protection from adverse effects is the goal of risk management actions. Measurement endpoints are environmental parameters that can be measured through field and laboratory analysis, and provide a good indication of the condition of an assessment endpoint.

The assessment and measurement endpoints evaluated in the BERA include:

- Viability of the benthic estuarine community as evaluated by three measurement endpoints: 1) comparisons of concentrations of COPCs in surface sediment to site-specific effects levels; 2) results of toxicity tests conducted with sensitive life stages of benthic biota exposed to surface sediment; and 3) evaluation of the indigenous benthic community;
- Viability of omnivorous reptiles utilizing the marsh, as evaluated by HQs derived from food-web exposure models for diamondback terrapins (*Malaclemys terrapin*);
- Viability of omnivorous avian species utilizing the LCP Chemicals marsh, as evaluated by two basic measurement endpoints: 1) HQs derived from food-web exposure models for red-winged blackbirds (*Agelaius phoeniceus*); and 2) HQs derived from food-web exposure models for clapper rails (*Rallus longirostris*);
- Viability of piscivorous avian species utilizing the marsh, as evaluated by HQs derived from food-web exposure models for green herons (*Butorides striatus*);

- Viability of herbivorous mammalian species utilizing the marsh, as estimated by HQs derived from food-web exposure models for marsh rabbits (*Sylvilagus palustris*);
- Viability of omnivorous mammalian species utilizing the marsh, as estimated by HQs derived from food-web exposure models for raccoons (*Procyon lotor*);
- Viability of piscivorous mammalian species utilizing the marsh, as estimated by HQs derived from food-web exposure models for river otters (*Lutra canadensis*); and
- Viability of finfish utilizing the estuarine system, as evaluated by five measurement endpoints: 1) comparisons of concentrations of COPCs in surface water to general literature-based effects levels; 2) results of toxicity tests conducted with early (and sensitive) life stages of aquatic biota exposed to COPCs in surface water; 3) tissue residue HQs derived from finfish bioaccumulation models; 4) tissue residue HQs derived from field-collected finfish; and 5) evaluation of the benthic community as a food source for juvenile and adult fish.

Detailed quantitative assessment of select populations of fish and wildlife were conducted by selecting individual species representative of various feeding preferences, predatory levels, and habitats. Receptors selected to represent the LCP Chemicals marsh ecological community for the BERA included two species of benthic invertebrates, one species of reptile, three species of birds, three species of mammals and five species of finfish. Concentrations of COCs in prey items for these species were also measured (e.g., in fiddler crabs, blue crabs, and mummichogs). The remaining receptors (i.e., aquatic plants and oysters) were evaluated qualitatively.

7.2.3 Identification of Contaminants of Concern for Ecological Receptors

The BERA evaluated the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more chemical stressors. The COCs quantitatively evaluated in the BERA included mercury, Aroclor-1268, lead and PAHs. Both inorganic mercury and methylmercury were evaluated as COCs in sediment, surface water, and biota. Receptors exposed to these COPCs included benthic invertebrates, omnivorous reptiles, omnivorous birds, piscivorous birds, piscivorous mammals, herbivorous mammals and finfish. The framework used for assessing site-related ecological risks is similar to that used for the HHRA and consists of problem formulation, ecological exposure assessment, ecological effects assessment, and risk characterization.

Tables 20a and 20b summarize the ecological COCs and their associated concentrations in sediment and surface water, respectively.

7.2.4 Ecological Exposure Assessment

Exposure assumptions and dietary models were used to predict the potential exposure of biota to COCs associated with the LCP Chemicals marsh. Exposure parameters (e.g., body weight, prey ingestion rate, home range) of the representative fish and wildlife

species were used to calculate the exposure concentrations or dietary doses. Site-specific measured COCs in the dietary components of each modeled receptor were included to provide better predictive power and reduce uncertainty.

The primary means of assessing exposure to benthic organisms was the use of 245 sediment toxicity tests to amphipods and 110 toxicity tests with grass shrimp that included a variety of endpoints such as embryo development, reproductive response and survival. The tests were conducted during the multi-year study period as part of the annual monitoring for the 2001 removal action. Details of the toxicity tests may be found in Appendix C of the BERA.

Table 21 presents a summary of ecological exposure pathways evaluated in the BERA.

7.2.5 Ecological Effects Assessment

The BERA evaluated the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to the contaminants associated with the LCP Chemicals marsh. The COCs quantitatively evaluated in the BERA included mercury, Aroclor 1268, lead, and PAHs. Receptors exposed to these COCs included benthic invertebrates, omnivorous reptiles **(**represented by the diamondback terrapin**),** omnivorous birds (represented by the clapper rain and redwing blackbirds), piscivorous birds (represented by the green heron)**,** piscivorous mammals (represented by the river otter)**,** herbivorous mammals (represented by the marsh rabbit**),** omnivorous mammals (represented by the raccoon) and finfish. The framework used for assessing site-related ecological risks is similar to that used for the Baseline HHRA.

The BERA evaluated multiple lines of evidence (LOE), based on various measured effects, to determine if contamination from the LCP Chemicals marsh had adversely affected the biota in and around the marsh. The LOE for each receptor and associated results are summarized below.

Benthic Invertebrates. The three LOE used to assess the benthic community were: 1) comparisons of concentrations of COCs in surface sediment with site-specific effects levels; 2) results of toxicity tests conducted with sensitive life stages of benthic biota exposed to surface sediment; and 3) evaluation of the indigenous benthic community. The collective results from these LOE indicate that the viability of the structure and function of the benthic community in the LCP Chemicals marsh is at risk from the COCs, especially in the LCP Ditch and Eastern Creek.

Two sensitive species were selected for the toxicity tests: 1) amphipods (*Leptocheirus plumulosus*) that burrow into the sediment and grass shrimp (*Palaemonetes pugio*) that generally float above the sediment. Results of over 300 sediment toxicity tests conducted between 2000 and 2006 provided the data for assessing risks to the benthic community. For the amphipods, survival was the most sensitive endpoint, followed by reproductive response; and for grass shrimp the most sensitive endpoint was embryo development. The results from tests on amphipods that burrow into the sediment indicated toxic effects in

up to 85 percent of sediment samples from the LCP Chemicals marsh. However, toxicity was also observed in several reference samples from Troup Creek. Toxicity tests with grass shrimp showed toxic effects in up to 69 percent of the samples, including a few from reference stations. Although limited toxicity occurred in some reference sediment samples, this did not add intractable uncertainty. A detailed analysis of potential causes of the toxicity was presented in the BERA, along with the conclusion that, in addition to the COCs in sediment, various other non-measured factors likely influenced the tests, such as sulfides and organic carbon content, redox conditions, sediment pH, and grain size.

Notwithstanding the toxicity test results, sediment effect concentrations (SECs) which are guidelines used to predict sediment toxicity were calculated for both species based on several measurement endpoints that included tests for survival, reproduction, and growth rates. The results of each measurement endpoint were then evaluated using five different statistical analyses to determine SECs, such as threshold effect levels (TELs) and probable effects levels (PELs). Each of the five SECs conveys a sense of variability and are not considered a "bright line" for defining toxicity. In addition, accuracies in predicting SECs were calculated based on numbers of false positives and false negatives.

The TEL and effects range-low (ER-L) form the most conservative or lower end of the SECs while a probable effects level (PEL) concentration suggests that the sediment will likely be toxic. The effects range median (ER-M) and the apparent effects threshold (AET) were used to define the less conservative upper end effects. Table 22 summarizes the SEC concentrations based on the five statistical measures for the most sensitive toxicity tests (amphipod survival and grass shrimp embryo development). The data indicates a wide range of effect concentrations with low average accuracies among the five measures.

Using all valid toxicity test data, the SECs selected to represent the low-end of effects are highlighted in yellow color on Table 22. These concentrations represent conservative values that takes into account the widespread toxicity observed at the site as well as toxicity observed at the reference locations. The upper-end of the SECs (blue highlights on Table 22) represents values that address the toxicity to sensitive test organisms with a small margin for error. The selected SECs were also more reliable and accurate (generally between 55 and 60 percent accuracy). Other less sensitive test endpoints such as reproductive response and embryo hatching resulted in higher SECs and less accuracy. The SECs presented in Table 22 provide the basis for development of preliminary remedial goals (see Section 8.1).

Finfish. There were five basic measurement endpoints available for evaluating the viability of finfish utilizing the LCP Chemicals marsh: 1) comparisons of concentrations of COCs in surface water to general state and federal water quality criteria; 2) results of toxicity tests conducted with early (and sensitive) life stages of mysids and sheepshead minnows exposed to COCs in surface water; 3) HQs derived from food-web exposure models for finfish (silver perch, red drum, black drum, spotted seatrout, and striped

mullet); 4) HQs derived from actual measured residues in field-collected finfish; and 5) evaluation of the benthic macroinvertebrate community (as a food source for juvenile and adult fishes). The overall conclusion derived from these five measurement endpoints is that there is no risk to finfish in the marsh from direct exposure to COCs in the water column. However, the dietary modeling and tissue data for field-collected finfish suggest that chronic risk to the viability of finfish indigenous to the LCP Chemicals marsh is of concern. The lowest-observed-adverse-effect-level (LOAEL) methylmercury HQs for field-collected finfish ranged from 0.1 to 2.2 and from 0.4 to 4 for exposure to Aroclor-1268. Finfish with LOAEL HQs < 1 are not likely to be at significant adverse risk. The LOAEL HQs suggest persistent low-level chronic effects.

Wildlife. To assess exposure to various wildlife receptors that occurs in the LCP Chemicals marsh, food-web models were used. These models included conservative assumptions and input values to ensure protectiveness, such as assuming that each receptor spends its entire life in the LCP Chemicals marsh and that the COCs are 100 percent bioavailable. Calculated intake doses were compared to toxicity reference values based on the NOAEL and the LOAEL. Table 23 summarizes the modeled results and lists the COCs generating the potential risks.

The results indicate that lead and PAHs do not present unacceptable risk to the wildlife receptors. Methylmercury is of concern to birds, while Aroclor 1268 is of concern to mammals. None of the LOAEL HQs were exceeded for the redwing blackbird, marsh rabbit, raccoon and river otter, indicating minimal risks. The green heron (piscivorous birds) are at most risk.

7.2.6 Ecological Risk Characterization

The BERA was primarily designed to address potential risk pertaining to the following eight fundamental assessment endpoints according to a “strength-of-evidence” approach.

Multiple lines of evidence (LOE), based on various measured effects, were used to evaluate major components of the LCP Chemicals marsh ecosystem to determine if contamination has adversely affected the biota in and around the marsh. Based on the availability of data, some of the assessment endpoints had only one or two LOE such as those receptors evaluated in the food chain model, while other receptors such as finfish had several LOE.

The three LOE to assess the benthic estuarine community indicate that the viability of the structure and function of the benthic estuarine community in the LCP Chemicals marsh is at risk from the COCs, especially in the southeastern part of the marsh (in particular, the LCP Ditch and Eastern Creek).

The two LOE generated to evaluate the viability of omnivorous birds utilizing the LCP Chemicals marsh suggested minimal risk to the red-winged blackbird and the clapper rail.

The single LOE available to evaluate the viability of the green heron utilizing the LCP Chemicals marsh suggested that potential risk to the viability of the green heron in the LCP Chemicals marsh, due to exposure to methylmercury is moderate.

The single LOE available for evaluating the viability of herbivorous mammalian species utilizing the LCP Chemicals marsh consisted of HQs derived from food-web exposure models for marsh rabbits. A modeling study for marsh rabbits concluded that the potential for risk to the viability of herbivorous mammals utilizing the LCP Chemicals marsh is minimal.

The only LOE generated for assessing the viability of omnivorous mammals utilizing the LCP Chemicals marsh consisted of HQs derived from food-web exposure models for raccoons. In the modeling study, all HQs for inorganic mercury, methylmercury, and lead derived for raccoons indigenous to the LCP Chemicals marsh were less than unity (1). Consequently, the potential for risk to omnivorous mammals was judged to be minimal.

The sole LOE for evaluating the viability of piscivorous mammals utilizing the LCP Chemicals marsh consisted of HQs derived from a food-web exposure model for river otters. The model results indicated that potential adverse risk to piscivorous mammals using the LCP Chemicals marsh is minimal.

Based on the five above-discussed measurement endpoints for finfish, it was concluded that there is no acute life threat to finfish in the LCP Chemicals marsh from direct exposure to COCs in the water column. However, the dietary modeling and tissue data for field-collected finfish suggest that chronic risk to viability of finfish indigenous to the LCP Chemicals marsh is of concern.

Table 24 summarizes the range of COC concentrations in sediment that are expected to be protective of fish and wildlife receptors. The protective concentrations are generally defined to be between the NOAEL and LOAEL.

7.2.7 Uncertainties Analysis for BERA

The OU1 BERA examined a variety of uncertainties associated with the components of the BERA process and considered whether these uncertainties tend to over or underestimate risks. It also presents findings from several independent studies conducted at the Site and evaluates whether those studies lend additional support to, or conflict with, the conclusions of the BERA. The most significant sources of uncertainty in the OU1 BERA are briefly described below.

- The evaluation of potential adverse effects to the benthic invertebrate community relied on hundreds of site-specific acute and chronic toxicity test measurements using both indigenous and laboratory-cultured organisms. The OU1 BERA notes that the development of the lower end of the preliminary remedial goals (PRGs) range for the protection of benthic invertebrates is “highly uncertain with poor

accuracies" and that "only conservative assumptions were used" for this purpose. The upper-end of the benthic PRG range was less conservative and less uncertain;

- The evaluation of potential adverse effects to mammalian receptors from Aroclor 1268 is based on a toxicity reference factor (TRV) for Aroclor 1254. Aroclor 1254 is generally accepted to be more toxic to mammals; and
- The evaluation of potential adverse effects to upper-trophic level fish from Aroclor 1268 is based on a tissue residue TRV derived by the EPA for that PCB mixture. This TRV is based on significant weight changes observed in mummichogs that were conservatively determined to represent a lowest-observed-adverse-effect-level (LOAEL) rather than a no-observed-adverse-effect level (NOAEL), which likely overestimates risk to finfish.

7.2.8 Qualitative Estimation of Risks Posed by PCDD/PCDF to Ecological Receptors

The EPA developed a dioxins/furans memorandum (EPA 2014) that included a method used to estimate the sediment dioxin TEC protective levels based on assumptions and calculations associated primarily with the 2,3,7,8-TCDD congener. This method resulted in an estimated sediment concentration of 260 ng/kg TEC as a protective level for the omnivorous mammal, such as the river otter. Similarly, the calculated sediment concentration considered protective of 95 percent of fish species is 32 ng/kg TEC or a level of 0.909 ng/g lipid in fish tissue. These concentrations are considered very conservative because they are based largely on 2,3,7,8-TCDD data from literature, whereas bioaccumulation and toxicity data are generally not available for the other congeners. In addition, it is likely that the heavier chlorinated furans, that are more prevalent in the LCP Chemicals marsh than dioxins, partition from sediment to a lesser degree than 2,3,7,8-TCDD and thus would be less bioavailable as well as less toxic. Furthermore, application of these sediment concentrations must take into account the numerous congeners that are not detected but conservatively assumed to be present at one half their detection limit.

7.2.9 Summary of Human Health and Ecological Risks

Human Health. The HHRA found that contamination in the LCP Chemicals marsh poses unacceptable risks to human health. The primary sources of these cancer risks and non-cancer health hazards are due to mercury and Aroclor 1268 as a result of consumption of fish and shellfish harvested from the LCP Chemicals marsh (Table 18). The concentrations of dioxins/furans in fish tissue samples (collected from the LCP Ditch during the late 1990s marsh removal period) were low and do not appear to present unacceptable risk (see Section 7.1.6).

Ecological. The BERA indicates that ecological risks from hazardous substances released to the LCP Chemicals marsh create a need to evaluate measures that would reduce the incidence of adverse growth and reproductive effects to benthic organisms, fish, and wildlife. The receptors at risk include: 1) omnivorous and piscivorous birds from methylmercury; 2) herbivorous, omnivorous, and piscivorous mammals from Aroclor 1268; 3) fish from methylmercury and Aroclor 1268; and 4) benthic invertebrates

from mercury, Aroclor 1268, lead, and PAHs. Risk to finfish from dioxin and furans appears low.

The risk assessments concluded that the COCs in the LCP Chemicals marsh are mercury, Aroclor 1268, lead, and PAHs in sediment, surface water, and biota.

Mercury and Aroclor 1268 are persistent and therefore, the risks associated with these contaminants (including any co-located dioxins/furans) are unlikely to decrease significantly in the absence of taking action. Therefore, based on the BERA, the receptors listed above are at risk.

7.3 Basis for Action

Based upon the results of the RI and the risk assessments, the EPA and GAEPD have determined that action under CERCLA is necessary to protect public health and the environment. The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

8.0 Remedial Action Objectives

Remedial action objectives (RAOs) are established to support the development and evaluation of remedial alternatives for areas with the potential for unacceptable risk as identified in the human health and ecological risk assessments. The RAOs are established by the risks posed by the contamination in media of concern, through potential exposure pathways to receptors and remediation objectives.
The following RAOs were identified for OU1:

1. Prevent or minimize releases of COCs in contaminated in-stream sediment from entering Purvis Creek.
2. Reduce to acceptable levels, piscivorous bird and mammal population exposure to COCs from ingestion of prey exposed to contaminated sediment in the LCP Chemicals marsh, considering spatial forage areas of the wildlife and movement of forage prey.
3. Prevent human exposure, through the ingestion of finfish and shellfish, to COCs above levels that pose unacceptable health risk to recreational and high quantity fish consumers.
4. Reduce risks to benthic organisms exposed to COC-contaminated sediment to levels that will result in self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas.
5. Reduce, to acceptable levels, finfish exposures to COCs from ingestion of prey and contaminated sediment in the LCP Chemicals marsh.
6. Restore surface water COC concentration to levels which are protective for recreational users, high quantity finfish consumers and ecological receptors.

This section further describes the selected cleanup levels (see Section 8.1), ARARs (see Section 8.2), and fish and shellfish tissue concentrations (see Section 8.3) for the LCP Chemicals marsh cleanup and key factors that formed the basis for each. The selected cleanup levels are contaminant concentrations that will be used to measure the success of the cleanup alternatives in meeting the RAOs. Cleanup levels are based on ARARs, which provide minimum legal standards, and in the absence of ARARs, risk-based concentrations.

8.1 Derivation of Sediment Preliminary Remedial Goals

The Feasibility Study developed remedial alternatives designed to meet the RAOs. In addition to the RAOs, a range of sediment PRGs was derived from the human health and ecological risk assessments and the November 30, 2011 letter from EPA to Honeywell. Given that fish, shorebirds and mammals move throughout the LCP Chemicals marsh, PRGs for these mobile receptors were separated from benthic community PRGs because the benthic organisms are highly sedentary with very limited mobility.

8.1.1 PRGs for Fish, Wildlife and Humans

Development of PRGs for the LCP Chemicals marsh was based on the premise that the source of contamination is the contaminated sediment, regardless of how the fish,

shellfish, birds, or mammals acquired the contaminants through the local food web. This means that the tissue concentrations measured in the consumed food items are ultimately related to the levels of contamination in the sediment. This relationship is expressed as bioaccumulation factors (BAFs).

For finfish and shellfish, the average area-weighted creek sediment concentrations were used to represent the exposure source. These sediments represent permanently inundated habitat areas for fish and shellfish. Marsh sediments were not included in the creek analysis because they are tidally influenced and subject to periodic wet-dry cycles.

For the clapper rail exposed to tidal marsh sediment instead of creek sediment, the average marsh sediment concentrations were used to represent the exposure source.

For human health, the sediment concentrations were compared to the fish tissue concentrations at the levels that resulted in a non-cancer HI ≥1 or in cancer risk of ≥1E-06. This BAF relationship was then used to predict sediment and/or tissue concentrations that would result a HI=1.0 or cancer risk =1E-04, both considered to be protective of human health. This approach was used to develop a range of sediment PRGs for each consumption scenario for the adult and child as described in Section 7.1.2. For example, the sediment goals for Aroclor 1268 for the adult consumer ranged between 2.4 mg/kg if consuming clapper rail and 8.5 mg/kg if consuming shellfish.

BAFs were also used to predict exposure in piscivorous birds, mammals, and several species of finfish to back-calculate a range of sediment concentrations considered protective between the NOAEL and the LOAEL. For example, the sediment goals for mercury ranged from 1 mg/kg (NOAEL) to 3 mg/kg (LOAEL) in both wading bird and finfish receptors.

The numerous calculated sediment concentrations considered protective of a variety of receptors and consumption scenarios were then synthesized to provide a conservative range of PRGs that would assist in the development of remedial alternatives.

The range of PRGs for the highly mobile fish, wildlife and humans that are exposed over wide areas of the marsh and its various creeks are provided below:

- Mercury – between 1 and 2 mg/kg
- Aroclor 1268 – between 2 and 4 mg/kg

These PRGs are applicable to RAOs 2, 3 and 5 and are applied to each individual exposure domain due to their large areas and applied to the total creeks area (not for each small creek or ditch).

Because fish, shorebirds and mammals move throughout the LCP Chemicals marsh, sediment surface weighted average concentrations (SWACs) were calculated for Aroclor 1268 and mercury for each of the domains and major creeks identified in the risk

assessments (PAHs and lead were not of concern to these receptors). Table 25 lists sediment SWACs in the various domains and creeks within the LCP Chemicals marsh along with their size in acres. These SWACs represent current sediment exposure concentrations to these receptors that are exposed over large spatial scales that encompass multiple sample locations.

8.1.2 Benthic Community PRGs

Benthic PRGs were based on site-specific toxicity tests results and their associated uncertainties (refer to the highlighted values in Table 22 and the discussion in Section 7.2.5). The following benthic community PRG ranges were used to guide alternative development:

- Mercury – 4 to 11 mg/kg
- Aroclor 1268 – 6 to 16 mg/kg
- Lead – 90 to 177 mg/kg
- PAHs – 4 mg/kg

Given the lack of wide-spread mobility of benthic organisms, these PRGs were applied to contaminated areas as measured by 50 by 50 meter grids. The range of benthic PRGs was provided for the FS because extending the alternative footprints in certain areas was prudent to address uncertainty in the existing data. The concentrations of COCs just slightly higher than the upper-end of the benthic PRG range are toxic to sensitive benthic organisms with a high degree of certainty. The lower-end of the PRG range adds a degree of conservatism to the alternative footprints to ensure that all of the concentrations above the upper-end of the PRG range will be captured. However, isolated samples with contamination above the lower-end of the PRG range do not contribute unacceptable risk to the benthic invertebrate community. The benthic PRGs are quantifiable measures to evaluate attainment of RAO #4.

8.2 Cleanup Levels

After the alternatives were developed (Section 9 of this ROD) and compared and evaluated against the National Contingency Plan (NCP) criteria (Section 10), the PRGs described above were then refined into sediment cleanup levels (CULs).

The most conservative sediment PRG at 1E-06 cancer, for protection of human health from consumption of fish, is Aroclor 1268 at 0.037 mg/kg. However, this would result in destruction of over 700 acres of functioning marsh and was therefore rejected as a potential cleanup level. Similarly, a 1E-05 cancer risk would result in an Aroclor 1268 concentration of 0.37 mg/kg which would impact approximately 586 acres or 77 percent of the entire marsh. Therefore, that level was also rejected as a potential cleanup level. Additionally, given the conservative assumptions used in the HHBRA and BERA along with their associated uncertainties as described in Sections 7.1.5 and 7.2.7, such extensive remediation would be unnecessary.

For fish, wildlife and humans the following SWAC CULs will be applied to each exposure domain and the total creeks area so as to achieve the predicted post-remediation SWACs for the Selected Remedy:

- Mercury – 2 mg/kg
- Aroclor 1268 – 3 mg/kg

Each of the alternatives described in Section 9 required an analysis of achieving the RAOs and result in sediment concentrations within the protective PRG range. Table 26 shows the predicted post-remediation SWACs in each exposure domain and creeks for the alternatives, along with the SWAC CULs. The purpose of the CULs is to attain the necessary predicted risk-based SWACs for each domain and total creeks. For example, the SWAC CUL of 2 mg/kg for mercury is expected to result in a SWAC concentration in Domain 1 of 1.1 mg/kg which is the ultimate goal (Alternative 6 in Table 26). Similarly, the SWAC CUL for Aroclor 1268 of 3 mg/kg is predicted to attain a total creeks concentration of 2.7 mg/kg. The differences in the predicted SWACs depend on the features of each alternative and the influence of the benthic PRGs as described in Section 9.

Using the same approach to define PRGs as outlined in the November 30, 2011 letter from EPA to Honeywell, for the adult high quantity fish consumer, the risk-based area weighted mercury sediment concentration of 2.74 mg/kg resulted in a HI of 2.0. The resulting mercury SWAC of 1.4 for total creeks (Table 26) results in a HI of 1 (2.74/2 = 1.4/X). Similarly for Aroclor 1268, the risk-based total creeks sediment concentration resulted in an HI of 3 for the adult high quantity fish consumer. A total creeks SWAC of 2.7 mg/kg would result in an HI of 1 (7.44/3 = 2.7/X). Therefore, these sediment SWAC CULs are expected to be protective of the high quantity fish consumer, provided they consume roughly the same fish mixture as in ROD Table 7.

Note that the risk-based, area-weighted sediment concentrations derived from the risk assessments are not identical to the current SWACs due to the additional sediment data collected during the FS and refinements to the polygons used to calculate the current SWACs (e.g., greater accuracy of domain and creek areas, and polygon-specific morphological adjustments based on field data).

Based on the analysis in Section 10, the benthic community PRGs were refined into the following CULs:

- Mercury – 11 mg/kg
- Aroclor 1268 – 16 mg/kg
- Lead – 177 mg/kg
- PAHs – 4 mg/kg

Surface water CULs are based on the State of Georgia water quality standards as discussed in Section 8.3.2.

8.3 ARARs

ARARs are legally applicable or relevant and appropriate substantive (as opposed to administrative) standards, requirements, criteria, or limitations under any federal environmental law, or promulgated under any state environmental or facility siting law that is more stringent than under federal law. Section 121(d) of CERCLA, as amended, specifies that remedial actions for cleanup of hazardous substances must comply with the ARARs that are applicable or relevant and appropriate to the hazardous substances or particular circumstances at a site unless such ARARs are waived under CERCLA Section 121(d) (4). See also 40 Code of Federal Regulations (CFR) § 300.430(f)(1)(ii)(B).

This section discusses State of Georgia surface water quality requirements. ARARs are also discussed in Sections 10.1.2 and 14.2, and a complete list of ARARs is in Table 27.

8.3.1 Sediment Quality ARARs

No federal or State of Georgia sediment standards exist.

8.3.2 Surface Water Quality ARARs

Surface water quality ARARs consist of applicable promulgated state water quality standards and, in accordance with Section 121(d)(2)(A)(ii) and (B)(i) of CERCLA, federal recommended Clean Water Act Section 304(a) Ambient Water Quality Criteria (AWQC) guidance values where they are relevant and appropriate. The AWQC for human health include values to protect for consumption of organisms only, and those to protect for consumption of organisms and water. For the LCP Chemicals marsh, the relevant and appropriate AWQC for the protection of human health are those established for the consumption of organisms only because surface water within the marsh is not a source of consumable water due to high salinity. The AWQC also include acute and chronic criteria values for the protection of aquatic life, including benthic organisms. State standards in Georgia include those standards promulgated in GA Rule §391-3-6-.03(5)(e)(ii), GA Rule §391-3-6-.03(5)(e)(vii) and, for protection of human health, EPA's 1992 promulgated National Toxics Rule (NTR) standards. Consistent with Section 121(d) of CERCLA, the NCP, and the preceding State of Georgia rules, ARARs are the most stringent of the values.

Surface water will not be directly remediated but will be improved by implementation of the selected remedy and by source control to be implemented as discussed in Section 13. Surface water is a key exposure pathway for consumption of aquatic organisms by humans or wildlife. Surface water quality monitoring data will be compared to these ARAR values to measure progress towards achieving RAO 6, and evaluated as discussed in Appendix A.

8.4 Fish and Shellfish Target Tissue Concentrations

EPA has established fish and shellfish tissue concentrations to measure progress toward achieving RAO 3. Remediating contaminated sediments will reduce COC concentrations in surface water and in fish and shellfish tissue in addition to reducing COC

concentrations in sediment. Table 19 lists resident fish, shellfish (blue crab and white shrimp) and clapper rail target tissue concentrations for RAO 3. They are based on 1E-04 ECR or HQ of 1 for the adult high quantity fish consumer RME scenario. The non-cancer risk tissue goals are more conservative than the cancer risk tissue goals and provide more protection. These tissue concentrations were developed in the Baseline HHRA by setting the HQ to 1 or risk to 1E-04 and back calculating the protective tissue concentrations. The relationship between the tissue and sediment concentrations that used the BAF approach was discussed in Sections 8.1.1 and 8.2.

It is important to note that these tissue concentrations are not cleanup levels; they will be used to assess potential interim risks to people who consume resident fish and shellfish post-remediation and measure progress to achieving RAO 3. Tissue monitoring data will also inform the content or degree of any potential future fish advisories, other ICs intended to minimize risk to the fishing community, or other response actions that may be identified in a potential future ROD Amendment.

Due to the wide range of prey species in the diet of piscivorous birds and finfish, site-specific tissue concentrations have not been developed for these receptors. However, tissue monitoring for mercury and Aroclor 1268 in common prey (mummichog, fiddler crab and blue crab) will be included in the monitoring program (See Appendix A). The resulting monitoring data will be used to assess potential residual risks based on the same dietary models conducted in the BERA. If the resulting calculated hazard quotients for the receptors are less than one, then the goal of reducing exposures to these receptors (i.e., RAOs 2 and 5) would be achieved.

9.0 Description of Alternatives

9.1 Framework for Developing Alternatives

Under its legal authorities, the EPA responds to releases or threat of releases and/or takes action at an imminent and substantial endangerment from an actual or threatened release of a hazardous substance at Superfund sites. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that the EPA's remedial action, when complete, must comply with all federal and more stringent state environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that the EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Remedial alternatives were developed to be consistent with these statutory requirements.

Detailed descriptions of the remedial alternatives for addressing the contamination and the risks posed by the Site can be found in the RI report, the FS report and the Proposed Plan. This decision document is supported by the Administrative Record. The FS report presents six alternatives that involve the following remedial technologies:

- Sediment dredging (removal)
- Capping
- Enhanced monitored natural recovery (thin-layer placement)
- Monitoring

Each of the alternatives, except no action, also includes habitat restoration / reestablishment of areas disturbed by remedial activities. Reestablishment can be either restoring the same type of habitat that existed prior to remediation, or establishing a slightly different type of habitat that has been deemed appropriate for the ecological conditions of the area. The design and construction of habitat improvement and restoration elements must be consistent with the substantive requirements of permits associated with disturbance of state and federal regulated wetlands. A comprehensive mitigation Work Plan will be developed during the Remedial Design (RD) phase. This plan will be specific to the final remedy, selected in this document, to address restoration needs of disturbed areas (e.g., access roads, staging areas), and will likely include re-grading and planting of marsh vegetation to restore natural hydrological and habitat conditions.

Key ARARs for the alternatives include the Clean Water Act restrictions on the discharge of dredged material into the waters of the U.S., State of Georgia’s regulations on construction in coastal marshlands, and the federal laws and regulations that protect marine mammals, migratory birds, and endangered species. See the ARARs table (Table 27) for reference to the specific regulations and more detail. Because all alternatives use

similar technologies, the key ARARs are the same for all alternatives. All alternatives, including the Selected Remedy (except Alternative 1, No Action), include off-site disposal of dredged material. Data for the RI/FS indicate that sediment removed from the LCP Chemicals marsh can be disposed of in a solid waste landfill that is in compliance with RCRA Subtitle D. If wastes that require disposal in a landfill permitted to receive RCRA hazardous wastes or Toxic Substances Control Act (TSCA) regulated wastes are encountered during remedial design or remedial action, they will disposed in a landfill compliant with RCRA Subtitle C or TSCA.

The remedial action alternatives for the LCP Chemicals marsh are:

1. No Action
2. Sediment Removal – 48 acres
3. Sediment Removal, Capping and Thin-Layer Placement – 48 acres
4. Sediment Removal – 18 acres
5. Sediment Removal, Capping and Thin-Layer Placement – 18 acres
6. Sediment Removal, Capping and Thin-Layer Placement – 24 acres

9.2 Summary of Remedial Alternatives

9.2.1 Alternative 1: No Action

Estimated Capital Cost: $ 0
Estimated Operation and Maintenance (O&M) Cost: $ 0
Estimated Present Worth Costs: $ 0
Estimated Construction Time Frame: N/A

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. The no-action remedial alternative does not include any physical remedial measures that address the problem of sediment contamination and resulting risks to human health and the environment at the Site. Because this alternative, or any of the other alternatives, results in contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure to site media, CERCLA requires that the Site be reviewed at least once every five years to ensure that the remedy is protective.

9.2.2 Alternative 2: Sediment Removal - 48 acres

Estimated Capital Costs: $ 64.5 million
Estimated Operation and Maintenance (O&M) Costs: $385,000
Estimated Present Worth Costs: $64.8 million
Estimated Construction Time Frame: 3-to-4 years

Alternative 2 achieves the RAOs in the 48-acre remediation area by combining sediment removal, ICs (such as administrative and legal controls to minimize the potential for exposure and to ensure the long-term integrity of the remedy), and long-term monitoring (LTM). This alternative uses a SWAC range for human health, mammals, and birds of 2

mg/kg for mercury and 2 mg/kg for Aroclor-1268. In addition, the lower-end PRGs for benthic organisms are targeted (i.e., 4 mg/kg for mercury, 6 mg/kg for Aroclor 1268; 90 mg/kg lead, and 4 mg/kg for total PAHs).

This alternative involves sediment removal and backfilling within Eastern Creek, Western Creek, LCP Ditch, Purvis Creek, the Domain 3 Creek, Dillon Duck, and the vegetated marshes of Domains 1a, 2 and 3, as shown on Figure 24. This is expected to improve the surface water body quality. This alternative includes:

- Dredging approximately 48 acres (~153,000 CY) in the areas shown on Figure 24 to a target depth of 18 inches, where the contaminants concentrations are expected to meet the goals;
- Backfilling dredged area with 12 inches (approximately 96,000 CY) of clean material;
- Dewatering sediments on-site and disposing off-site at a licensed facility;
- Treating dewatering fluids, prior to discharge to the marsh;
- Constructing various staging areas and temporary access roads to facilitate material management and sediment dredging/excavation (approximately 11 additional acres of disturbance); and
- Restoration of disturbed areas.

Short-term monitoring activities will span the construction phase and will be defined during the remedial design phase. Some of these activities could include monitoring for elevated COC levels during dredging activities, soundings and surveys to verify removal and backfilling depths, and/or backfill material coverage assessments.

Current institutional controls will be maintained as necessary – specifically fish advisories already in place for Purvis Creek and the Turtle River system, and an existing commercial fishing ban for Purvis Creek. With time, when fish chemical concentrations fall below the criteria to maintain the fish advisories and/or commercial fishing ban, the State of Georgia may elect to remove the advisories and/or commercial fishing ban. Current U.S. Army Corps of Engineers permit requirements for dredging, capping, or other construction activities under Section 401 and 404 of the Clean Water Act will also serve as institutional controls for future construction in and adjacent to the LCP Chemicals marsh. Finally, the Coastal Marshlands Protection Act (OCGA§ 12-5-280 et seq.) protects marshland areas against construction alterations in the State of Georgia without first obtaining a permit from the Coastal Marshlands Protection Committee.

Long-term monitoring measures the remedy's long-term effectiveness in enhancing ecosystem recovery and reducing risks to human health and the environment and ensuring the integrity of the remedy. A framework outline of the long-term monitoring plan is provided in Appendix A and includes, but is not limited to, the following:

- Physical measurements to monitor the integrity of backfilled areas (e.g., bathymetric surveys, push cores, or visual observation via camera or video

profiling);
- Visual observations and surveys of marsh recovery, including plant growth and plant density;
- Contaminant measurements in tissues of fish and shellfish;
- Measurements of COCs in sediment; and
- Surface water sampling as necessary to demonstrate compliance with ARARs.

Final specific details of the LTM plan will be developed by EPA and GAEPD during the RD phase.

9.2.3 Alternative 3: Sediment Removal, Capping and Enhanced Monitored Natural Recovery (EMNR) – 48 acres

Estimated Capital Costs: $ 37.6 million
Estimated O&M Costs: $1.4 million
Estimated Present Worth Costs: $38.7 million
Estimated Construction Time Frame: 3-to-4 years

Alternative 3 achieves the RAOs in a 48-acre remediation area by combining sediment removal, sediment capping, and EMNR (thin-layer placement) , ICs (as described for Alternative 2), and LTM. This alternative targets the same SWAC cleanup levels and benthic community goals as Alternative 2, with the same area footprint.

This alternative includes sediment removal and backfilling in Eastern Creek, Western Creek, and LCP Ditch and capping in Purvis Creek and Domain 3 Creek. Thin-layers would be placed within Dillon Duck and the vegetated marshes of Domains 1a, 2 and 3 as shown on Figure 25.

This alternative includes:

- Dredging approximately 9 acres (~27,000 CY) to a target depth of 18 inches;
- Backfilling with 12 inches approximately 17,000 CY of clean material (e.g., sand);
- Capping approximately 16 acres with an isolation layer of clean material of (for costing purposes) at least 6 inches and at least 6 inches of an armored layer of coarse sand and/or gravel;
- Thin-layer placement of clean sediment or sand on approximately 23 acres;
- Dewatering sediments on-site and disposing of them at a licensed off-site facility;
- Treating dewatered liquids, prior to discharge to the marsh;
- Constructing various staging areas and temporary access roads to facilitate material management and sediment excavation (approximately 8 additional acres of disturbance); and
- Restoration of disturbed areas.

Short and long term monitoring will be implemented as described above under Alternative 2. In addition, although caps are designed to withstand high-energy flows, they may require repairs if damaged by erosion or unexpected conditions, such as storm events. The extent of these potential repairs will be evaluated during post-remediation site inspections.

Sediment caps isolate underlying sediment contaminants; control contaminant migration, physical erosion and biological contact with underlying sediment contaminants; and provide a clean sediment surface for habitat restoration. Modeling was used to design the thickness and material size for the cap armor layer to ensure that the cap retains its integrity under worst case shear stress conditions. Contaminant isolation modeling concluded that a 6-inch base isolation layer with up to six inches of coarse sand-to-gravel armoring will adequately protect against contaminant migration through the cap, as well as erosive forces resulting from storm events. Cap placement could be performed as a barge-based operation in north and south Purvis Creek and as a land-based operation in Domain 3 Creek.

Given shallow water depths, narrow creeks and tidal effects, the cap may need to be placed by small mechanical equipment (e.g., backhoe or similar excavator with a fixed arm or a telescoping conveyor belt) operating from the shoreline and/or a shallow-draft barge.

The horizontal extent of the thin-layer placement for Alternative 3 is shown on Figure 25. The proposed thin-layer placement area is approximately 23 acres. Thin layers consisting of six inches of clean sediment or sand are targeted for the lower contaminant concentration, low-energy environments within the LCP Chemicals marsh to accelerate ongoing natural recovery processes (e.g., contaminant burial), reduce risks to human health and the environment, and provide a clean sediment surface for habitat restoration. Thin-layer placement is best suited for wetlands or marsh environments where tidal energy and potential erosion is at a minimum. Thin-layer placement minimizes the negative ecological impacts of sediment capping (e.g., loss of aquatic habitat, potential changes in marsh inundation patterns) and sediment removal (e.g., destruction of marsh habitat, areas of limited accessibility). It is recognized that some bioturbation will occur through the thin layer by deep-burrowing macroinvertebrates, but that the resulting sediment COC concentrations in those disturbed areas would be still be below the CULs.

9.2.4 Alternative 4: Sediment Removal – 18 acres

Estimated Capital Costs: $ 33.8 million
Estimated O&M Costs: $ 257,000
Estimated Present Worth Costs: $ 34.1 million
Estimated Construction Time Frame: 2 years

Alternative 4 addresses exceedances of the cleanup levels and achieves RAOs in the 18-acre remediation area by combining sediment removal, ICs (such as administrative and legal controls to minimize the potential for exposure and to ensure the long-term integrity

of the remedy), and LTM. This alternative targets the SWAC for human health, mammals, and birds at 2 mg/kg for mercury and 4 mg/kg for Aroclor 1268. In addition, achieves the benthic community CULs.

This remedial alternative includes sediment removal and backfilling which would be performed in parts of Eastern Creek, the LCP Ditch, the Domain 3 Creek, Dillon Duck and the vegetated marsh areas of Domains 1a and 2 (Figure 26):

- Dredging approximately 18 acres (~ 57,000 CY) to a target depth of 18 inches;
- Backfilling with 12 inches (~ 36,000 CY) of clean material such as sand;
- Dewatering sediments on-site and disposing off-site at a licensed facility;
- Treating dewatering liquids, prior to discharge to the marsh;
- Constructing staging areas and temporary access roads to facilitate material management and sediment excavation (approximately 11 additional acres of disturbance); and
- Restoration of disturbed areas.

Short-term monitoring activities will span the construction phase and will be defined during the remedy design phase. Some of these activities could include soundings and surveys to verify removal depths, depth verification measurements to document backfill material placed, and/or backfill material coverage assessments.

Long-term remedy monitoring measures the remedy's long-term effectiveness in enhancing ecosystem recovery and reducing risks to human health and the environment. Appendix A provides an outline of the LTM plan with specific monitoring details to be worked out in the RD phase.

9.2.5 Alternative 5: Sediment Removal, Capping and EMNR – 18 acres

Estimated Capital Costs: $ 25.6 million
Estimated O&M Costs: $ 475,000
Estimated Present Worth Costs: $ 26.0 million
Estimated Construction Time Frame: 2 years
This alternative targets the same SWAC and benthic community CULs as Alternative 4 with the same area footprint. It combines sediment removal, sediment capping and EMNR (thin-layer placement) to accelerate natural recovery, ICs (such as administrative and legal controls to minimize the potential for exposure and to ensure the long-term integrity of the remedy), and LTM.

This alternative (Figure 27) incorporates the following components:

- Dredging approximately 7 acres (~22,000 CY) in the LCP Ditch and Eastern Creek to a depth of 18 inches;
- Backfilling the dredged area with 12 inches (~14,000 CY) of clean material;
- Capping approximately 3 acres of Domain 3 Creek;

- Thin-layer placement on approximately 8 acres with clean sediment or sand;
- Dewatering sediment on-site and disposing of it at licensed off-site facilities;
- Treating the dewatered liquids, prior to discharge to the marsh;
- Constructing staging areas and temporary access roads which will require approximately 8 acres of additional disturbance beyond the 18-acre footprint; and
- Restoration of disturbed areas.

Short and long term monitoring will be implemented as described above under Alternative 2. In addition, although caps are designed to withstand high-energy flows, they may require repairs if damaged by erosion or unexpected conditions, such as storm events. The extent of these potential repairs will be evaluated during monitoring Site inspections. Sediment caps isolate underlying sediment contaminants; control contaminant migration, physical erosion and biological contact with underlying sediment contaminants; and provide a clean sediment surface for habitat restoration. Modeling was used to design the thickness and material size for the cap armor layer to ensure that the cap retains its integrity under worst case shear stress conditions. Contaminant isolation modeling concluded that a 6-inch base isolation layer with up to 6 inches of coarse sand-to-gravel armoring will adequately protect against contaminant migration through the cap, as well as erosive forces resulting from storm events. Cap placement could be performed as a land-based operation (Domain 3 Creek). Given the shallow water depths, narrow creeks and tidal effects, the cap may need to be placed by small mechanical equipment (e.g., backhoe or similar excavator with a fixed arm or a telescoping conveyor belt) operating from the shoreline and/or a shallow-draft barge.

Land-based access to the Domain 3 Creek requires construction of a small number of temporary access roads across the soft sediments of Domain 3 marshes and Uplands areas. Construction of various material staging areas (8 acres) is also required to facilitate material management and sediment cap placement. While the anticipated amount of submerged debris is relatively high, since the proposed sediment removal areas have not been periodically maintained, debris will remain in place unless it interferes with capping operations. Any removed debris will be disposed of off-site at licensed facilities.

The boundaries of thin-layer placement for Alternative 5 are shown on Figure 27. The proposed thin-layer placement area is approximately eight acres. Thin layers consisting of 6 inches of clean sediment or sand are targeted for the lower contaminant concentration, low-energy environments within OU1 to accelerate ongoing natural recovery processes (e.g., contaminant burial), reduce risks to human health and the environment, and provide a clean sediment surface for habitat restoration. Thin-layer placement is best suited for wetlands or marsh environments where tidal energy and potential erosion is at a minimum. Thin-layer placement minimizes the negative ecological impacts of sediment capping (e.g., loss of aquatic habitat, potential changes in marsh inundation patterns) and sediment removal (e.g., destruction of marsh habitat, areas of limited accessibility).

9.2.6 Alternative 6: Sediment Removal, Capping and EMNR – 24 acres

Estimated Capital Costs: $ 27.9 million
Estimated O&M Costs: $ 673,000
Estimated Present Worth Costs: $ 28.6 million
Estimated Construction Time Frame: 2 years

Alternative 6 addresses a total of 24 acres (Figure 28). This includes achieving exceedances of cleanup levels and RAOs in the 18-acre remediation area similar to Alternative 5, plus an additional six acres located in Purvis Creek and Domain 1. This alternative combines sediment removal, sediment capping and thin-layer placement to accelerate natural recovery, ICs (such as administrative and legal controls to minimize the potential for exposure and to ensure the long-term integrity of the remedy) and LTM. This alternative targets the SWAC for human health, mammals and birds at 2 mg/kg for mercury, and 4 mg/kg for Aroclor 1268; and the benthic community CULs.
The six additional acres in Purvis Creek and Domain 1 were included in the footprint for this alternative for the following reasons:

- Addressing areas in Purvis Creek and Domain 1 helps achieve the SWAC-based goals for mercury and Aroclor 1268;
- Because most of Purvis Creek is permanently submerged, even at low tide, exposure times for fish and piscivorous wildlife are longest in Purvis Creek;
- Purvis Creek is relatively accessible from water so remedial actions in the creek will not adversely or significantly impact vegetated marsh areas beyond impacts already contemplated for Alternatives 4 or 5; and
- The additional remedial area in Domain 1 is located immediately adjacent to areas where other work (i.e., work in LCP Ditch and Eastern Creek) is already planned, making expansion into Domain 1 easily implementable with minimal additional marsh impacts.

Remedial components of this alternative include:

- Dredging approximately 7 acres (~22,000 CY) in the LCP Ditch and Eastern Creek to a target depth of 18 inches;
- Backfilling dredged areas with 12 inches (~14,000 CY) of clean material;
- Capping approximately 6 acres in Domain 3 Creek and Purvis Creek;
- Thin-layer capping approximately 11 acres of marsh with clean sediment or sand;
- Dewatering sediments on-site and disposing of them at licensed off-site facilities;
- Treating the dewatered liquids, prior to discharge to the marsh;
- Constructing various staging areas and temporary access roads, which will require an additional disturbance of approximately 7 acres, beyond the 24 acres of active remediation;
- Sampling and analysis for PCDD/PCDF during remedial design to confirm co-location with Aroclor 1268; and
- Restoration of disturbed areas.

As indicated in the Alternative 3 discussion, thin-layer covers are targeted for the lower contaminant concentration, low-energy environments within OU1 to accelerate natural recovery processes (i.e., contaminant burial), reduce risks to human health and the environment, and provide a clean sediment surface for habitat restoration. Although caps are designed to withstand high-energy flows, they may require repairs if damaged by erosion or unexpected conditions, such as storm events. The extent of these potential repairs will be evaluated during monitoring Site inspections. The LTM plan in Appendix A outlines monitoring requirements.

Alternative 6 differs from Alternatives 2 and 3 in that a response action for the western limb of the WCC is not proposed for the following reasons. The WCC is accessible only from Upland areas because the creek is narrow and completely drains at low tide. Land-based access to the WCC would require construction of temporary roads to access remedial areas and facilitate material (e.g. excavated material, backfill material, cover or capping material) transport to and from each remediation area. These roads would need surface elevations of at least one foot above the mean high water elevation so operations could be performed above water. Construction and use of these elevated roads would have significant negative impact on the marsh. Further, upon completion of construction activities, the roads would have to be removed or integrated into the remedial action, perhaps as backfill for excavated areas. This would create additional negative impacts on the marsh.

Because the areas with higher contaminant concentrations within the WCC are discontinuous and isolated from other areas in the creek complex, capping discrete areas would likely result in the creation of troughs and valleys within the narrow and shallow WCC. These troughs would likely restrict flow conveyance, especially at low tide, and thus could negatively impact the vegetated marshes surrounding the creek. Therefore, sediment capping was not retained for evaluation for the WCC, and sediment removal is considered the only viable remedial alternative in this area. Productivity and accessibility of equipment, material, and personnel from work areas may be limited by tidal effects.

10.0 Summary of Comparative Analysis of Alternatives

The EPA uses nine NCP criteria to evaluate remedial alternatives for the cleanup of a release. These nine criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met in order for an alternative to be eligible for selection. The threshold criteria are overall protection of human health and the environment and compliance with Applicable or Relevant and Appropriate Requirements (ARARs). The balancing criteria are used to weight major tradeoffs among alternatives. The five balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost. The modifying criteria are state acceptance and community acceptance.

10.1 Threshold Criteria

10.1.1 Overall Protection of Human Health and the Environment

Alternatives 2 through 6 are protective of human health and environment because they are designed to comply with ARARs, achieve RAOs and reduce contaminant concentrations to acceptable levels, which are within the protective PRG ranges. Although not all individual sediment stations, domains, and creeks meet the CULs, such as mercury in the Domain 3 Creek (Table 26), they are protective of the local ecosystem when the creeks and/or domains are considered collectively.

Each alternative results in reduction of mercury sediment concentrations. All the creeks and domains meet the 2 mg/kg mercury SWAC CUL, except Domain 3 Creek (3.7 mg/kg) and the WCC (2.1 mg/kg). Only very small discontinuous segments in these two creeks that comprise approximately three percent of the total creeks habitat exceed the CUL. However, when all creeks are combined, the mercury SWAC CUL is met (Table 26).

Under each alternative (except the no-action alternative) all creeks and domains will be reduced to below the SWAC PRG of 4 mg/kg for Aroclor 1268, which is within the acceptable risk range. Compared to Alternatives 2, 3 and 6, Alternatives 4 and 5 are less protective because they do not result in a change in the Aroclor 1268 exposure concentration of 3.6 mg/kg in Purvis Creek (Table 26) which is above the CUL of 3 mg/kg. Mercury is further reduced in the Purvis Creek and in Domain 1 marsh under Alternative 6.

Each alternative (except no-action) is predicted to result in reductions of mercury and Aroclor 1268 levels in finfish and shellfish concentrations sufficient to meet fish tissue goals for human health (Table 19) and justify an eventual end to the consumption advisories within the TRBE. These reductions are likely to be observed only after several years post remediation.

The larger remedy footprint associated with Alternatives 2 and 3 were based on cleanup to the lower end of the benthic community PRG range and achieve lower residual COC concentrations than the smaller remedy footprints associated with Alternatives 4, 5 and 6.

Cleanup to the lower end of the benthic PRGs may be unnecessary to be protective since the entire range is protective and would result in more physical impacts to existing benthic community habitat.

Surface water quality is expected to improve with each alternative except the No Action Alternative. Therefore, the ambient water quality criteria for protection of aquatic life are expected to be achieved, as will the requirements of RAO 6. It remains to be seen whether any of the alternatives will be able to achieve the surface water quality PCB ARAR for protection of human health (i.e., 0.000064 µg/L), which is very low. The lower surface sediment COC concentrations achieved by each of the alternatives, except the No Action Alternative, will substantially decrease the potential for the suspension and transport of contaminated sediment particles. Alternatives 2 through 6 are expected to achieve federal and state water quality criteria for dissolved-phase and total mercury and Aroclor 1268.

10.1.2 Compliance with ARARs

Section 121(d)(2) of CERCLA requires that remedial actions must comply with federal and more stringent state environmental laws or regulations that are legally "applicable" or "relevant and appropriate" (commonly referred to as "ARARs") under the circumstances of the release or threatened release of such hazardous substance or pollutant or contaminant. Further, the NCP at 40 CFR § 300.435(b)(2) requires remedies to attain, or waive under CERCLA Section 121(d)(4), ARARs during the course of a remedial action.

For ease of identification, EPA has classified ARARs into three categories, chemical-, action-, and location-specific. *Chemical-specific* ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numeric values. These values establish an acceptable amount or concentration of a chemical that may remain in, or be discharged to, the ambient environment. *Location-specific* ARARs are restrictions on hazardous substances or the conduct of response activities solely based on their location in a special geographic area (e.g. wetlands, watersheds, floodplains, sensitive habitats, coastal zones, historic places). *Action-specific* ARARs are technology- or activity-based requirements or limits on actions taken with respect to particular hazardous substance or waste type (*e.g.*, RCRA hazardous waste or TSCA PCB waste). These requirements are triggered by a particular remedial activity (*e.g.*, excavate soil, stage waste in pile or containers, treat, dispose, emit, discharge to surface water, cap with waste in place, etc.).

The State of Georgia surface water quality standard for mercury and total PCBs (i.e., the standard for protection of human health [via fish consumption] of 0.025 µg/L dissolved mercury and 0.000064 µg/L for total PCBs).

Due to these exceptionally low concentrations, it may not be feasible for the remedial action to attain Georgia's water quality criteria in the surface water bodies impacted by this Site. Once the remedial action has been implemented and remedy effectiveness monitored for a number of years (including surface water quality), the EPA will evaluate

whether a waiver under CERCLA Section 121(d)(4)(C) of these chemical-specific standards is warranted at this Site. As required in CERCLA and the NCP, any waiver of an ARAR must be documented in a ROD (or an Amended ROD) and must include a justification for invoking the waiver.

Federal and State of Georgia ARARs (Chemical-, Location- and Action-specific) for the OU1 selected remedy are provided in Table 27.

10.2 Balancing Criteria

10.2.1 Long-Term Effectiveness and Permanence

Other than the No Action Alternative, all alternatives include measures for long-term human health and ecological risk reduction by targeting site-specific exceedances of CULs for removal, capping, or thin-layer placement, thus reducing risk of exposure to contaminated material. Sediment removal, sediment capping, and to a lesser degree thin-layer placement have been found reliable and effective at sites similar to the LCP Chemicals marsh.

Sediment removal would permanently remove COCs from the LCP Chemicals marsh and backfilling would address residuals. Capping and thin-layer covers are engineered to account for hydrodynamic conditions to ensure their permanence. Overall the LCP Chemicals marsh is characterized as stable and relatively resistant to scour and sediment re-suspension. The results from hydrodynamic model simulations demonstrated relatively low velocities (generally less than 2 feet per second [ft/sec]) throughout the LCP Chemicals marsh during spring-neap tidal cycles, 100-year flood conditions, and hurricane storm surge conditions. Velocities that could result in cap material instability are addressed through armoring to minimize or prevent erosion. The thin-layer covers are only placed in low-energy areas in marsh habitat and not in the creeks. This substantially reduces erosion of the cover that may occur from major storm events. Figure 29 shows the maximum predicted current velocity for existing conditions under hurricane storm surge. The figure shows that, under hurricane conditions, maximum scour would be expected in Purvis Creek and certain portions of the LCP Ditch and the Eastern Creek. Under hurricane conditions, the marsh flats are predicted to have maximum current velocities of less than 0.25 feet per second.

Materials for sediment capping and thin-layer placement will be sized to ensure protection against erosion and scour. However, the thin-layer cover is not an armored contaminant barrier. Based on several case studies, some burrowing and other types of biological activities will occur in the thin-layer cover, but are not expected to significantly impact its effectiveness in reducing exposures to the benthic community. These covers are also only being used in areas where erosion potential is low. Monitoring and maintenance will be performed as necessary to ensure long-term remedy effectiveness.

ICs (e.g., land use or deed restrictions, maintenance agreements, permits limiting land use for future activities and fish consumptions advisories) will be used, as necessary, to

control residual risks following remedy implementation. In addition, LTM ensures confirmation of long-term structural integrity and effectiveness.

10.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 provides no reduction in risk to humans or the environment beyond current on-going natural processes. In Purvis Creek, there is evidence that mercury concentrations in fish and shellfish tissue have decreased over time. However, there is no clear evidence that Aroclor 1268 fish tissue concentrations have decreased in Purvis Creek. Therefore, Alternative 1 may not satisfy the RAO goals over the long-term. It is not clear how long it would take to reduce fish tissue levels, and without monitoring, risk reduction cannot be confirmed. Therefore, the No Action Alternative does not provide adequate risk reduction or adequately address residual risk for human health and some ecological receptors.

All of the other alternatives include varying degrees of sediment removal, which reduces the volume of COC-impacted sediment in the marsh following remedy implementation. Where alternatives include sediment capping and thin-layer placement, long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials. The thin-layer cover is not intended to function as an absolute contaminant barrier, but as a layer which will stimulate ongoing natural recovery processes, which is limited in its capacity for rapid natural recovery because of low background sedimentation rates. Therefore, some possible bioturbation beyond the cover depth is not expected to diminish the effectiveness of this remedy and would not preclude its beneficial use as a component of a protective remedy.

Alternatives 2 through 6 target cleanup of sediments that exceed benthic cleanup levels. Although these alternatives achieve an acceptable risk level for the benthic community and are expected to meet RAO 4, residual risks may occur with varying degrees of uncertainty. Alternatives 2 and 3 are expected to have less residual risks to the benthic community than Alternatives 4, 5 and 6, because they remove more contaminant mass.

Sediment removal reduces long-term risks of exposure since contaminated material is removed. Backfilling addresses dredge residuals that otherwise pose risks. Capping and thin-layer cover placements, which leave contaminant material in place, isolate COCs and reduce bioavailability and mobility through burial with clean material.

Residual risks posed by COCs left un-remediated are addressed through ICs (including permit requirements, which are already in place to limit use or future activities in the LCP Chemicals marsh and fish consumption advisories) and LTM. The ICs and LTM will help ensure the remedy's long-term structural integrity and effectiveness in reducing COC concentrations in fish/shellfish as well as the achievement of RAO 4 for the affected benthic community.

10.2.3 Short-Term Effectiveness

Implementation of any alternative, other than the No Action Alternative, presents short-term impacts associated with on-site construction and remediation operations. As indicated below, the extent of these impacts is proportional to the remedial footprint, the sediment removal volume, the selected remedy components, the time required to complete the remedy, and on-site material handling requirements. Alternative 2 includes the removal of 153,000 CY of contaminated sediment material from 48 acres of OU1 and construction is estimated to span 3-to-4 years. Thus, Alternative 2 poses greater short-term risks and potential impacts to human health and the environment than the rest of the alternatives.

Alternatives 3 and 4 require the removal, transportation, and disposal of 27,000 and 57,000 CY of contaminated material from nine and 18 acres, respectively. These volumes represent approximately 18 percent and 37 percent, respectively, of the 153,000 CY volume considered for removal in Alternative 2. Based strictly on the volume of contaminated materials to be removed, Alternative 2 poses greater short-term impacts than Alternative 3 and 4. These negative impacts primarily relate to extensive use of heavy equipment for dredging and the transport of contaminated sediments through the community to an uplands disposal facility and clean material transport to the Site. Since the negative short-term human health and ecological impacts of sediment capping and thin-layer cover placement are generally associated with transportation of the clean material and heavy equipment usage, short-term effectiveness strongly correlates to the duration of construction activities. The longer the construction time, the more risk of such negative impacts. These impacts can be managed by best management practices (BMPs) and site-specific safety plans. The estimated construction duration for the alternatives range from two years (Alternative 4, 5 and 6) to three-to-four years for Alternatives 2 and 3. Thus, 4, 5 and 6 provide greater short term effectiveness than Alternatives 2 and 3 by one-to two years.

Since the risk of sediment re-suspension increases during excavation, the greater the volume of sediment excavated, the greater the impacts to adjacent areas by the re-suspended sediment.

10.2.4 Implementability

There are no implementability constraints for the No Action Alternative because no remedial action is taken.

Portions of each other alternative pose different challenges and technical difficulties associated with remedy implementation. Since tides in the LCP Chemicals marsh will severely affect accessibility to equipment, material and personnel, productivity will be severely impacted, regardless of whether a land- or water-based operation is employed. An example of this is presented by the WCC, as discussed in detail in Section 9.2.6. To summarize:

- The WWC is accessible only from Upland areas because the contaminated limb is narrow and completely drains at low tide;
- Land-based access to the WCC requires construction of temporary roads for access. Construction and use of these elevated roads would have negative impacts on the marsh;
- Because the areas with higher contaminant concentrations within the WCC are discontinuous and isolated from other areas in the creek complex, capping discrete areas would result in the creation of troughs and valleys within the narrow and shallow WCC. These troughs would restrict flow, especially at low tide, and would negatively impact the marsh surrounding the creek;
- Finally, pre-remediation SWAC of mercury in the WCC is already 2.1 mg/kg and the Aroclor 1268 is 3.0 mg/kg. Active remediation would reduce it 1.2 mg/kg and 1.7 mg/kg, respectively. The small reduction in risk does not appear to justify the negative impacts to the marsh.

Implementation of any remedial technology (whether sediment removal, sediment capping or thin-layer placement) will encounter the following constraints:

- As with other sediment remediation projects, the removal, transportation, off-loading, dewatering/solidification, and disposal of contaminated sediment and debris present significant implementation challenges, such as traffic management, noise control, and suitable disposal facility capacity identification.
- Scattered debris has been observed throughout the LCP Chemicals marsh, including large stone lining the banks of the LCP Ditch. Debris within removal areas will be removed and disposed of off-site during remedy implementation.

There are technologies and techniques available to meet the challenges associated with working in soft sediments in tidally influenced marsh areas. These include employing low-ground-pressure earth-moving equipment, telescoping conveyor belts for cap placement, shallow draft barges for water-based sediment removal and sediment capping, and hydraulic equipment to place thin-layer material. Most of these issues will be resolved during design and the construction bidding process.

10.2.5 Cost

A summary of the remedial alternative costs are presented in Table 28. Thirty-year net-present value costs for each alternative, calculated with a 7 percent discount rate, were presented for each alternative. The basis of cost estimates and assumptions made in developing these estimates are detailed in Appendix H of the FS.

10.3 Modifying Criteria

10.3.1 State/Support Agency Acceptance

The State of Georgia concurs with the selected remedy (see concurrence letter in Appendix B).

10.3.2 Community Acceptance

The public comments to the EPA's Proposed Plan were generally supportive of a more robust cleanup of the LCP Chemicals marsh that should proceed without undue delay. However, this support was not without significant concerns and additional desires. The comments received during the public comment period are summarized and addressed in the Responsiveness Summary, Part 3 of this ROD.

A large number of comments expressed the desire to clean up 48 acres of the Site, as reflected in Alternatives 2 or 3 of the Proposed Plan. Several commenters opposed the preferred remedy because it was not extensive enough and that leaving contamination in the marsh was simply postponing the final resolution of the problem to future generations.

Most of the comments were highly technical and questioned the methodologies used in the human health and ecological risk assessments. The primary human health concerns were that the seafood consumption scenarios were not conservative (protective) enough and the lack of including potential risks from dioxins and furans. These issues would subsequently impact the cleanup levels that would likely result in more remediation sediments in the LCP Chemicals marsh. The primary concerns with the ecological risk assessment were that more receptors should have been included such as dolphins, mink, and manatees. The assertion of including these sensitive receptors would likely change the cleanup levels.

There were a number of concerns pertaining to statements regarding the long-term monitoring (LTM) plan without any details provides in the Proposed Plan. Several technically knowledgeable groups submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, extent of contamination outside the current Superfund Site boundaries, cleanup levels, mercury cycling, exposure assumptions, statistical treatment of data, impact of dioxins/furans, and effectiveness of thin-cover placement.

11.0 Principal Threat Wastes

The NCP establishes the expectation that treatment will be used to address the principal threats posed by a site whenever practicable (40 CFR 300.430[a] [1] [iii] [A]). In general, principal threat wastes (PTW) are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner, or will present a significant risk to human health or the environment should exposure occur.

The PTW in LCP Chemicals marsh included mercury at concentrations over 1,000 mg/kg and PCBs in concentrations above 1,000 mg/kg. They were successfully excavated during the removal action at the Site in 1998-1999, when more than 13 acres of saltwater tidal marsh, including vegetated tidal flats and small drainage channels located immediately adjacent to the Uplands, were removed. In addition, more than 2,650 linear feet of tidal channels contaminated with PTW were also partly excavated. The residual lower-level threat mercury and Aroclor 1268 waste will be addressed by this action. However, the selected remedy (Alternative 6) does not use treatment to address the residual contamination. Therefore, remedy does not meet the preference for treatment.

12.0 Documentation of Significant Changes to the Selected Remedy

There have been to significant changes to the Selected Remedy from the Proposed Plan.

13.0 Selected Remedy

Based on CERCLA requirements, the detailed analysis of remedial alternatives, and consideration of public comments, EPA selects Alternative 6 as the Selected Remedy for the LCP Chemicals OU1- marsh. This section provides EPA's rationale for the Selected Remedy, and a description of its anticipated scope, how the remedy will be implemented, and its expected outcomes.

13.1 Summary of the Rationale for the Selected Remedy

The Selected Remedy is protective of human health and the environment. Risks are reduced through the removal of the highest concentrations of mercury and Aroclor 1268-contaminated sediment currently located in the LCP Ditch and the Eastern Creek. Tidal channels least impacted by tidal scouring will be dredged and stabilized with clean backfill. Armored caps will be placed over contaminated sediments in scour-prone tidal areas, to protect the sediments from tide induces scour. In addition, lead and PAHs present in the Domain 3 creek will be isolated under an armored cap. The low mercury and Aroclor 1268 concentrations present on the marsh surface flanking the tidal channels will be addressed through a thin-layer sand placement. The Selected Remedy (Alternative 6) will comply with ARARs and is protective of human health and the environment.

Although the Selected Remedy will leave elevated concentrations of mercury and Aroclor 1268 in isolated portions of Domain 3 Creek and in the WCC that exceed benthic CULs, the SWAC CULs are met. Long-term monitoring in these two creeks should confirm that residual contamination does not pose an adverse risk to fish, wildlife, and humans.

While Alternatives 4 and 5 addresses most contaminants above the CULs except in the WCC, Upper Domain 3 Creek, and in Purvis Creek, the Selected Remedy additionally addresses the majority of areas in Purvis Creek above the CUL. Each of the alternatives provide for long-term human health and ecological risk reduction by decreasing surface sediment COC concentrations, which leads to reduced chemical mobility and chemical uptake by human and ecological receptors, which in turn leads to reduced risks to human health, mammals, birds, fish, and the benthic community. LTM will measure the long-term remedy integrity and effectiveness.

The Selected Remedy prevents or minimizes COC contaminated in-stream sediment from entering Purvis Creek. The remedy removes the highest COC concentrations in OU1; i.e.; the LCP Ditch, Eastern Creek, Domain 3 Creek and Purvis Creek, without undue harm to the existing habitat. The larger remedy footprints of Alternatives 2 and 3 are based on conservative assumptions related solely to the predicted increase in protection of benthic communities, even though the benthic CULs are still protective. The additional impacts to the marsh, with the goal of protecting benthic organisms, does not significantly increase the remedy's effectiveness for protecting of fish, wildlife, and humans, where bioaccumulation of mercury and Aroclor 1268 is of paramount concern.

The Selected Remedy meets the site-specific RAOs insofar as it achieves the sediment CULs for the COCs. Furthermore, post-remediation HQs for all species, including the most sensitive species (green heron), are at or below 1 for all alternatives. Thus, the five alternatives reduce sediment concentrations to acceptable levels, especially when considering spatial forage areas of wildlife and movement of forage prey. Each alternative is predicted to achieve total creek and total marsh SWACs that meet the SWAC CULs, leading to reductions of mercury and Aroclor 1268 in fish and shellfish. After several years post-remediation, reductions are expected to result in reducing fish and shellfish consumption advisories within the Turtle River Brunswick Estuary.

The Selected Remedy reduces risks to benthic organisms exposed to contaminated sediment to levels that are consistent with the benthic community CULs. The Selected Remedy is also expected to reduce finfish exposures to COCs to acceptable levels. Long-term monitoring will be conducted to monitor the reduction of levels in sediment, surface water and fish tissue.

The Selected Remedy is expected to meet the applicable EPA and Georgia Water Quality Standards for protection of aquatic life in the marsh, using total and dissolved-phase mercury and PCB measures. However, it may not be feasible to meet the State of Georgia surface water quality standard for mercury and total PCBs (i.e., the standard for protection of human health [via fish consumption] of 0.025 µg/L total mercury and 0.000064 µg/L for total PCBs). Once the remedial action has been implemented and remedy effectiveness monitored for a number of years (including surface water quality), the EPA will evaluate whether a waiver under CERCLA Section 121(d)(4)(C) of these chemical-specific standards is warranted at this Site. As required in CERCLA and the NCP, any waiver of an ARAR must be documented in a ROD (or an Amended ROD) and must include a justification for invoking the waiver.

The Selected Remedy balances human and ecological risk reduction with sustaining and protecting existing habitat and wildlife to varying degrees. Alternatives 2 and 3 addressed larger areas and thus have the potential for greater risk reduction, but more substantially impact the existing vegetated marsh habitat than the Selected Remedy. The Selected Remedy reduces the uncertainty in meeting the fish tissue goals by adding six acres of capping in Purvis Creek, thereby reducing the SWAC in Purvis Creek. The remedy also reduces the mercury and Aroclor 1268 SWACs in Domain 1 by extending the thin cover to a portion of Domain 1A to provide greater protection to the green heron.

For the marginal improvement in risk reduction for mammals, birds, fish, and benthic organisms, the dredge-only alternatives (Alternatives 2 and 3) are less cost efficient when compared to alternatives that combine and optimize the use of removal, capping, and thin-layer placement.

13.2 Description of Remedial Components

The selected remedy is consistent with EPA's preferred alternative outlined in the November 2014 Proposed Plan, and is consistent with Alternative 6, as described in the

October 2014 Public Comment Draft FS. The following is a brief description of each of the components of the Selected Remedy.

13.2.1 Active Cleanup of 24 Acres

Apply active cleanup technologies in a total of 24 acres of sediment, as described in Section 9.2.6 and shown in Figure 28. The major components of the remedy are as follows:

- Dredge of seven acres (22,000 CY) of the LCP Ditch and Eastern Creek to a target depth of 18 inches and backfill with 12 inches of clean material. Dredged sediments will be taken to a licensed disposal facility;
- Place of 14,000 CY of engineered sediment cap on six acres of the Domain 3 Creek and Purvis Creek South;
- Place 13,000 CY of thin-layer sand on eleven acres of the Dillon Duck, Domain 1A and Domain 2 to reduce exposures and enhance natural recovery. A detailed evaluation regarding material types and specifications for the thin-cover layer will take place during remedy design;
- Sample and analyze PCDD/PCDF during remedial design to confirm co-location with Aroclor 1268 (see Section 13.2.2);
- LTM, including biological monitoring;
- ICs throughout the LCP Chemicals marsh – i.e., community outreach as well as posting and maintenance of signs advising against the consumption of fish where they are unsafe for regular consumption; and
- Five-Year Reviews.

13.2.2 Confirm Co-Location of PCDDs/PCDFs with Aroclor 1268

Existing PCDD/PCDF and Aroclor 1268 sediment data support the conclusion that the PCDDs and PCDFs are co-located with Aroclor 1268. Sufficient sampling in Domains 1, 2 and 3 will be undertaken during the Remedial Design phase to confirm that the PCDDs and PCDFs are co-located located with the Aroclor 1268. In the event that they are not co-located, a ROD Amendment may be required.

13.2.3 Long-Term Monitoring Program

Monitoring plans are recommended during and after remedial action. Monitoring is conducted for a variety of reasons, including: 1) to assess compliance with design and performance standards; 2) to assess short-term remedy performance and effectiveness in meeting sediment cleanup levels; and/or 3) to evaluate long-term remedy effectiveness in achieving RAOs and in reducing human health and/or environmental risk. In addition, monitoring data are usually needed to complete the five-year review process where a review is conducted.

A sediment remedy typically is one where the sediment contaminant CULs and/or target tissue levels have been met and maintained over time, and where all relevant risks have

been reduced to acceptable levels. Due to the potential for post-remedial residual contamination or the inability to control all significant sources of contamination to the water body, reaching sediment or biota levels resulting in unlimited exposure and unrestricted use may take many years if not a few decades. However, it is expected that contamination in biota within the LCP Chemicals marsh will be substantially reduced after several years post-remediation.

The focus of the long-term monitoring plan (LTMP) is to verify:

- risk reduction to acceptable levels;
- meet RAOs and clean-up levels; and
- the physical integrity of remedy construction elements, specifically the caps; and the assumptions used in remedy selection, such as the sediment concentrations in thin-layer areas affected by burrowing organisms.

The primary purpose of the LTMP framework is to provide an overview of the data needed to assist in determining remedy effectiveness and is organized to cover each of the following major data acquisition programs:

- Sediment monitoring;
- Water column monitoring;
- Fish and shellfish monitoring;
- Cap and thin-layer cover monitoring; and
- Benthic community assessment and re-vegetation of disturbed areas.

Appendix A contains the framework outline for the LTMP, which will be further developed during the Remedial Design phase. Target fish and shellfish tissue concentrations are listed in Table 19.

13.2.4 Institutional Controls

The selected remedy requires a fishing advisory, installation of signs, public outreach and implementation of a plan to gauge the effectiveness of these measures.

To ensure that information is received by the target fishing population, the EPA will undertake public outreach and education. The EPA understands that many of the more intensive users of the St. Simons estuary (i.e., those potentially eating the most fish caught from the area) are likely from minority and lower-income groups. The EPA will take steps to ensure that outreach activities are developed and implemented to also identify and target these specific groups. This will likely include continued posting of signs using pictograms and in multiple languages, such as English and Spanish. The EPA may also prepare outreach materials, such as public service announcements and internet postings targeted to these specific groups.

13.2.5 Five-Year Reviews

The selected remedy leaves waste in place above levels that allow for unlimited use and unrestricted exposure, therefore CERCLA requires periodic reviews of the remedy. A statutory review will be conducted at least every five years to evaluate the protectiveness of the remedy. The purpose of these five-year reviews is to evaluate the implementation and performance of the remedy in order to determine if the remedy is or will be protective of human health and the environment. The five-year review will document recommendations and follow-up actions as necessary to ensure long-term protectiveness of the remedy.

13.3 Summary of Estimated Remedy Costs

The total estimated cost of the selected remedy is approximately $28.6 million. A summary table of the major capital and annual operation, maintenance; and monitoring cost elements for each component of the selected remedy is shown in Table 29. The discount rate used for calculating total present worth costs was 7 percent.

The information in these cost estimate summary tables are based on the best available information regarding the anticipated scope of the selected remedy. Changes in the cost elements are likely to occur as a result of new information and data which may be obtained during the pre-design phase. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

13.4 Expected Outcomes of Selected Remedy

Expected residual risks associated with the preferred remedy include:

- RAO 1 – Minimal residual risks would be expected since the primary contaminated source areas in the LCP Ditch and Eastern Creek would be dredged. Residual contamination in the WCC and Domain 3 Creek is not expected to contribute any substantial releases of COCs to Purvis Creek.
- RAO 2 – LOAEL risks to piscivorous birds and mammals will be reduced to an HI of 1 or less. Fish tissue concentrations are expected to be reduced within several years after post construction. Monitoring of fish and shellfish will occur to assess remedy effectiveness.
- RAO 3 – The predicted high quantity finfish consumer excess cancer risk for Aroclor 1268 will be reduced to acceptable levels. Similar to RAO 2, the fish tissue concentrations are anticipated to decrease several years after construction is complete and a corresponding decrease in the limitations of the fish advisories.
- RAO 4 – Residual risks to the benthic community may occur in those areas where COC concentrations exceed the CULs, such as in isolated areas in the WCC and in Domain 3. However, it is not expected that these relatively isolated exceedances would adversely impact the overall benthic community in the various creeks and domains.

- For RAO 5 – LOAEL finfish exposures would be reduced to HQs less than 1, with the possible exception of stripped mullet (a bottom feeder) exposure to Aroclor 1268.
- RAO 6 – It is anticipated that the applicable EPA and State of Georgia water quality standards for protection of aquatic life will be met after construction is complete and that any residual risks from COCs in surface water would not be significant.

14.0 Statutory Determinations

The remedial action selected for OU1 at the LCP Chemicals marsh is consistent with CERCLA and, to the extent practicable, the NCP. The Selected Remedy for the LCP Chemicals marsh is protective of human health and the environment, will comply with ARARs and is cost effective. In addition, the Selected Remedy utilizes permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable, and although it does not satisfy the statutory preference for treatment, the Selected Remedy does significantly reduce the mobility of contaminants that could be considered a principal threat. Removal, capping and thin-layer sand placement of mercury and PCB contaminated sediments have been demonstrated to be reliable for this type of contamination and reduces mobility and accessibility through physical isolation and immobilization of the contaminants through capping.

14.1 The Selected Remedy is Protective of Human Health and the Environment

The remedy for the LCP Chemicals marsh will adequately protect human health and the environment by eliminating or controlling exposures to human and environment receptors through engineering controls and ICs as described in Section 13.2.

The Selected Remedy will reduce potential human health non-cancer risk levels such that they do not exceed EPA's acceptable hazard index of 1. Similarly, risks to ecological receptors will be reduced to acceptable levels below the LOAEL. The remedy will comply with ARARs and To Be Considered criteria, as specified in Table 27.

Implementation of the Selected Remedy will not pose any unacceptable short term risks or cause any cross-media impacts.

14.2 The Selected Remedy Complies with ARARs

Section 121(d) of CERCLA, as amended, specifies, in part, that remedial actions for cleanup of hazardous substances must comply with ARARs or obtain a waiver under CERCLA Section 121(d)(4). *See also* 40 CFR § 300.430(f)(1)(ii)(B). ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. Compliance with Occupational Safety and Health Administration (OSHA) standards is required by 40 CFR § 300.150 and therefore the CERCLA requirement for compliance with or wavier of ARARs does not apply to OSHA standards.

Key ARARs for the LCP Marsh include the Clean Water Act restrictions on the discharge of dredged material into the waters of the U.S., the State of Georgia’s regulations on construction in coastal marshlands, and the federal laws and regulation that protect marine mammals, migratory birds, and endangered species.

Under CERCLA Section 121(e)(1), federal, state, or local permits are not required for the portion of any removal or remedial action conducted entirely on-site as defined in 40 CFR § 300.5. *See also* 40 CFR §§ 300.400(e)(1) & (2). Also, on-site CERCLA response

actions must only comply with the "substantive requirements," not the administrative requirements of a regulation. Administrative requirements include permit applications, reporting, record keeping, and consultation with administrative bodies. Although consultation with state and federal agencies responsible for issuing permits is not required, it is recommended for determining compliance with certain requirements such as those typically identified as Location-specific ARARs.

In accordance with 40 CFR § 300.400(g)(5), the EPA and State of Georgia have identified the ARARs and TBCs for the selected remedy. Table 27 lists respectively, the Chemical-specific, Location-specific and Action-specific ARARs for the selected remedy. The Selected Remedy is expected to attain all identified ARARs, so a statutory waiver is not necessary at this time. *See* 40 CFR § 300.430(f)(5)(ii)(B).

14.3 The Selected Remedy is Cost Effective

The Selected Remedy is cost-effective because the remedy's costs are proportional to its overall effectiveness (see 40 CFR 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all federal and any more stringent ARARs, or as appropriate, waive ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each alternative then was compared to the alternative's costs. The Selected Remedy was determined have the best tradeoffs for the cost.

14.4 The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The NCP establishes an expectation that the EPA will use treatment to address the principal threat posed at a site wherever practicable (Section 300.430(a)(1)(iii)[A]). In practice, the "principal threat" concept is applied by the EPA to the characterization of "source materials" at a Superfund site. A source material includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to groundwater, surface water or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The LCP Chemicals marsh mercury and Aroclor 1268 contaminated sediments being addressed by this action are considered low-level threat waste. Sediments considered to be a principal threat were addressed by previous removal actions. However, capping has been demonstrated to be reliable containment remedies for this type of contamination.

14.5 The Selected Remedy Does Not Satisfy the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

The selected remedy for the LCP Chemicals marsh does not satisfy the statutory preference for treatment as a principal element of the remedy. The sediment that is addressed in this ROD has been classified as low-level threat. Because of the relatively high volume of sediments involved, and the concentrations of mercury and Aroclor 1268 involved, treatment of sediments was not considered practical. The toxicity, mobility and volume of mercury and Aroclor 1268 in sediments will be significantly reduced through dredging and physically isolating the contaminated sediments from the aquatic environment. *In situ* caps are generally accepted as reliable containment for contaminated sediment.

14.6 Five Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure, a CERCLA statutory review is required and will be conducted every five years after initiation of remediation to ensure that the remedy is, or will be, protective of human health and the environment.

15.0 Key Terms

Administrative Record (AR): Documents, including correspondence, public comments, Records of Decision and other decision documents, and technical reports upon which the agencies base their remedial action selection.

Amphipod: A small, shrimp-like crustacean.

Apparent effects threshold (AET): A sediment effects concentration representing the sediment concentration above which a particular effect always occurs. The AET is the concentration above which all of the sediment samples were observed to be toxic.

Applicable or Relevant and Appropriate Requirements (ARARs): ARARs are any promulgated standards, requirements, criteria, or limitations under federal environmental laws, or any promulgated standards, requirements, criteria, or limitations under state environmental or siting laws that are more stringent than federal requirements, that are either legally 'applicable or relevant and appropriate' under the circumstances. Under CERCLA Section 121(d), a remedial action must comply (or justify a waiver) with ARARs.

Aroclor: A discontinued registered trademark for a series of PCB compounds. Aroclors were first sold in 1930. It was available as viscous oils and thermoplastic solids with high refractive indices. Aroclors are no longer used because of its high toxicity. Aroclor production was discontinued in the United States in 1977.

Aroclor 1268: A polychlorinated biphenyl mixture where the second two numbers indicate the percentage of chlorine by mass in the mixture. Hence, Aroclor 1268 means that the PCB mixture contains approximately 68 percent chlorine by weight.

Assessment Endpoint: An explicit expression of a valuable aspect of the ecology to be evaluated in the ecological risk assessment. This is generally some characteristic(s) of a species of plant or animal, such as reproduction, that can be described numerically.

Baseline Risk Assessment (BRA): A qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and the environment by the presence or potential presence of specific contaminants.

Benthic invertebrates: Small but visible animals (e.g., insects, worms, clams, and snails) that live in or on the sediment at the bottom of a marsh, lake, or stream.

Bioaccumulation: The uptake and storage of chemicals by living animals and plants. This can occur through direct contact with contaminated water or sediment or through the ingestion of another organism that is contaminated. For example, a small fish might eat contaminated algae, a bigger fish might eat several contaminated fish and a human might eat a bigger, now-contaminated fish. Contaminants typically increase in concentration as they move up the food chain.

Bioavailability: Degree of ability to be absorbed and metabolized in an organism.

Biomagnification: A process causing an increase in concentration of a substance in the tissues of predator relative to the concentration in the tissues of its prey. Biomagnification causes chemical concentrations to increase with passage through the food web from lower trophic levels to higher trophic levels.

Bioturbation: The process whereby bottom dwelling and burrowing organisms mix-up sediment and destroy primary layering.

Cancer slope factor (CFS): Used to estimate the risk of cancer associated with exposure to a carcinogenic or potentially carcinogenic substance. A slope factor is an upper bound, approximating a 95 percent confidence limit, on the increased cancer risk from a lifetime exposure to an agent by ingestion or inhalation.

Central tendency exposure (CTE): An estimate of the average experienced by the affected population, based on the amount of chemical present in the environment and the frequency and duration of exposure.

Chemical of Concern (COC): A hazardous substance or group of substances that pose unacceptable risk to human health or the environment at a site.

Chlor-alkali: There are three production methods for producing chlorine and sodium hydroxide in use. The mercury cell method produces chlorine-free sodium hydroxide. In a normal production cycle a few hundred pounds of mercury per year are emitted, which accumulate in the environment. Additionally, the chlorine and sodium hydroxide produced via the mercury-cell chlor-alkali process are themselves contaminated with trace amounts of mercury. The membrane and diaphragm method use no mercury, but the sodium hydroxide contains chlorine, which must be removed.

Clapper Rail: The Clapper Rail is a chicken-sized game bird that rarely flies. It is grayish brown with a pale chestnut breast and a noticeable white patch under the tail.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): A federal law (also known as Superfund) passed in 1980 and modified in 1986 by the Superfund Amendment and Reauthorization Act (SARA); the act authorizes EPA to investigate and cleanup abandoned or uncontrolled hazardous waste sites. The law authorizes the federal government to respond directly to releases of hazardous substances that may endanger public health or the environment. EPA is responsible for managing the Superfund.

Dewatering: Removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes, such as removal of residual liquid from a filter cake by a filter press as part of various industrial processes.

Dioxin/furans: Dioxins and furans are the abbreviated or short names for a family of toxic substances that all share a similar chemical structure. Dioxins, in their purest form, look like crystals or a colorless solid. Most dioxins and furans are not man-made or produced intentionally, but are created when other chemicals or products are made. Of all of the dioxins and furans, one, 2,3,7,8-tetrachloro-p-dibenzo-dioxin (2,3,7,8 TCDD,) is considered the most toxic.

Discharge: Flow of surface water in a stream or the outflow of groundwater from a flowing well, ditch, or spring. It can also apply to release of liquid effluent from a facility or to chemical emissions into the air.

Ecological Risk Assessment (ERA): The application of a formal framework, analytical process, or model to estimate the effects of human actions on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose/response assessments, and risk characterization.

Effects range-low (ER-L): A sediment effects concentration representing the lower 10^{th} percentile of sediment concentrations associated with a particular effect. The ER-L is where the effects of the toxicant begin to manifest at a rate of about 10 percent.

Effects range-median (ER-M): A sediment effects concentration representing the median concentration of sediment associated with a particular effect. The ER-M is the sediment effects concentration above which about 50 percent of the sediment samples are expected to be toxic. Like a PEL, an ER-M is a sediment concentration above which a particular effect is likely to occur.

Feasibility Study (FS): A study of the applicability or practicability of a proposed action or plan conducted after the Remedial Investigation to determine what alternatives or technologies could be applicable to clean up the site-specific COCs.

Grass shrimp: A very small shrimp that lives among the marsh grasses in fresh and brackish waterways in many parts of the eastern United States. They are pinkish in color but so pale as to be almost transparent, with yellowish eye stalks protruding from their heads. These shrimp are also sometimes called popcorn shrimp.

Hazard Index (HI): The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways.

Hazard Quotient (HQ): The ratio of an exposure level to a substance to a toxicity value selected for the risk assessment for that substance.

Heavy metals: Metallic elements with high atomic weight, e.g., mercury, chromium, cadmium, arsenic, and lead. They can damage living things at low concentrations and tend to accumulate in the food chain.

Herbivorous: Animals that feed on plants.

Human Health Risk Assessment (HHRA): A qualitative and quantitative evaluation performed in an effort to define the risk posed to human health by the presence or potential presence of specific contaminants.

Information Repository: A library or other location where documents and data related to a Superfund project are placed to allow public access to the material.

In situ: Situated in the original, natural, or existing; not having been moved to another location.

Institutional Control (IC): Restriction that prevents an owner inappropriately using a property. The restriction is designed to reduce exposure to hazardous substances for workers or the general public and maintain the integrity of the remedy.

Lowest-observed-adverse-effects-level (LOAEL): The lowest level of a chemical stressor evaluated in a toxicity test that shows harmful effects on a plant or animal.

Macroinvertebrate: An invertebrate that is large enough to be seen without the use of a microscope.

Mercury Cell Process: In the mercury cell process, sodium forms an amalgam (a "mixture" of two metals) with the mercury at the cathode. The amalgam reacts with the water in a separate reactor called a decomposer where hydrogen gas and caustic soda solution at 50 percent are produced. The products are extremely pure. The chlorine gas, produced at the anode, contain a small amount of oxygen and can generally be used without further purification.

Methylation: The addition of a methyl group, CH3, to a molecule.

Mummichog: A small killifish found in the eastern United States. Also known as mummies, gudgeons, and mud minnows, these fish are found in brackish and coastal waters including estuaries and salt marshes along the eastern seaboard of the United States as well as the Atlantic coast of Canada. The mummichog is a popular research subject in toxicological studies.

Mysids: Mysida is an order of small, shrimp-like crustaceans in the malacostracan superorder Peracarida. Their common name opossum shrimps stems from the presence of a brood pouch or "marsupium" in females.

Nanogram (ng): One billionth of a gram.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): The federal regulations governing CERCLA cleanups and the determination of the sites to be

addressed under both the Superfund program and Oil Pollution Act to prevent or control spills into waters of the U.S. and elsewhere. 40 CFR Part 300 et seq.

National Priorities List (NPL): List of high priority sites with hazardous waste releases which may be addressed by EPA's Superfund program.

Net Present-Value Analysis/Present-Value Cost: A method of evaluation of expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different remedial action alternatives can be compared. When calculating present worth costs for Superfund sites, capital and O&M costs are included.

No observed adverse effect level (NOAEL): The highest level of a chemical stressor in a toxicity test that did not cause harmful effect in a plant or animal.

Omnivorous: An animal that eats food from both plants and animals, which may include eggs, insects, fungi and algae. Many rely on both vegetation and animal protein to remain healthy.

Operable Units (OUs): Separate activities undertaken as part of a Superfund site cleanup. Often a Superfund Site is divided in phases to better address different pathways and areas of contamination.

Persistence: Refers, in general, to the length of time a compound remains in the environment, once introduced. A compound may persist for less than a second or indefinitely.

Piscivorous: Describes a carnivorous diet that consists largely of fish, though a piscivorous diet may also include similar aquatic foods such as aquatic insects, mollusks and crustaceans.

Polycyclic Aromatic Hydrocarbons (PAHs): Also known as poly-aromatic hydrocarbons or polynuclear aromatic hydrocarbons, they are fused aromatic rings and do not contain heteroatoms or carry substituents. Naphthalene is the simplest example of a PAH. PAHs occur in oil, coal, and tar deposits and are produced as byproducts of fuel burning (whether fossil fuel or biomass).

Polychlorinated Biphenyl (PCB): A high molecular-weight halogenated organic compound formerly used in dielectric fluids in transformers and other electrical equipment.

Probable effects level (PEL): A sediment effects concentration above which a particular effect is likely to occur or below which no effect is expected to occur. It is calculated as the geometric mean of the ER-M and the 85^{th} percentile of the sediment concentrations where no effects were observed.

Proposed Plan: A Superfund public participation fact sheet that summarizes the preferred cleanup strategy for a Superfund Site.

Reasonable Maximum Exposure (RME): The maximum exposure reasonably expected to occur in a population.

Receptor: Entity exposed to a stressor.

Record of Decision (ROD): A legal, technical, and public document that identifies the selected remedy at a site, outlines the process used to reach a decision on the remedy, and confirms that the decision complies with CERCLA.

Reference Dose (RfD): An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's non-cancer health assessments.

Reference Station: A sampling station believed to be un-impacted by the site being investigated and used for comparison purposes.

Remedial Action Objectives (RAOs): They provide overall cleanup goals which guide the comparison and selection of remedial options.

Remedial Design (RD): A phase of remedial action that follows the remedial investigation / feasibility study and Record of Decision and includes development of engineering drawings and specifications for a site cleanup.

Remedial Investigation/Feasibility Study (RI/FS): A two-part investigation conducted to fully assess the nature and extent of a release, or threat of release, of hazardous substances, pollutants, or contaminants, and to identify alternatives for cleanup. The Remedial Investigation gathers the necessary data to support the corresponding Feasibility Study.

Remediation: Cleanup or other methods used to remove or contain a toxic spill or hazardous substances from a Superfund site.

Residuals: Contaminants that are left in place following remediation.

Responsiveness Summary: A summary of oral and written comments received by EPA during a comment period on key EPA documents, and EPA’s responses to those comments. The responsiveness summary is a key part of the ROD, highlighting community concerns for EPA decision-makers.

Sediment effect concentrations (SEC): Sediment quality guidelines used to predict sediment toxicity. Site-specific SECs were derived for the LCP Chemicals marsh based on the results of the chronic toxicity tests.

Semi-volatile Organic Compounds (SVOCs): Organic chemicals that evaporate slowly at standard temperature (70 degrees Fahrenheit).

Superfund: The common name for the program operated under the legislative authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), the federal law that governs cleanup of abandoned hazardous waste sites. The Superfund Amendments and Reauthorization Act (SARA) amended CERCLA on October 17, 1986.

Surface Weighted Average Concentrations (SWAC): The average contaminant concentration in the biologically active portion of sediment, that takes into account the surface area associated with each sample along with the concentration. SWACs are generally used when evaluating sediment exposures that occur over spatial scales that encompass multiple sample locations.

Thin-layer placement: The placement of a thin (typically six inches or less) layer of sediment, sand or amendments to reduce exposure to underlying sediments. Also referred to as thin-layer placement and enhanced natural recovery.

Threshold effects level (TEL): A sediment effects concentration above which a particular effect is expected to occur or below which effects are unlikely to occur. It is calculated as the geometric mean of the median of the sediment concentrations where no effects were observed and the 15^{th} percentile of the sediment concentrations where effects were observed.

Toxicity Equivalence Factor (TEF): Estimate of the potency, relative to 2,3,7,8-TCDD, of an individual polychlorinated dibenzo-p-dioxin, dibenzofuran or biphenyl congener, using careful scientific judgment after considering all available relative potency data.

Toxicity Equivalence Concentration (TEC): The TEC is the product of the TEF multiplied by the concentration for an individual congener. The total TEC for a mixture is calculated as the sum of 2,3,7,8-TCDD equivalence concentrations of all congeners present in the mixture.

Toxicity reference value: Represents a daily dose associated with an effect level or threshold and is expressed in units of milligrams of chemical per kilogram of body weight of the wildlife receptor per day. TRVs are developed in the effects assessment and used in the risk characterization phases of a BERA.

Trophic level: A feeding level within an ecosystem at which energy is transferred (e.g., insectivores, herbivores, carnivores).

Trophic transfer: The movement of chemical concentrations from tissue body burdens in organisms in a lower trophic level to chemical concentrations in tissue body burdens in organisms at a higher trophic level, i.e., predators receiving body burdens from chemicals in their prey.

Volatile organic compound (VOC): Chemicals that, as liquids, evaporate into the air.

16.0 Documentation of Significant Changes

No significant changes have occurred.

17.0 References Cited

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Table 1: Dioxin Toxicity Equivalency Concentration (TEC) and Aroclor-1268 Sediment and Soil Data

Location	Year	TEC Dioxin Total ng/kg	Aroclor-1268 µg/kg	Description
17/18	1995	213.7	56,000	LCP ditch - Already Removed
36	1995	393.2	55,000	LCP ditch - Already Removed
61	1995	2,768.3	1,300,000	Eastern Creek - Will be Removed
68	1995	762.4	330,000	Eastern Creek - Will be Removed
E3	1995	4,905.4	3,800,000	FFDA - Already Removed
F2 (surf.)	1996	2,639.8	1,100,000	FFDA - Already Removed
F2 (subsurf.)	1996	1,326.1	88,000	FFDA - Already Removed
H1	1995	12,760.7	4,000,000	FFDA - Already Removed
Grid Marsh	1995	119.4	6,100	FFDA - Already Removed
Cell Bldg.	1995	244.6	53,000	Uplands soil - Already Removed
Process S.	1995	764.1	450,000	Uplands soil - Already Removed
100	1996	22.5	1,100	Purvis Creek
101	1996	6.6	85	Purvis Creek
102	1996	7.4	130	Purvis Creek
105	1996	8.7	990	Turtle River
106	1996	5.1	160	Turtle River
107	1996	4.3	580	Turtle River
108	1996	3.1	600	Turtle River
110	1996	2.7	250	Purvis Creek
111	1996	137.6	6,100	LCP Ditch
117	1996	6.9	11,000	Purvis Creek
118	1996	9.4	10,000	Western Creek Complex - Will not be Removed
BR000	1995	11.4	-	Turtle River
BR003	1995	15.1	5	Turtle River
BR008	1995	13.4	590	Turtle River
BR010	1995	15.1	45	Turtle River
BR022	1995	15.2	47	Near Troup Creek
BR028	1995	15.1	250	Turtle River
BR030	1995	15.4	110	Black River
BR032	1995	19.7	610	East River (side channel)
BR041	1995	11.2	120	Turtle River
BR048	1995	20.4	1,400	Gibson Creek
BR052	1995	14.7	100	Saint Simons Sound
BR055	1995	15.1	250	South Brunswick River
BR074	1995	15.6	43	Turtle River
BR080	1995	14.9	48	Turtle River
ES	1996	1,271.3	567	Excavation soil - Already Removed
MS	1996	614.2	481	Marsh sediment - Already Removed

Table 1: Dioxin Toxicity Equivalency Concentration (TEC) and Aroclor-1268 Sediment and Soil Data - Continued

Location	Year	TEC Dioxin Total ng/kg	Aroclor-1268 µg/kg	Description
MS	1996	614.2	481	Marsh sediment - Already Removed
CS	1996	56	9.6	Creek sediment
C-6	2000	1,877.8	7,580	Eastern Creek - Will be Removed
C-8	2000	123.3	2,200	Eastern Creek - Will be Removed
C-15	2000	53.6	99	Mouth of WCC - Will not be Removed
TC-C	2000	6.9	0.045	Troup Creek reference station
CR-C	2000	13.1	0.022	Crescent River- reference station
AL-J1-83	2011	125.5	41	Altamaha canal south of Site - Not a part of OU1
AL-D1-12	2011	61.9	22	Altamaha canal south of Site - Not a part of OU1
AL-M1-1	2011	68.0	43	Altamaha canal south of Site - Not a part of OU1
AL-S1-32	2011	20.3	34	Altamaha canal south of Site - Not a part of OU1

Notes:
FFDA - Former Facility Disposal Area
BR Stations are from the Brunswick Initiative sampling.
ng/kg - nanograms per kilogram
OU – operable unit
µg/kg - micrograms per kilogram

Table 2: Chemicals of Concern (COC) in Surface Water of Major Creeks in the LCP Chemicals Marsh (2000-2007) Yearly Averages

Year	Mercury (ng/L)		Methylmercury		Aroclor 1268	Lead (µg/L)	
	Total[c]	Dissolved	(ng/L)	% of total mercury	Total (µg/L)[d,e]	Total	Dissolved[f]
Mouth of Main Canal (C-5)							
2000	59	0.1	-------	-------	0.50	2.5	2.5
2002	-------	-------	-------	-------	-------	-------	-------
2003	-------	-------	-------	-------	-------	-------	-------
2004	-------	-------	-------	-------	-------	-------	-------
2005	71	-------	0.59	0.83	0.83	-------	-------
2006	37	4.4	-------	-------	0.082	0.393	0.046
2007	120	4.2	-------	-------	0.79	1.0	0.026
Mouth of Eastern Creek (C-9)							
2000	188	-------	0.94	0.49	0.19	2.5	-------
2002	-------	-------	-------	-------	-------	-------	-------
2003	-------	-------	-------	-------	-------	-------	-------
2004	-------	-------	-------	-------	-------	-------	-------
2005	13	-------	0.22	1.7	-------	-------	-------
2006	160	5.0	-------	-------	0.18	0.449	0.027
2007	43	3.4	-------	-------	0.44		0.079
Mouth of Western Creek Complex (C-15)							
2000	12	-------	0.22	1.8	0.50	2.5	-------
2002	-------	-------	-------	-------	-------	-------	-------
2003	-------	-------	-------	-------	-------	-------	-------
2004	-------	-------	-------	-------	-------	-------	-------
2005	36	-------	0.89	2.5	-------	-------	-------
2006	15	3.8	-------	-------	0.026	0.441	0.025
2007	49	2.9	-------	-------	0.22	1.1	0.021
Upper Purvis Creek (Station C-36)							
2000	99	0.1	10	10	0.50	2.5	0.50
2002	11	-------	0.28	2.6	0.50	25	-------
2003	48	-------	1.2	2.5	0.25	2.5	-------
2004	49	-------	2.2	4.5	0.60	0.60	-------
2005	8.4	-------	0.35	4.2	0.010	0.58	-------
2006	12	4.6	-------	-------	0.021	0.363	0.014
2007	23	3.2	-------	-------	0.024	0.41	0.018

Table 2. Chemicals of concern (COC) in surface water of major creeks in the LCP Chemicals Marsh (2000-2007) Yearly Averages – Continued

Year	Mercury (ng/L)		Methylmercury		Aroclor 1268	Lead (µg/L)	
	Total[c]	Dissolved	(ng/L)	% of total mercury	Total (µg/L)[d,e]	Total	Dissolved[f]
Mid-stretch of Purvis Creek (Station C-29)							
2000	24	-------	0.38	1.6	0.50	2.5	-------
2002	8.1	-------	0.15	1.9	0.50	25	-------
2003	44	-------	1.0	2.3	0.25	2.5	-------
2004	46	-------	1.6	3.5	0.60	0.60	-------
2005	9.8	-------	0.36	3.7	0.010	0.22	-------
2006	17	3.7	-------	-------	0.044	0.575	0.019
2007	29	4.7	-------	-------	0.031	0.50	0.029
Mouth of Purvis Creek (Station C-16)							
2000	16	0.1	0.20	1.2	0.50	1.8	1.9
2002	11	-------	0.18	1.6	0.50	25	-------
2003	33	-------	0.61	1.8	1.0	2.5	-------
2004	21	-------	1.6	7.6	0.60	0.60	-------
2005	9.6	-------	0.25	2.6	0.010	0.56	-------
2006	25	3.4	-------	-------	0.029	0.561	0.022
2007	50	3.6	-------	-------	0.037	1.2	0.15
Troup Creek (Reference)							
2000	3.3	0.1	0.036	1.1	0.50	2.5	2.5
2002	1.1	-------	0.050	4.5	0.50	25	-------
2003	2.1	-------	0.012	-------	0.25	2.5	-------
2004	4.6	-------	0.22	4.8	0.60	0.60	-------
2005	4.7	-------	0.088	1.9	0.50	-------	-------
2006	1.8	1.0	-------	-------	0.0012	0.213	0.010
2007	78	1.3	-------	-------	0.0024	0.43	0.025
Crescent River (Reference)							
2000	1.7	0.1	0.012	-------	0.33	2.5	2.5
2002	1.2	-------	0.043	3.6	0.50	25	-------
2003	1.2	-------	0.012	-------	0.25	2.5	-------
2004	1.6	-------	0.047	2.9	0.60	0.60	-------
2005	1.2	-------	0.008	-------	1.4	-------	-------
2006	0.70	0.60	-------	-------	0.0005	0.371	0.010

Notes:

a - Creek surface water was typically collected during ebb tide.

b - Concentrations of COPC identified by underlining were non-detected values that were assigned a value of 1/2 of detection limit.

c - The U.S. EPA chronic ambient water quality criterion for mercury (total mercury) is 940 ng/L (this value does not account for food-web uptake by biota.) The State of Georgia chronic ecological screening value (ESV) is 25 ng/L (based on marketability of fishes).

d - The State of Georgia water quality standard for total PCBs in coastal and marine estuarine waters is 0.03 µg/L.

e - There are no U. S. EPA or Region 4 toxicological benchmarks for Aroclor 1268.

f - The State of Georgia water quality standard for lead (dissolved lead) is 8.1 µg/L.

Table 3. Surface Water Dioxin Toxicity Equivalence Concentration (TEC) and Aroclor-1268 Concentrations

Location	Year	Dioxin Total TEC, pg/L	Aroclor-1268, µg/L	Description
C-6	2000	1.69	1 U	Eastern Creek
C-8	2000	3.72	1 U	Eastern Creek
C-15	2000	2.74	1 U	mouth of Western Creek
C-15 (duplicate)	2000	4.64	NA	mouth of Western Creek
TC-C	2000	1.91	1 U	Troup Creek reference
CR-C	2000	2.85	0.33 J	Crescent River reference

Notes:
TEC conversion used WHO TEF (2005) factor
NA - not analyzed
pg/L - picogram per liter
µg/L - microgram per liter
U - Below detection limit
J - Estimated value

Table 4. Wholebody Biota Tissue Concentration Used in the BERA

Receptor	Average Wholebody Tissue Concentrations (mg/kg dry weight)	
	Site	Reference
Black Drum n = 50 n = 16		
Mercury	0.84	0.10
Aroclor 1268	5.51	0.10
Red Drum n = 39 / n = 13		
Mercury	1.14	0.30
Aroclor 1268	1.43	0.10
Silver Perch n = 55 / n = 32		
Mercury	1.6	0.29
Aroclor 1268	5.67	0.19
Spotted Seatrout n = 49 / n = 21		
Mercury	2.27	0.34
Aroclor 1268	4.92	0.16
Striped Mullet n = 27 / n = 13		
Mercury	0.23	0.05
Aroclor 1268	13.2	0.18
Blue Crab n = 91 / n = 49		
Mercury	1.59	0.15
Aroclor 1268	1.61	0.13
Fiddler Crab n = 43 / n = 48		
Mercury	0.57	0.04
Aroclor 1268	2.86	0.22
Mummichog n = 16 / n = 22		
Mercury	0.58	0.09
Aroclor 1268	4.28	0.15

Notes:
Site tissue data are from Purvis Creek except fiddler crabs and mummichogs from the LCP Ditch.

Table 5. Summary of Total Toxic Equivalent Concentration (TEC)[1] in Gamefish and Bottom Feeder Fillets and Whole Fish Samples Collected from the Turtle River near the Brunswick Cellulose Mill - 1989 through 2005[2]

	Station 1- Upstream from mill TECs in ng/kg		Station 2 – Downstream from mill TECs in ng/kg		Reference Station Sapelo Sound TECs in ng/kg	
Sample Year [3,4]	**Gamefish Fillets**	**Bottom Feeder Fillets**	**Gamefish Fillets**	**Bottom Feeder Fillets**	**Gamefish Fillets**	**Bottom Feeder Fillets**
1989	4.84	1.04	1.93	1.14	0.02	0.04
1990	0.24	0.10	ND[3]	5.21	0.06	3.56
1991	1.88	2.69	2.61	0.2	0.18	ND
1992	0.07	0.06	0.19	0.96	0.01	0.21
1993	0.95	0.36	0.47	2.05	<0.15[7]	0.31
1994	0.25	3.38	0.12	1.78	ND	0.29
1996	0.31	0.85	0.56	1.47	0.33	3.86
1999	0.0	0.0	0.0	0.23	0.0	0.0
2002	0.07	0.54	0.21	0.08	0.06	2.62
2005	0.08	0.12	1.88	0.92	0.0	0.67
Average	**0.87**	**0.91**	**0.86**	**1.40**	**0.08**	**1.28**

Sample Year	**Gamefish Whole Fish**	**Bottom Feeder Whole Fish**	**Gamefish Whole Fish**	**Bottom Feeder Whole Fish**	**Gamefish Whole Fish**	**Bottom Feeder Whole Fish**
1989	7.29	3.65	6.61	2.81	0.05	0.05
1990	NA[4]	0.1	ND	5.21	0.06	3.56
1991	3.58	7.96	9.15	1.39	ND	0.06
1992	3.96	0.07	1.5	2.75	0.03	0.2
1993	<2.65	0.96	1.25	4.06	0.18	0.85
1994	0.08	3.53	0.12	1.59	ND	0.26
1996	NA	NA	NA	NA	NA	NA
1999	NA	NA	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA
Average	**3.73**	**2.71**	**3.73**	**2.97**	**0.08**	**0.83**

Notes:

1 - TEC calculation procedure followed USEPA. 1989. Interim procedures for estimating risks associated with exposures to mixtures of polychlorinated dibenzo-p-dioxins and dibenzo-p-furans (PCDDs and PCDFs) and 1989 update. Risk Assessment Forum. EPA/625/3-89/016.

2 - Summarized from available fish tissue bio-monitoring reports produced for the Georgia-Pacific Brunswick Mill during the period since the fish tissue dioxin monitoring requirement was activated in the mill's NPDES Permit.

3 - Original protocol required laboratory analysis using NCASI Method 551 for detection only of 2,3,7,8-TCDD and 2,3,7,8-TCDF during 1989-1993. Subsequent tri-annual surveys used revised protocol and Method 1613 for detection of all 17 congeners of 2,3,7,8-TDDD and 2,3,7,8-TCDF.

4 - Sample species varied within the list of approved target or fallback species over the course of the survey period based on availability in the catches.

ND - Not detected

NA – Not available

Assume half value for calculation.

Table 6. Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations Used in the Human Health Risk Assessment

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Statistical Measure
		Min	Max				
Scenario Timeframe: Current/Future **Medium: Sediment (mg/kg)** **Exposure Sediment**							
Sediment Onsite ingestion and direct contact	Aroclor 1268	0.043	300	mg/kg	269/296	2.571	95% H-UCL
	Mercury	0.029	62.9	mg/kg	307/311	3.62	95% Chebyshev
Scenario Timeframe: Current/Future Ingestion of Fish **Medium:** **Exposure Medium: Fish Tissue**							
Atlantic Croaker	Aroclor 1268	0.36	2.244	mg/kg	11/11	1.427	95% Approx. Gamma UCL
	Mercury	0.00004	0.02	mg/kg	11/11	0.302	95% Approx. Gamma UCL
Black Drum	Aroclor 1268	0.052	0.83	mg/kg	22/28	0.343	95% Approx. Gamma UCL
	Mercury	0.00037	0.02	mg/kg	28/28	0.177	95% Student's T - test
Red Drum	Aroclor 1268	0.097	0.1936	mg/kg	4/12	0.148	95% Student's T - test
	Mercury	0.02	0.05	mg/kg	12/12	0.348	95% Student's T - test
Sheepshead	Aroclor 1268	0.16	0.858	mg/kg	8/8	0.724	95% Approx. Gamma UCL
	Mercury	0.263	0.448	mg/kg	8/8	0.372	95% Student's T - test
Southern Flounder	Aroclor 1268	0.026	0.408	mg/kg	5/11	0.249	95% H-UCL
	Mercury	0.198	0.315	mg/kg	11	11	95% Student's T - test
Southern Kingfish	Aroclor 1268	0.1	1.344	mg/kg	11/12	0.716	95% Student's T - test
	Mercury	0.189	1.13	mg/kg	12/12	0.663	95% Approx.
Spot	Aroclor 1268	0.69	3.072	mg/kg	8/9	1.785	95% Student's T - test
	Mercury	0.0495	0.166	mg/kg	9/9	0.124	95% Student's T - test
Spotted Seatrout	Aroclor 1268	0,089	1.2	mg/kg	31/31	0.556	95% Approx. Gamma UCL
	Mercury	0.12	0.941	mg/kg	31/31	0.495	95% Student's T - test
Striped Mullet	Aroclor 1268	0.027	10.5	mg/kg	26/26	2.704	95% Approx. Gamma UCL
	Mercury	0.0111	0.0775	mg/kg	26/26	0.042	95% Student's T - test

Table 6. Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations Used in the Human Health Risk Assessment – Continued

Exposure Point	Chemical of Concern	Concentration Detected		Units	Frequency of Detection	Exposure Point Concentration	Statistical Measure
		Min	Max				
Scenario Timeframe: Current/Future Ingestion of Shellfish **Medium:** **Exposure Medium: Shellfish**							
Blue Crab	Aroclor 1268	0.0073	0.4	mg/kg	15/18	0.195	95% Approx. Gamma UCL
	Mercury	0.255	1.12	mg/kg	18/18	0.708	95% Student's T - test
White Shrimp	Aroclor 1268	7.48	22	mg/kg	9/9	0.533	95% Chebychev
	Mercury	0.0374	0.125	mg/kg	9/9	0.112	95% Student's T - test
Scenario Timeframe: Current/Future Ingestion of Clapper Rail **Medium:** **Exposure Medium: Bird Tissue**							
Clapper Rail	Aroclor 1268	0.19	19.42	mg/kg	14/14	19.94	95% Chebychev
	Mercury	0.68	7.3	mg/kg	14/14	4.671	95% Approx. Gamma UCL

Notes:
mg/kg: milligrams per kilogram
100% of total mercury analyzed assumed to be methylmercury

Table 7. Percent of Total Catch of Various Fish Species Based on Angling Success

Wave	Sheepshead	Spotted Seatrout	Southern Kingfish	Black Drum	Red Drum	Southern Flounder	Spot	Atlantic Croaker	Striped Mullet
Jan-Feb	9.1%	52.5%	9.4%	0.5%	25.9%	2.6%	0.00%	0.0%	0.0%
Mar	12.9%	23.9%	40.8%	2.6%	16.4%	2.8%	0.04%	0.6%	0.0%
Apr	20.5%	28.9%	27.2%	5.9%	5.4%	5.8%	0.02%	1.8%	4.6%
May	3.3%	38.7%	22.5%	8.7%	12.8%	10.2%	0.07%	3.4%	0.2%
Jun/Jul	5.1%	35.3%	13.9%	4.4%	37.3%	3.5%	0.07%	0.5%	0.0%
Aug	8.7%	57.2%	4.5%	1.4%	26.2%	1.9%	0.04%	0.1%	0.01%
Yearly	**9.9%**	**39.4%**	**19.7%**	**3.9%**	**20.7%**	**4.4%**	**0.04%**	**1.1%**	**0.8%**

Notes:
Species-specific fish harvest data from 2001-2005 in Georgia were obtained from the Marine Recreational Fisheries Statistics Survey (MRFSS) (NMFSS, 2007).

Table 8. Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal							
Chemical of Concern	**Oral Cancer Slope Factor**	**Oral Absorption Efficiency for Dermal (1)**	**Adjusted Dermal Cancer Slope Factor (2)**	**Slope Factor Units**	**Weight of Evidence / Cancer Guideline Description**	**Source**	**Date**
Aroclor 1268	2.0	1.0	2.0	$mg/kg\text{-}d^{-1}$	B2 (PCBs)	IRIS	06/01/1997

Notes:
IRIS – Integrated Risk Information System
1. GI ABS value based on EPA RAGs Part E.
2. Derived by dividing the oral slope factor by the oral absorption efficiency.

Table 9. Non-Cancer Toxicity Data Summary

Pathway: Ingestion, Dermal										
Chemical of Concern	**Chronic/ Subchronic**	**Oral RfD Value**	**Oral RfD Units**	**Oral Absorption Efficiency for Dermal[1]**	**Adjusted Dermal RfD[1]**	**Dermal RfD Units**	**Primary Target Organ Effects**	**Combined Uncertainty/ Modifying Factors**	**Sources of RfD: Target Organ**	**Dates of RfD: Target Organ**
Aroclor 1268	Chronic	7.0E-05	mg/kg-day	1.0	7.0E-05	mg/kg-day	CNS (developmental)	100 [2]	IRIS	04/01/1991
Methylmercury	Chronic	1.0E-04	mg/kg-day	1.0	1.0E-04	mg/kg-day	CNS (developmental)	10	IRIS	07/27/2001

Notes:
IRIS – Integrated Risk Information System
Source: RAGs Part E (2004).
RfD – reference dose
1 Adjusted dermal RfD = (oral RfD) X (oral absorption efficiency).
2 Oral RfD based on Aroclor 1016.

Table 10. Non-Cancer Hazard Index from Exposure to Marsh Sediment

Non-Cancer Hazard	Dermal HQ	Oral HQ	Total HQ
Adult			
Aroclor 1268	0.024	0.0075	0.031
Aluminum	0	0.0071	0.0071
Chromium	0	0.0084	0.0084
Manganese	0	0.00074	0.00074
Mercury	0	0.0074	0.0074
Methylmercury	0	0.000021	0.000021
Thallium	0	0.0068	0.0068
		Adult	**HI = 0.06**
Adolescent			
Aroclor 1268	0.024	0.012	0.036
Aluminum	0	0.011	0.011
Chromium	0	0.013	0.013
Manganese	0	0.0012	0.0012
Mercury	0	0.011	0.011
Methylmercury	0	0.000033	0.000033
Thallium	0	0.011	0.011
		Adolescent	**HI = 0.08**

Table 11. Lifetime Cancer Risks from Exposure to Marsh Sediment

Cancer Risk	Dermal Risk	Oral Risk	Total Risk
Adult			
Aroclor 1268	1.4E-06	4.5E-07	1.9E-06
B(a)P toxic equivalence	1.1E-06	3.8E-07	1.5E-06
Chromium	0	5.4E-06	5.4E-06
		Adult	**8.8E-06**
Adolescent			
Aroclor 1268	4.9E-07	2.3E-07	7.2E-07
B(a)P toxic equivalence	3.9E-07	2.0E-07	5.9E-07
Chromium	0	2.8E-06	2.8E-06
		Adolescent	**4.1E-06**
Lifetime Receptor	**2.6E-06**	**7.4E-06**	**1.0E-05**

Table 12. Non-Cancer Hazard Index (HI) from Consumption of Finfish [1]

Fish Consumption RME Scenarios	COC	Primary Target Organ	Cumulative Hazard
Adult Recreational	Mercury	CNS/developmental	1.0
	Aroclor 1268	CNS/developmental	1.7
			HI = 2.7
Adolescent Recreational	Mercury	CNS/developmental	1.1
	Aroclor 1268	CNS/developmental	1.7
			HI = 2.8
Child Recreational	Mercury	CNS/developmental	1.7
	Aroclor 1268	CNS/developmental	2.6
			HI = 4.3
Adult High Quantity	Mercury	CNS/developmental	2.1
	Aroclor 1268	CNS/developmental	2.9
			HI = 5.0
Adolescent High Quantity	Mercury	CNS/developmental	1.3
	Aroclor 1268	CNS/developmental	3.0
			HI = 4.3
Child High Quantity	Mercury	CNS/developmental	2.9
	Aroclor 1268	CNS/developmental	5.1
			HI = 8.0

Notes:
[1] – Fish caught from Zones D, H and I of the St. Simons Estuary.
Based on average percentage of fish caught and consumed by anglers (see Table 7).
RME – reasonable maximum exposure
COC – chemical of concern.
CNS – central nervous system.

Table 13. Non-Cancer Hazard Index (HI) from Consumption of Shellfish [1]

Shellfish Consumption RME Scenarios	Shellfish Tissue	COC	Primary Target Organ	Cumulative Hazard
Adult	Blue Crab	Mercury	CNS/developmental	0.6
		Aroclor 1268	CNS/developmental	0.2
	White Shrimp	Mercury	CNS/developmental	0.09
		Aroclor 1268	CNS/developmental	0.64
				HI = 1.6
Adolescent	Blue Crab	Mercury	CNS/developmental	0.3
		Aroclor 1268	CNS/developmental	0.1
	White Shrimp	Mercury	CNS/developmental	0.04
		Aroclor 1268	CNS/developmental	0.3
				HI = 0.7
Child	Blue Crab	Mercury	CNS/developmental	1.4
		Aroclor 1268	CNS/developmental	0.6
	White Shrimp	Mercury	CNS/developmental	0.2
		Aroclor 1268	CNS/developmental	1.6
				HI = 3.8

Notes:
[1] – Combination of blue crab and white shrimp caught from Zones D, H and I of the St. Simons Estuary.
RME – reasonable maximum exposure
COC – chemical of concern.
CNS – central nervous system.

Table 14. Non-Cancer Hazard Index (HI) from Consumption of Clapper Rail [1]

Clapper Rail Consumption RME Scenarios	COC	Primary Target Organ	Cumulative Hazard
Adult	Mercury	CNS/developmental	0.2
	Aroclor 1268	CNS/developmental	1.4
			HI = 1.6
Adolescent	Mercury	CNS/developmental	0.2
	Aroclor 1268	CNS/developmental	1.0
			HI = 1.2
Child	Mercury	CNS/developmental	0.6
	Aroclor 1268	CNS/developmental	4.0
			HI = 4.6

Notes:
[1] – Clapper Rail breast tissue harvested from Domain 1.
RME – reasonable maximum exposure
COC – chemical of concern.
CNS – central nervous system.

Table15. Lifetime Cancer Risks from Consumption of Finfish [1]

Fish Consumption RME Scenarios	COC	Pathway	Cancer Risk
Adult – Recreation	Aroclor 1268	Ingestion	1.0 E-04
Adolescent – Recreation	Aroclor 1268	Ingestion	3.2 E-05
Child – Recreation	Aroclor 1268	Ingestion	3.2 E-05
		Lifetime Cancer Risk	**1.1 E-04**
Adult – High Quantity	Aroclor 1268	Ingestion	1.7 E-04
Adolescent – High Quantity	Aroclor 1268	Ingestion	5.4 E-05
Child – High Quantity	Aroclor 1268	Ingestion	6.0 E-05
		Lifetime Cancer Risk	**2.0 E-04**

Notes:
[1] – Fish caught from Zones D, H and I of the St. Simons Estuary.
Based on average percentage of fish caught and consumed by anglers (see Table 7).
Lifetime receptor cancer risk was calculated using 0.5 times the adult risk plus the adolescent and child risk to equal a 30 year exposure period.
RME – reasonable maximum exposure
COC – chemical of concern.

Table 16. Lifetime Cancer Risks from Consumption of Shellfish [1]

Shellfish Consumption RME Scenarios	COC	Pathway	Cancer Risk
Adult	Aroclor 1268	Ingestion	5.3 E-05
Adolescent	Aroclor 1268	Ingestion	7.1 E-06
Child	Aroclor 1268	Ingestion	2.5 E-05
		Lifetime Cancer Risk	**5.8 E-05**

Notes:
[1] – Blue crab and white shrimp caught from Zones D, H and I of the St. Simons Estuary.
Lifetime receptor cancer risk was calculated using 0.5 times the adult risk plus the adolescent and child risk to equal a 30 year exposure period.
RME – reasonable maximum exposure
COC – chemical of concern.

Table 17. Lifetime Cancer Risks from Consumption of Clapper Rail [1]

Clapper Rail Consumption RME Scenarios	COC	Pathway	Cancer Risk
Adult	Aroclor 1268	Ingestion	4.1 E-05
Adolescent	Aroclor 1268	Ingestion	9.4 E-06
Child	Aroclor 1268	Ingestion	2.4 E-05
		Lifetime Cancer Risk	**1.1 E-04**

Notes:
[1] – Clapper Rail breast tissue harvested from Domain 1.
Lifetime receptor cancer risk was calculated using 0.5 times the adult risk plus the adolescent and child risk to equal a 30 year exposure period.
RME – reasonable maximum exposure
COC – chemical of concern.

Table 18. Summary of Risk Estimates

Exposure Scenario	Receptor	Cancer Risk [1]		Non-Cancer HI	
		RME	CTE	RME	CTE
Marsh Trespasser					
	Lifetime	1E-05	2E-07		
	Adult			0.06	0.005
	Adolescent			0.08	0.006
Recreational Finfish Consumer					
	Lifetime	1E-04	2E-05		
	Adult			3	0.8
	Adolescent			3	0.9
	Child			4	1
High Quantity Finfish Consumer					
	Lifetime	2E-04	4E-05		
	Adult			5	2
	Adolescent			5	3
	Child			8	2
Shellfish Consumer					
	Lifetime	6E-05	9E-06		
	Adult			2	0.6
	Adolescent			0.7	0.2
	Child			4	2
Clapper Rail Consumer					
	Lifetime	1E-04	8E-06		
	Adult			2	0.4
	Adolescent			1	0.1
	Child			5	0.4

Notes:
RME – reasonable maximum exposure
CTE – central tendency exposure
1 – Cancer risk based on exposure to Aroclor 1268.

Table 19. Tissue Concentrations Protective of Human Health Based on RME Adult High Quantity Fish Consumer

Receptor	Edible Tissue Concentrations (mg/kg dry weight)		
	Current Average	HI = 1 Non-Cancer Tissue Goals	1E-04 Cancer Risk Tissue Goals
Atlantic Croaker			
Mercury	0.24	0.060	-
Aroclor 1268	0.99	0.285	0.71
Black Drum			
Mercury	0.16	0.035	-
Aroclor 1268	0.27	0.069	0.17
Red Drum			
Mercury	0.29	0.070	-
Aroclor 1268	0.13	0.030	0.07
Sheepshead			
Mercury	0.33	0.074	-
Aroclor 1268	0.43	0.14	0.36
Southern Flounder			
Mercury	0.24	0.051	-
Aroclor 1268	0.14	0.050	0.12
Southern Kingfish			
Mercury	0.49	0.133	-
Aroclor 1268	0.51	0.143	0.36
Spot			
Mercury	0.10	0.025	-
Aroclor 1268	1.2	0.357	0.89
Spotted Seatrout			
Mercury	0.439	0.099	-
Aroclor 1268	0.445	0.11	0.28
Striped Mullet			
Mercury	0.04	0.008	-
Aroclor 1268	1.91	0.54	1.35
Shellfish			
Blue Crab			
Mercury	0.60	0.43	-
Aroclor 1268	0.12	0.12	0.33
White Shrimp			
Mercury	0.09	0.07	-
Aroclor 1268	0.22	0.32	0.91
Wildlife			
Clapper Rail			
Mercury	3.1	2.9	-
Aroclor 1268	5.0	12.2	18.0

Notes:
All fish and shellfish collected from Purvis Creek, Gibson Creek and in the Turtle River adjacent to the LCP Chemicals Site.
Clapper rail collected from Domain 1.

Table 20a. Occurrence, Distribution and Selection of Chemicals of Concern in Sediment

Exposure Medium: Sediment								
Chemical of Concern	**Minimum Conc.**	**Maximum Conc.**	**Mean Conc.**	**95% UCL of the Mean**	**Mean Background Conc.**	**Screening Toxicity Value [i]**	**Maximum HQ**	**COC Flag (Y or N)**
Domain 1								
Aroclor 1268	0.053	300	11.45	23.43	0.05	0.00003	10,000,000	Y
Mercury	0.01	62	4.85	11.51	0.08	0.13	477	Y
Lead	2.1	210	31	40.7	17.6	30.2	7	Y
Total PAHs	0.08	1.6	0.56	0.89	0.15	1.7	0.94	N
Domain 2								
Aroclor 1268	0.0465	65	3.75	5.05	0.05	0.00003	2,166,666	Y
Mercury	0.18	62.9	3.85	5.84	0.08	0.13	484	Y
Lead	11	765	40.9	63.0	17.6	30.2	25.3	Y
Total PAHs	0.40	40.88	2.06	7.9	0.15	1.7	24.0	Y
Domain 3								
Aroclor 1268	0.013	9	1.67	2.04	0.05	0.00003	300,000	Y
Mercury	0.044	8.37	1.88	2.23	0.08	0.13	64.8	Y
Lead	8.9	1590	90.7	133	17.6	30.2	52.6	Y
Total PAHs	0.15	27.93	1.87	4.58	0.15	1.7	16.4	Y
Domain 4								
Aroclor 1268	0.0445	8.8	1.14	1.36	0.05	0.00003	293,333	Y
Mercury	0.03	4.62	0.63	1.07	0.08	0.13	35.5	Y
Lead	8.8	52.7	21.7	22.9	17.6	30.2	1.7	Y
Total PAHs	0.08	7.98	0.87	1.37	0.15	1.7	4.7	Y
LCP Ditch (Main Canal)								
Aroclor 1268	0.25	570	27.64	41.71	0.05	0.00003	19,000,000	Y
Mercury	0.196	55	7.40	8.72	0.08	0.13	35.5	Y
Lead	3.9	69.9	26.1	28.1	17.6	30.2	2.3	Y
Total PAHs	0.16	16.68	1.00	2.21	0.15	1.7	9.8	Y
Eastern Creek								
Aroclor 1268	0.0074	460	49.57	65.28	0.05	0.00003	15,333,333	Y
Mercury	0.0437	145	20.28	25.04	0.08	0.13	125	Y
Lead	5.74	238	35.7	41.5	17.6	30.2	7.9	Y
Total PAHs	0.006	38.45	1.46	3.75	0.15	1.7	22.6	Y
Western Creek Complex								
Aroclor 1268	0.0079	25	3.18	3.84	0.05	0.00003	83,333	Y
Mercury	0.043	16.3	2.75	3.31	0.08	0.13	2.1	Y
Lead	13	51.8	29.0	30.1	17.6	30.2	0.96	N
Total PAHs	0.083	11.37	0.87	1.62	0.15	1.7	6.7	Y
Purvis Creek								
Aroclor 1268	0.007	28	3.78	5.07	0.05	0.00003	933,333	Y
Mercury	0.0071	6.83	1.22	1.53	0.08	0.13	52.5	Y
Lead	2.03	34.6	17.4	23.1	17.6	30.2	1.1	Y
Total PAHs	0.006	7.21	0.83	1.05	0.15	1.7	4.2	Y

Notes:
All concentrations in mg/kg dw
1 – Source of screening values are from EPA Region 4 Sediment Ecological Screening values.

Table 20b. Occurrence, Distribution, and Selection of Chemicals of Concern in Surface Water

Exposure Medium: Surface Water									
Chemical of Potential Concern	**Minimum Conc.**	**Maximum Conc.**	**Mean Conc.**	**95% UCL of the Mean**	**Mean Background Conc.**	**Screening Toxicity Value**	**Screening Toxicity Value Source [1]**	**Maximum HQ**	**COC Flag (Y or N)**
Mercury (total) (ng/L)	8.08	188	43.68	57.24	7.9	25	GADEP	7.5	Y
Mercury (dissolved) (ng/L)	0.1	5	3.15	3.8	1.01	25	GADEP	7.5	Y
Methylmercury (ng/L)	0.15	2.23	0.70	0.96	0.05	-	-	-	Y
Aroclor 1268 (µg/L)	0.01	1.0	0.26	0.38	0.0018	0.03	GADEP	33	Y

Notes:
1 – GADEP (Georgia Department of Environmental Protection) water quality standards

Table 21. Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag	Receptor	Endangered/ Threatened	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Sediment	No	Benthic organisms	No	Direct contact with COPCs in sediment.	Viability of the benthic estuarine community.	1) Comparison of sediment COPC concentrations to site-specific effect levels. 2) Results of toxicity tests conducted with sensitive life stages to amphipods and grass shrimp. 3) Evaluation of indigenous benthic community.
Surface Water	No	Mysid shrimp (epibenthic organisms)	No	Direct contact and uptake of COPCs in surface water.	Viability of the benthic estuarine community.	1) Comparison of surface water COPC concentrations to general literature-based effect levels. 2) Results of toxicity tests (survival and growth) conducted with mysid shrimp.
		Finfish			Viability of finfish utilizing the LCP Estuary.	1) Comparison of surface water COPC concentrations to general literature-based effect levels. 2) Results of toxicity tests (survival and growth) conducted with sheepshead minnows.
Biota	No	Finfish	No	Ingestion of contaminated food items (fiddler crabs, blue crabs, and mummichogs).	Viability of finfish utilizing the LCP Estuary.	1) Hazard quotients (HQs) derived from residue-based toxicity reference values (TRVs) and finfish bioaccumulation models. 2) HQs derived from residue-based TRVs and finfish collected in Purvis Creek. 3) Evaluation of benthic organisms as a food source for juvenile and adult fish.
Biota	No	Omnivorous avians	No	Ingestion of contaminated food items (insects, fiddler crabs, and mummichogs).	Viability of omnivorous avians utilizing the LCP Estuary.	1) HQs derived from food-web exposure model for red-winged blackbirds. 2) HQs derived from food-web exposure model for clapper rails.

Table 21. Ecological Exposure Pathways of Concern – Continued

Exposure Medium	Sensitive Environment Flag	Receptor	Endangered/ Threatened	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Biota	No	Piscivorous avians	Yes Wood stork	Ingestion of contaminated food items (fiddler crabs, blue crabs, and mummichogs).	Viability of piscivorous avians utilizing the LCP Estuary.	HQs derived from food-web exposure model for green herons.
Biota	No	Herbivorous mammals	Yes Manatee	Ingestion of contaminated cordgrass.	Viability of herbivorous mammals using the LCP Estuary.	HQs derived from food-web exposure model for marsh rabbits. Manatee not modeled.
Biota	No	Omnivorous mammals	No	Ingestion of contaminated food items (fiddler crabs, blue crabs, and mummichogs).	Viability of omnivorous mammals using the LCP Estuary.	HQs derived from food-web exposure model for raccoons.
Biota	No	Piscivorous mammals	Yes Bottlenose dolphin	Ingestion of contaminated food items (fiddler crabs, blue crabs, silver perch, & mummichogs).	Viability of piscivorous mammals using the LCP Estuary.	HQs derived from food-web exposure model for river otters. Dolphin not modeled due to general lack of site-specific data.

Table 22. Summary of Sediment Effect Concentrations to Most Sensitive Benthic Organism Toxicity Test Endpoints

Chemical of Concern	Sediment Effect Concentrations (SECs)					Average % accuracy in predicting effects
	TEL	ER-L	PEL	ER-M	AET	
Amphipod Survival – 240 tests						
Mercury	4.2	11.3	15.4	21.7	62	34
Aroclor 1268	6.2	16	20.3	32	64	42
Total PAHs	0.8	1.5	2.1	4.4	6	24
Lead	40.8	59.8	88.4	196	177	29
Grass Shrimp Embryo Development – 77 tests						
Mercury	1.4	3.2	4.8	10.5	11	54
Aroclor 1268	3.2	12	10.7	20	41	49
Total PAHs	1.6	4.0	4.5	6.1	11.5	31
Lead	139	1,190	198	1,190	419	35

Notes:
Yellow shading indicates the sediment effect concentration was used for the lower end of the benthic community preliminary remediation
goal (PRG) range. Blue shading indicates the sediment effects concentration was used for the upper end of the benthic community PRG range. Some sediment effects concentrations in this table were rounded before they were used as PRGs.
TEL – Threshold Effect Level; **ER-L** – Effects Range-Low; **PE**L – Probable Effects Level; **ER-M** – Effects Range-Medium;
AET – Apparent Effects Threshold

Table 23. Summary of Risks to Wildlife Receptors

Receptor	COC	Maximum NOAEL HQ	Maximum LOAEL HQ	Areas of Concern
Diamondback terrapin	None	< 1	< 1	None
Clapper rail	MeHg	1.0	3.0	Domain 1
Redwing blackbird	MeHg	1.0	0.3	Eastern Creek, LCP Ditch, Domain 1
Green heron	MeHg	10.6	3.5	Eastern Creek, LCP Ditch, Domains 1, 3
Marsh rabbit	Aroclor 1268	4.8	0.5	Eastern Creek, LCP Ditch
Raccoon	Aroclor 1268	4.9	0.5	Eastern Creek, LCP Ditch
River otter	Aroclor 1268	3.9	0.4	Domains 2, 3, 4, Blythe Island

Notes:
COC – Contaminant of Concern
LOAEL HQ - Lowest Observed Adverse Effect Level Hazard Quotient
NOAEL HQ – No-Observed-Adverse-Effect Level Hazard Quotient
MeHg - Methylmercury

Table 24. COC Sediment Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Exposure Medium	COC	Protective Range	Units	Basis	Assessment Endpoint
Sediment	Mercury	1 to 3	mg/kg	Based on levels between the NOAEL and LOAEL RGs for blue heron derived using sediment to fish BSAF uptake model.	Protection of piscivorous birds (green heron)
		2 to 4		Selected between the NOAEL and LOAEL.	Protection of piscivorous mammals (river otter)
		1 to 3		Finfish range based on sediment concentration resulting from back-calculation of fish bioaccumulation models to 5 different finfish species and selected between the NOAEL and LOAEL from the more sensitive fish species.	Protection of finfish
	Aroclor 1268	2 to 5	mg/kg	Range begins between the geometric mean between the NOAEL and LOAEL, and to the LOAEL for piscivorous mammals.	Protection of piscivorous mammals (river otter)
		3 to 6		Finfish range based on sediment concentration resulting from back-calculation of fish bioaccumulation models to 5 different finfish species and generally selected between their NOAELs and LOAELs.	Protection of finfish

Notes:
COC – chemical of concern
NOAEL – no observed adverse effect level
LOAEL – lowest observed adverse effect level

Table 25. Current SWAC Concentrations

Domain	Domain Area (acres)	Current SWAC (mg/kg)
Mercury		
Dillon Duck	1.8	1.4
Domain 1	21.0	4.8
Domain 2	114.6	2.5
Domain 3	107.7	1.7
Domain 4 East	191.9	2.0
Domain 4 West	224.5	0.7
Total Domains	**661.5**	**1.7**
Domain 3 Creek	12.4	5.9
Eastern Creek	4.2	14.6
LCP Ditch	2.5	7.7
Purvis Creek	70.5	1.2
Western Creek Complex	9.0	2.1
Total Creek	**98.5**	**2.6**
Mercury Total Marsh	**760.0**	**1.8**
Aroclor 1268		
Dillon Duck	1.8	2.1
Domain 1	21.0	3.1
Domain 2	114.6	1.9
Domain 3	107.7	1.7
Domain 4 East	191.9	2.1
Domain 4 West	224.5	0.8
Total Domains	**661.5**	**1.6**
Domain 3 Creek	12.4	5.7
Eastern Creek	4.2	43.5
LCP Ditch	2.5	25.4
Purvis Creek	70.5	3.6
Western Creek Complex	9.0	3.0
Total Creeks	**98.5**	**6.0**
Aroclor 1268 Total Marsh	**760.0**	**2.2**

Notes:
SWAC – Surface Weighted Average Concentration

Table 26. Predicted Sediment SWAC Concentrations between Alternatives

Domain	Domain Area (acres)	Current SWAC (mg/kg)	SWAC Cleanup Level (CUL)	Post-Remediation Predicted SWAC Concentrations (mg/kg)		
				48-Acres Alternatives 2, 3	18-Acres Alternatives 4, 5	24-Acres Alternative 6
Mercury						
Dillon Duck	1.8	1.4	2	0.3	0.3	0.3
Domain 1	21.0	4.8	2	0.6	1.6	1.1
Domain 2	114.6	2.5	2	0.9	1.3	1.3
Domain 3	107.7	1.7	2	1.5	1.7	1.7
Domain 4 East	191.9	2.0	2	2.0	2.0	2.0
Domain 4 West	224.5	0.7	2	0.7	0.7	0.7
Total Domains	**661.5**	**1.7**	**--**	**1.2**	**1.4**	**1.3**
Domain 3 Creek	12.4	5.9	--	1.0	3.7	3.7
Eastern Creek	4.2	14.6	--	0.3	0.3	0.3
LCP Ditch	2.5	7.7	--	0.3	0.4	0.4
Purvis Creek	70.5	1.2	--	0.9	1.2	1.1
Western Creek Complex	9.0	2.1	--	1.2	2.1	2.1
Total Creeks	**98.5**	**2.6**	**2**	**0.9**	**1.5**	**1.4**
Mercury Total Marsh	**760.0**	**1.8**		**1.2**	**1.4**	**1.4**
Aroclor 1268						
Dillon Duck	1.8	2.1	3	0.2	0.2	0.2
Domain 1	21.0	3.1	3	0.6	1.2	0.9
Domain 2	114.6	1.9	3	1.4	1.5	1.5
Domain 3	107.7	1.7	3	1.5	1.7	1.7
Domain 4 East	191.9	2.1	3	2.1	2.1	2.1
Domain 4 West	224.5	0.8	3	0.8	0.8	0.8
Total Domains	**661.5**	**1.6**	**--**	**1.4**	**1.5**	**1.4**
Domain 3 Creek	12.4	5.7	--	1.1	3.4	3.4
Eastern Creek	4.2	43.5	--	0.2	0.2	0.2
LCP Ditch	2.5	25.4	--	0.2	0.3	0.3
Purvis Creek	70.5	3.6	--	1.7	3.6	2.7
Western Creek Complex	9.0	3.0	--	1.7	3.0	3.0
Total Creeks	**98.5**	**6.0**	**3**	**1.6**	**3.3**	**2.7**
Aroclor 1268 Total Marsh	**760.0**	**2.2**		**1.4**	**1.7**	**1.6**

Notes:
SWAC – Surface Weighted Average Concentration

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site

Chemical-Specific ARARs/TBC			
Action/Media	**Requirements**	**Prerequisite**	**Citation**
Restoration of coastal and marine estuarine waters	The following criteria are deemed to be necessary and applicable to all waters of the State: (a) All waters shall be free from materials associated with municipal or domestic sewage, industrial waste or any other waste which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable. (b) All waters shall be free from oil, scum and floating debris associated with municipal or domestic sewage, industrial waste or other discharges in amounts sufficient to be unsightly or to interfere with legitimate water uses. (c) All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses. (d) All waters shall be free from turbidity which results in a substantial visual contrast in a water body due to a man-made activity. The upstream appearance of a body of water shall be as observed at a point immediately upstream of a turbidity-causing man-made activity. That upstream appearance shall be compared to a point which is located sufficiently downstream from the activity so as to provide an appropriate mixing zone. For land disturbing activities, proper design, installation, and maintenance of best management practices and compliance with issued permits shall constitute compliance with Paragraph 391-3-6-.03(5)(d). All waters shall be free from toxic, corrosive, acidic and caustic substances discharged from municipalities, industries or other sources, such as nonpoint sources, in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.	Waters of the State of Georgia with designated uses of *Recreation, Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life and Coastal Fishing* under the Georgia Water Use Classifications at GA Rule §391-3-6-.03(4) – **relevant and appropriate**	GA Rule §391-3-6-.03 (5) *General Criteria for All Waters*

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site – Continued

Chemical-Specific ARARs/TBC			
Action/Media	**Requirements**	**Prerequisite**	**Citation**
Restoration of coastal and marine estuarine waters	In-stream concentrations of the following chemical constituents listed by the U.S.EPA as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed the chronic criteria indicated below under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions except within established mixing zones or in accordance with site specific effluent limitations developed in accordance with procedures presented in §391-3-6-.06. Lead - *Coastal and Marine Estuarine Waters* - 8.1 µg/L[1] Mercury - *Coastal and Marine Estuarine Waters* - 0.025 µg/L[2] *NOTE:* Current methods available in commercial laboratory can detect at or below the specified concentration. Total mercury is recoverable form (not dissolved) as specified at GA Rule §391-3-6-.03 (5)(e)(ii). Thus aqueous samples are not filtered as indicated in the reference to approved methods in 40 CFR 136 at GA Rule §391-3-6-.03(13). See table entry below.	Waters of the State of Georgia with designated uses of *Recreation, Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life and Coastal Fishing* under the Georgia Water Use Classifications at GA Rule §391-3-6-.03(4) – **relevant and appropriate**	GA Rule §391-3-6-.03(5)(e)(ii) *Criteria for Protection of Aquatic Life*
Restoration of coastal and marine estuarine waters	In-stream concentrations of the following chemical constituents listed by the U.S.EPA as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed criteria indicated below under 7-day, 10-year minimum flow (7Q10) or higher stream flow conditions except within established mixing zones or in accordance with site specific effluent limitations developed in accordance with procedures presented in 391-3-6-.06. Total PCBs-*Coastal and Marine Estuarine Waters*-0.03 µg/L* * The in-stream criterion is lower than the EPD laboratory detection limits.	Waters of the State of Georgia with designated uses of *Recreation, Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life and Coastal Fishing* under the Georgia Water Use Classifications at GA Rule §391-3-6-.03(4) – **relevant and appropriate**	GA Rule §391-3-6-.03(5)(e)(iii) *Criterion for Protection of Aquatic Life*

1 The in-stream criterion is expressed in terms of the dissolved fraction in the water column. Conversion factors used to calculate dissolved criteria are found in the EPA document – National Recommended Water Quality Criteria – EPA 2006.

2 The in-stream criterion is lower than the EPD laboratory detection limits (A "*" indicates that the criterion may be higher than or lower than EPD laboratory detection limits depending upon the hardness of the water).

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site – Continued

Chemical-Specific ARARs/TBC			
Action/Media	**Requirements**	**Prerequisite**	**Citation**
	NOTE: Current methods available in commercial laboratory can detect at or below the specified concentration.		
	In-stream concentrations of the following chemical constituents listed by the U.S.EPA as toxic priority pollutants pursuant to Section 307(a)(1) of the Federal Clean Water Act (as amended) shall not exceed criteria indicated below under annual average or higher stream flow conditions: Total PCBs - 0.000064 µg/L *NOTE:* Current method detection limit is close to specified concentration. Background levels of Total PCBs in surface water has been established by EPA as part of the CERCLA remedy selection process and may be used in determining cleanup level instead of the specified criterion.		GA Rule §391-3-6-.03(5)(e)(iv) *Criterion for Protection of Human Health*
Restoration of coastal and marine estuarine waters	For the protection of human health, total mercury concentrations bioaccumulating in a waterbody, in a representative population of fish, shellfish and/or other seafood representing different trophic levels, shall not exceed a total mercury concentration in edible tissues of 0.3 mg/kg wet weight. This standard is in accord with the USEPA *Water Quality Criterion for the Protection of Human Health: Methylmercury*, (January 2001, EPA-823-R-01-001), and because nearly 100% of the mercury in fish tissue is methylmercury, adoption of the standard as total mercury is an additional conservative measure. The representative fish tissue total mercury concentration for a waterbody is determined by calculating a Trophic-Weighted Residue Value, as described by the Georgia EPD Protocol (October 19, 2001).	Waters of the State of Georgia with designated uses of *Recreation, Fishing, Propagation of Fish, Shellfish, Game and Other Aquatic Life and Coastal Fishing* under the Georgia Water Use Classifications at GA Rule §391-3-6-.03(4) – **relevant and appropriate**	GA Rule §391-3-6-.03(5)(e)(vii) *Mercury Fish Tissue Concentration for Protection of Human Health*
Sampling of surface water to assess compliance with criteria specified in GA Rule §391-3-6-.03(5)	Analytical standards for these samples must comply with the requirements of *Title 40, Code of Federal Regulations*, Part 136.	Sampling methods for water quality samples collected and reported by any person(s), (including volunteer groups), to the Division – **relevant and appropriate**	GA Rule §391-3-6-.03(13) *Acceptance of Data*

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Wetlands			
Presence of wetlands	Requires Federal agencies to evaluate action to minimize the destruction, loss or degradation of wetlands and to preserve and enhance beneficial values of wetlands.	Actions that involve potential impacts to, or take place within, wetlands – **TBC**	Executive Order 11990 – *Protection of Wetlands* Section 1.(a)
Presence of wetlands	If project will have unavoidable adverse impacts after all appropriate and practicable steps have been taken to avoid or minimize impacts, responsible party must implement compensatory mitigation – i.e., the restoration, creation, enhancement, or (in some circumstances) preservation of aquatic resources. This requires a mitigation work plan, including detailed specifications and descriptions for compensatory mitigation. The regulations also require objective performance standards, monitoring for at least 5 years and active long-term management and maintenance where necessary to ensure long-term sustainability. *NOTE:* Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a CWA 404(b) permit including appropriate and practicable mitigation after consultation with USCOE.	Actions that involve unavoidable adverse impacts to waters of the United States (including jurisdictional wetlands) – **applicable**	33 CFR PART 332 *et. seq.* Compensatory Mitigation For Losses of Aquatic Resources
Floodplains			
Presence of floodplain designated as such on a map	Shall consider alternatives to avoid, to the extent possible adverse effects and incompatible development in the floodplain. Design or modify its action in order to minimize potential harm to or within the floodplain. Shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains	Federal actions that involve potential impacts to, or take place within, floodplains – **TBC**	Executive Order 11988 – *Floodplain Management, as amended by Executive Order 13690, Section 2(i).*

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Aquatic Resources and Coastal Zone Areas			
Location encompassing *aquatic ecosystem* as defined in 40 CFR 230.3(c)	Except as provided under [CWA] section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	Clean Water Act Section 404(b)(1) Guidelines regulations 40 CFR Part 230.10(a) Restrictions on Discharge
	No discharge of dredged or fill material shall be permitted if it: (1) Causes or contributes, after consideration of disposal site dilution and dispersion, to violations of any applicable State water quality standard; (2) Violates any applicable toxic effluent standard or prohibition under section 307 of the CWA; (3) Jeopardizes the continued existence of species listed as endangered or threatened under the Endangered Species Act of 1973, as amended, or results in likelihood of the destruction or adverse modification of a habitat which is determined by the Secretary of Interior or Commerce, as appropriate, to be a critical habitat under the Endangered Species Act of 1973, as amended. If an exemption has been granted by the Endangered Species Committee, the terms of such exemption shall apply in lieu of this subparagraph; (4) Violates any requirement imposed by the Secretary of Commerce to protect any marine sanctuary designated under title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 CFR Part 230.10(b) Restrictions on Discharge
Location encompassing *aquatic ecosystem* as defined in 40 CFR 230.3(c) *Cont'd*	Except as provided under [CWA] section 404(b)(2), no discharge of dredged or fill material shall be permitted which will cause or contribute to significant degradation of the waters of the United States.	Action that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – **applicable**	40 CFR Part 230.10(c) Restrictions on Discharge

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Aquatic Resources and Coastal Zone Areas			
	Except as provided under [CWA] section 404(b)(2), No discharge of dredged or fill material shall be permitted unless appropriate and practicable steps in accordance with 40 CFR 230.70 *et seq. Actions To Minimize Adverse Effects* have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.		40 CFR Part 230.10(d) Restrictions on Discharge
Location encompassing aquatic ecosystem as defined in 40 CFR 230.3(c)	Must comply with the substantive requirements of the NWP 38 General Conditions, as appropriate, any regional or case-specific conditions recommended by the Corps District Engineer, after consultation. NOTE: Despite that consultation may be considered an administrative requirement; it should be performed to ensure activities are in compliance with substantive provisions of the permit.	On-site CERCLA action conducted by Federal agency that involves the discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands – applicable	Nation Wide Permit (38) Cleanup of Hazardous and Toxic Waste 33 CFR Part 323.3(b)
Presence of coastal marshlands	No person shall remove, fill, dredge, drain, or otherwise alter any marshlands or construct or locate any structure on or over marshlands in this state within the estuarine area thereof without first obtaining a permit. NOTE: Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.	Alteration to, or construction on or over, the marshlands or water bottoms within the estuarine area of the State – applicable	Georgia Coastal Marshlands Protection Act O.C.G.A. §12-5-286(a)
Presence of marshlands and estuarine area	There is a 50-foot marshlands buffer applicable to the upland component of the project as measured horizontally inland from the coastal marshland-upland interface, which is the Coastal Marshland Protection Act jurisdiction line, so as to ensure the project does not result in the filling or other alteration of the coastal marshlands.	Upland component of the project as defined in GA Rule 391-2-3-.02(2)(i) in coastal marshlands as defined in GA Rule §391-2-3-.02(2)(b) – applicable	GA Rule §391-2-3-.02(4)(a)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Aquatic Resources and Coastal Zone Areas			
Presence of marshlands and estuarine area	Except as provided in subparagraph 2. of this paragraph and paragraphs (d) and (g) below, no land-disturbing activities within the project boundaries shall be conducted within the 50-foot marshlands buffer, and such marshlands buffer shall remain in its natural, undisturbed state of vegetation, so as to naturally treat stormwater during both construction and post construction phases of the upland component of the project.	Upland component of the project as defined in GA Rule 391-2-3-.02(2)(i) in coastal marshlands as defined in GA Rule §391-2-3-.02(2)(b) – applicable	GA Rule §391-2-3-.02(4)(b)(1)
	Land disturbance and construction of structures within the 50-foot marshlands buffer in the upland component of the project shall be limited to the following: (i) Construction and maintenance of temporary structures necessary for construction of the marshlands component of the project; (ii) Construction and maintenance of permanent structures that are required for the functionality of and/or provide permanent access to the marshlands component of the project; and (iii) Planting and grading with vegetated materials within the marshlands buffer to enhance stormwater management, such as erosion and sediment control measures, and to allow pedestrian access for passive recreation.		GA Rule §391-2-3-.02(4)(b)(2)
Presence of marshlands and estuarine area	After such land disturbing activities associated with (b)2.(i) above are completed, and except as allowed for in (b)2.(ii) and (iii) above, the marshlands buffer must be restored to and maintained in a natural vegetated state or in a vegetated state at least as protective or better than pre-construction conditions, subject to hand trimming and thinning as authorized in the permit. *NOTE:* Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.	Upland component of the project as defined in GA Rule 391-2-3-.02(2)(i) in *coastal marshlands* as defined in GA Rule §391-2-3-.02(2)(b) – **applicable**	GA Rule §391-2-3-.02(4)(c)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Aquatic Resources and Coastal Zone Areas			
	Already existing impervious surfaces and structures within the marshlands buffer area may remain and be maintained, provided the replacement, modification or upgrade does not increase any encroachment upon the required marshlands buffer in effect at the time of the replacement, modification or upgrade.		GA Rule §391-2-3-.02(4)(d)
	Marshlands buffers shall be designed, installed and/or maintained sufficiently such that stormwater discharge to coastal marshlands from the marshlands buffer is managed according to the policy, criteria, and information including technical specifications and standards in the Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, 1st Edition, April 2009.		GA Rule§ 391-2-3-.02(4)(e)
Georgia Shore Protection	No person shall construct or erect any structure or construct, erect, conduct, or engage in any shoreline engineering activity or engage in any land alteration which alters the natural topography or vegetation of any area within the jurisdiction of this part except in accordance with the terms and conditions of a permit. *NOTE:* Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.	Activities that affect beaches and dynamic dune fields located on Georgia's barrier islands and the submerged shoreline lands adjacent to such beaches and dynamic dune fields seaward – **relevant and appropriate**	Georgia Shore Protection Act O.C.G.A. §12-5-237(a)
Submerged Cultural Resources	All findings of submerged cultural resources shall be reported to the Georgia Department of Natural Resources within two days of discovery, Saturday, Sundays, and legal holidays excluded.	Discovery of prehistoric or historic sites, ruins, artifacts, treasure, treasure-trove, and shipwrecks or vessels and their cargo or tackle, which have remained on the bottom for more than 50 years, and similar sites and objects found in the Atlantic Ocean within the three-mile territorial limit of the State of Georgia or within its navigable waters – **relevant and appropriate**	O.C.G.A. §12-3-81

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Location-Specific ARARs/TBC			
Location Characteristics	**Requirements**	**Prerequisite**	**Citation**
Threatened and Endangered Species			
Presence of Threatened and Endangered Wildlife listed in 50 CFR 17.11(h) – or critical habitat of such species	Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary of Interior, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section. *NOTE:* Despite that consultation may be considered an administrative requirement; it should be performed to ensure activities are in compliance with substantive provisions of the Endangered Species Act and regulations.	Agency action that may jeopardize listed wildlife species, or destroy or adversely modify critical habitat – **applicable**	16 U.S.C. §1536 (a)(2) –or Section 7(a)(2) of *the Endangered Species Act of 1973*
Presence of Threatened and Endangered Wildlife listed in 50 CFR 17.11(h)	It is unlawful to take threatened or endangered wildlife in the United States. *NOTE:* Under 50 CFR 10.12 *Definitions* the term *Take* means to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect.	Action that may jeopardize listed wildlife species – **applicable**	50 CFR Part 17.21(c) 50 CFR Part 17.31(a) 50 CFR Part 17.42(a)(2)
Presence of protected Marine Mammals	It is unlawful to take any marine mammal in waters or on lands under the jurisdiction of the United States.	Action that may jeopardize protected marine mammals – **applicable**	Marine Mammal Protection Act, 16 U.S.C. §1372 Section 102 (a)(2)(A)
Presence of Migratory Birds listed in 50 CFR 10.13	No person may take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird except as may be permitted under the terms of a valid permit issued pursuant to the provisions of this part and part 13 of this chapter, or as permitted by regulations in this part, or part 20 of this subchapter (the hunting regulations).	Action that have potential impacts on, or is likely to result in a 'take' (as defined in 50 CFR 10.12) of migratory birds – **applicable**	Migratory Bird Treaty Act, 16 U.S.C. §703(a) 50 CFR 21.11

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
General Construction Standards – All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)			
Managing stormwater runoff from land-disturbing activities	Shall implement best management practices, including sound conservation and engineering practices to prevent and minimize erosion and resultant sedimentation, as provided in O.G.C.A. § 12-7-6(b), during excavation activity.	Land-disturbing activity (as defined in O.C.G.A. §12-7-3(9)) of more than one acre of land – **applicable**	GA Erosion and Sedimentation Act O.G.C.A. §12-7-6(b)
	Shall control turbidity of stormwater runoff discharges to the extent the limits in O.C.G.A. § 12-7-6 shall not be exceeded.	Land-disturbing activity (as defined in O.C.G.A. §12-7-3(9)) of more than one acre of land – **applicable**	GA Rule §391-3-7-.06
Managing stormwater runoff from upland area	There shall be no discharge of untreated stormwater from developed or disturbed areas, whether surface or piped, to coastal marshlands from the upland component of the project. The Committee is authorized to waive this requirement if the Committee finds that the site or project characteristics prohibit treatment, there is no practicable alternative, and it has minimal adverse impact.	Upland component of the project as defined in GA Rule §391-2-3-.02(2)(i) in coastal marshlands as defined in GA Rule 391-2-3-.02(2)(b) – **applicable**	GA Rule §391-2-3-.02(5)(a)
	In addition to the requirements of Section (5)(a) above, discharged stormwater from the upland component of the project shall be managed according to the policy, criteria, and information including technical specifications and standards in the Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, 1st Edition, April 2009.		GA Rule §391-2-3-.02(5)(b)
Managing discharge of wastewater	No person shall discharge, allow, or cause to be discharged into the CS4 or watercourses any materials, other than stormwater, including but not limited to pollutants or waters containing any pollutants that cause or contribute to a violation of applicable water quality standards. Shall take all reasonable precautions to prevent fugitive dust from becoming airborne, including the following precautions: (i) use of water or chemicals for dust control; (ii) application of asphalt, water, or chemicals on surfaces that can give rise to airborne dusts; (iii) installation of hoods, fans, and filters to enclose and vent the handling of dusty materials;	Discharge of wastewater other than stormwater – **relevant and appropriate**	Glynn County Ordinance 2-27-11

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
General Construction Standards – All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)			
Managing fugitive dust emissions	(iv) covering, at all times when in motion, open bodied trucks transporting materials likely to give rise to airborne dusts; and (v) prompt removal of earth or other material from paved streets onto which it has been deposited.	Operations, processes, handling, transportation or storage which may result in fugitive dust – **relevant and appropriate**	Georgia Air Quality Control Regulations Rule §391-3-1-.02(2)(n)(1)
	Shall not allow the percent opacity from any fugitive dust source to equal or exceed 20 percent		Georgia Air Quality Control Regulations Rule §391-3-1-.02(2)(n)(2)
Waste Characterization – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
Characterization of solid waste (all primary and secondary waste)	Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4(b); and must determine if waste is listed under 40 CFR Part 261.	Generation of solid waste as defined in 40 CFR 261.2 and which is not excluded under 40 CFR 261.4(a) – **applicable**	40 CFR 262.11(a) and (b) GA Rule §391-3-11-.08
	Must determine whether the waste is (characteristic waste) identified in subpart C of 40 CFR part 261by either: (1) Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or (2) Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.		40 CFR 262.11(c) GA Rule§391-3-11-.08
	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous – **applicable**	40 CFR 262.11(d) GA Rule §391-3-11-.08
Characterization of *hazardous* waste (all primary and secondary waste)	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	Generation of RCRA hazardous waste for storage, treatment or disposal – **applicable**	40 CFR 264.13(a)(1) GA Rule §391-3-11-.10
Characterization of *hazardous* waste (all primary and secondary waste) *Cont'd*	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal – **applicable**	40 CFR 268.9(a) GA Rule §391-3-11-.16

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Waste Characterization – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
	Must determine if the waste is restricted from land disposal under 40 CFR 268 *et seq*. by testing in accordance with prescribed methods or use of generator knowledge of waste. This determination can be made concurrently with the hazardous waste determination required in 40 CFR 262.11.		40 CFR 268.7 GA Rule §391-3-11-.16
	Must comply with the special requirements of 40 CFR § 268.9 in addition to any applicable requirements in 40 CFR § 268.7.	Generation of waste or soil that displays a hazardous characteristic of ignitability, corrosivity, reactivity, or toxicity for storage, treatment or disposal – **applicable**	40 CFR 268.7(a)(1) GA Rule §391-3-11-.16
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 *et. seq*. This determination may be made concurrently with the hazardous waste determination required in Sec. 262.11 of this chapter.		40 CFR 268.9(a) GA Rule §391-3-11-.16
Management of PCB waste (e.g., contaminated soil, PPE, equipment, wastewater)	Any person storing or disposing of PCB waste must do so in accordance with 40 CFR 761, Subpart D.	Generation of waste containing PCBs at concentrations ≥ 50 ppm – **applicable**	40 CFR 761.50(a)
	Any person cleaning up and disposing of PCBs shall do so based on the concentration at which the PCBs are found.	Generation of PCB remediation waste as defined in 40 CFR 761.3 – **applicable**	40 CFR 761.61
Temporary Storage of Wastes – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
Temporary storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that: • waste is placed in containers that comply with 40 CFR 265.171-173 • the date upon which accumulation begins is clearly marked and visible for inspection on each container • container is marked with the words "hazardous waste"	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 – **applicable**	40 CFR 262.34(a)(1)-(3) GA Rule §391-3-11-.08
	• container may be marked with other words that identify the contents	Accumulation of 55 gal. or less of RCRA hazardous waste at or near any point of generation – **applicable**	40 CFR 262.34(c)(1) GA Rule §391-3-11-.08

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Temporary Storage of Wastes – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
Use and management of hazardous waste in containers	If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition.	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR 265.171 GA Rule §391-3-11-.10
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired.		40 CFR 265.172 GA Rule §391-3-11-.10
	Keep containers closed during storage, except to add/remove waste.		40 CFR 265.173(a) GA Rule §391-3-11-.10
	Open, handle and store containers in a manner that will not cause containers to rupture or leak.		40 CFR 265.173(b) GA Rule §391-3-11-.10
Storage of hazardous waste in container area	Area must have a containment system designed and operated in accordance with 40 CFR 264.175(b).	Storage of RCRA hazardous waste in containers with *free liquids* – **applicable**	40 CFR 264.175(a) GA Rule §391-3-11-.10
	Area must be sloped or otherwise designed and operated to drain liquid from precipitation, or Containers must be elevated or otherwise protected from contact with accumulated liquid.	Storage of RCRA hazardous waste in containers that *do not contain free liquids* (other than F020, F021, F022, F023,F026 and F027) – **applicable**	40 CFR 264.175(c)(1) and (2) GA Rule §391-3-11-.10
Closure performance standard for RCRA container storage unit	Must close the facility (e.g., container storage unit) in a manner that: • Minimizes the need for further maintenance; • Controls minimizes or eliminates to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated run –off, or hazardous waste decomposition products to the ground or surface waters or the atmosphere; and • Complies with the closure requirements of subpart, but not limited to, the requirements of 40 CFR 264.178 for containers.	Storage of RCRA hazardous waste in containers – **applicable**	40 CFR 264.111 GA Rule §391-3-11-.10

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Temporary Storage of Wastes – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
Closure of RCRA container storage unit	At closure, all hazardous waste and hazardous waste residues must be removed from the containment system. Remaining containers, liners, bases, and soils containing or contaminated with hazardous waste and hazardous waste residues must be decontaminated or removed. [Comment: At closure, as throughout the operating period, unless the owner or operator can demonstrate in accordance with 40 CFR 261.3(d) of this chapter that the solid waste removed from the containment system is not a hazardous waste, the owner or operator becomes a generator of hazardous waste and must manage it in accordance with all applicable requirements of parts 262 through 266 of this chapter].	Storage of RCRA hazardous waste in containers in a unit with a containment system – **applicable**	40 CFR 264.178 GA Rule §391-3-11-.10
Performance criteria for staging pile	Staging pile must: • facilitate a reliable, effective and protective remedy; • must be designed to prevent or minimize releases of hazardous wastes and constituents into the environment, and minimize or adequately control cross–media transfer as necessary to protect human health and the environment (e.g. use of liners, covers, run–off/run–on controls).	Storage of remediation waste in a staging pile – **applicable**	40 CFR 264.554(d)(1)(i) and (ii) GA Rule §391-3-11-.10
Operation of a staging pile	Must not operate for more than two years, except when an operating term extension under 40 CFR 264.554(i) is granted. *Note:* Must measure the two-year limit (or other operating term specified) from first time remediation waste placed in staging pile	Storage of remediation waste in a staging pile – **applicable**	40 CFR 264.554(d)(1)(iii) GA Rule §391-3-11-.10
	Must not use staging pile longer than the length of time designated by EPA in appropriate decision document.		40 CFR 264.554(h) GA Rule §391-3-11-.10
Design criteria for staging pile	In setting standards and design criteria must consider the following factors: • Length of time pile will be in operation; • Volumes of waste you intend to store in the pile; • Physical and chemical characteristics of the wastes to be stored in the unit; • Potential for releases from the unit;	Storage of remediation waste in a staging pile – **applicable**	40 CFR 264.554(d)(2)(i) – (vi) GA Rule §391-3-11-.10

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Temporary Storage of Wastes – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes(e.g., wastewaters and spent treatment media)			
	• Hydrogeological and other relevant environmental conditions at the facility that may influence the migration of any potential releases; and • Potential for human and environmental exposure to potential releases from the unit.		
Operation of a staging pile	Must not place in the same staging pile unless you have complied with 40 CFR 264.17(b).	Storage of "incompatible" remediation waste (as defined in 40 CFR 260.10) in staging pile – **applicable**	40 CFR 264.554(f)(1) GA Rule §391-3-11-.10
	Must separate the incompatible waste or materials, or protect them from one another by using a dike, berm, wall or other device.	Staging pile of remediation waste stored nearby to incompatible wastes or materials in containers, other piles, open tanks or land disposal units – **applicable**	40 CFR 264.554(f)(2) GA Rule §391-3-11-.10
	Must not pile remediation waste on same base where incompatible wastes or materials were previously piled unless you have sufficiently decontaminated the base to comply with 40 CFR 264.17(b).		40 CFR 264.554(f)(3) GA Rule §391-3-11-.10
Closure of staging pile of remediation waste	Must be closed within 180 days after the operating term by removing or decontaminating all remediation waste, contaminated containment system components, and structures and equipment contaminated with waste and leachate. Must decontaminate contaminated subsoils in a manner that EPA determines will protect human and the environment.	Storage of remediation waste in staging pile in previously contaminated area – **applicable**	40 CFR 264.554(j)(1) and (2) GA Rule §391-3-11-.10
	Must be closed within 180 days after the operating term according to 40 CFR 264.258(a) and 264.111 or 265.258(a) and 265.111.	Storage of remediation waste in staging pile in uncontaminated area – **applicable**	40 CFR 264.554(k) GA Rule §391-3-11-.10
Storage of PCBs			
Storage of PCB Waste in a RCRA-regulated container storgae area	Does not have to meet storage unit requirements in 40 CFR 761.65(b)(1) provided unit: • is permitted by EPA under RCRA §3004, or • qualifies for interim status under RCRA §3005; or • is permitted by an authorized state under RCRA §3006 and, PCB spills cleaned up in accordance with Subpart G of 40 CFR 761.	Storage of PCBs and PCB Items designated for disposal – **applicable**	40 CFR Part 761.65(b)(2)(i)-(iv)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Storage of PCBs			
	NOTE: Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.		
Temporary storage of bulk PCB remediation waste in a waste pile	Waste must be placed in a pile that: • Is designed and operated to control dispersal by wind, where necessary, by means other than wetting; and Does not generate leachate through decomposition or other reactions.	Storage PCB remediation waste (as defined in 40 CFR 761.3) at cleanup site or site of generation up to 180 days – **applicable**	40 CFR Part 761.65(c)(9)(i) and (ii)
Waste pile liner performance	The storage site must have a liner designed, constructed, and installed to prevent any migration of wastes off or through liner into adjacent subsurface soil, groundwater, or surface water at any time during active life (including closure period) of the storage site.		40 CFR 761.65(c)(9)(iii)(A)
Construction of storage pile liner	Liner must be: • Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure because of pressure gradients, physical contact with waste or leachate to which they are exposed, climactic conditions, the stress of installation, and the stress of daily operation; • Placed on foundation or base capable of providing support to liner and resisitance to pressure from gradients above and below the liner to present failure because of settlement compression or uplift; Installed to cover all surrounding earth likely to be in contact with waste.		40 CFR 761.65(c)(9)(iii)(A)(*l*)-(3)
Construction of storage pile cover	The storage site must have a cover that: • Meets the requirements of 40 CFR 761.65(c)(9)(iii)(A); • Is installed to cover all of the stored waste likely to be contacted by the precipitation; and • Is secured so as to not be functionally disabled by winds expected under normal weather conditions.	Storage PCB remediation waste or PCB bulk product waste at cleanup site or site of generation up to 180 days – **appicable**	40 CFR 761.65(c)(9)(iii)(B)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Storage of PCBs			
Construction of storage pile run-on control system	The storage site must have a run-on control system designed, constructed, operated, and maintained such that it: • Prevents flow on the stored waste during peak discharge from at least a 25-year storm; • Collects and controls at least the water volume resulting from a 24-hour, 25-year storm. Collection and holding facilities (e.g., tanks or basins) must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system.		40 CFR 761.65(c)(9)(iii)(c)(*l*) and (2)
Treatment and Disposal of PCBs			
Disposal of decontamination wastes and residues	Such waste shall be disposed of at their existing PCB concentration unless otherwise specified in 40 CFR 761.79(g)(1-6).	Decontamination waste and residues – **applicable**	40 CFR 761.79(g)
	Are regulated for disposal as PCB remediation waste.	Distillation bottoms or residues and filter media – **applicable**	40 CFR 761.79(g)(1)
	Are regulated for disposal at their original concentration.	PCBs physically separated from regulated waste during decontamination, other than distillation bottoms and filter media – **applicable**	40 CFR 761.79(g)(2)
Disposal liquid PCB remediation waste (self-implementing option)	Shall either: • Decontaminate the waste to the levels specified in 40 CFR 761.79(b)(1) or (2); or Dispose of the waste in accordance with 40 CFR 761.61(b) or a risk-based approval under 40 CFR 761.61(c).	Liquid PCB remediation waste (as defined in 40 CFR 761.3) – **relevant and appropriate**	40 CFR 761.61(A)(5)(iv) 40 CFR 761.61(a)(5)(iv)(A) and (B)
Disposal of bulk PCB remediation waste off-site (self-implementing option)	May be sent off-site for decontamination or disposal provided the waste is either dewatered on-site or transported off-site in containers meeting the requirements of DOT HMR at 49 CFR parts 171-180.	Generation of bulk PCB remediation waste (as defined in 40 CFR 761.3) for disposal – **relevant and appropriate**	40 CFR 761.61(A)(5)(i)(B)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Treatment and Disposal of PCBs			
	Must provide written notice including the quanitity to be shipped and highest concentration of PCBs [using extraction EPA Method 3500B/3540C or Method 8082 in SW-846 or methods validated under 40 CFR 761.320-26 (Subpart Q)] at least 15 days before the first shipment of waste to each off-site facility	Generation of bulk PCB remediation waste (as defined in 40 CFR 761.3) for disposal at an off-site facility where the waste is destined for an area not subject to a TSCA PCB Disposal Approval – **relevant and appropriate**	40 CFR 761.61(A)(5)(i)(B)(2)(iv)
	Shall be disposed of in accordance with the provisions for Cleanup wastes at 40 CFR 761.61(a)(5)(v)(A).	Bulk PCB remediation waste which has been dewatered and with a PCB concentration < 50 ppm – **relevant and appropriate**	40 CFR 761.61(A)(5)(i)(B)(2)(ii)
	Shall be disposed of: • In a hazardous waste landfill permitted by EPA under §3004 of RCRA; • In a hazardous waste landfill permitted by a State authorized under §3006 of RCRA; or In a PCB disposal facility approved under 40 CFR 761.60.	Bulk PCB remediation waste which has been dewatered and with a PCB concentration ≥ 50 ppm – **relevant and appropriate**	40 CFR 761.61(A)(5)(i)(B)(2)(iii)
Performance-based disposal of PCB remediation waste	Shall dispose by one of the following methods: • In a high-temperature incinerator approved under 40 CFR 761.70(b); • By an alternate disposal method approved under 40 CFR 761.60(e); • In a chemical waste landfill approved under 40 CFR 761.75; • In a facility with a coordinated approval issed under 40 CFR 761.77; or • Through decontamination in accordance with 40 CFR 761.79.	Disposal of non-liquid PCB remediation waste (as defined in 40 CFR 761.3) – **relevant and appropriate**	40 CFR 761.61(b)(2) 40 CFR 761.61(b)(2)(i) 40 CFR 761.61(b)(2)(ii)
	Shall be disposed according to 40 CFR 761.60(a) or (e), or decontaminate in accordance with 40 CFR 761.79.	Disposal of liquid PCB remediation waste – **applicable**	40 CFR 761.61(b)(1)
Disposal of PCB cleanup wastes (e.g., PPE, rags, non-liquid cleaning materials) (self-implementing option)	Shall be disposed of either: • In a facility permitted, licensed, or registered by a State to manage municipal solid waste under 40 CFR 258 or non-municipal, non-hazardous waste subject to 40 CFR 257.5 thru 257.30; or	Generation of non-liquid PCBs at any concentration during and from the cleanup of PCB remediation waste –**relevant and appropriate**	40 CFR 761.61(a)(5)(v)(A)(1)-(4)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Treatment and Disposal of PCBs			
	• In a RCRA Subtitle C landfill permitted by a State to accept PCB waste; or • In an approved PCB disposal facility; or • Through decontamination under 40 CFR 761.79(b) or (c).		
Decontamination of PCB contaminated water	For discharge to a treatment works as defined in 40 CFR 503.9(aa), or discharge to navigable waters, meet standard of < 3 ppb PCBs; or For unrestricted use, meet standard of ≤ 0.5 ppb PCBs	Water containing PCBs regulated for disposal – **applicable**	40 CFR 761.61(b)(1)(ii) 40 CFR 761.61(b)(1)(iii)
Waste Treatment and Disposal – Primary Wastes (e.g., excavated soil/sediment) and Secondary Wastes (e.g., wastewaters, spent treatment media)			
Disposal of RCRA-hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste – **applicable**	40 CFR 268.40(a) GA Rule §391-3-11-.16
	Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils – **applicable**	40 CFR 268.49(b) GA Rule §391-3-11-.16
Disposal of RCRA characteristic wastewaters in an NPDES permitted WWTU	Are not prohibited, if the wastes are managed in a treatment system which subsequently discharges to waters of the U.S. pursuant to a permit issued under 402 of CWA (i.e., NPDES permitted), unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR 268.40, or D003 reactive cyanide. *NOTE*: For purposes of this exclusion, a CERCLA on-site wastewater treatment unit that meets all of the identified CWA NPDES ARARs for point source discharges from such system is considered wastewater treatment system that is NPDES permitted.	Land disposal of RCRA restricted hazardous wastewaters that are hazardous only because they exhibit a characteristic and not otherwise prohibited under 40 CFR 268 – **applicable**	40 CFR 268.1(c)(4)(i) GA Rule §391-3-11-.16
Disposal of RCRA characteristic wastewaters in a POTW	Are not prohibited, if wastes are treated for purposes of the pretreatment requirements of Section 307 of the CWA, unless the wastes are subject to a specified method of treatment other than DEACT in 40 CFR 268.40, or are D003 reactive cyanide.	Land disposal of hazardous wastewaters that are hazardous only because they exhibit a characteristic and are not otherwise prohibited under 40 CFR 268 – **applicable**	40 CFR 268.49(b) GA Rule §391-3-11-.16

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharge of Wastewaters			
Discharge of wastewater from treatment unit or de-watering	All pollutants shall receive such treatment or corrective action so as to ensure compliance with the terms and conditions of the issued permit and with the following, whenever applicable: • Effluent limitations established by EPA pursuant to Sections 301, 302, 303 and 316 of the Federal CWA; • Effluent limitations and prohibitions and pretreatment standards established by the EPA pursuant to Section 307 of the Federal CWA; • Notwithstanding the above, more stringent effluent limitations may be required as deemed necessary by the EPD (a) to meet any other existing Federal laws or regulations, or (b) to ensure compliance with any applicable State water quality standards, effluent limitations, treatment standards, or schedules of compliance. *NOTE:* Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.	Discharge of any pollutant into the waters of the State – **applicable**	GA Rule §391-3-6-.06(4)(a) (1),(3) and (10) Degree of Waste Treatment Required
Discharge of wastewater from treatment unit or de-watering *Cont'd*	Until such time as such criteria, standards, limitations, and prohibitions are promulgated pursuant to Sections 301, 302, 303, 304(e), 306, 307 and 405 of the Federal CWA, the EPD shall apply such standards, limitations and prohibitions necessary to achieve the purposes of said sections of the Federal Act. With respect to individual point sources, such limitations, standards, or prohibitions shall be based upon an assessment of technology and processes, to-wit: 1. To existing point sources, other than publicly owned treatment works, effluent limitations based on application of the best practicable control technology currently available; 2. To publicly owned treatment works, effluent limitations based upon the application of secondary treatment or treatment equivalent to secondary treatment in accordance with Federal Regulations, 40 C.F.R. 133.102 and .105;		GA Rule §391-3-6-.06(4)(d) Degree of Waste Treatment Required

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharge of Wastewaters			
	3. To any point source, other than publicly owned treatment works, whose construction commences after the initial effective date of this Paragraph, and for which there are not new source performance standards, effluent limitations which reflect the greatest degree of effluent reduction which the EPD determines to be achievable through application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants, consistent with 40 C.F.R. 125.3(c)(2); 4. To any point source, as appropriate, effluent limitations or prohibitions designed to prohibit the discharge of toxic pollutants in toxic amounts or to require pretreatment of pollutants which interfere with, pass through, or otherwise are incompatible with the operation of publicly owned treatment works; and 5. To any point source, as appropriate, more stringent effluent limitations as are required to ensure compliance with applicable State water quality standards, including those to prohibit the discharge of toxic pollutants in toxic amounts. Where necessary, NPDES Permits issued or reissued after the adoption of this paragraph shall include numeric criteria based upon the following procedures to ensure that toxic substances and other priority pollutants are not discharged to surface waters in harmful amounts. *NOTE:* Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit.		
Monitoring of discharges into surface water	The monitoring requirements of any discharge authorized by any such permit shall be consistent with Federal Regulations, 40 C.F.R. 122.41, 122.42, and 122.44 and applicable State laws.	Discharge of any pollutant into the waters of the State – **applicable**	GA Rule §391-3-6-.06(11)(a)

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Discharge of Wastewaters			
	NOTE: Per CERCLA §121(e)(1) permits are not required for on-site response action; however project must comply with any substantive requirements that otherwise would be included in a permit. Monitoring parameters including frequency will be included in a CERCLA document such as a Remedial Action Work Plan that is reviewed by EPD.		
Decontamintation of PCB contaminated water	For discharge to a treatment works as defined in 40 CFR 503.9(aa), or discharge to navigable waters, meet standard of < 3 ppb PCBs; or For unrestricted use, meet standard of ≤ 0.5 ppb PCBs.	Water containing PCBs regulated for disposal – **applicable**	40 CFR 761.61(b)(1)(ii) 40 CFR 761.61(b)(1)(iii)
Transportation of Wastes			
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 CFR 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way – **applicable**	40 CFR 262.20(f) GA Rule §391-3-11-.08
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 CFR 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number.	Preparation and initiation of shipment of hazardous waste off-site – **applicable**	40 CFR 262.10(h); GA Rule §391-3-11-.08
	Must comply with the requirements of 40 CFR 263.11-263.31. A transporter who meets all applicable requirements of 49 CFR 171-179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263.	Transportation of hazardous waste within the United States requiring a manifest – **applicable**	40 CFR 263.10(a) GA Rule §391-3-11-.09
Transportation of samples (i.e. contaminated soils and wastewaters)	Are not subject to any requirements of 40 CFR Parts 261 through 268 or 270 when: • the sample is being transported to a laboratory for the purpose of testing; or • the sample is being stored by sample collector before transport to a lab for testing	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition **– applicable**	40 CFR 261.4(d)(1)(i)–(iii) GA Rule §391-3-11-.07

Table 27. Applicable or Relevant and Appropriate Requirements (ARARs) for OU1 at the LCP Chemicals Site - Continued

Action-Specific ARARs/TBC			
Action	**Requirements**	**Prerequisite**	**Citation**
Transportation of Wastes			
	• the sample is being stored by sample collector before transport to a lab for testing		
	In order to qualify for the exemption in paragraphs (d)(1)(i) and (ii), a sample collector shipping samples to a laboratory must: • Comply with U.S. DOT, U.S. Postal Service, or any other applicable shipping requirements • Assure that the information provided in (1) thru (5) of this section accompanies the sample. • Package the sample so that it does not leak, spill, or vaporize from its packaging.	Samples of solid waste or a sample of water, soil for purpose of conducting testing to determine its characteristics or composition– **applicable**	40 CFR 261.4(d)(2)(i)(A) and (B) GA Rule §391-3-11-.07
Transportation and handling of solid waste	No person shall engage in solid waste or special solid waste handling in Georgia or construct or operate a solid waste handling facility in Georgia, except those individuals exempted from this part under Code Section 12-8-30.10, without first obtaining a permit from the director authorizing such activity.	Management of solid waste in Georgia – **applicable**	Georgia Solid Waste Management Act of 1990 O.C.G.A. §12-8-24

Notes:
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act of 1972
DEACT = deactivation
DOT = U.S. Department of Transportation
EPA = U.S. Environmental Protection Agency
EPD = Georgia Environmental Protection Division of the Georgia Department of Natural Resources
HMR = Hazardous Materials Regulations
HMTA = Hazardous Materials Transportation Act
GAC = granulated activated carbon
GA Rule = *Rules and Regulations*, Section as noted
LDR = Land Disposal Restrictions
NPDES = National Pollutant Discharge Elimination System
O.C.G.A. = *Official Code of Georgia Annotated*, Chapter as noted
POTW = Publicly Owned Treatment Works
RCRA = Resource Conservation and Recovery Act of 1976
TBC = to be considered
TCLP = Toxicity Characteristic Leaching Procedure
U.S. = United States
USCOE = U.S. Corps of Engineers
UTS = Universal Treatment Standard
WWTU = Waste Water Treatment Unit

Table 28. Summary of Remedial Alternative Costs

	Alternatives and Remedial Actions	Area (Acres)	Total Estimated Indirect Costs (Present Day $MM)	Total Estimated Direct Costs (Present Day $MM)	Total Estimated Recurring Costs (Present Day $MM)	Contingency Cost (Present Day $MM)
Alt 1	**No Action**	-	$0.0	$0.0	$0.0	$0.0
Alt 2	**Dredge:** All Areas	48	$8.6	$48.6	$0.4	$7.3
Alt 3	**Dredge:** LCP Ditch, Eastern & Western Creek Complex	8				
	Cap: Domain 3 Creek, Purvis Creek North & South	16	$5.3	$27.9	$1.4	$4.2
	Thin Cover: Domain 1A, 2, 3 and Dillon Duck	23				
Alt 4	**Dredge:** All Areas	18	$4.9	$25.2	$0.3	$3.8
Alt 5	**Dredge:** LCP Ditch & Eastern Creek	7				
	Cap: Domain 3 Creek	3	$3.9	$18.9	$0.5	$2.8
	Thin Cover: Dillon Duck, Domain 1A & 2	8				
Alt 6	**Dredge:** LCP Ditch & Eastern Creek	7				
	Cap: Domain 3 Creek & Purvis Creek South	6	$4.2	$20.7	$0.7	$3.1
	Thin Cover: Dillon Duck, Domain 1A & 2	11				

Note: Recurring Costs include Operations and Maintenance (O&M) and long-term monitoring

Table 29. Cost Estimate Summary for the Selected Remedy

Task	Quantity	Unit	Unit Cost	Total Cost
Indirect Costs				
1.01 Institutional Controls	1	LS	$250,000	$250,000
1.02 Predesign Investigations and Reporting	1	LS	$600,000	$600,000
1.03 Remedial Design		8%	$0	$1,653,280
1.04 Construction Management		8%	$0	$1,653,280
Direct Construction Costs				
2.0 Mobilization and Site Preparation	1	LS	$6,888,000	$6,888,000
3.0 Dredging	21,600	CY	$400	$8,604,000
4.0 Capping				
4.1 Sand	7,260	CY	$82	$598,500
4.2 Armor Stone	7,260	CY	$134	$971,500
5.0 Thin-Layer Cover	13,190	CY	$114	$1,505,000
6.0 Marsh Restoration	1	LS	$1,408,000	$1,408,000
7.0 Demobilization and Site Restoration	1	LS	$691,000	$691,000
Recurring Costs				
8.0 Long-term Monitoring of Capping Areas	1	LS	$236,000	$236,000
9.0 Long-term Monitoring of Thin-Layer Cover Areas	1	LS	$226,000	$226,000
10.0 Long-term Monitoring of Marsh Restoration Areas	1	LS	$211,000	$211,000
			Contingency (15% of TDCC)	$3,099,900
			Total Alternative Cost	**$28,595,460**

General Notes

- All costs are provided in present day dollars and all cost expenditures are assumed to occur at the start of construction.
- Work is to be conducted 5 days per week, 12 hours per day. Work is to be conducted year round with no planned interruptions in operations.
- Costs do not include property costs (where applicable), access costs, legal fees, Agency oversight, or public relations efforts.
- These costs have been developed using currently available information regarding site characteristics, such as site bathymetry, potential debris, and physical properties of the existing sediment at the site. As information regarding these site characteristics changes or new information becomes available, these costs will be subject to change.
- These estimates are developed using current and generally accepted engineering cost estimation methods. Note that these estimates are based on assumptions concerning future events and actual costs may be affected by known and unknown risks including, but not limited to, changes in general economic and business conditions, site conditions that were unknown to Anchor QEA, LLC at the time the estimates were performed, future changes in site conditions, regulatory or enforcement policy changes, and delays in performance. Actual costs may vary from these estimates and such variations may be material. Anchor QEA, LLC is not licensed as accountants, or securities attorneys, and, therefore, make no representations that these costs form an appropriate basis for complying with financial reporting requirements for such costs.

Table 29. Cost Estimate Summary for the Selected Remedy – Continued

Assumptions:

1.01 Institutional controls include deed restrictions, navigational controls and signage installation as deemed necessary.

1.02 Pre-design investigation includes all sampling, analysis and design work to be conducted prior to construction.

1.03 Remedial design work includes all plans, specifications and reporting necessary for construction to be implemented at the site. This has been preliminarily estimated as 8% of the direct construction costs based on best engineering judgment and previous experience at similar sites.

1.04 Construction management costs include necessary monitoring and oversight throughout construction. This includes only elevation verification after excavation, surface WQ measurement during dredging, and post backfill verification that the surface layer is clean. This cost has been preliminarily estimated as 8% of the direct construction costs based on best engineering judgment and previous experience at similar sites.

2.0 Mobilization and site preparation includes all pre-construction submittals and bonds. Also includes construction of temporary facilities, access roads, staging areas, mooring facilities and installation of soil erosion and sediment controls. Includes all costs necessary to mobilize construction equipment and general construction support materials necessary to complete the work.

3.0 Dredging costs include all equipment, labor, and materials necessary to perform the sediment removal operations at the site. Variations in dredging costs have been developed to account for adjustments in sediment disposal characterization, removal methodology due to site conditions and limited working times due to tidal cycles. Costs for sediment dewatering and disposal are also included in this task and vary depending on material characterization. This task also includes costs associated with turbidity controls, turbidity monitoring, health and safety oversight, and site surveying.

4.0 Capping costs include all equipment, labor, and materials necessary to perform the capping operations. Costs for delivery and placement of the cap components are included and placement cost variations have been developed to account for variable site conditions which impact production of this task. Also includes costs associated with turbidity monitoring and health and safety oversight.

5.0 Thin-layer cover costs include all equipment, labor and materials necessary to perform the thin layer placement operations. Costs for delivery and placement of the cover material is included. It is assumed that thin-layer placement will be conducted utilizing a pipeline transport system to deliver the slurried cover materials. Also includes costs associated with turbidity monitoring and health and safety oversight.

6.0 Marsh restoration costs include all equipment, labor and materials necessary to perform the restoration activities over the area impacted by the construction of access roads. Assumes that general plantings will be spaced on 2-foot centers over the restoration area.

7.0 Demobilization and site restoration involves removing equipment, materials, and labor from the site and restoring all disturbed areas to conditions similar to those existing prior to the start of construction. Disturbed areas include, at a minimum the two constructed staging areas, access roads, temporary site facilities, and temporary mooring facilities. It is assumed that only the top 2 inches of gravel on the access roads will be transported off site for disposal and that all remaining road fill material will be utilized in the remedy to the extent possible.

8.0 The cost for cap monitoring has been estimated in this analysis as 15% of the total direct capping cost of the alternative.

9.0 The cost for thin-layer cover monitoring has been estimated in this analysis as 15% of the total direct thin-layer cover cost of the alternative.

10.0 The cost for marsh restoration monitoring has been estimated in this analysis as 15% of the total direct marsh restoration cost of the alternative.

FIGURES

November 8, 2010

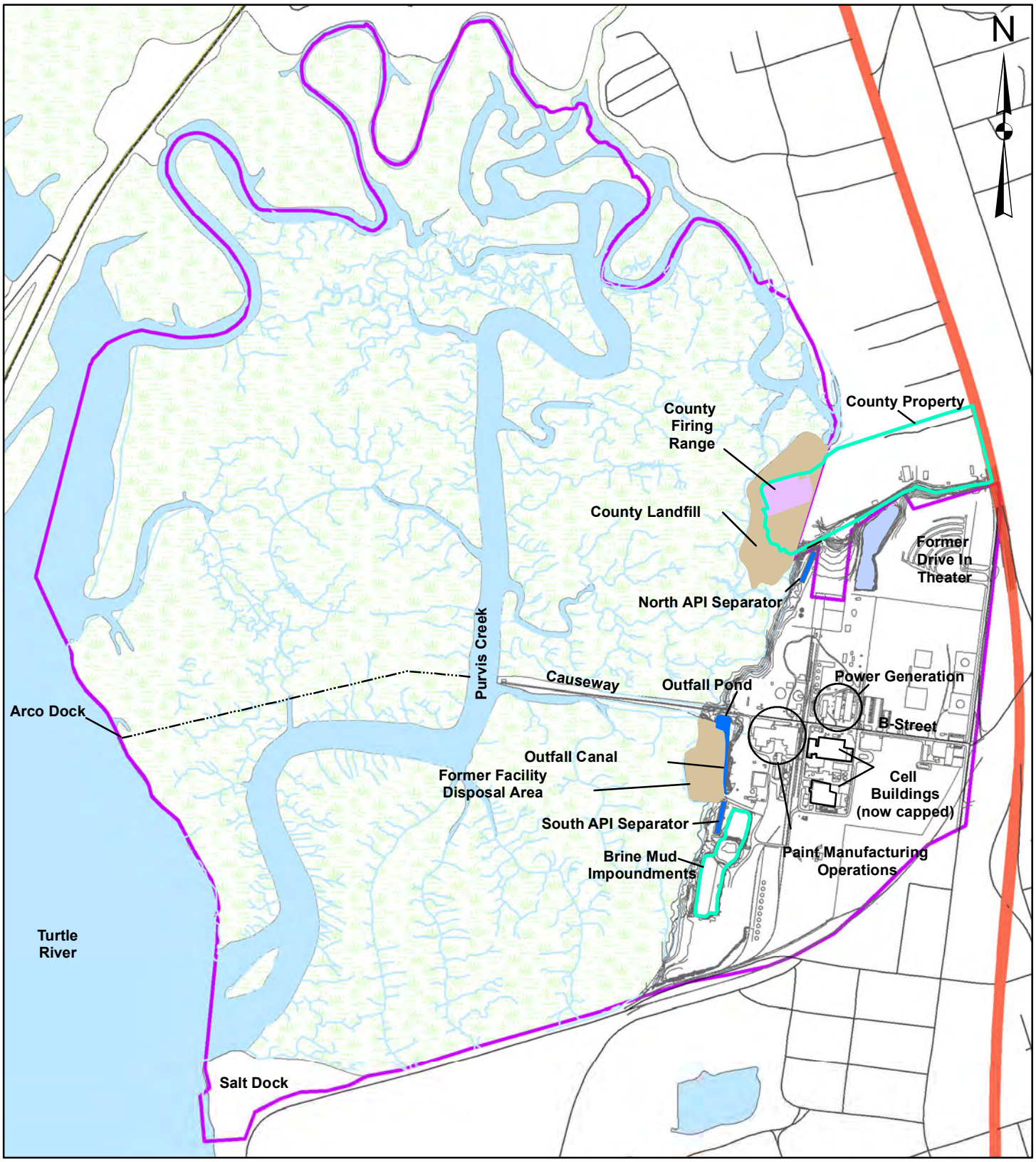
E:\PROJECTS\LCPMapDocs

LCP Site Map

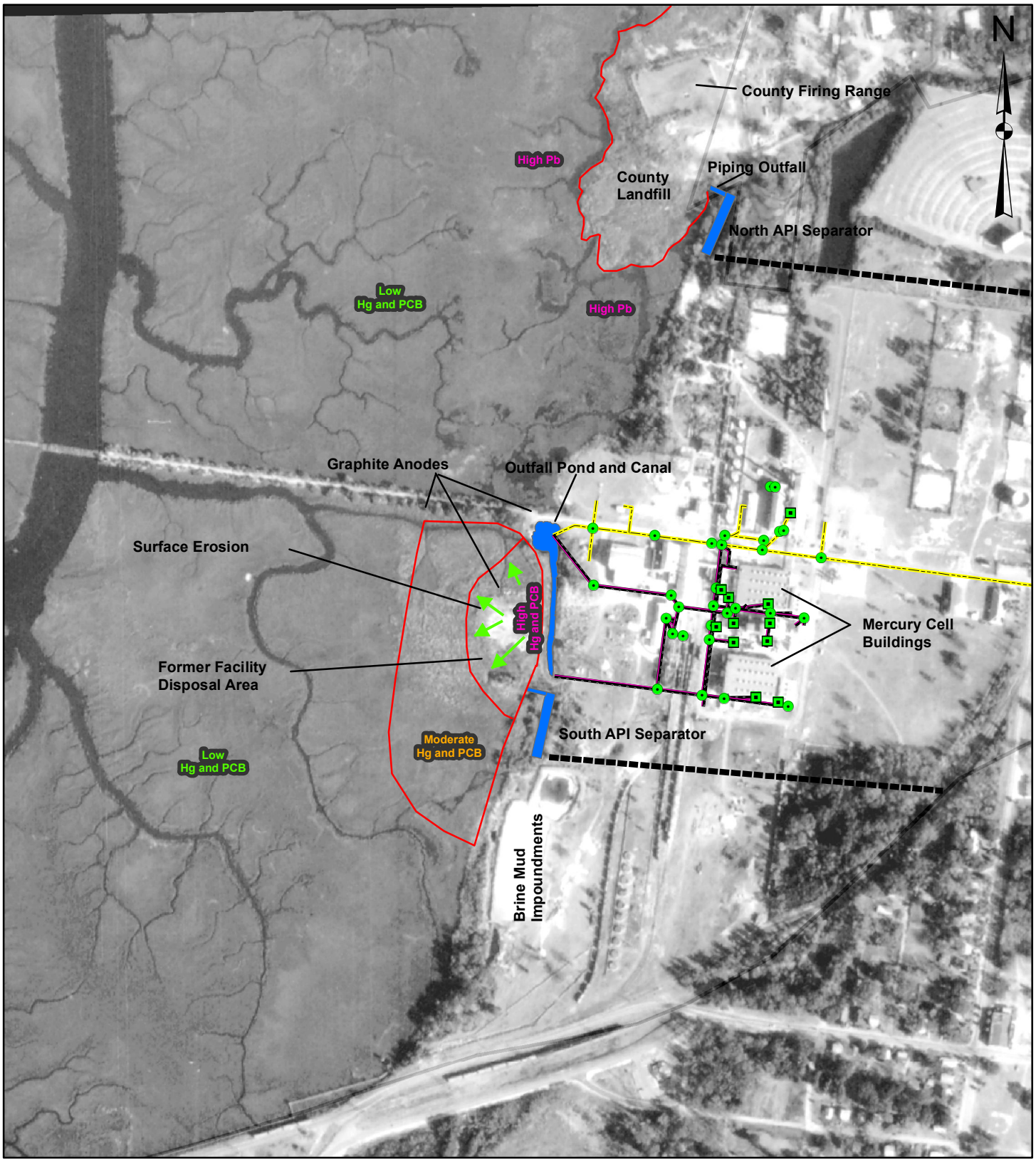
Glynn County, Georgia

Figure 1

Features of the LCP Estuary **Figure 2**



Features of the Upland Portion of the LCP Site **Figure 3**



Source: 1990 Aerial Photo

0 250 500 1,000

Feet

Legend

- Process Piping
- Stormwater Piping
- Manhole
- Sump
- Estimated Location of ARCO Community Sewer Lines Connects to API Separator

Source Areas for COC Transport to the Marsh **Figure 4**

AS CONSTRUCTED MARSH AND RAILROAD REMOVAL AREAS

N

LEGEND

As Constructed Marsh Removal Area
- 0.3 ft
- 1 ft
- 2 ft
- 2.5 ft
- 3 ft
- 5 ft

As Constructed Tidal Channel Removal Areas
- 1 ft
- 2 ft
- 3 ft
- 4 ft

As Constructed Railroad Removal Area
- 1 ft
- 1.5 ft
- 3 ft

Previous Upland Removal Areas

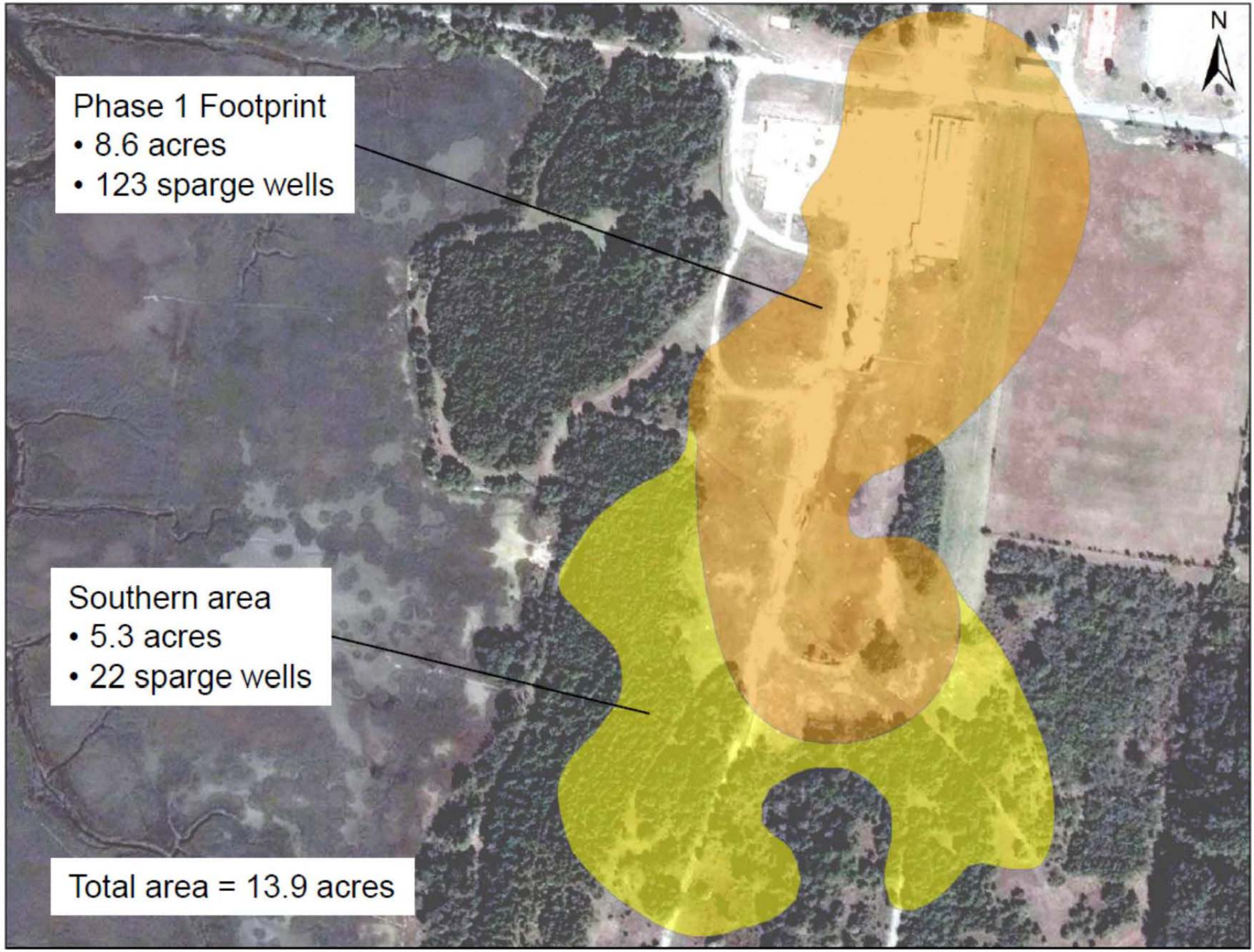
100 0 100 200 Feet

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE 5

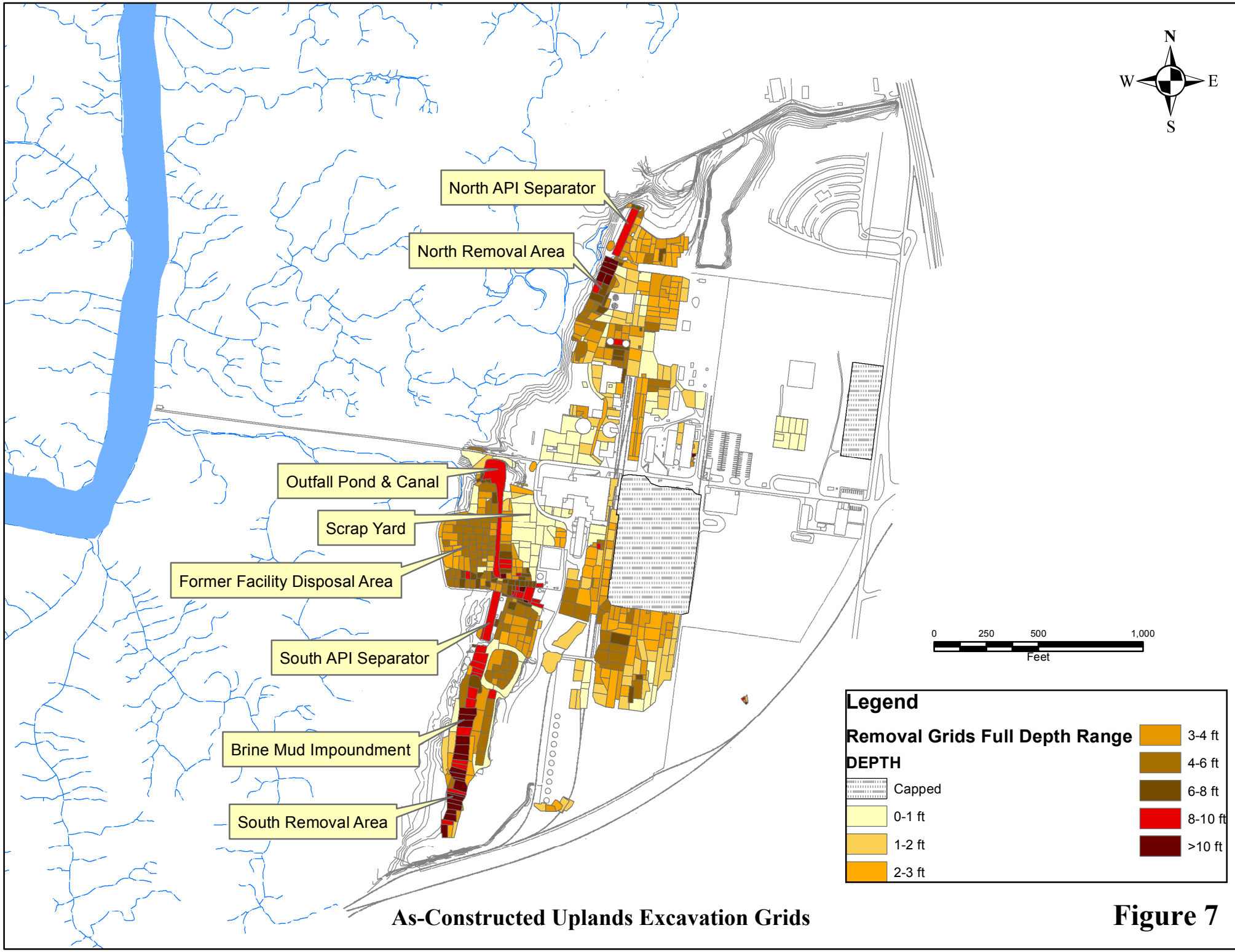
DATE: 27 SEPTEMBER 1999	SCALE: 1"= 200 FEET
PROJECT NO. GL0440	FIGURE NO. 3
DOCUMENT NO. GA990830	FILE NO. CLOSEOUT.APR

N:\LGP\GA\MARSH\REMOVAL\CLOSEOUT\CLOSEOUT.APR



Extent of the Caustic Brine Pool

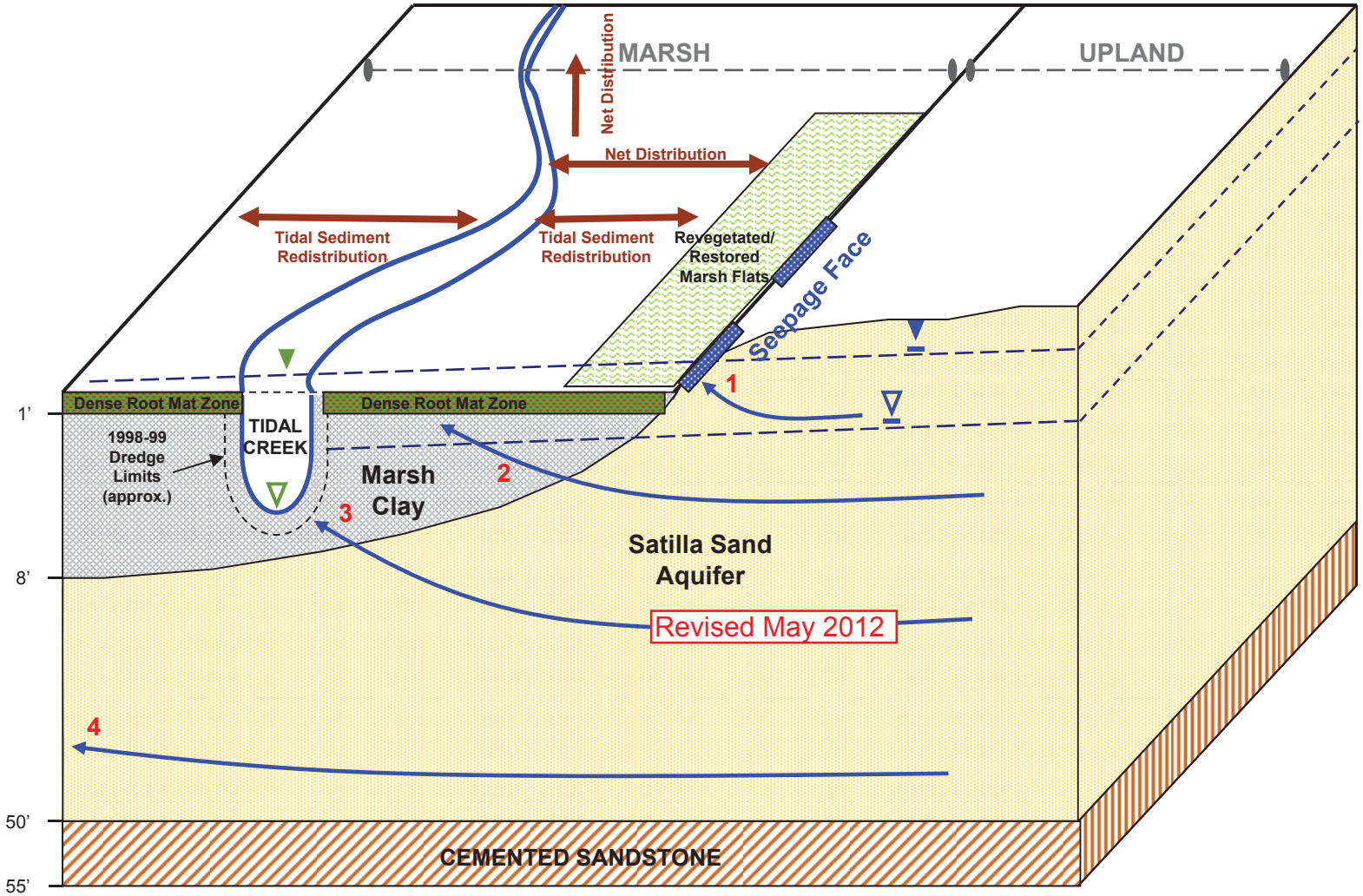
Figure 6



As-Constructed Uplands Excavation Grids

Figure 7

Revised May 2012



1 Seep along marsh edge (only at high water table condition).
2 Diffuse groundwater seepage through marsh clay discharging to marsh surface.
3 Diffuse groundwater seepage through marsh clay discharging to tidal tributary.
4 Deeper groundwater migrates to distant discharge boundary (e.g. Turtle River).

High water table condition

Low water table condition

High tide level in tidal tributary

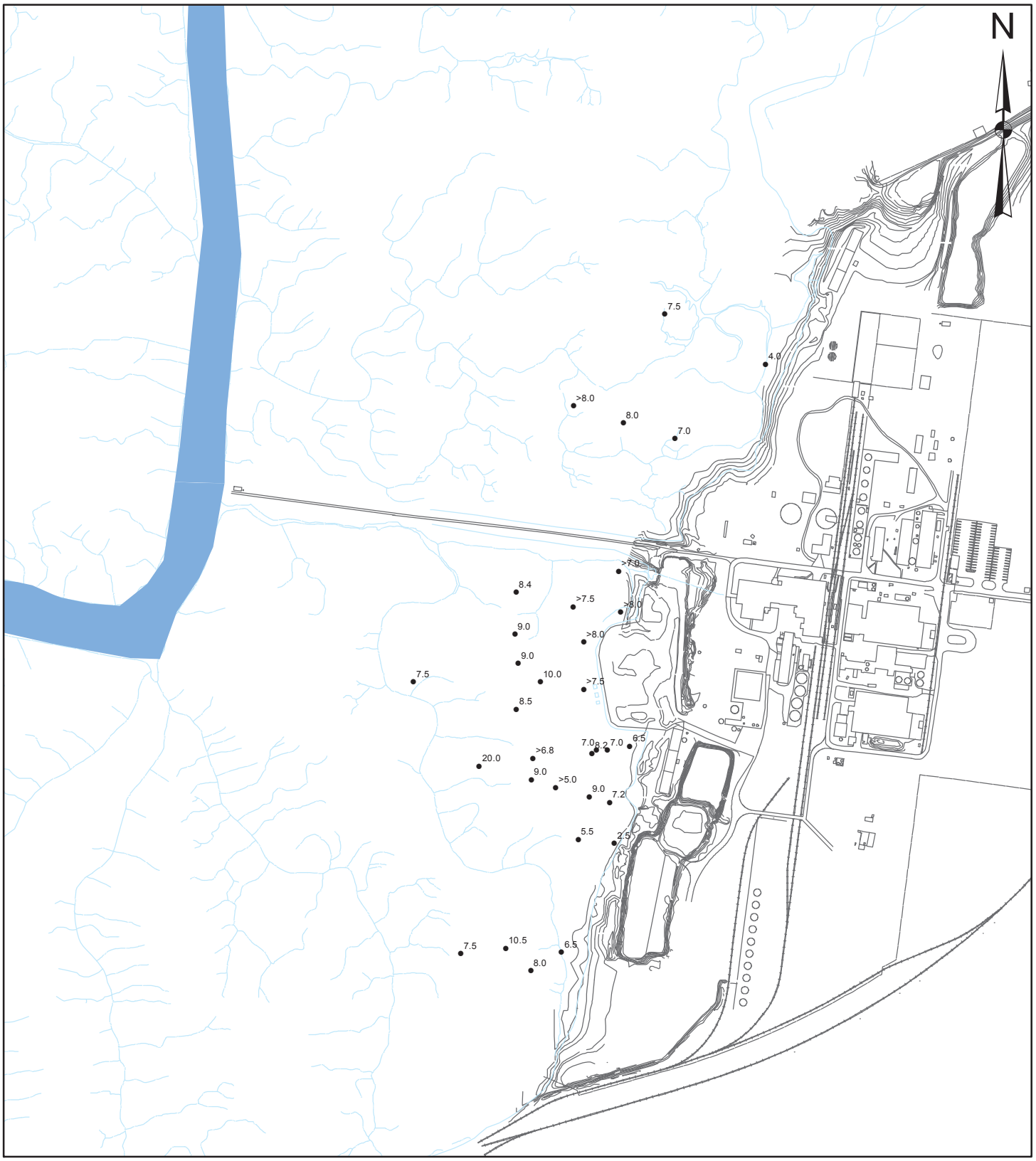
Low tide level in tidal tributary (dry)

Note: The "Dredge Limits" shown in the tidal creek is conceptual, but conveys that the 1998-99 removal action dredging removed approximately 1ft of sediment from the channel profile while at no time did the dredging cut through the marsh clay to the underlying sand aquifer.

Note: Marsh clay texture is variable and the thermal IR photography indicates some discharge into the marsh.

Conceptual Site Model of LCP Marsh

Figure 8



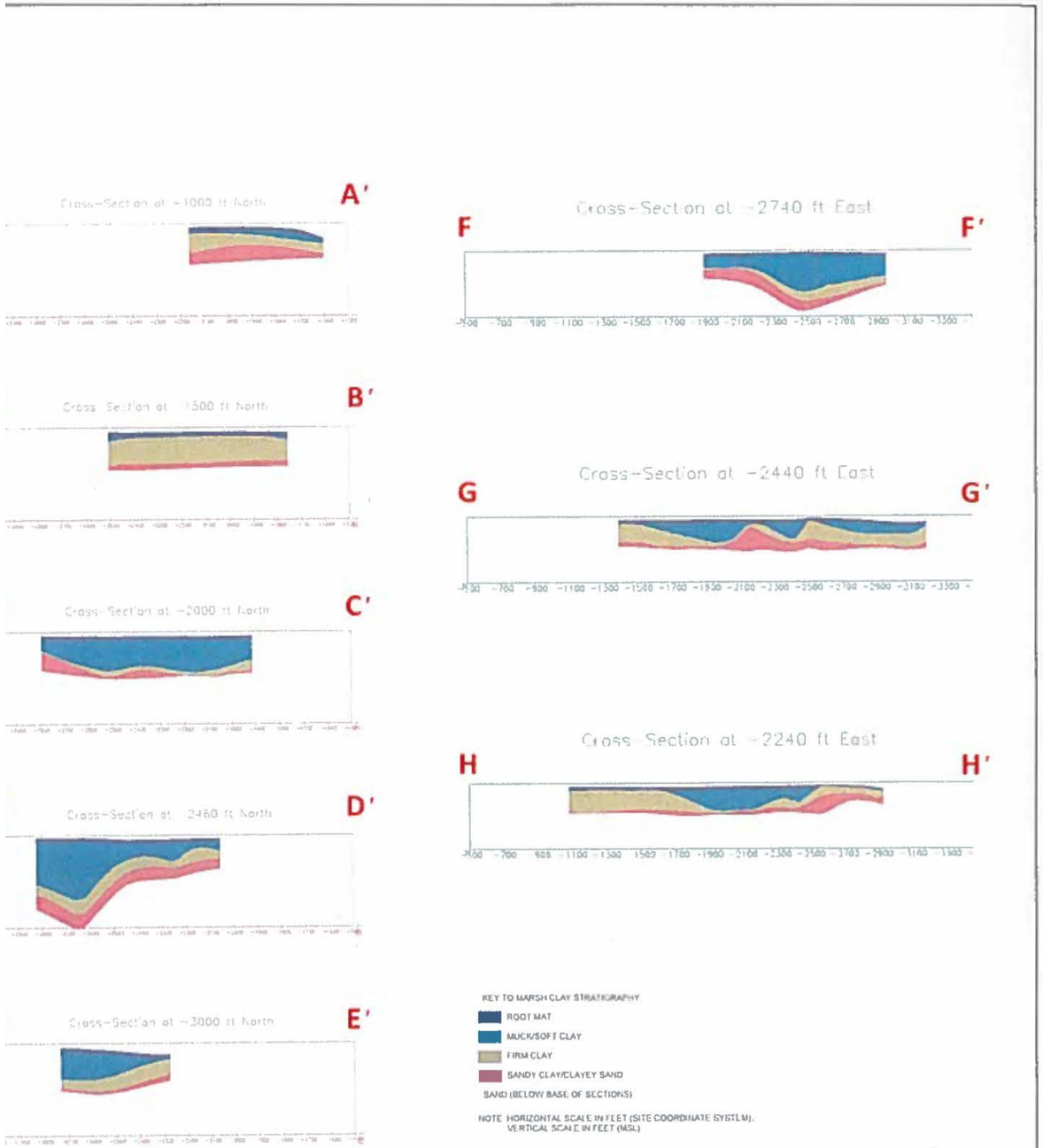
0 250 500 1,000
Feet

Legend

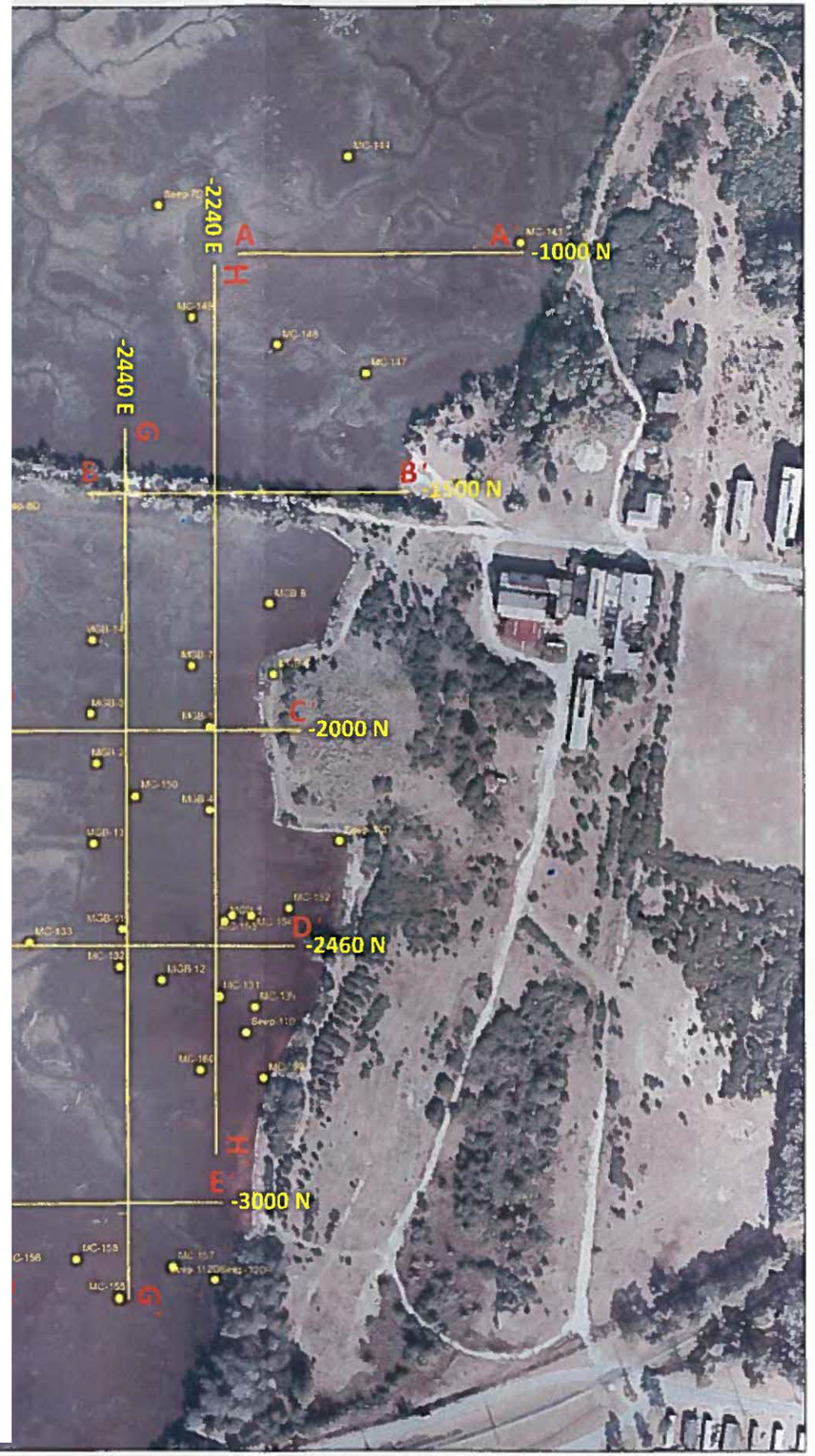
- Marsh Clay Thickness Measuerment Locations (depth in ft)
- Creeks
- Site Features (1994 Topography)

Marsh Clay Thickness (Overlying Surficial Sand Aquifer) **Figure 9**

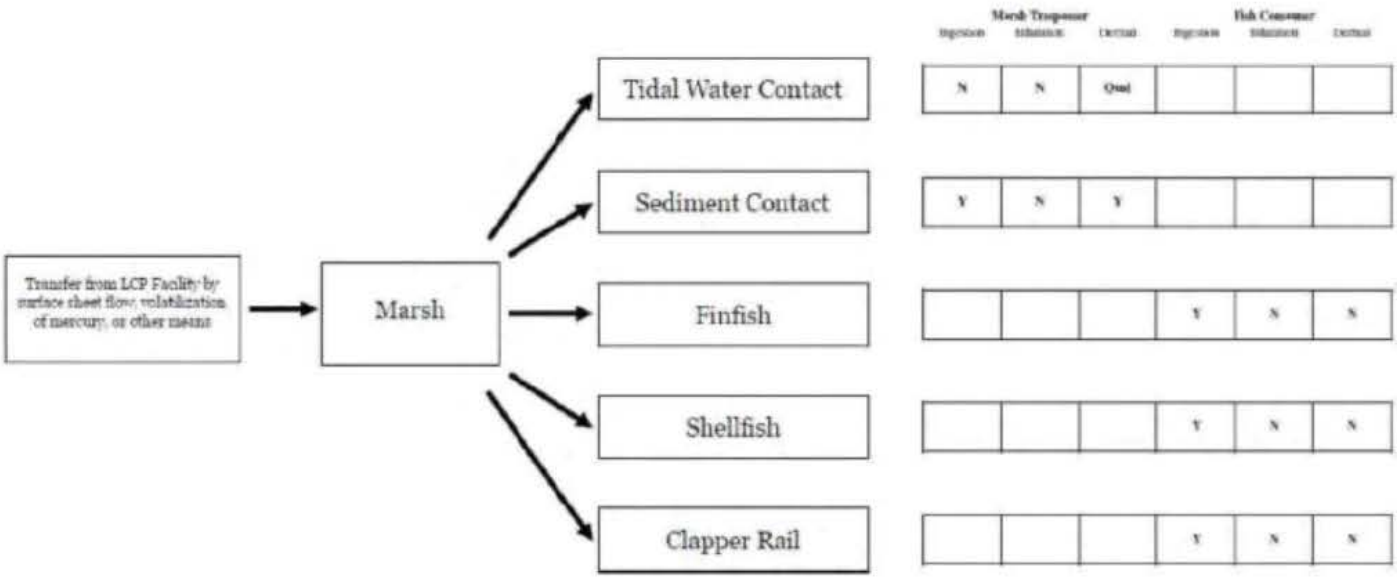
Drawing No. 1



te: Cross sections in the original Site coordinate system



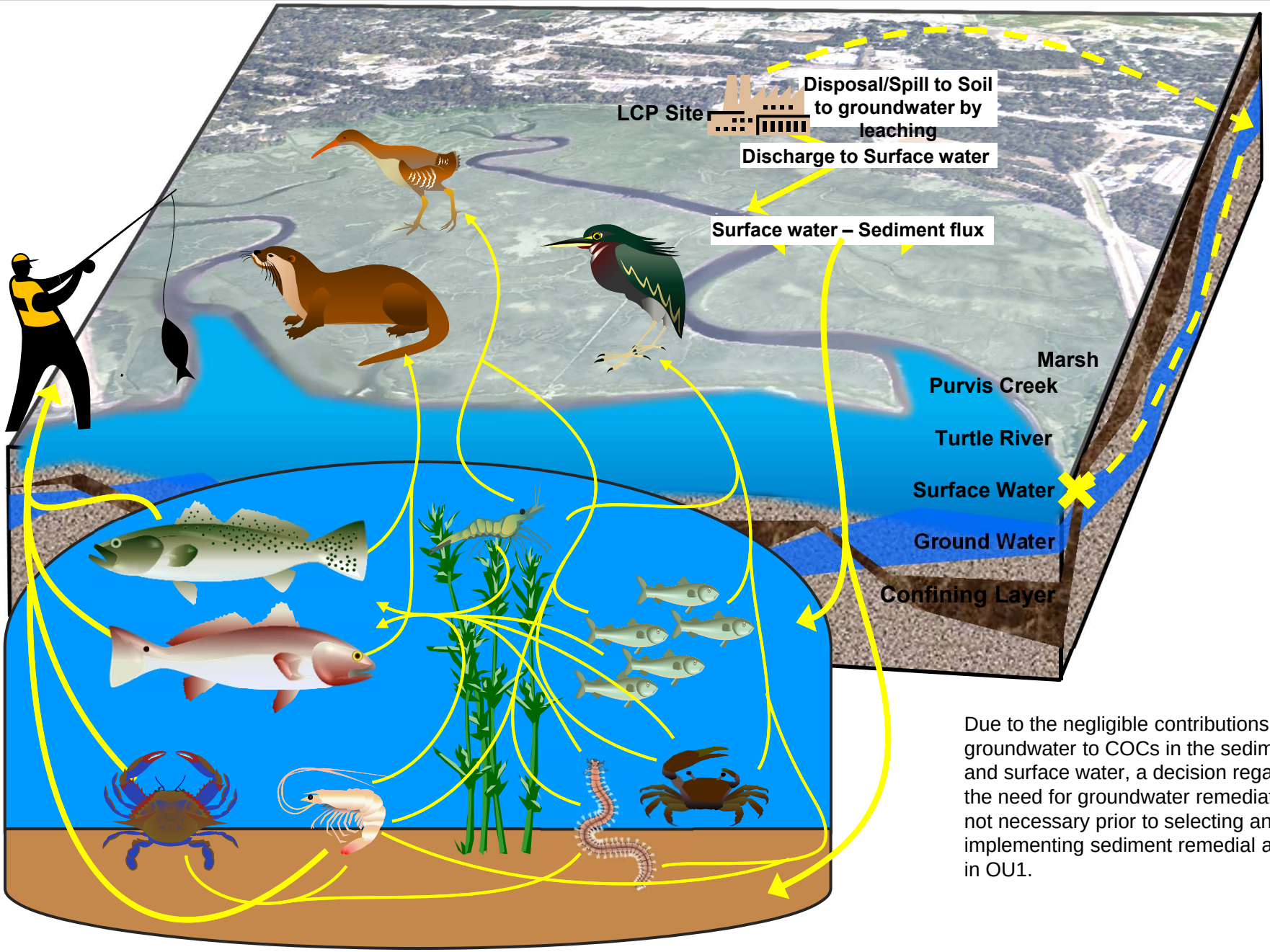
Stratigraphic Cross Sections of the LCP Marsh



Marsh Trespasser, Fish, Shellfish and Game Consumption
LCP Chemical Site
Brunswick, GA

Figure 11
Conceptual Site Model

Baseline Risk Assessment



Due to the negligible contributions of groundwater to COCs in the sediments and surface water, a decision regarding the need for groundwater remediation is not necessary prior to selecting and implementing sediment remedial actions in OU1.

Conceptual Site Model for OU1

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

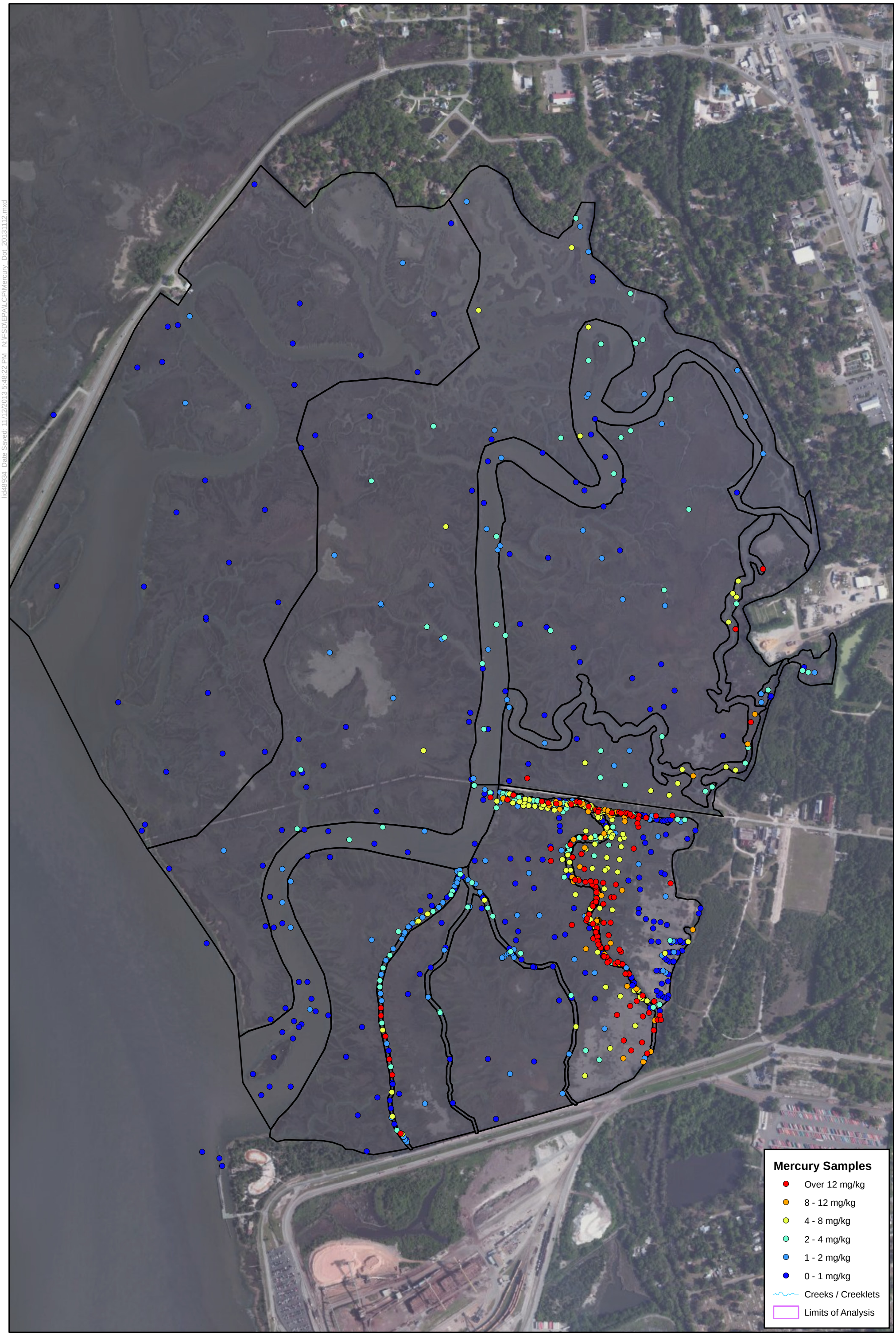
Figure 12

Troup Creek and Crescent River Reference Stations
Brunswick, GA

Figure
13

Ryan Date Saved: 4/8/2015 9:40:41 AM C:\FSD\EPA\LCP\Reference_Locations.mxd

lid48934 Date Saved: 11/12/2013 5:48:22 PM N:\FSD\EPA\LCP\Mercury_Dot_20131112.mxd



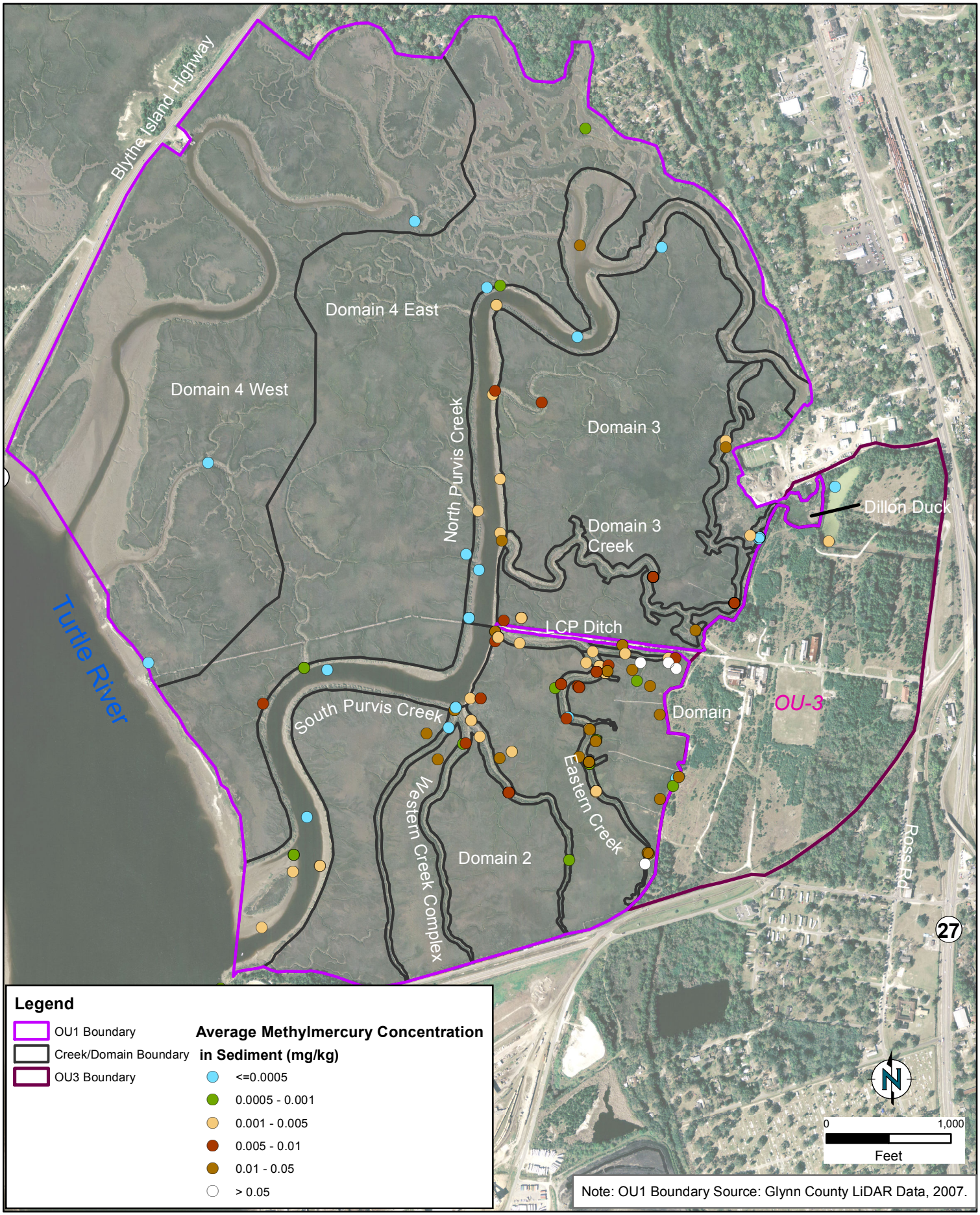
N

0 250 500 750 1,000

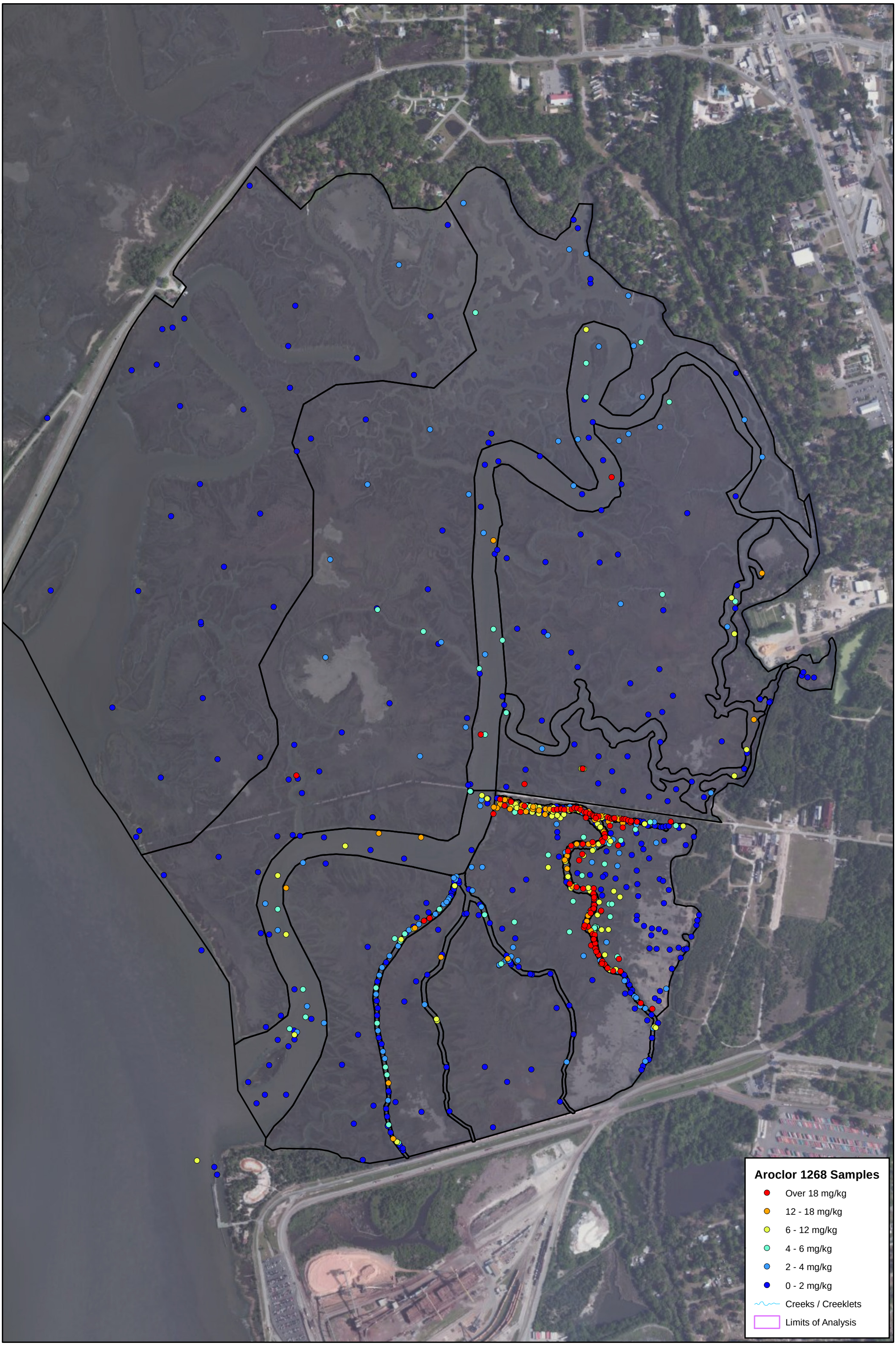
Feet

Mercury Concentrations in LCP Estuary Sediments Brunswick, GA

Figure 14



	Average Methylmercury Concentration in Surface Sediments	**Figure 15**
	LCP CHEMICAL SITE, BRUNSWICK, GEORGIA	



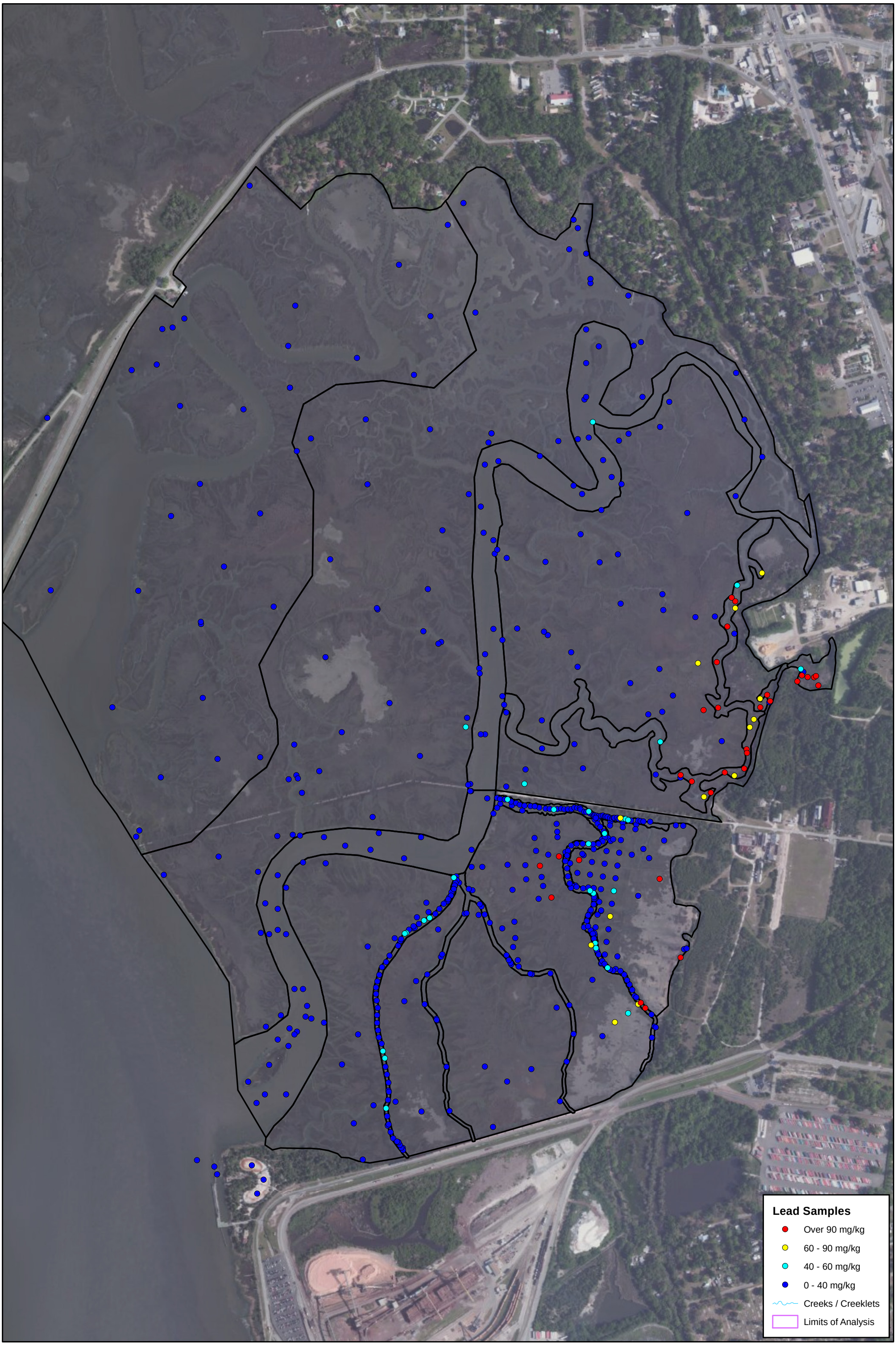
N

0 250 500 750 1,000

Feet

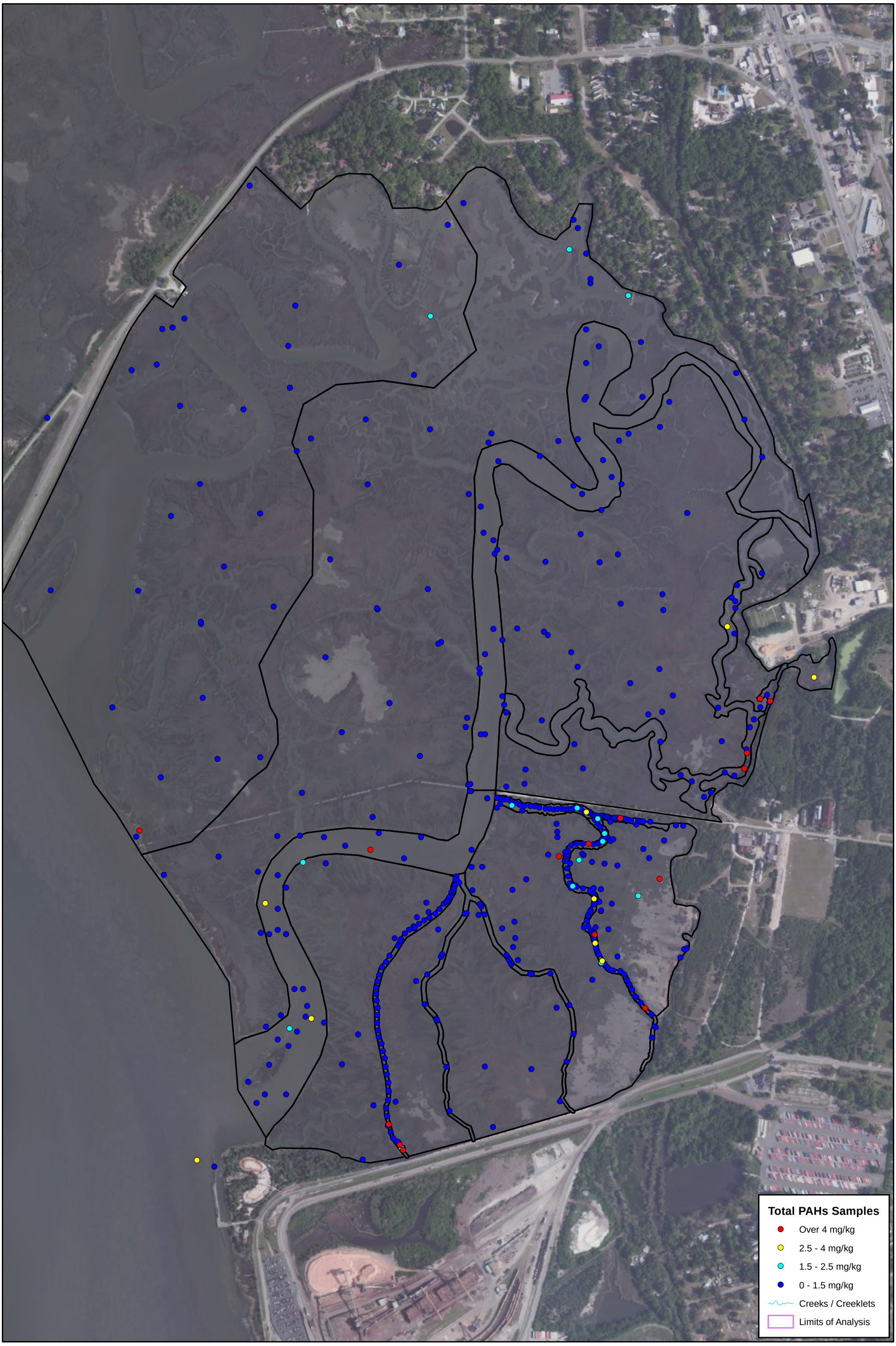
Aroclor 1268 Concentrations in LCP Estuary Sediments Brunswick, GA

Figure 16



Lead Concentrations in LCP Estuary Sediments
Brunswick, GA

Figure 17



N

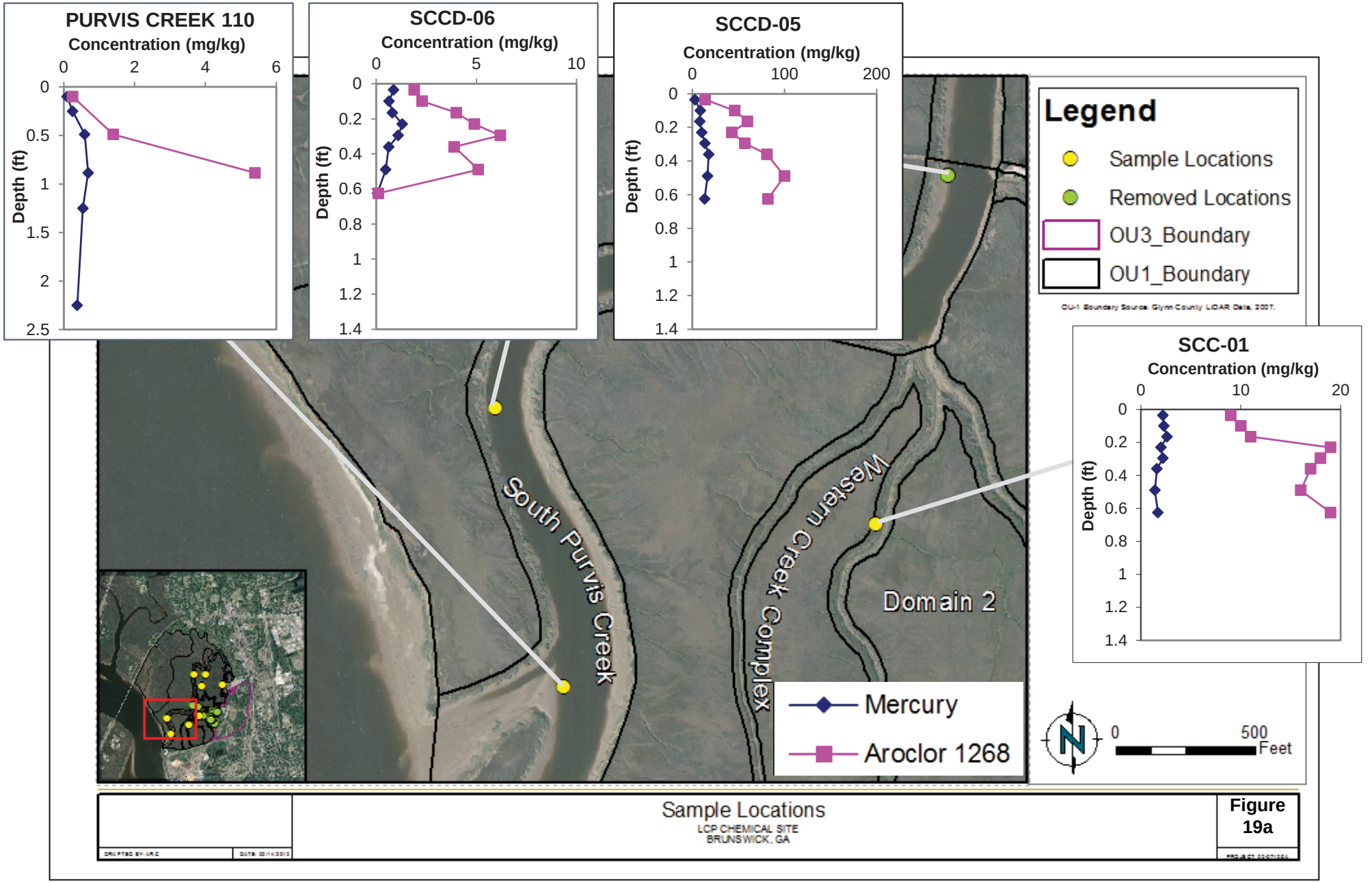
0 250 500 750 1,000

Feet

Total PAH Concentrations in LCP Estuary Sediments Brunswick, GA

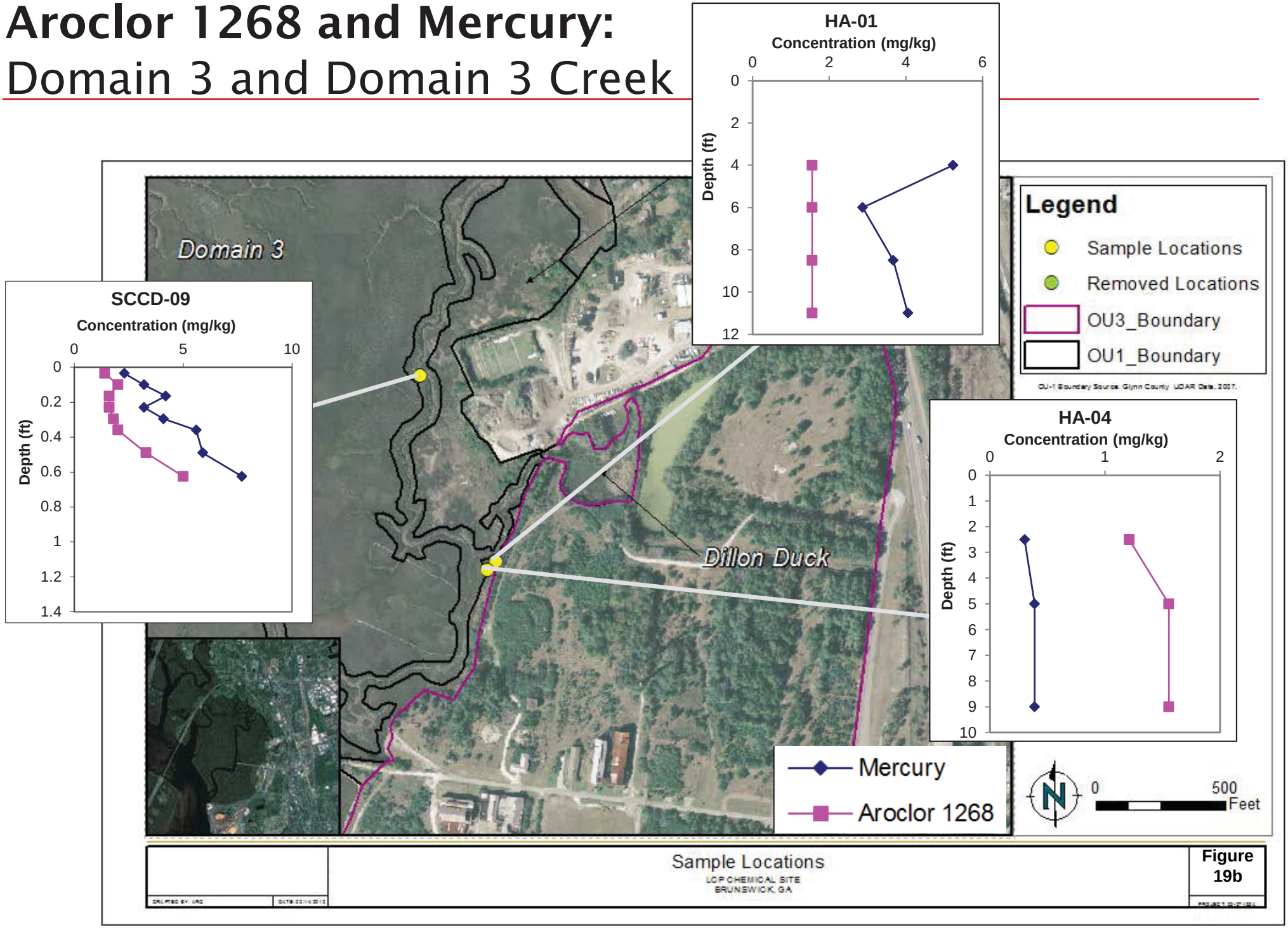
Figure 18

Aroclor 1268 and Mercury:
Western Creek and South Purvis Creek



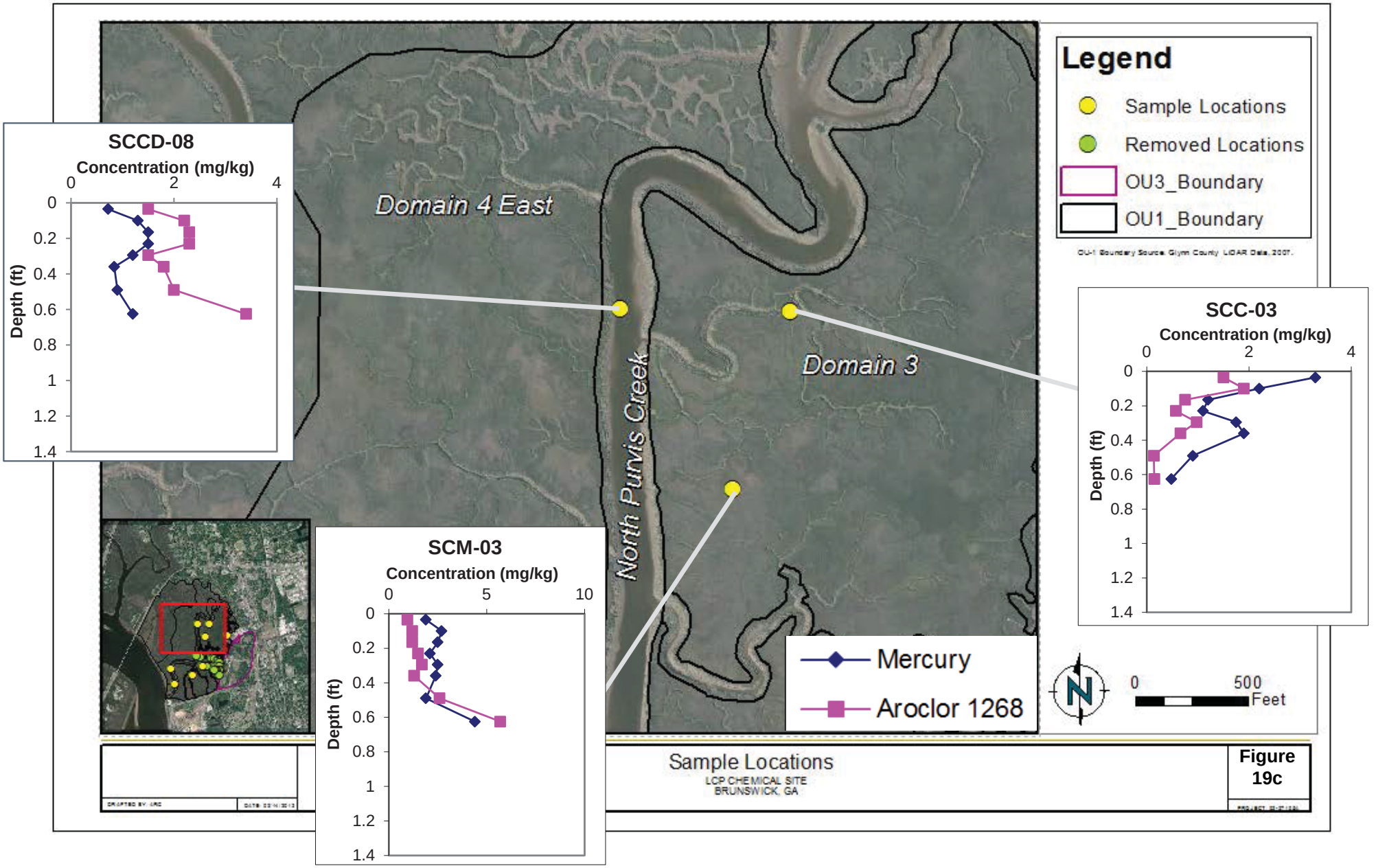
Revised May 2012

Aroclor 1268 and Mercury:
Domain 3 and Domain 3 Creek



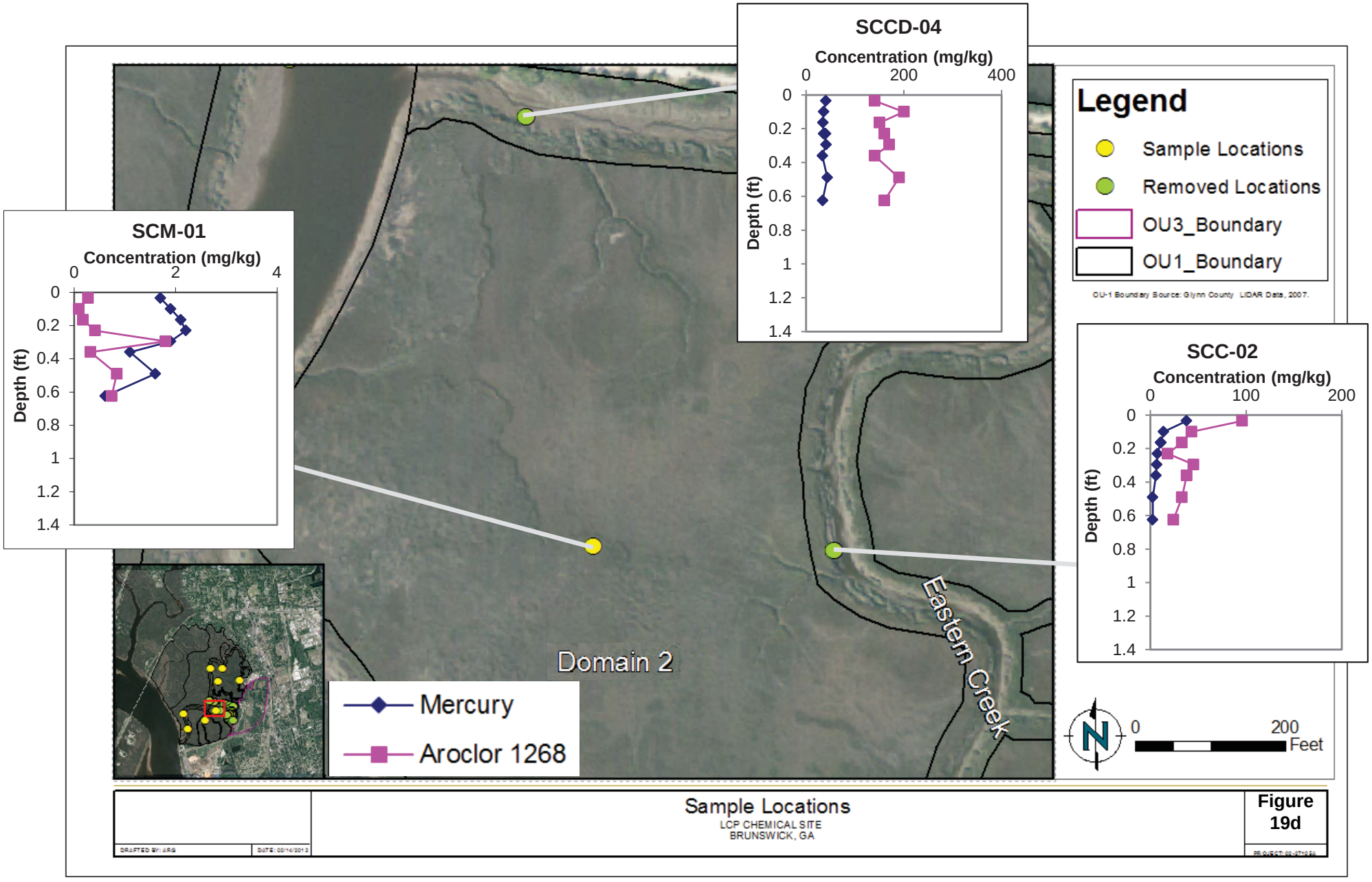
Revised May 2012

Aroclor 1268 and Mercury:
Domain 3 and North Purvis Creek



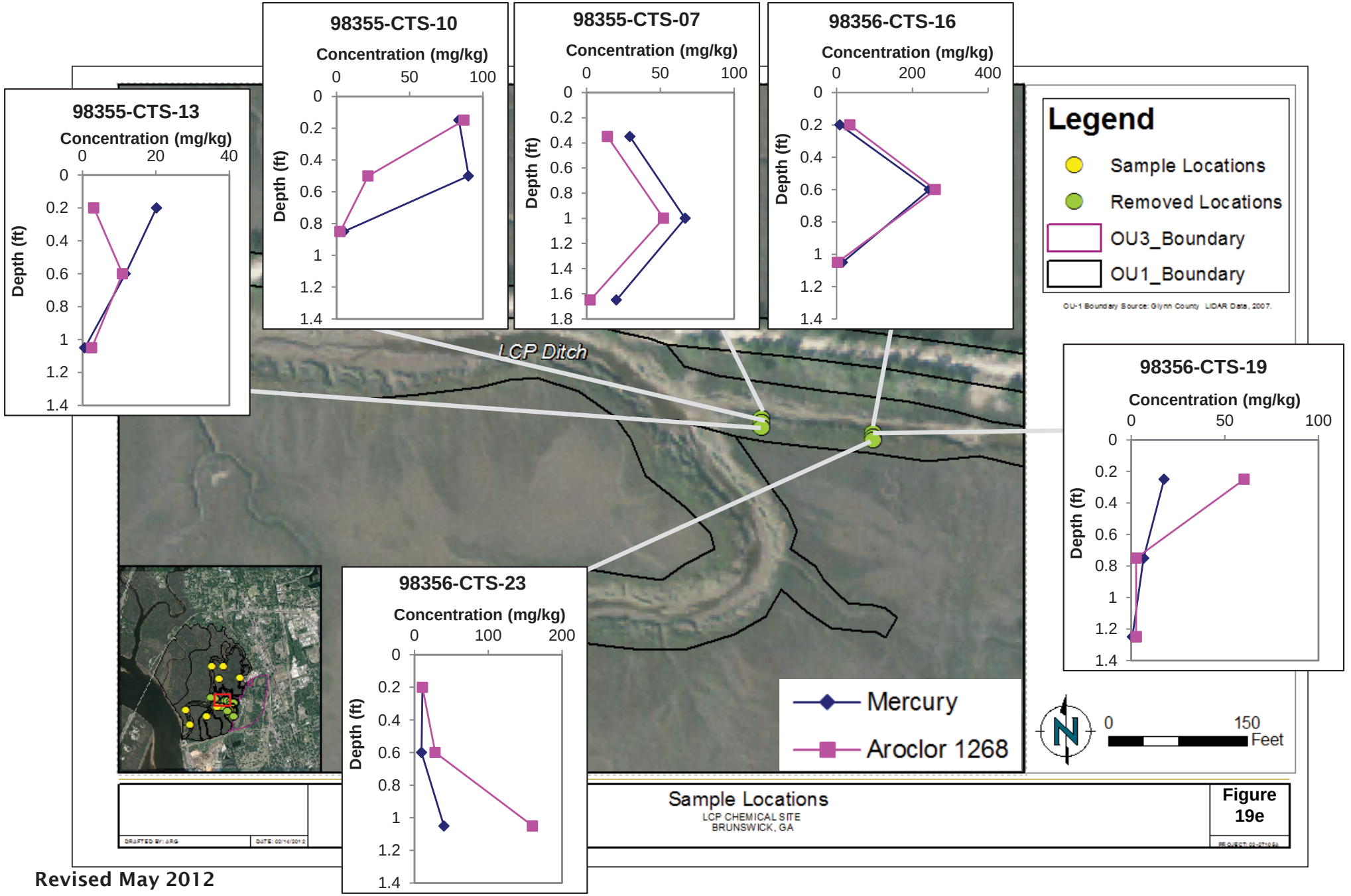
Revised May 2012

Aroclor 1268 and Mercury:
LCP Ditch, Domain 2 and Eastern Creek



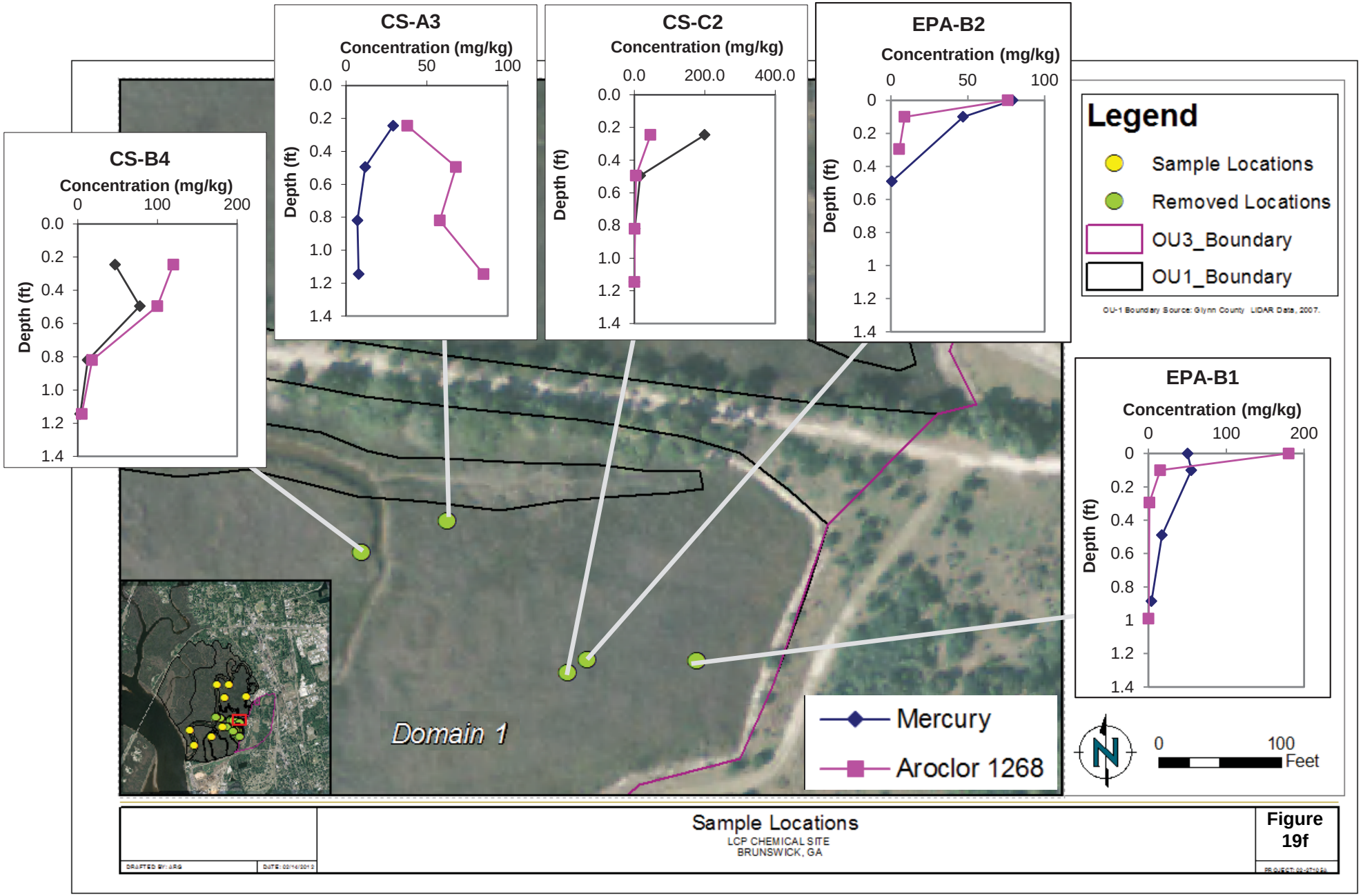
Revised May 2012

Aroclor 1268 and Mercury:
LCP Ditch



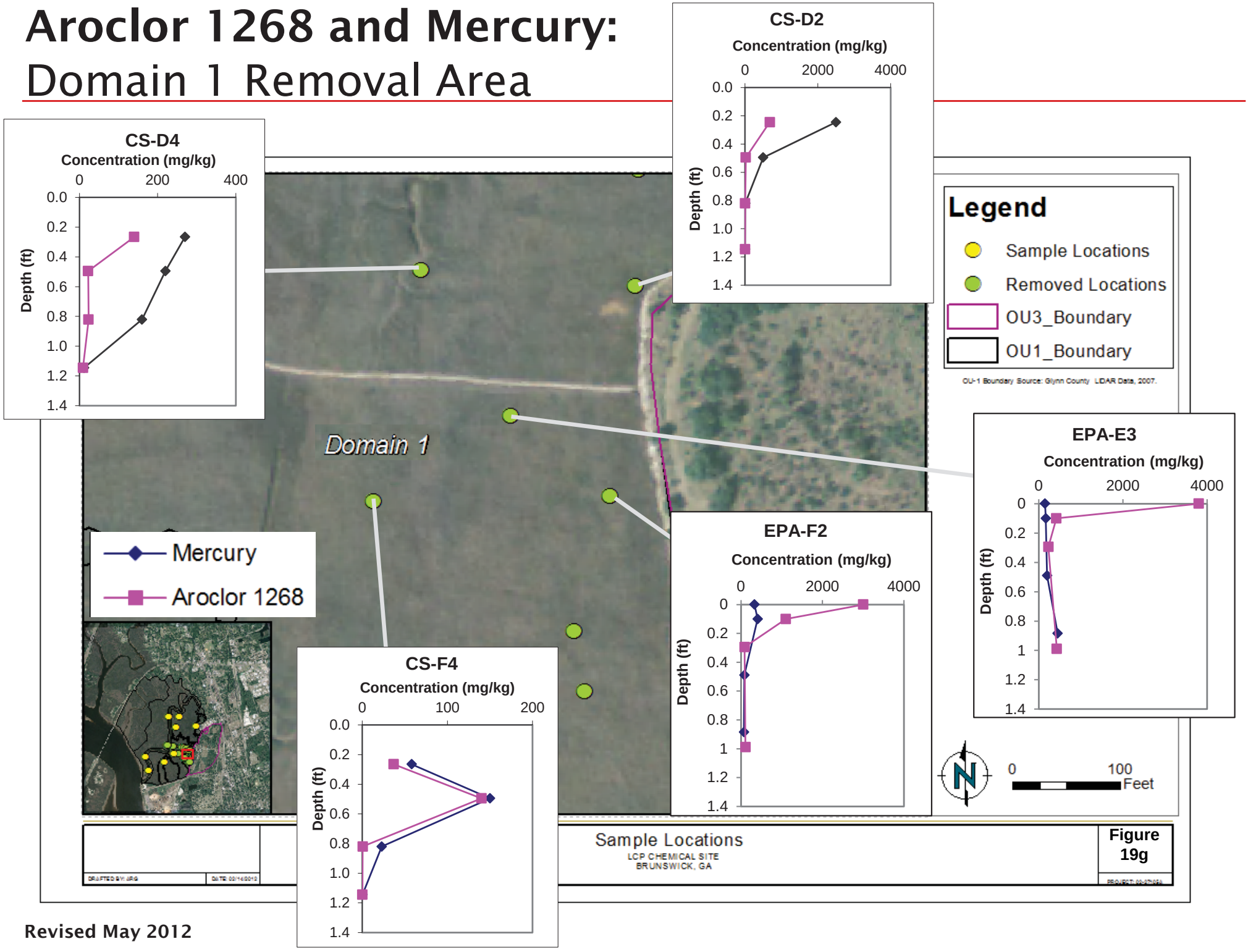
Revised May 2012

Aroclor 1268 and Mercury:
Domain 1 Removal Area



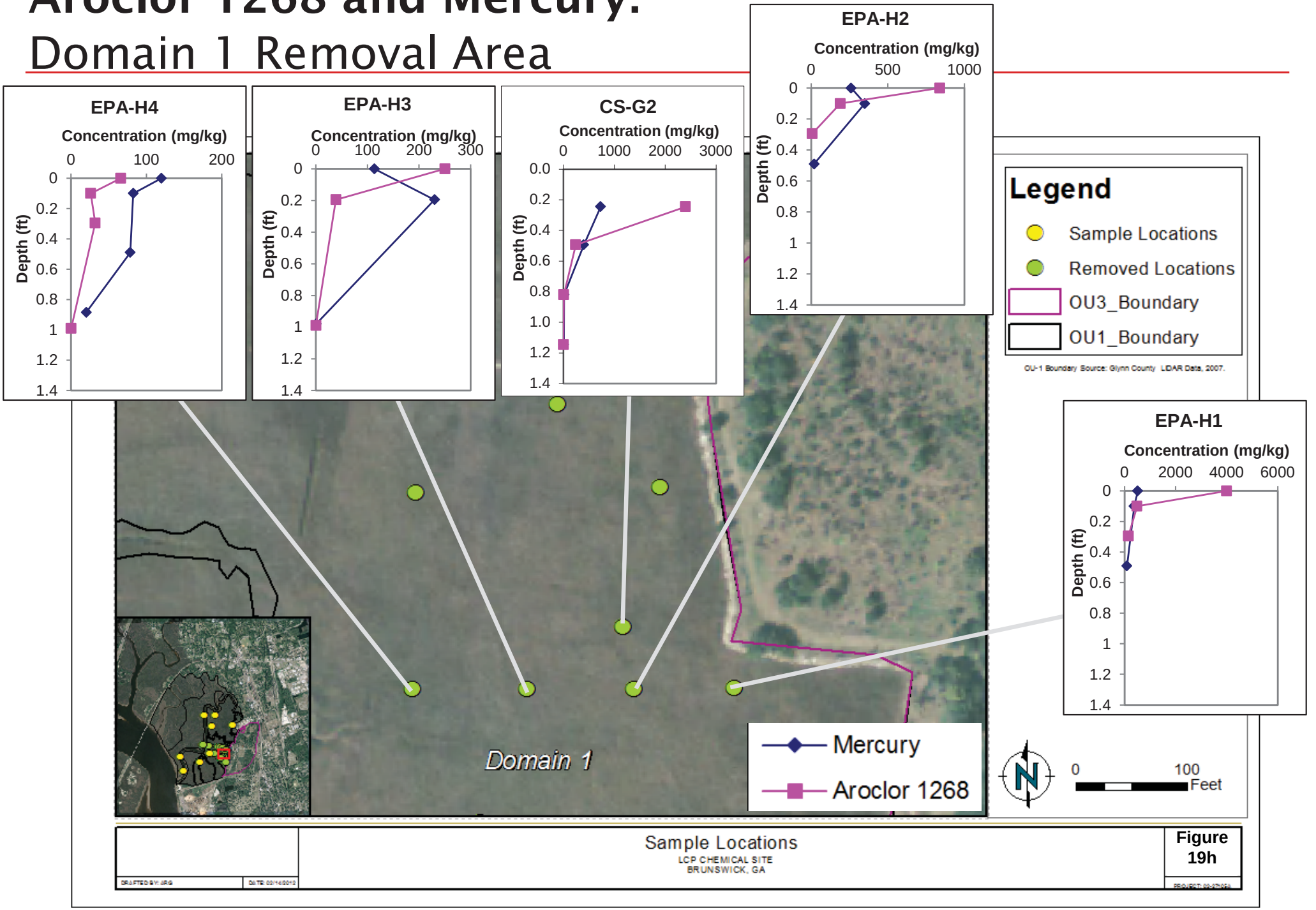
Revised May 2012

Aroclor 1268 and Mercury:
Domain 1 Removal Area



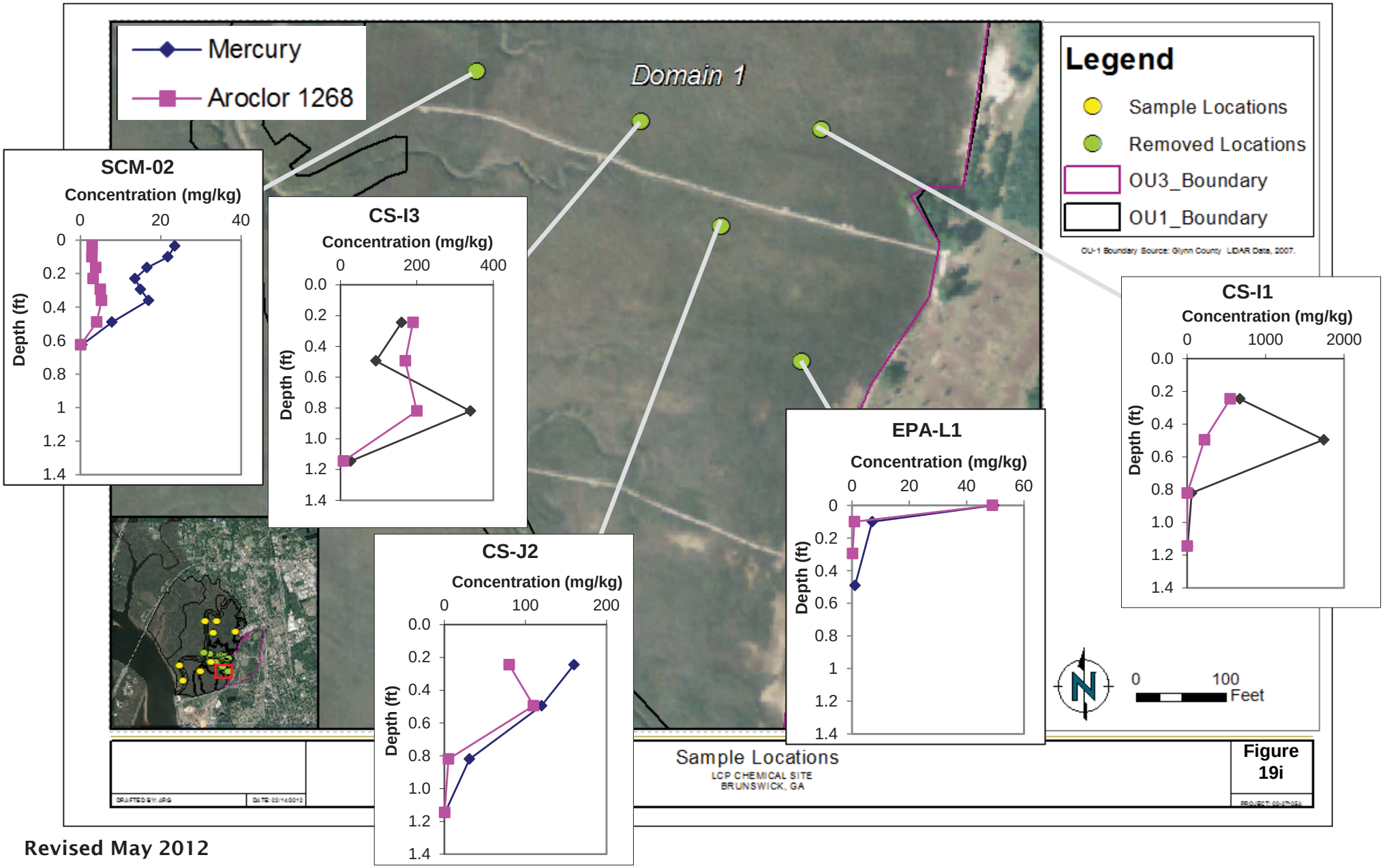
Revised May 2012

Aroclor 1268 and Mercury:
Domain 1 Removal Area



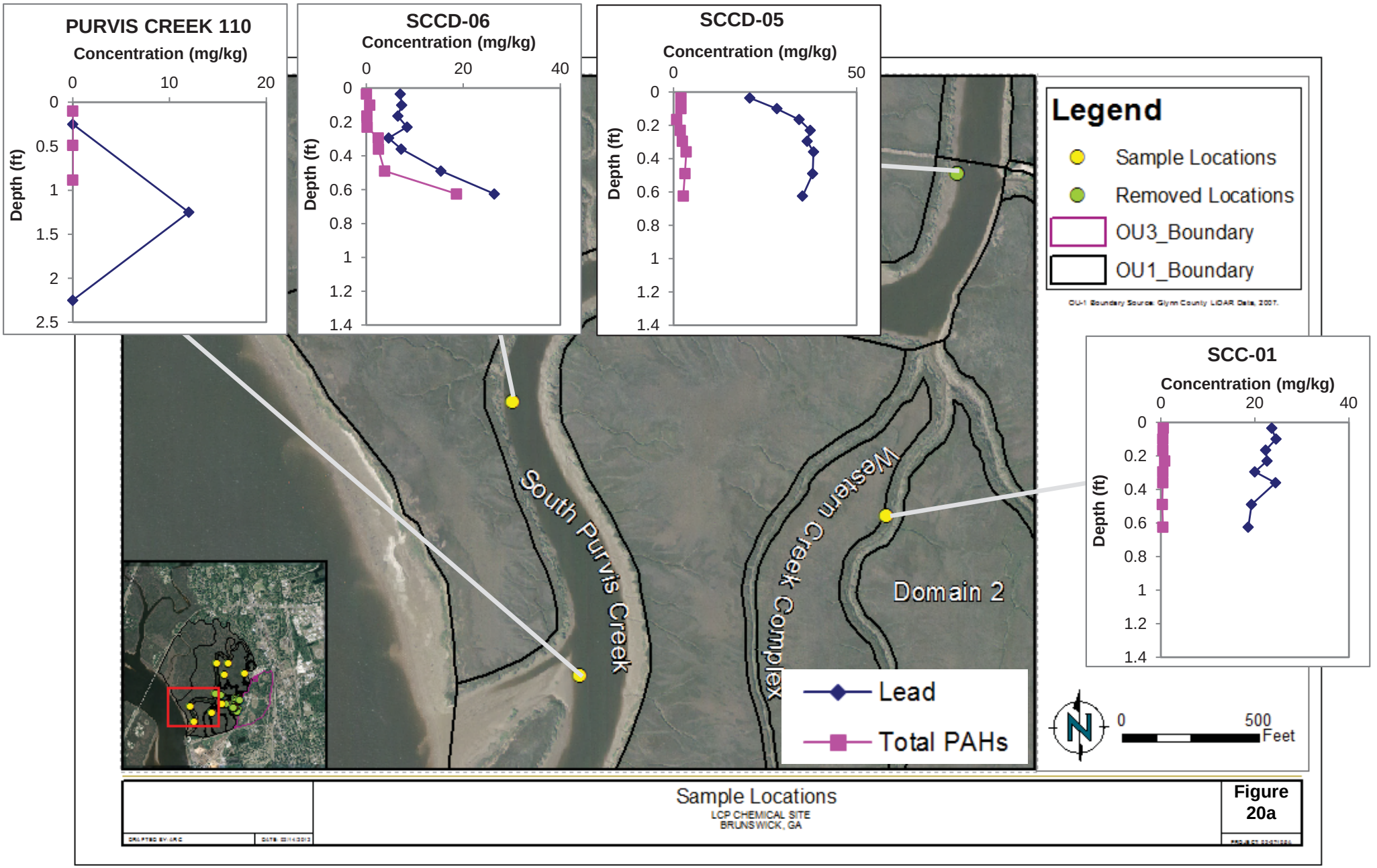
Revised May 2012

Aroclor 1268 and Mercury:
Domain 1 Removal Area



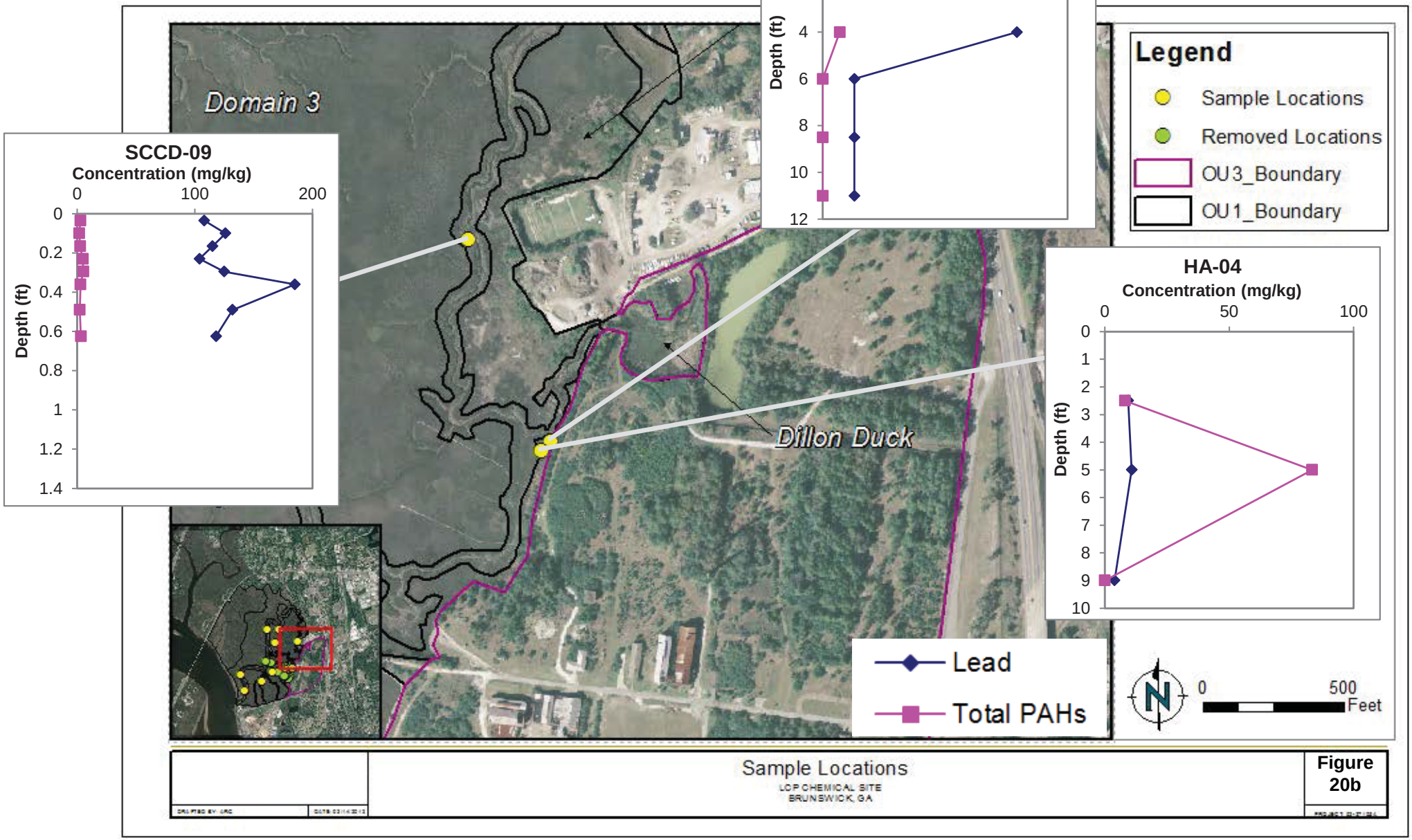
Revised May 2012

Lead and Total PAHs:
Western Creek and South Purvis Creek



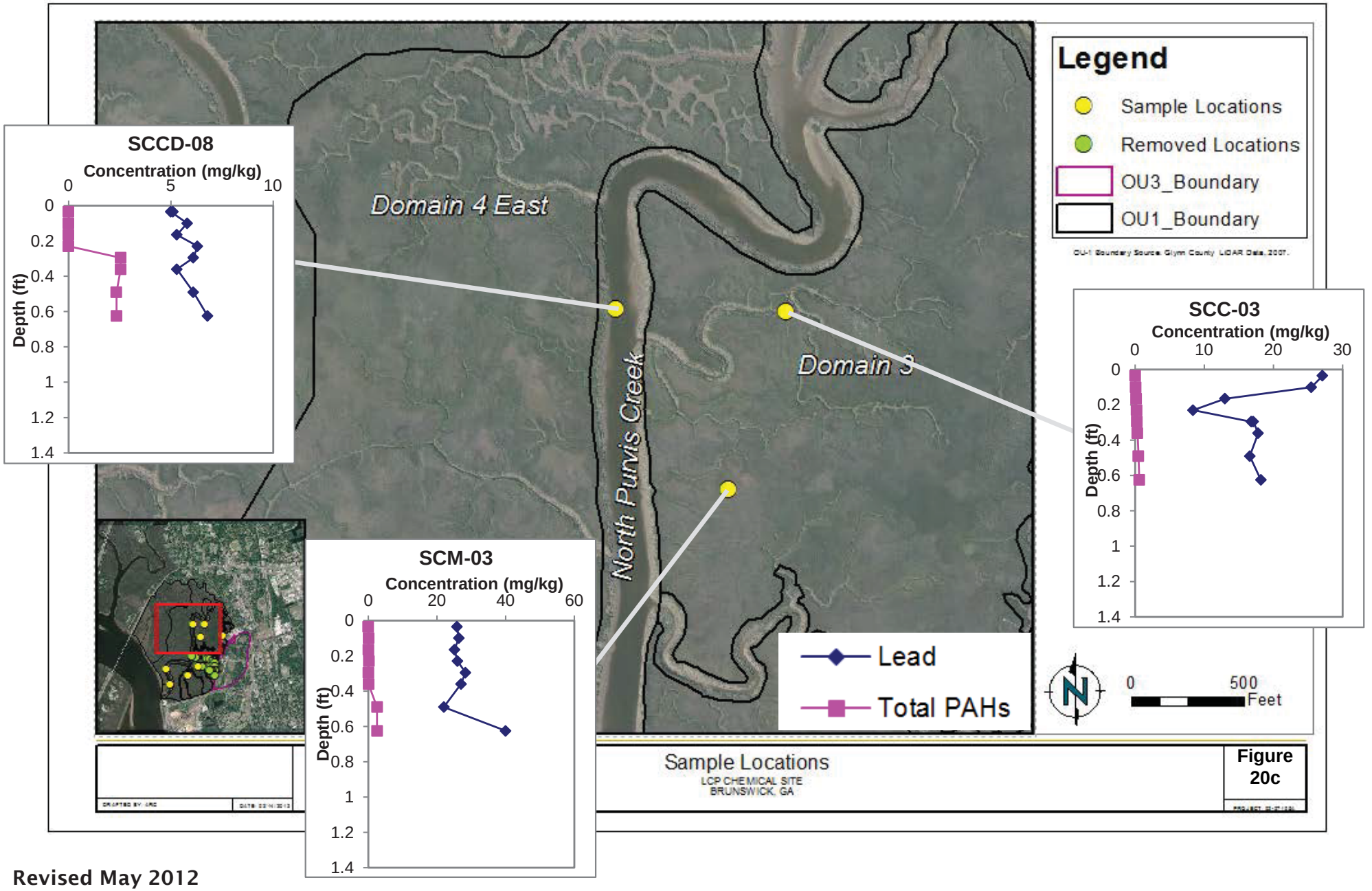
Revised May 2012

Lead and Total PAHs:
Domain 3 and Domain 3 Creek



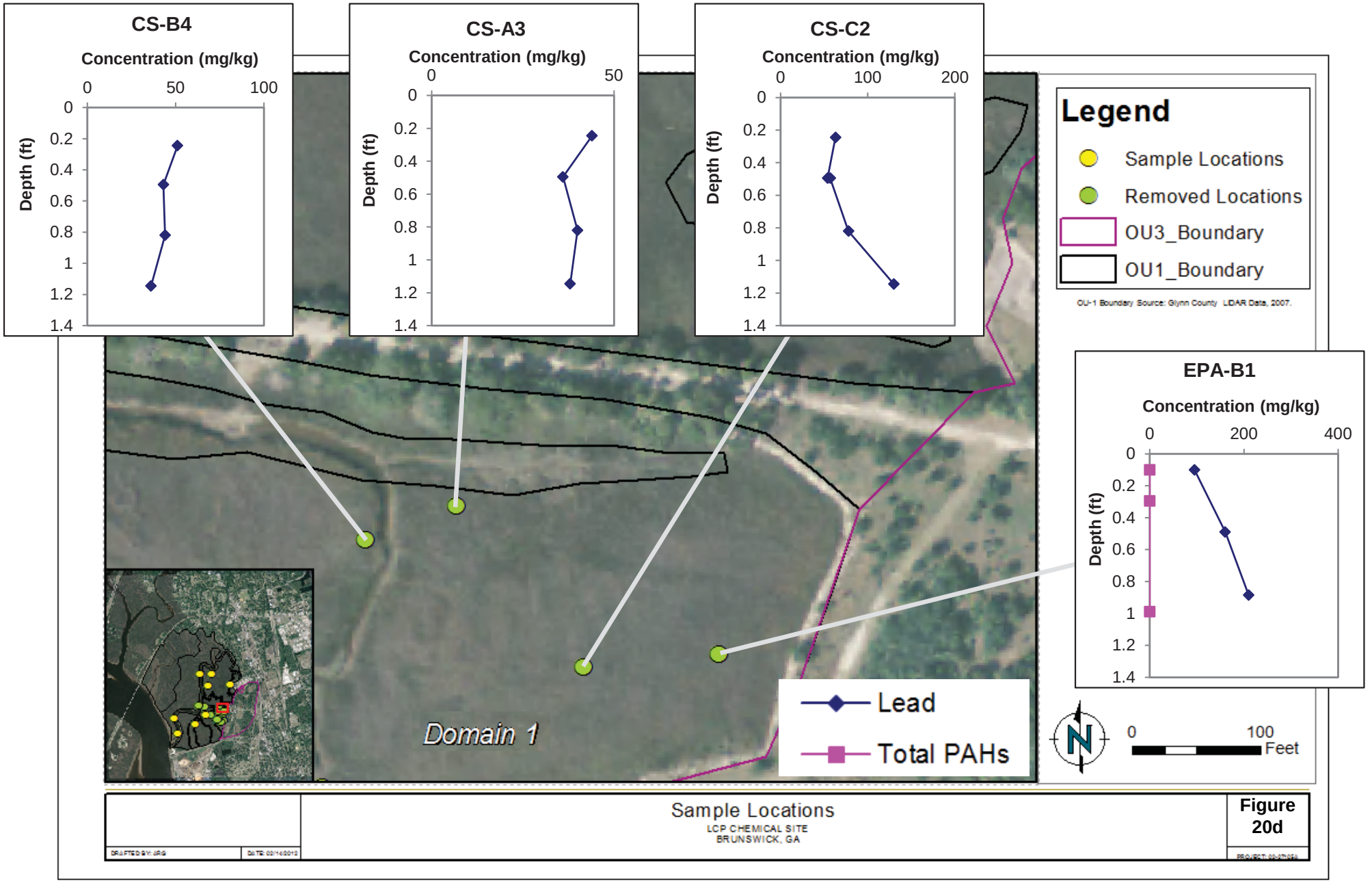
Revised May 2012

Lead and Total PAHs:
Domain 3 and North Purvis Creek



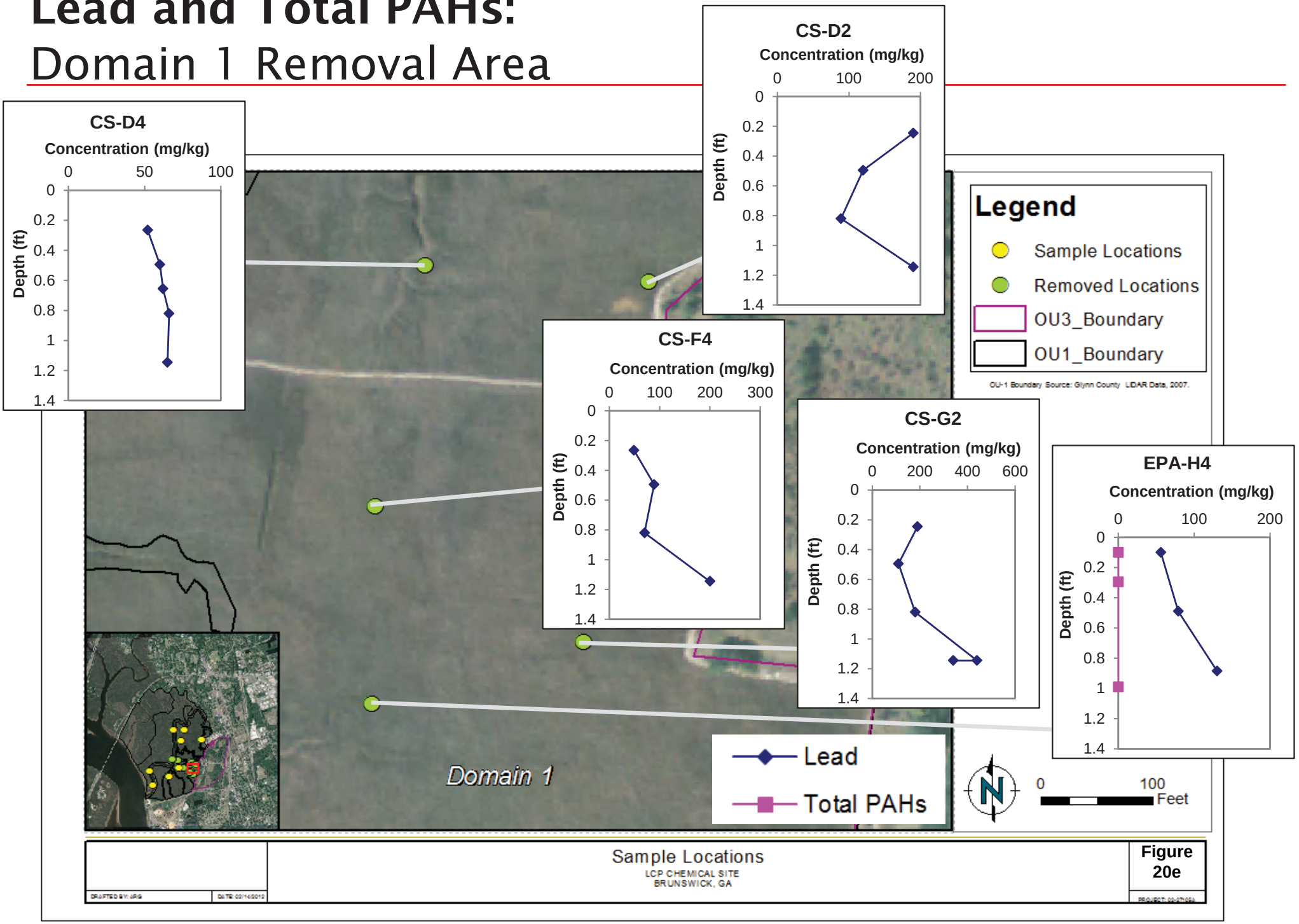
Revised May 2012

Lead and Total PAHs:
Domain 1 Removal Area



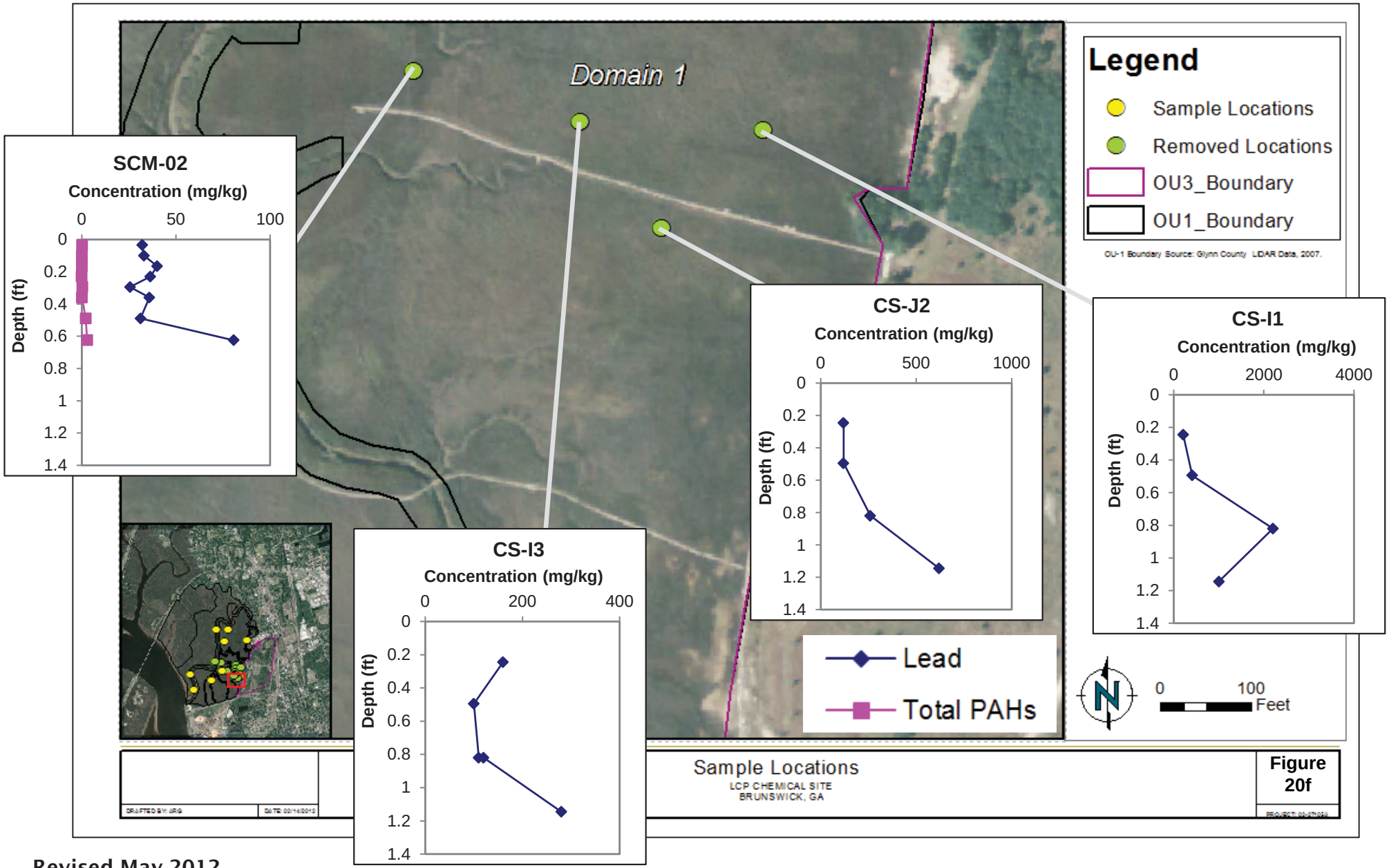
Revised May 2012

Lead and Total PAHs:
Domain 1 Removal Area



Revised May 2012

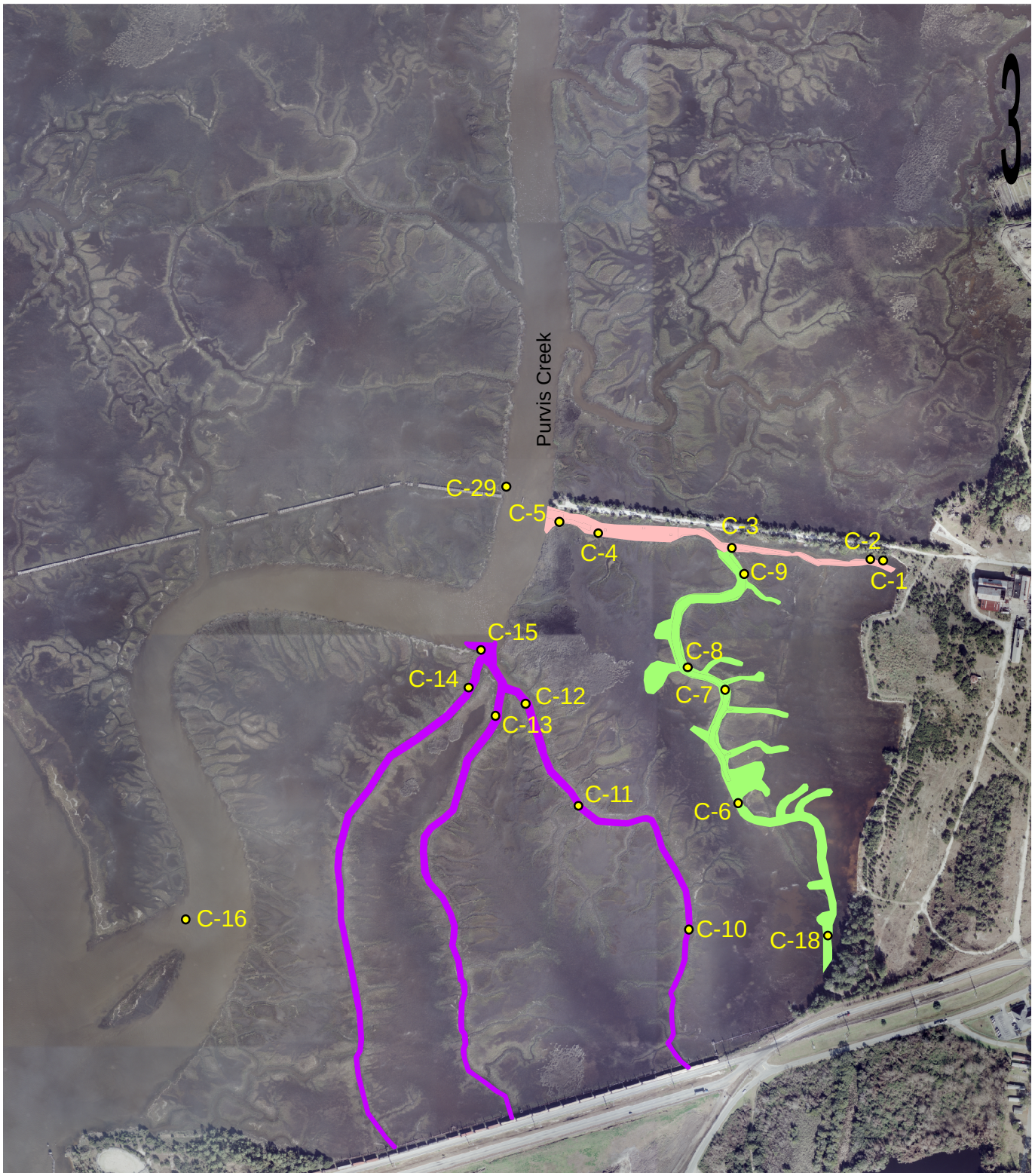
Lead and Total PAHs:
Domain 1 Removal Area

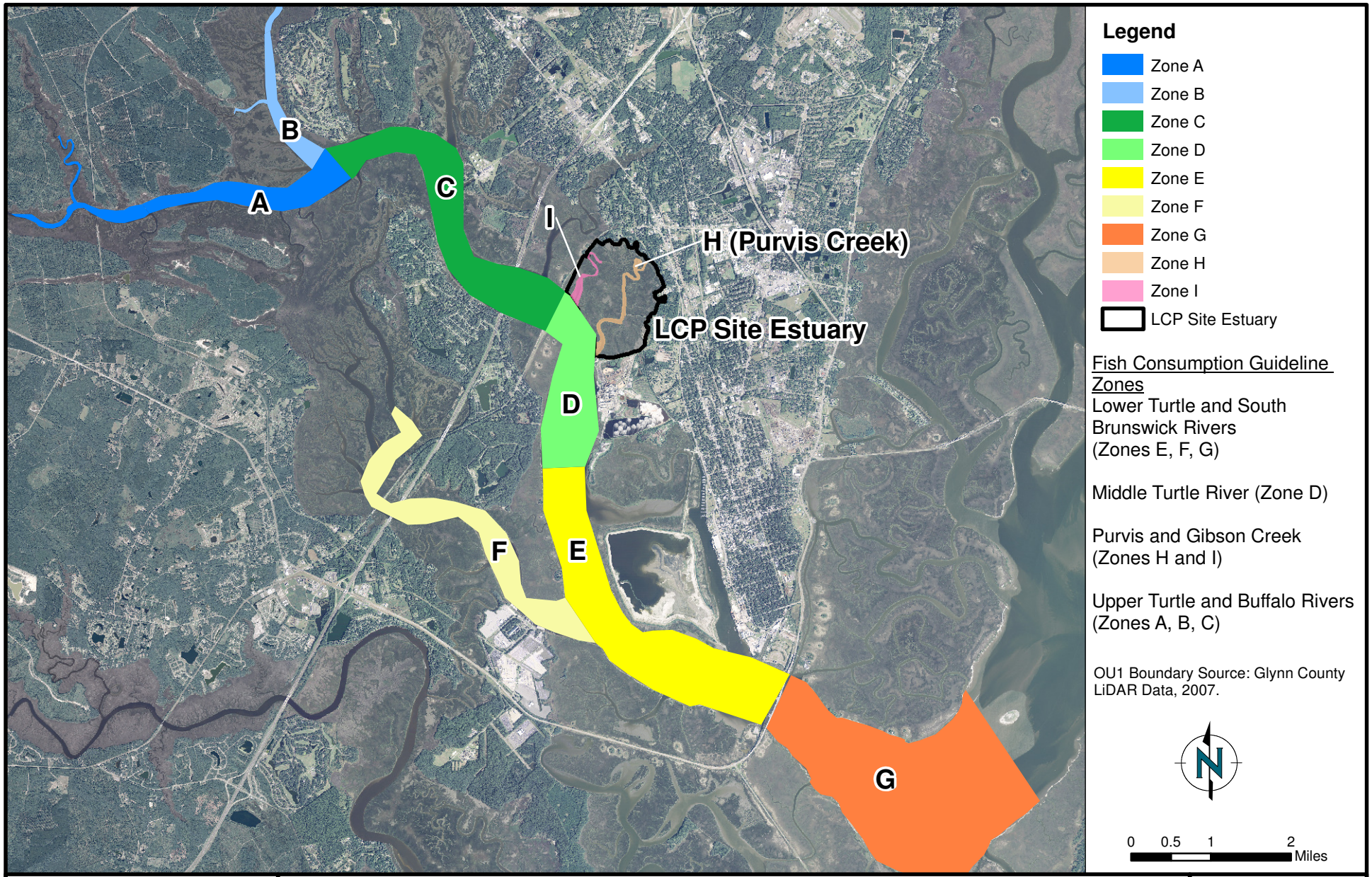


Revised May 2012

Figure 21. Locations of 1995 and 1996 Sediment Samples Analyzed for Dioxins/Furans and Aroclor 1268

Figure 22 - Locations of sampling stations for surface water of major creeks and associated biota in estuary at LCP Site. Refer to Table 2 for details of sampling of environmental media.





Collection Locations for Fish and Shellfish within the Turtle River / Brunswick Estuary

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure 23

Legend

Alternative 2: 48 Acres

- Dredge All (48 acres)
- OU-1 Boundary
- Creek/Domain Boundary
- OU-3 Boundary

N

0 800 1,600

Feet

OU-1 Boundary Source: Glynn County LiDAR Data, 2007.

DRAFTED BY: MRJ	DATE: 03/28/2013

Sediment Remedy Alternative 2: Sediment Removal - 48 Acres

LCP CHEMICAL SITE
BRUNSWICK, GA

DRAFT

Figure 24

PROJECT: 02-27105C

Legend

Alternative 3: 48 Acres

- Dredge (9 acres)
- Cap (16 acres)
- Thin Cover - 6 in (23 acres)
- OU-1 Boundary
- Creek/Domain Boundary
- OU-3 Boundary

N

0 800 1,600

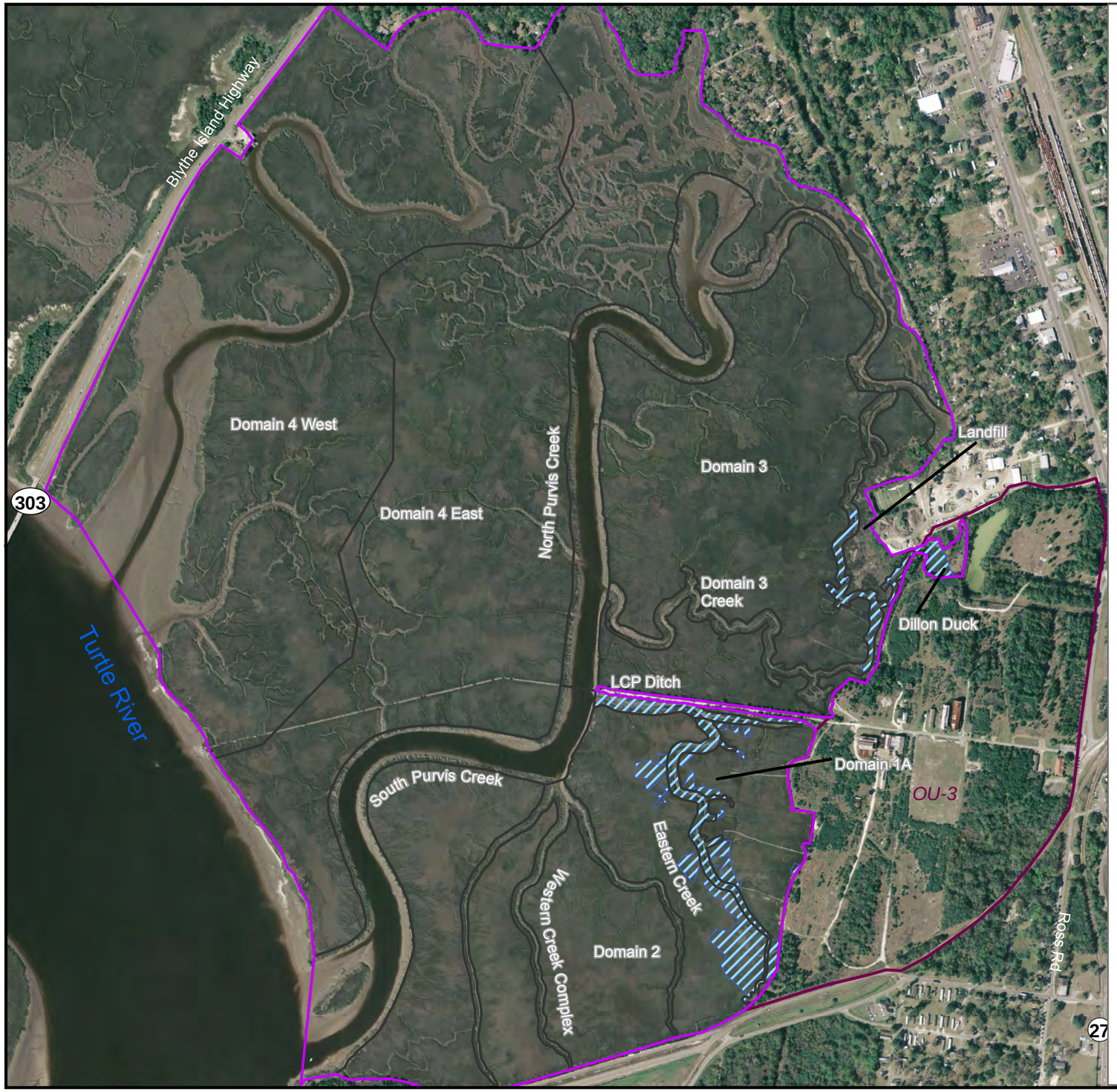
Feet

OU-1 Boundary Source: Glynn County LiDAR Data, 2007.

DRAFTED BY: MRJ	DATE: 03/28/2013	Sediment Remedy Alternative 3: Sediment Removal, Capping and Thin Cover - 48 Acres LCP CHEMICAL SITE BRUNSWICK, GA	DRAFT

Figure 25

PROJECT: 02-27105C



Legend

Alternative 4: 18 Acres

- Dredge All (18 acres)
- OU-1 Boundary
- Creek/Domain Boundary
- OU-3 Boundary

N

0 800 1,600

Feet

OU-1 Boundary Source: Glynn County LiDAR Data, 2007.

Sediment Remedy Alternative 4: Sediment Removal - 18 Acres

LCP CHEMICAL SITE
BRUNSWICK, GA

DRAFT

DRAFTED BY: MRJ | DATE: 03/28/2013

Figure 26

PROJECT: 02-27105C

Legend

Alternative 5: 18 Acres

- Dredge (7 acres)
- Cap (3 acres)
- Thin Cover - 6 in (8 acres)
- OU-1 Boundary
- Creek/Domain Boundary
- OU-3 Boundary

N

0 800 1,600

Feet

OU-1 Boundary Source: Glynn County LiDAR Data, 2007.

DRAFTED BY: MRJ	DATE: 03/28/2013	Sediment Remedy Alternative 5: Sediment Removal, Capping and Thin Cover - 18 Acres LCP CHEMICAL SITE BRUNSWICK, GA DRAFT
		Figure 27
		PROJECT: 02-27105C

Legend

Alternative 6: 24 Acres

- Dredge (7 acres)
- Cap (6 acres)
- Thin Cover - 6 in (11 acres)
- OU-1 Boundary
- Creek/Domain Boundary
- OU-3 Boundary

N

0 800 1,600

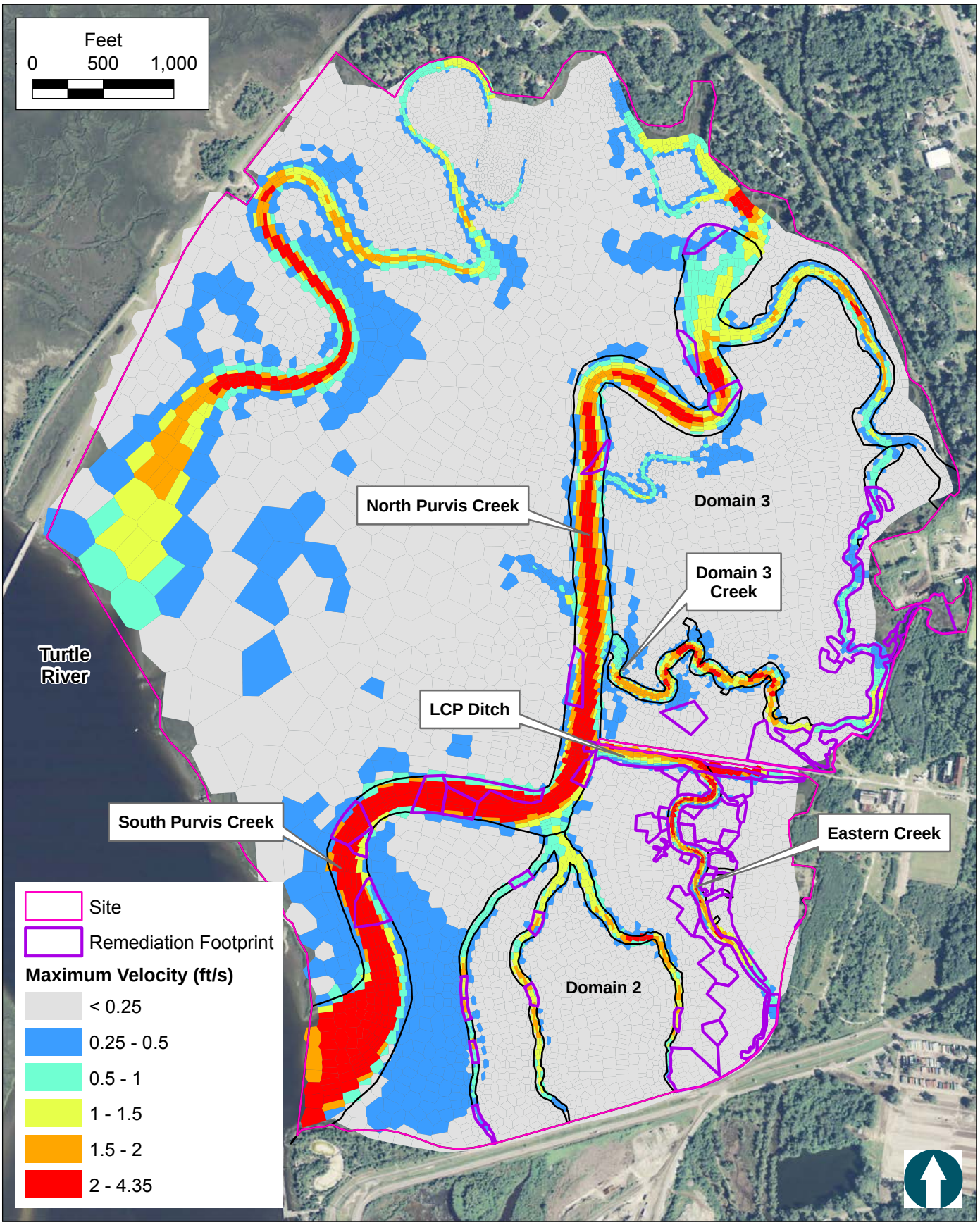
Feet

OU-1 Boundary Source: Glynn County LiDAR Data, 2007.

DRAFTED BY: MRJ	DATE: 03/28/2013	Sediment Remedy Alternative 6: Sediment Removal, Capping and Thin Cover - 24 Acres LCP CHEMICAL SITE BRUNSWICK, GA	DRAFT

Figure 28

PROJECT: 02-27105C



Maximum Predicted Current Velocity for Existing Conditions: Hurricane Storm Surge

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure 29

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APPENDIX A
Long-Term Monitoring Plan Framework

Long-Term Monitoring Plan Framework

1.0 Introduction

A rigorous monitoring plan is required as part of the remediation plan for Operable Unit (OU) 1, the marsh area. Monitoring plans are recommended during and after all remedial actions. When contaminants are left in place and/or when attainment of remediation goals is anticipated to occur over time, a monitoring plan is also required. Monitoring may be conducted with a variety of objectives, including: 1) to assess compliance with design and construction performance standards; 2) to assess short-term remedy performance and effectiveness in meeting sediment cleanup levels; and/or 3) to evaluate long-term remedy effectiveness in achieving remedial action objectives (RAOs) and in reducing human health and/or environmental risk. The monitoring data are utilized in the five-year review process (five year review cycle) where the data and any decisions made are documented.

As part of the remedy for OU1, a Long Term Monitoring Plan (LTMP) is being developed. The development of this plan reflects the Agencies commitment to the full remediation of the LCP Site and the marsh. The Agency has acknowledged that there are uncertainties associated with the marsh remedy and that there are contaminants being left in place which are of concern. In addition, the agency acknowledges that, post remedy implementation, declines in fish tissue contaminant levels are expected, but that these declines may not be immediate in all areas of the marsh and that the declines must be maintained over time. In addition, monitoring may highlight contamination sources or exposure pathways which may or may not be associated with the Site, thereby influencing what can be obtained through the current remedial action.

The objectives of the LCP OU1 LTMP will include verification that the remedy is performing as designed and is or will meet the Record of Decision (ROD) RAOs. There are a number of aspects of remediation in OU1 that will require monitoring and include:

- Thin-layer cover area for material loss, material incorporation, changes in contaminant flux;
- Capped areas, cap integrity/erosion;
- Marsh-wide to location-specific bioaccumulation;
- Monitoring of key species for exposure to humans and ecological receptors;
- Sediment monitoring to assess recontamination;
- Water monitoring to assess compliance with State Applicable or Relevant and Appropriate Requirement (ARARs);
- Overall flux of Site contaminants from OU1; and
- Marsh reconstruction/stabilization.

This list of aspects of monitoring components should not be viewed as complete, but a starting point from which the development of the LTMP can be initiated. It is anticipated that the design of the LTMP will consider how data collected can serve multiple purposes. Efforts to use data for several objectives can result in an effective design with multiple lines of evidence and more rigorous conclusions.

Based upon the ROD RAOs, the LTMP will develop specific goals and data quality objectives (DQOs) which will define the data needed and upon which the plan for collection of data (*e.g.* the sampling design) will be based. In addition, performance measures or triggers related to each RAO will be developed in the LTMP. For example, if an aspect of the remedy is successful, then monitoring of it can be discontinued; or if a portion of the remedy failed, such as loss of capping material, then an action must be taken to repair the cap or implement an appropriate alternate remedy.

The monitoring plan will not revisit the risk assessments. If new information becomes available which would substantially change the existing risk assessments; revisions to the risk assessments should be done independent of the monitoring program.

Biomonitoring trend analysis (e.g., bioaccumulation of mercury and Aroclor 1268 in tissues) may indicate substantive declines in contaminant levels, which in turn, could trigger reduction in monitoring intensity. The reverse applies to determine if further action may be required.

2.0 Specific Monitoring Aspects of Remediation Components

Thin-layer Cover (TLC) Monitoring

Thin-layer covers are an integral component of the remedy. The objectives of TLC monitoring will include: confirmation of successful application of the TLC material, stability and/or loss of the cap material, rate of incorporation of the cap material, changes in the physical and or biological condition of the TLC marsh area, and flux of contamination. Specifics of the monitoring will depend on the actual cap final designs and placement parameters but may include bathymetric surveys, physical measures of cap material depth, sediment sampling for physical parameters (e.g. total organic carbon [TOC] and grain size) with depth, changes in the marsh plant community, sediment sampling for contaminant levels and other visual tools to assess any changes.

Frequency of cap monitoring would be expected during predesign (baseline), upon capping completion (time zero), years 1, 3, and 5; further monitoring frequency will be dependent upon the performance of the TLC. The TLC areas will require selected monitoring components after severe storm/catastrophic events such as hurricane-type events independent of planned monitoring events.

Performance standards and triggers for the TLC area will be defined during the design phase and in the LTMP. As there are many ways to generate data which can answer individual monitoring goals, and input from all stakeholders is important to the success of the monitoring program, only illustrative examples of performance standards and triggers are included here. Potential examples include:

- If the loss of TLC material exceeds 30 percent of the applied material, then a reapplication of capping material will occur.
- If greater than a 20 percent loss of marsh plant density occurs, then it will be concluded that the TLC that cap stability is being compromised.
- If TLC biomonitoring does not demonstrate a significant and substantial decline in contaminant flux into the food web, then it will be concluded that the TLC was unsuccessful.

Capped Areas
The goal of in-place capping is to isolate contaminated sediments. The objective of cap monitoring is to confirm cap integrity, stability, and containment of the contaminants within the caps. Erosion of the caps or excessive settling could compromise their long-term effectiveness. Monitoring will depend on the actual cap final designs and placement parameters but may include bathymetric surveys and other visual tools to assess any changes as well as other options.

Frequency of cap monitoring would be expected during predesign (baseline), upon capping completion (time zero), years 1, 3, and 5; further monitoring frequency will be dependent upon the performance of the cap. The capped areas will require selected monitoring components after severe storm/catastrophic events such as hurricane-type events independent of planned monitoring events.

Potential "if then" performance statements may include:

- If greater than 20 percent loss of cap thickness occurs within a monitoring period and/or cap thickness monitoring indicates continual loss of cap thickness then it may be concluded that the cap is ineffective.
- If surface water, pore water or another measure of contaminant flux suggests the capping is not isolating the contamination from the marsh system, then it may be concluded that the capping of the specific area has failed.

Specifics of these or other statements must be evaluated and agreed to by stakeholders during the development of the LTMP.

Sediment Monitoring
Within the LTMP sediment sampling and analysis is anticipated to be a component of multiple evaluations of the overall remedy performance. Sediment monitoring is anticipated to be used in assessing attainment of cleanup levels, contaminant redistribution in the marsh, contaminant flux, incorporation of TLC material into the marsh surface, as well as other data needs. The specific sediment monitoring parameters will be established during design and in the LTMP and linked to ROD RAOs as will all monitoring efforts. For example: sediment monitoring is needed to meet RAO #1 in the ROD which is to "*Prevent or minimize chemicals of concern (COCs) in contaminated in-stream sediment from entering Purvis Creek.*"

Water Quality Monitoring
A primary objective of long-term surface water quality monitoring is to determine compliance with ARARs. The State of Georgia water quality standards (for saltwater) apply in the LCP Chemicals marsh for mercury (0.025 microgram per liter [µg/L]), lead (8.1 µg/L), and polychlorinated biphenyls (PCBs) at 0.03 µg/L. RAO #6 in the ROD states "*Restore surface water COC concentration to levels which are protective for recreational users, high quantity finfish consumers and ecological receptors.*"

Sampling protocols will need to be very prescriptive and account for variables such as specific times during the tide cycle, weather conditions, and specific dates and frequencies. These would be developed in the LTMP. However, it is expected that both filtered and un-filtered samples will be collected during post-remediation years 1, 3 and 5.

Fish and Shellfish Monitoring

Fish and/or shellfish sampling will be prominent feature of the LTMP. Sampling biota can provide data related to risk reduction and contaminant flux in the marsh. Dependent upon the species selected, the data can provide information on spatial scales from localized points (e.g. on the thin-layer cover) to larger portions of the marsh complex (e.g., mobile finfish species). Monitoring fish and shellfish tissue can provide a basis for tracking reductions in concentrations of COCs in biota and determining attainment of target tissue levels (TTLs), which may be triggers for concluding remedy success. The TTLs can be based on RAO #3 in the ROD which is to prevent human exposure, through the ingestion of finfish and shellfish that pose unacceptable health risk to recreational and high quantity fish consumers.

The LTMP will need to develop specific performance triggers will need to be species-specific (e.g., at least two finfish species for human health and other ecological "trigger" species such as mummichogs and blue crab), and specific to the size and time of year of capture, as well as other factors which must be specified in the LTMP. The trigger values will include those listed in ROD Table #19 and may also be based upon State fish advisories.

With respect to RAO #2 to protect piscivorous birds and mammals, and RAO #5 that protects finfish, typical prey items include mummichog, fiddler crab and blue crab. Tissue data from these prey items were used in the Baseline Ecological Risk Assessment (BERA) to evaluate exposures to the birds and mammals. For LTM purposes, tissue concentrations of mercury and Aroclor 1268 in these three organisms could be used to monitor potential exposures to wildlife. The specific sampling methodologies, frequencies, numbers of organisms to be collected and from where will be developed in LTMP during the remedial design (RD) phase. This may require baseline sampling prior to implementing the remedy.

Because of the wide array of potential use of biomonitoring within the LTMP, it will be important to craft the collection efforts, species and sizes to be collected along with other factors in order to obtain an effective and implementable design upon which all the stakeholders concur. This effort will be done during the design phase development of the LTMP.

Benthic Community Assessment

The objective of a benthic community assessment is to determine achievement of RAO #4, which states "*Reduce risks to benthic organisms exposed to COC-contaminated sediment to levels that will result in self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas*."

Establishing baseline benthic community conditions both before and after remediation is important. Benthic community assessments may be targeted at locations in TLC areas to assess impacts of the cover on reestablishment of the benthic community. In addition, benthic assessments may be targeted in selected un-remediated portions of the marsh and compared to an appropriate reference envelope so that monitoring results (various biological integrity metrics appropriate to the habitat) are evaluated within a range of background marsh conditions. This is because community assessments have many confounding factors such as particle size distribution, detrital and organic carbon contents, sediment stratification, and variable tidal positions within the marsh.

Benthic monitoring will require a baseline surveys in the affected areas and in the reference envelope prior to remedial action. Then, an anticipated frequency could be at years 5 and 10 post-remediation. Again, specifics of the surveys will need to be established and agreed to by the stakeholders during LTMP development.

Revegetation of Disturbed Areas

To implement the remedy, various areas of the marsh may be disturbed due to construction of temporary access roads, staging areas, and general disturbances from dredging and sediment removal actions. These disturbed areas will be revegetated according to a work plan to be developed in the RD phase. The LTMP will include monitoring the success of vegetative recovery and would likely include percent cover and diversity.

APPENDIX B
State Concurrence Letter

Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive, Suite 1456, Atlanta, Georgia 30334
Judson H. Turner, Director
(404) 656-4713

SEP 1 8 2015

CERTIFIED MAIL
Return Receipt Requested

Mr. Franklin E. Hill
Director, Superfund Division
USEPA Region IV
Atlanta Federal Center
61 Forsyth Street
Mail Code: 9T25
Atlanta, Georgia 30303-8960

Re: LCP Chemicals NPL Site, Operable Unit 1 (OU1) Record of Decision (ROD)

Dear Mr. Hill:

The Environmental Protection Division (EPD) has reviewed the above referenced document, received August 24, 2015. EPD appreciates the opportunity to have participated fully with EPA Region IV in the development of the remedial alternatives for OU1 of the site; the marsh and estuary. We concur that the remedial alternative proposed provides the greatest level of environmental restoration consistent with an acceptable compromise between aggressive cleanup and concomitant damage to the coastal salt marsh. In concurring with the ROD, we reiterate our requirement for a robust monitoring program. A quality monitoring program is essential so that EPD, EPA and other affected parties can evaluate the effectiveness and permanence of the remedy in a reasonable timeframe.

EPD appreciates the effort by all parties that was necessary to develop this decision document on the largest portion of the LCP NPL site. Please continue to contact Jim Brown, of my staff, at 404-656-7802 regarding the LCP NPL site.

Sincerely:

Mary S. Walker
Assistant Director

Part 3

RESPONSIVENESS SUMMARY

LCP CHEMICALS SUPERFUND SITE OPERABLE UNIT 1
PROPOSED PLAN RESPONSIVENESS SUMMARY

Table of Contents

Please note that a list of acronyms/abbreviations and the references for this Responsiveness Summary are contained in the Record of Decision (Part 1).

List of Tables

Attachments

1.0 PUBLIC REVIEW PROCESS

1.1 Introduction

This Responsiveness Summary (RS) provides a summary of comments and concerns received during the public comment period related to the LCP Chemicals Superfund Site, Operable Unit 1 (OU1) remedial investigation and feasibility study (RI/FS) and the Proposed Plan, and provides the responses of the US Environment Protection Agency (EPA) to those comments and concerns.

A responsiveness summary serves two functions: first, it provides the decision maker with information about the views of the public, government agencies, and potentially responsible parties (PRPs) regarding the proposed remedial action and other alternatives; and second, it documents the way in which public comments have been considered during the decision-making process and provide answers to significant comments.

The Human Health Risk Assessment RI report (EPS, 2011) and the Baseline Ecological Risk Assessment (Black & Veatch, 2011) evaluates risks to human health and the environment from exposure to hazardous substances. The RI report (EPS and Environ, 2012) describes the nature and extent of the contamination in the LCP Chemicals marsh. The FS report (Environ and Anchor QEA, 2014) evaluates remedial alternatives to address this contamination. The Proposed Plan (EPA, 2014) identifies the EPA's preferred remedy and the basis for that preference.

Public involvement in the review of Proposed Plans is stipulated in Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended, and Sections 300.430(f)(3)(i)(F) and 300.430(f)(5)(iii)(B) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). These regulations provide for active solicitation of public comment.

All public comments received are addressed in this RS, which was prepared following guidance provided by the EPA in EPA 540-R-92-009 and the Office of Solid Waste and Emergency Response (OSWER) in OSWER 9836.0-1A. The comments presented in this document have been considered in EPA's final decision in the selection of a remedy to address the contamination at OU1 of the LCP Chemicals Site.

Under the EPA policy, responsiveness summaries are divided into two parts. The first part is a summary of general stakeholder issues and concerns, and it will expressly acknowledge and respond to those issues and concerns raised by major stakeholders (e.g., community groups, support agencies, businesses, municipalities, PRPs). The second part is a comprehensive response to all specific comments. It is comprised mostly of specific legal and technical questions, and, if necessary, will elaborate with technical detail on answers covered in the first part of the responsiveness summary.

The text of this RS explains the public review process and how comments were responded to. In addition to this text, there are three attachments:

Attachment 1 The Comment and Response Index, which contains summaries of every comment received and EPA's response.
Attachment 2 Comments provided during the public comment period, including letters, e-mails, and oral statements. This attachment contains copies of every comment received.
Attachment 3 Transcript of the December 4, 2014 public meeting.

1.2 Public Review Process

The EPA relies on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each Superfund site. To this end, the Proposed Plan for the LCP Chemicals OU1 Superfund Site, Brunswick, Georgia was made available to the community on November 20, 2014. A ten-page summary was released with the Proposed Plan and both were made available on the EPA's web site (http://www2.epa.gov/foia/region-4-virtual-reading-room-lcp-chemicals-site-brunswick-ga)

The complete Administrative Record file, which contains the information including the RI/FS reports and risk assessments, upon which the Selected Remedy is based, is available at the locations listed below.

Information Repositories for the LCP Chemicals Superfund Site
Administrative Record

Brunswick-Glynn Co. Library
208 Gloucester Street
Brunswick, GA 31520
(912) 267-1212

U.S. EPA - Region 4
Superfund Records Center
61 Forsyth St., SW
Atlanta, GA 30303

1.3 Public Comment Period, Public Meeting and Availability Sessions

The public comment period is intended to gather information about the views of the public regarding both the remedial alternatives and general concerns about the site. A notice of the start of the public comment period, the public meeting date, the preferred remedy, contact information, and the availability of above-referenced documents was provided in a fact sheet distributed to the public on November 20, 2014 and published in the Brunswick News on December 1, 2014.

The public comment period for the LCP Chemicals OU1 Proposed Plan commenced on December 4, 2014 and continued until March 16, 2015. During that period, a public meeting was held on December 4, 2014, followed by a public availability session on February 26, 2015. Approximately 120 people, including residents, local business people, university students, media, and state and local government officials, attended the public meeting and approximately 70 people attended the availability session. A question-and-answer session followed the formal presentation at the public meetings. A complete transcript of the public meeting can be found in Attachment 3 of this RS.

1.4 Receipt and Identification of Comments

Public comments on the Proposed Plan and EPA Region 4 responses were received in several forms, including:

- Written comments submitted to the EPA Region 4 via e-mail;
- Written comments submitted at the public meeting;
- Written comments mailed to the EPA;
- Oral comments made at the public meeting.

Each submission received, whether written or contained in the transcript of the public meeting, was assigned one of the following letter codes:

GEC – Glynn Environmental Coalition
ESC – Environmental Stewardship Concepts
SELC – Southern Environmental Law Center
SR – Satilla Riverkeeper
T – Natural Resource Trustees
R – Regional or local agencies and officials.
C – Corporations
P – Public (individuals).
O – Oral (comments presented at the public meeting).

These codes were assigned for the convenience of readers and to assist in the organization of this RS; there was no priority or special treatment given to one commenter over another in the responses to comments. Within each of the coded categories, the comments were put in order based on the original page number and comment number if given, and assigned a number, such as GEC 3.1, GEC 3.2, and so on.

RS Table 1 lists all of the submissions received during the comment period. The written comments are summarized and responses are provided in the Comment and Response Index (Attachment 1). Note that comments reproduced in Attachment 1 are presented as submitted, including spelling and grammatical errors. Copies of all written submissions have been included in Attachment 2.

RS Table 2 provides a summary of oral comments given during the question/answer period during the December 4, 2014 public meeting. These oral comments are part of the transcript. A full copy of the public meeting transcript is provided in Attachment 3.

1.5 Locating Responses to Comments within the Comment and Response Index

The Comment and Response Index (Attachment 1) contains a complete listing of all comments and responses from the EPA. The index allows readers to find answers to specific questions they have raised and is organized as follows:

- The first column lists the location (i.e., commenter), according to their assigned letter code (e.g., GEC, SELC, T) and page or comment number (e.g., SELC 3.1) which refers to original page 3, comment 1 from the Southern Environmental Law Center's letter to the EPA.
- The second column provides a summary of the comment.
- The third column provides the response to the comment or a reference to see responses to frequent, technical, or other comments (see section below).

In a few instances, a commenter may appear in the Comment and Response Index more than once, because he/she sent different letters, sent letters that were different from their oral statements, or made different oral statements. If an individual spoke for a group and then wrote a letter in his/her own name (or vice-versa), the submissions were coded separately and each appears in the Comment and Response Index.

It was not always clear if a commenter intended to represent an organization/group or simply himself /herself. The reader is advised to examine both the listing for the name of the group, firm, or association used on the letterhead of a written submission and the public (P) list for his/her own name.

1.6 Kinds of Responses

Due to the complexity of the LCP Chemicals OU1 Site and the large number of comments received, comments are addressed according to three categories: frequent comments, technically detailed comments, and individual comments. These categories are defined as follows:

- **Frequent comments** are comments that were made by many commenters. A frequent comment may be a combination of several comments on a similar topic. Frequent comments and the associated responses are in the text of the RS below, in the section called "Summary of Major Public Comments and EPA Responses."
- **Technically detailed comments** are those that required a lengthy scientific or engineering explanation. Technical comments and the associated responses are in the text of the RS below, in the section called "Summary of Major Public Comments and EPS Responses."
- **Individual comments** are answered directly in the Comment and Response Index (Attachment 1).

The EPA carefully considered each comment received and made every effort to be fully responsive. All comments received are addressed in this RS, and a copy of every comment is provided in Attachment 2.

2.0 SUMMARY OF COMMENTOR'S MAJOR ISSUES AND CONCERNS AND EPA RESPONSES

2.1 Frequent Comments and Responses

Frequent comments are comments that were made by many commenters. A frequent comment is typically a combination of several comments on a similar topic. One answer has been provided for each frequent comment.

Frequent Comment #1: A relatively large number of comments expressed the desire to clean up 48 acres of the Site as reflected in Alternatives 2 or 3 of the Proposed Plan.

Response to Frequent Comment #1: The Selected Remedy balances the need to remove from the marsh system the contaminants posing risk to human health and the environment, while limiting the impacts to the areas with lower concentrations of contaminants. The two areas with the highest mercury and Aroclor 1268 concentrations in the LCP Chemicals marsh are the Eastern Creek and LCP Ditch. Both of these tidal channels, which are scoured twice daily by the tides, have contaminants present at elevated concentrations to depths of about 18 inches below the channel surface. Under the Selected Remedy, both of these tidal channels will be excavated and backfilled with clean sand, thereby removing the highest concentrations of mercury and Aroclor 1268 from the marsh system. Available vertical profiles suggest that the marsh surface, immediately flanking the tidal channels (presumably contaminated over the decades of incoming and outgoing tides overtopping the channels) are contaminated to depths of six inches or less. The concentrations in these areas that flank the tidal channels are appreciably lower than in the channels themselves. For these reasons, thin-layer covering is specified under the Selected Remedy for the estimated 11 acre areas with lower concentrations, rather than removal. Excavation of the lower concentrations would not only disturb the 11 acres but additional acreage necessary to construct the roads to permit the access for the heavy equipment. Finally, Alternative 2, which entails excavation of 48 acres of marsh, plus an additional 11 acres in access roads beyond the remedy footprint, for a total of 59 acres was judged to be too disruptive to the marsh for the benefit gained. Other, less disruptive methods at achieving the same risk reduction were preferred and ultimately selected.

Frequent Comment #2: Most of the comments were highly technical and questioned the methodologies used in the human health and ecological risk assessments. The primary human health concerns were that the seafood consumption scenarios were not conservative (protective). This issue would subsequently impact the cleanup levels that would likely result in more remediation sediments in the LCP Chemicals marsh.

Response to Frequent Comment #2: The Proposed Plan was in error in only citing the 40 and 26 meals per year fish consumption rate for the high quantity and recreational fish consumer, respectively. The following is a more detailed description of the assumptions used in the Human Health Baseline Risk Assessment (HHBRA):

- The adult high quantity consumer scenario was assumed to consume, on average, 27 grams of finfish per day. Assuming a fish meal size of 0.3 pounds (135 grams), this translates to 73 meals/year, or approximately six meals per month (from Zones D, H and I, see ROD Figure

23), based on self-identified high-quantity consumers in an area-specific creel survey. Assuming a larger fish meal size (0.5 pounds), this translates to about 43 meals per year, or a little less than four meals per month;

- The recreational adult consumer was assumed to consume, on average, about 16 grams of finfish per day. Assuming a fish meal size of 0.3 pounds, this translates to about 38 fish meals per year, or about three and a half meals of finfish per month. Assuming a larger fish meal size (0.5 pounds), this translates to about 26 meals per year, or about two meals per month. For shellfish consumption, the adult recreational fisher was assumed to catch and eat about 12 grams per day, on average. This translates to about one and a half meals per month for a 0.5 pound meal or about two and a half meals of shellfish per month for a 0.3 pound meal size. These finfish (recreational scenario) and shellfish consumption quantities are based on upper-end of EPA defaults for recreational fishing in Southeast United States. The HHBRA conservatively assumes that these consumption amounts are for fish caught in the same area; and
- The area-specific creel survey was the basis for the high quantity fish consumption rates used in the HHBRA conducted by the Agency for Toxic Substances and Disease Registry (ATSDR; Division of Health Studies) and the Glynn County Health Department, which surveyed 211 Turtle River anglers. The creel survey covered racial/ethnic groups representative of area population. The NOAA fisheries information was used to assign site-specific weighting factors to the various species of fish caught and eaten. Table 7 in the ROD shows the average percentage of the various species of fish caught by coastal Georgia anglers between 2001 and 2005.

Fish filet tissue data used in the HHBRA is from the Georgia Department of Natural Resources (GADNR) Zones D, H and I. Zone D is considered to be the middle of the Turtle River. Zones H and I are Purvis Creek and Gibson Creek, respectively. Figure 23 in the ROD shows the GADNR Fish Consumption Guidelines Zones. The most recent fish fillet data (2011) shows that fish caught in Zone H (Purvis Creek) had the highest mercury and Aroclor 1268 concentrations in 56% of the species sampled. Hence, the HHBRA estimated the risks posed by consuming fish from the most contaminated zones in the St. Simon estuary.

Frequent Comment #3: An equally important human health concern is the risks from dioxins and furans. Similarly, this issue would subsequently impact the cleanup levels that would likely result in more remediation sediments in the LCP Chemicals marsh.

Response to Frequent Comment #3: The September 2, 2014 Dioxin/Furans Memorandum consolidated into one document all the known dioxin/furans data available for the Site. It also evaluated the risk posed by the dioxin/furans still in place, following the removals. The memo concluded that the dioxin/furans are very likely co-located. To confirm this, the ROD's Selected Remedy requires additional sampling during the remedial design (RD) to confirm this belief. Should co-location not be confirmed by the RD sampling, the ROD will have to be amended to address any locations that may pose unacceptable risk.

Frequent Comment #4: The primary concerns with the ecological risk assessment were that more receptors should have been included such as dolphins, mink, and manatees. The assertion of including these sensitive receptors would likely change the cleanup levels.

Response to Frequent Comment #4: The EPA appreciates concerns regarding sensitive species such as mink and dolphins. The EPA fully recognizes the latest data collected over the past several years on the bottlenose dolphin in the region. The baseline ecological risk assessment (BERA) was based on data collected between 2000 and 2007. Much of the dolphin data were unavailable at that time for meaningful quantification of dolphin exposure in the LCP Chemicals marsh. However, both the BERA and the HHBRA used very conservative exposure and effect assumptions to account for uncertainties where exposure to other potential indicator receptors may be unknown. The data and conclusions in the BERA and the HHBRA were used to develop cleanup goals in sediment that are expected to reduce COC fish concentrations to levels protective of humans, river otters, dolphins, and herons. Given their large home ranges, dolphins, river otters, and mink are exposed to contamination in fish in OU1 and in the broader TRBE. The proposed remedy will reduce the concentrations in fish tissue.

Manatees may occur in the Turtle River area and even more infrequently in Purvis Creek and may graze occasionally on *Spartina* containing elevated concentrations of mercury. Manatees feed on a wide variety of submerged, emergent, floating, and shoreline vegetation. The BERA focused on top carnivorous indicator species because they tend to accumulate more mercury in the more toxic form of methylmercury from their prey (mummichogs, crabs, finfish). In addition, these food items contain much higher methylmercury (MeHg) concentrations (up to 100%) than *Spartina*, which only contains about 10% MeHg relative to mercury. It was determined in the planning process that if the top level carnivorous species could be protected, this would also be protective of species that would likely have lower doses of MeHg. For these reasons, the manatee was not selected for quantitative exposure analysis in the BERA. Risk to the manatee was evaluated in EPA (1997) and PTI (1998). In addition, the BERA did not conclude unacceptable risk to the river otter. The manatee consumes vegetation and would be covered by the risk assessment for the marsh rabbit, which did not present unacceptable risk in the BERA. The reproduction of mink can be adversely affected by PCBs to a greater degree than anticipated for river otter. The BERA assumed a lowest observable effects level (LOAEL) toxicity reference value of 0.3 mg/kg-day for the river otter. The LOAEL used in the assessment of the river otter was appropriately conservative to be protective of mink. The concentrations of total PCBs in certain fish species captured in Purvis Creek (black drum, silver perch, spotted seatrout, striped mullet) in the BERA are currently above the estimated protective concentration of total PCBs in the diet of the mink (4.7 mg/kg dry weight). The PCB concentrations in fish of Purvis Creek will be reduced by the remedy.

With regards to the dolphin, it was not assessed in the BERA. Currently, there is a lack of information on the toxicity of PCBs related to survival, growth, or reproduction of dolphins that may be used in a BERA. The only available information for dolphins is on the effect of Aroclor-1268 on the thyroid hormone and immune system response. The 70 μg/g-lipid threshold for effects on thyroid hormone and immune response (Schwacke *et al.* 2012) is equivalent to about 28 mg/kg blubber tissue (wet weight) based on 40% lipid content in blubber. A fish-to-dolphin biomagnification factor of 15.2 was estimated by Maruya *et al.* (2004). Based on this rough

estimate, the concentrations of total PCBs in the diet of the dolphin would need to be on average 1.84 mg/kg wet weight in fish (7.36 mg/kg dry weight). This rough estimate of a protective concentration in fish tissue to protect dolphins from thyroid hormone and immune response effect is the same order of magnitude as the concentrations in fish necessary to protect other wildlife species.

The proposed remedy will reduce the fish tissue concentrations. Post-remedy monitoring of fish tissues will be conducted. Concentrations of PCBs in striped mullet consumed by dolphins will reduce as a consequence of the remedy.

Frequent Comment #5: There were a number of concerns pertaining to statements regarding a robust long-term monitoring plan (LTMP) without any details provided in the Proposed Plan.

Response to Frequent Comment #5: LTMPs are an important element of site remedies which leave some contamination in place, such as with the use of thin layer capping. Appendix A of the ROD provides a framework of the LTM plan and basic assumptions that will be developed in the remedial design phase. As noted, it is important that decision criteria be developed in conjunction with the LTM plan to insure that the appropriate data are generated such that conclusions on remedy effectiveness can be made, either success or failure.

Frequent Comment #6: Several comments touched on environmental sampling in the LCP Chemicals marsh.

Response to Frequent Comment #6: Marsh sampling has been ongoing since 1994, with a combination of grid node sampling and subsequent sampling directed by the results of the grid node sampling or other directed marsh sampling which suggested a source area or concentration gradient. The marsh sampling included surface water sampling, but focused upon sediment sampling and organism tissue sampling (biomonitoring). The historically generated data led to the identification of source material along the marsh border, which was removed as part of the 13-acre removal action. The data generated to date, both sediment data and biomonitoring/tissue data, support the conclusion that the nature and extent of contamination is known within the marsh. It is believed that additional sampling would identify the presence of site COCs particularly Hg and PCBs, as suggested by the comment, however, the EPA believes that the concentrations found would be similar and/or consistent with the concentrations of those contaminants in the area of the sampling.

Frequent Comment #7: Several commenters opposed the preferred remedy because it was not extensive enough and that by leaving contamination in the marsh was simply postponing the final resolution of the problem to future generations.

Response to Frequent Comment #7:

See response to Frequent Comment #1.

2.2 Technically Detailed Comments and Responses

This section provides a summary of frequent technically detailed comments that were typically asked by more than one commenter. More specific responses to individual technical comments are provided in the Comment and Response Index (Attachment 1 of this RS).

Technical Comment #1: Several technically knowledgeable groups (e.g., GEC, ESC, SELC) submitted comments and questions on specific technical aspects of the risk assessments, remedial investigation, feasibility study, and Proposed Plan. These topics included, among others, extent of contamination outside the current Superfund Site boundaries.

Response to Technical Comment #1: The EPA understands these comments to be based on the extent to which Aroclor 1268 can be found along the coast in the Brunswick area. Aroclor 1268, which was used at the LCP Chemicals Site, has been identified as being present in far-reaching areas based upon the presence of PCB 209, in particular. PCB 209 (decachlorobiphenyl) is one of the 209 individual PCB compounds (congeners) which comprise the Aroclor products that were used. PCB 209 is a component of Aroclor 1268 but is not commonly found in some of the most commonly used Aroclors. For this reason, the presence of PCB 209 has been used as a signal that Aroclor 1268 is present and that the PCB quantification should be made assuming that the PCBs found are from Aroclor 1268. However, PCBs are currently ubiquitous in our environment from multiple sources; and while the presence of PCB 209 and a few other congeners may indicate that a portion of the PCB content in a fish or dolphin originated from the LCP Chemicals Site, the amount of PCBs contributed by the Site cannot be easily determined and it may be impossible to determine. In addition, there exists evidence that PCB 209 is found throughout the east coast of the US, suggesting that sources of this and other congeners, commonly found in Aroclor 1268, exist other than from the LCP Chemicals Site in Brunswick, GA. In addition, none of the available information shows site-related PCBs at levels which we can effectively remediate (active remediation) outside of the LCP Chemicals marsh area.

Technical Comment #2: Several groups submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, cleanup levels.

Response to Technical Comment #2: The BERA described significant uncertainties associated with the derivation of RGOs. In addition, the BERA provided results of five different sediment effect concentrations (SECs) on eight test endpoints (e.g., survival, reproductive response) for the two test organisms (amphipods and grass shrimp) and for each of the four COCs, including attempts to normalize for organic carbon, for a total of 240 statistically derived potential SECs. For mercury, there were 40 SECs (25 for grass shrimp and 15 for amphipods). In accordance with risk assessment guidance, the initial RGOs were based on the most conservative numbers from the most sensitive sediment toxicity receptors and test endpoints. The actual range of sediment mercury SECs was between 1.4 and 145 mg/kg. For Aroclor 1268, the SEC range was between 4 and 420 mg/kg. Similarly for total PAHs and lead, the SEC concentrations range over

an order of magnitude. Thus, the BERA RGOs were very conservative and did not take into account the locations or magnitude of sediment contaminant distribution in the LCP Chemicals marsh.

When the BERA RGOs were overlain with the Site sediment spatial concentration distributions during development of the feasibility study (FS), it was determined that large areas of the LCP Chemicals marsh would be disturbed without commensurate risk reduction. In order to get to a realistic range to assess the feasibility of cleanup alternatives, the benthic PRGs were developed from the SECs by providing essential conservatism within the range of uncertainty. The lower of the two PRG values had higher uncertainty and therefore more conservative. Whereas the concentrations of COCs just slightly higher than the upper-end PRGs are toxic to sensitive benthic organisms with a high degree of certainty. The FS evaluated these uncertainties during alternative development which resulted in the variable spatial areas for potential cleanup.

After the evaluation of each alternative that was presented in the FS, it was determined that the proposed cleanup levels (CULs) would still provide substantial protection to the benthic community without undue harm to the existing marsh, especially in combination with a robust monitoring program that will include benthic community assessments.

Technical Comment #3: Several submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, exposure assumptions.

Response to Technical Comment #3: The 2014 ATSDR Public Health Assessment cited a study performed in 1997 between the Augusta Lock and Dam and the Route 301 Bridge of the Savannah River. This part of the Savannah River is about 140 miles "as the crow flies" from Brunswick, GA. Consumption rates are lower in the Savannah River study (64 meals/year for the African American population) than assumed in the LCP Chemicals marsh HHBRA (73 meals/year for high quantity). However, meal sizes in the Savannah River study were almost three times larger than modelled in the HHBRA. The Savannah River study's mean consumption rate is about 70 grams per day for adult African Americans, as opposed to the 27 grams per day used in the HHBRA for the adult high quantity fish consumer. Table 10-5 in EPA's 2011 Exposure Factor Handbook places the Savannah River study in context of other national studies. The mean 70 grams per day consumption rate is an outlier. The summary (mean ranges) on Table 10-5 are: Statewide Surveys: 5-to-51 grams/day, Rivers: 20-to-70 grams/day and Lakes: 5-to-10 grams/day.

A goal of the HHBRA is to develop reasonable maximum exposure scenarios to contaminants from a specific hazardous waste site. The purpose of the HHBRA is not to assume exposure on a regional scale but on a site-specific basis. The consumption rates used in the HHBRA (27 grams/day for the high quantity fish consumer) are very specific to assessing exposure to contaminated fish caught in the near vicinity of the LCP Chemicals marsh (Zones D, H, and I from the TRBE). The EPA recognizes that the same anglers who fish in these three zones also fish elsewhere in the TRBE, including upstream in the Turtle River or in the Sapelo Island area.

Any additional grams/day that the angler would obtain from those areas are not included in the site-specific risk assessment.

The HHBRA does not account for every fish meal that a person eats over the course of a 30 year period, but rather provides a reasonable maximum exposure (RME) related to the Site. Even though the dominant PCB signature of Aroclor 1268 in fish may extend to a much wider geographic area, the HHBRA does not use fish tissue data from afar. Similarly, even though local subsistence people may consume more seafood, not all of it is assumed to come from an area of approximately two square miles. To apply much higher consumption rates based on this small area would be unrealistically over-conservative. Conversely, to expand the geographic area to be more reflective of local fishing patterns would be less conservative because the concentrations of mercury and PCBs in fish are generally lower than those caught in Zones D, H, and I.

The anglers in the Sapelo Island area fish at various locations around the island. It is assumed that this behavior applies to most anglers in coastal Georgia. In addition, the EPA recognizes that there are differences in seafood consumption rates throughout the southeast coastal region and the value that these studies provide to our understanding of fishing behavior and consumption of seafood. However, consumption rates need to be applied at a RME scale specific to a contaminated site. Therefore, the higher fish consumption rates based on the Savannah River study (Berger et al., 1999) or the ATSDR 2014 study of nine individuals do not change the conservative RME consumption rates used in the HHBRA. Remaining grams/day obtained elsewhere may provide a more complete assessment of regional exposure but would not be very informative to develop site-specific cleanup levels of sediment in the LCP Chemicals marsh.

Technical Comment #4: Several groups submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, statistical treatment of data.

Response to Technical Comment #4: These comments questioned the difference between the use of the 95% upper confidence limit on the mean of fish fillet tissue levels for the human health risk assessment, and the use of surface weighted averages of corresponding sediment levels in the FS and in the BERA. Within the human health risk assessment, it is EPA policy for the exposure point concentration to evaluate exposure using the 95% UCL of the mean. Consumption of fish tissue is the human exposure scenario resulting in unacceptable health risk. It is the sediment, however, which must be remediated to reduce fish tissue contaminant levels. While the surface weighted average concentration (SWAC) is the sediment concentration, the long-term monitoring will verify the decline of contaminant levels in the fish tissue. Within an ecological risk assessment (ERA), there is more latitude on how the exposure may be estimated. This is because the types of data used can be more variable in the ERA. For example, site-specific toxicity testing is used, and exposure response relationships are evaluated, and co-located bioaccumulation tests are conducted using sediments collected at the biota sampling location. Some exposures do use the 95% UCL of the mean. Others do not, based upon the professional judgment of the risk assessors, with input from Stakeholders such as the State, Fish and Wildlife Service, and/or NOAA. The resulting exposure assessment is typically a mix of

more and less conservative assumptions and input parameters, and every attempt is made to make that process and the decisions open and transparent.

The use of surface weighted averages is an accepted approach to estimating surface soil/sediment exposure estimates. The EPA is mindful of not aggregating areas inappropriately--areas that are not the same habitat or by their size dilute the exposure estimate. Concerns on how to deal with outliers/hotspots and non-normally distributed contamination is a long standing issue within the EPA, and, to date, one standard approach has not been satisfactory between sites. Within the FS, various methods of defining areas and exposures were considered. The PRPs preferred approach is presented within the FS. The EPA did not find the approach to be technically wrong or to be misleading. Therefore, the EPA did not require that the PRPs conduct the evaluations using other means of defining areas or estimating exposure levels.

Technical Comment #5: Several groups submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, impact of dioxins/furans.

Response to Technical Comment #5: The BERA did not consider all the available PCDD/PCDF data and left it as an uncertainty. All the available PCDD/PCDF data was consolidated and evaluated in the September 2, 2014 Dioxin/Furans Memorandum for the Site. The Memo concluded that dioxin/furans concentrations of concern were likely either removed during the late 1990s removal or will be removed during the dredging under the Selected Remedy. This concept will be tested during the remedial design phase though sediment sampling of Domains 1, 2 and 3.

Technical Comment #6: Several groups submitted comments and questions on specific technical aspects of the risk assessments, RI, FS, and Proposed Plan. These topics included, among others, effectiveness of thin-cover placement.

Response to Technical Comment #6: The EPA agrees that actual removal of contaminated sediment from the marsh is more permanent for the marsh. However, the removed sediment would still require disposal elsewhere in a contained system. It is also acknowledged that thin-layer covers may be subject to bioturbation which is why there will be a monitoring program to ensure that this aspect of the remedy is effective. Thin caps will only be applied to low energy environments (i.e., in areas of minimal tidal/storm surge areas). This portion of the remedy is not to eliminate contamination, but to substantially reduce toxic exposures and contaminant mobility. Armored caps are only proposed in the tidal creeks, and they have been successfully used in major tidal rivers that are also subject to substantial flooding.

Technical Comment #7: A few comments suggested different and/or innovative technologies that could be considered for remediation.

Response to Technical Comment #7:

In Situ Treatment

In-situ treatments require contact between the contaminant and the treatment. For soil or sediments, this typically requires some means of dispersing the treatment into the sediment or mixing the soil to achieve contact. This requirement for establishing contact can result in an equal level of disturbance to the system as dredging or capping. Most in-situ technologies remain difficult to implement on a large scale and are typically suited to a specific concentration range. At both high and low concentrations, the technology may be ineffective. In time, several emerging technologies may become viable.

Bioremediation

The challenges in bioremediation are maintaining the favorable conditions to a specific microbe or a consortium of microbes and creating the contact between the microbes and the contaminant. Contact and contact time (maintaining conditions) are no different between a biodegradation process and a purely chemical process. Disturbance and materials handling (dredging, digging, transport, mixing, storage, etc.) create impediments to biodegradation as a treatment technology.

Phytoremediation

Burning PCB-contaminated plant matter for biofuel would lead to the long-recognized incineration issues. There are a couple points to be aware of regarding the use of phytoremediation as a technology. First, most, if not all, of the studies mentioned do not perform a mass balances or trace the degradation; they are either subject to the same limitations of PCB quantification that as the issues on Sapelo Island, or they only look only at one or a few of the more easily degraded congeners. Highly chlorinated congeners are more difficult to degrade, even in a laboratory. Second, soil/root zone degradation has to be aerobic, but dechlorination is strictly anaerobic, so what is the actual mechanism? There are outstanding scientific and technical questions regarding translating these studies into a treatment technology.

In-Situ Sediment Ozonator

Once again, the problem is translating to a field treatment technology. This technology is similar to chemical oxidation. When there is a lot of material that can react, such as organic matter, the organic matter will react with the reactant in competition with the Aroclor 1268. In order to effectively react/degrade the Aroclor 1268, one may have to destroy all the associated organic matter in that marsh.

Ex-Situ Technologies

All ex-situ technologies require the removal of the contaminated material from the system (dredging/excavation). Then the "cleaned" soil needs to be placed somewhere. If returned to where it was removed from, it needs to be lower than the clean-up goal. The process cannot modify or enrich concentration or the availability of elements in the sediment, and it is likely that

the sediment will need to be amended to restore its function. Lastly, there are costs associated with the soil handling (i.e. placing the soil back or replacing the removed material and stabilizing (e.g. re-vegetate). Collectively, these "costs" often exceed the disposal cost once the material has been dredged or excavated.

Monitored Natural Recovery (MNR)

MNR is a viable treatment technology in situations where there exists information that indicate the following: 1) where natural attenuation is or will occur, once the source areas are removed, 2) where the risk presented from the contamination will attenuate at an acceptable rate, 3) where impacts to the environment from active remediation are anticipated to be great and/or not recoverable and 4) where the disparity between the overall risk reduction between the use of MNR and other remediation alternatives is not great. We would add that MNR is not a containment technology.

Summary

In summary, while these technologies are emerging, there has been limited field application of these as field treatment technologies. On small scales, within laboratory settings, under specific conditions, or with a focused or limited contamination mix (specific congeners); these technologies show promise, and the EPA will continue to support the investigation and evaluation of these technologies. However, there are still currently limited proven remediation technologies for PCB-contaminated sediment and mercury-contaminated sediment and/or a mix of these two contaminants.

The EPA preferred remedy removes the contamination believed to be critical to achieve a protective remedy, but leaves contamination that which can be left in place (thin-layer cover) or that will naturally decline in concentration at an acceptable rate to achieve a protective remedy. The following are observations regarding the two principal contaminants at the Site:

- Both mercury and PCBs are difficult to remove from the environment;
- Mercury is an element and therefore cannot be destroyed;
- While PCBs can be destroyed, they are normally very stable in the environment; and
- Existing treatment technologies for mercury and PCBs are frequently mutually exclusive (what works for one does not work for the other or makes the other worse);

While the EPA is always looking for new and demonstrated treatment technologies, we have not found a demonstrated treatment technology which can be used as an interim measure to reduce all risks from the LCP Chemicals marsh. EPA's preferred remedy uses the technologies which can effectively remediate the contaminated marsh and achieve protectiveness over time. Finally, the references included in the comment suggest the overwhelming majority of the listed technologies are still at the university laboratory stage, nowhere near a full-scale application.

3.0 REFERENCES

Black & Veatch. 2011. Baseline Ecological Risk Assessment for the Estuary at the LCP Chemical Site in Brunswick, Georgia. Prepared for the U.S. Environmental Protection Agency, Region 4. April 2011.

Environmental Planning Specialists, Inc. (EPS). 2011. Human Health Risk Assessment for the Estuary, Operable Unit 1 Marsh Trespasser, Fish and Shellfish Consumer, Clapper Rail Consumer, Final, LCP Chemical Site, Brunswick, Georgia. Prepared for LCP Chemicals Site, Brunswick, Georgia. August 2011.

EPS and Environ International Corporation (Environ). 2012. Remedial Investigation Report Operable Unit 1 – Estuary, Revision 2, LCP Chemicals Site, Brunswick, Georgia. Prepared for LCP Site Steering Committee. August 2012.

Environ and Anchor QEA, LLC. 2014. Feasibility Study. LCP Chemical Superfund Site, Operable Unit 1 (Estuary), Brunswick, Georgia. June 2014.

U.S. Environmental Protection Agency (EPA). 2014. Proposed Plan, LCP Chemicals Superfund Site, Operable Unit 1. November 2014.

RESPONSIVENESS SUMMARY

Tables

RS Table 1 – Comment Directory

Letter Code	Last Name	First Name	Affiliation	Date Submitted	Form Submitted	Individual Comments
Groups and Associations						
GEC	Parshley	Daniel	Glynn Environmental Coalition	03-16-2015	Letter	GEC 3.1 – 54.1
GEC (2)	Parshley	Daniel	Glynn Environmental Coalition	02-13-2015	Letter	GEC (2) 1.1 – 2.13
SELC	Sapp	William	Southern Environmental Law Center	03-16-2015	Letter	SELC 3.1 – 17.1
ESC	deFur	Peter	Environmental Stewardship Concepts, LLC	03-16-2015	Letter	ESC 1.1 – 16.2
SR	Nix	Ashby	Satilla Riverkeeper	03-09-2015	Letter	SR 1.1 – 5.6
Regional or Local Officials						
R-1	Atwood	Alex	Georgia State House Representative – District 179	01-21-2015	Letter	R-1.1
R-2	Woodside	M. H.	Brunswick-Golden Isles Chamber of Commerce	03-10-2015	Letter	R-2.1
Trustees						
T	Meade	Norman	National Oceanic and Atmospheric Administration	01-29-2015	Letter	T.1 – T.3
Corporations						
C-1	Taylor	Paul	Atlantic Richfield Company	03-16-2015	E - Letter	C-1.1 – 3.4
C-2	Iannicelli	Joseph	Aquafine Corporation	No Date	Letter	C-2.1
Public Comments						
P-1	Abner	Jimmie Ann		03-07-2015	E – Mail	P-1.1 - .3
P-2	Ahl	Jessica		No Date	Joint Letter	P-2.1
P-3	Balbona	Virginia		03-16-2015	E – Mail	P-3.1
P-4	Barker	Beth		No Date	Joint Letter	P-4.1
P-5	Bartkovich	Becca		No Date	Joint Letter	P-5.1
P-6	Brand	Rachel		No Date	Joint Letter	P-6.1
P-7	Browning	Janice		03-07-2015 03-08-2015	E – Mails	P-7.1 - .8
P-8	Bryant	Kolin		03-16-2015	Post Card	P-8.1
P-9	Clauson	Patricia		03-16-2015	E – Mail	P-9.1
P-10	Cook	Gary B. Jr.		03-16-2015	Post Card	P-10.1
P-11	Cook	Jeremy		03-16-2015	Post Card	P-11.1
P-12	Cook	Valentina		03-16-2015	Post Card	P-12.1
P-13	Cook	Veda		03-16-2015	Post Card	P-13.1
P-14	Corson	Sam		03-03-2015	E – Mail	P-14.1
P-15	Deverger	Wesley		03-16-2015	Post Card	P-15.1
P-16	Fraser	Jane		03-16-2015	Letter	P-16.1 - .4
P-17	Gowen	Michael		01-21-2015	Letter	P-17.1
P-18	Hannah	Cora Lee		03-16-2015	Post Card	P-18.1
P-19	Henderson	Marla		03-13-2015	E – Mail	P-19.1
P-20	Jennings-McElheney	Jill		03-16-2015	E – Mail	P-20.1 - .2
P-21	Jeb	Antle M.		03-16-2015	Post Card	P-21.1
P-22	Kline	Amanda		No Date	Joint Letter	P-22.1

RS Table 1 – Comment Directory

Letter Code	Last Name	First Name	Affiliation	Date Submitted	Form Submitted	Individual Comments
Public Comments (continued)						
P-23	Knight	Cheryl		03-16-2015	Post Card	P-23.1
P-24	Ladson	Helen		03-16-2015	Post Card	P-24.1
P-25	Latham	Chuck		03-16-2015	Post Card	P-25.1
P-26	Lea	Frank & Luanne		03-08-2015	E – Mail	P-26.1 - .4
P-27	Mahas	John		No Date	Joint Letter	P-27.1
P-28	McInnis	Sarah		No Date	Joint Letter	P-28.1
P-29	McQuown	John R.		03-16-2015	E – Mail	P-29.1 - .10
P-30	Miller	Barbara		03-16-2015	Post Card	P-30.1
P-31	Montague	Clay		03-15-2015	E – Mail	P-31.1 - .8
P-32	O'Keefe	Kyle		02-09-2015	E – Mail	P-32.1
P-33	Patrick	James Wilson		03-15-2015	E – Mail	P-33.1
P-34	Patterson	Debra		03-16-2015	Post Card	P-34.1
P-35	Rader	Carolyn		12-04-2014	E – Mail	P-35.1
P-36	Sage	Jovan		03-16-2015	Post Card	P-36.1
P-37	Shellito	Joan & Charles		No Date	Note	P-37.1
P-38	Smith	Madeline		No Date	Joint Letter	P-38.1
P-39	Smith	Monica		No Date	EPA Form	P-39.1
P-40	Smith	Pat		03-16-2015	Post Card	P-40.1
P-41	Strong	Debra Ann		02-02-2015	Letter	P-41.1
P-42	Thomas	Shirleen		03-16-2015	Post Card	P-42.1
P-43	Vick	Alice		03-16-2015	Post Card	P-43.1
P-44	Weldon	Drew		No Date	Joint Letter	P-44.1
P-45	Wheat	Margaret		No Date	Joint Letter	P-45.1
P-46	Wooten	Mishaunda		03-16-2015	Post Card	P-46.1
Oral Comments at Public Meeting: December 4, 2014						
O-1	Brown	Carl				
O-2	Brown	Tommy				
O-3	Brown	Wendy				
O-4	Cidar	Kate				
O-5	Click	Damon				
O-6	Crooms	Lisa				
O-7	deFur	Peter				
O-8	Dressel	Floyd				
O-9	Freund	Mary				
O-10	Hubbard	Peach				
O-11	Hughes	Van				
O-12	Keyes	Alice				
O-13	Killian	Bob				
O-14	Kyler	David				
O-15	Lawrence	Larry				
O-16	Lloyd	Roger, Dr.				
O-17	McQuown	John				
O-18	Murray	Roger				

RS Table 1 – Comment Directory

Letter Code	Last Name	First Name	Affiliation	Date Submitted	Form Submitted	Individual Comments
Oral Comments at Public Meeting: December 4, 2014 (continued)						
O-19	Parshley	Daniel				
O-20	Paulin	James				
O-21	Purvis	Kim				
O-22	Renner	Jim				
O-23	Strong	Linda				
O-24	Wooten	Joel				

RS TABLE 2
Summary of Public Meeting Comments and Responses

Name/Agency	Location Page#, Line	Comment Summary	Response
Comments regarding the Proposed Remedy			
Dr. Roger Lloyd / Galo Jackson	22, 6	Do you have any reproducible data on the thin-cover cap in a nine to ten-foot diurnal tide situation like we have here?	Well, the thin-cover cap, we put that through hydrodynamic modeling, and in the feasibility study there's an appendix that has the results of the modeling that was performed to establish the thin-cover cap should work. Now keep in mind that once the thin-cover cap is applied there will be long-term monitoring going on -- periodic monitoring to see that it, indeed, is intact.
	22, 20	But previous to now it's just modeling?	Modeling and experience with other sites. There's a sediment site -- EPA website that has a number of sites where thin-cover placement has been applied. However, what I notice from that website is the feedback has not been received yet as to its effectiveness.
Floyd Dressel / Galo Jackson / Mr. Rhon	23, 12	Why is that cap off there by itself?	The design in the feasibility area is where they detected elevated Aroclor-1268. I think Purvis Creek is primarily conditions of elevated -- the PCB Aroclor-1268.
	23, 18	What is that going to do to the flow above the cap in Purvis Creek?	The flow will not change significantly.
	24, 2	Is it going to kill any of the marsh grass?	The cap might, but to a fairly limited extent.
	24, 6	I see where others are, but there's just one cap, right? That would block or dam Purvis Creek, and I live up here.	These caps are not going to be interfering with flow at all. What we did was we modeled the system with a hydrodynamic model, and we look at the scenario before we do any action -- you know, how would the system react today and how would it react -- you know, after we place a cap, and there's no significant change with respect to flow or the health and the behavior of the marsh following.
Van Hughes / Galo Jackson	24, 24	How thin is this thin cap, or to put it another way, how thick is it?	The thin-layer cover is about six inches.
	25, 3	So, it's only a six-inch cap, and it will stay there?	It's to restrict the -- it's on the flats, not in the creeks. In the creeks they're going to be armoring to make it stay. That's where your velocities are. That's where the modeling

RS TABLE 2
Summary of Public Meeting Comments and Responses

Name/Agency	Location Page#, Line	Comment Summary	Response
			indicated the velocities are that might erode. That's where the cap will be armored.
	25, 12	You'll change the elevation of the marsh by only six inches?	Correct, in the flats. In the flats, not the creeks.
Peach Hubbard / Galo Jackson	26, 10	Capping the marsh will not eliminate toxic contaminates in the shrimp, shellfish, and fish, and dolphins, and if a hurricane comes and moves all those rocks and those armaments you've wasted your money.	That's a comment we'll take.
Wendy Brown / Galo Jackson	26, 21	My question is you said institutional controls every time with the different alternatives. What does it mean? Give us an example of institutional controls.	Well, one example is fish consumption advisories that are already in place. Another one is the restrictions on the use of the marsh in perpetuity. Those are the two examples that come more readily to mind.
	27, 6	Well, I assume that that has never been done yet? You said it is, but I don't see something like this visible in marshes.	You're right. That's something that has to be worked on, and a record of decision will develop that.
Lisa Crooms / Galo Jackson	27, 14	I want to know where these advisories are posted.	They're state advisories. It's the State's responsibility -- they're under the state of Georgia, and they're on their web sites I believe. I've seen them myself.
	27, 20	What web site specifically, please?	I don't know off the top of my head, but I have looked at them
Jim Renner / Galo Jackson	37, 23	Why is the preferred alternative Alternative 6?	It's explained in the proposed plan summary, and there's a link to the full proposed plan which is on the web. It was a matter of balancing -- balancing the marsh disturbance and removal of contaminants. We have to balance those things.
	38, 10	Minimally invasive?	Well, not minimally invasive, but not taking out 48 acres which may or may not come back.
Floyd Dressel / Galo Jackson	40, 7	My question on the dredging, where will the dredge spoils go?	They'll be taken - depending on the concentration of the contaminants they'll be taken to hazardous or nonhazardous land-fills.
	40, 19	What's going to happen to all the water running all	The liquids will be treated, and that's in the proposed plan. I encourage everybody to use the link on the proposed plan summary. There's a link that takes you to the 50-page proposed plan with all the details.
	41, 1	None of the water will run back into there?	No. It will be treated and it will be monitored.

RS TABLE 2
Summary of Public Meeting Comments and Responses

Name/Agency	Location Page#, Line	Comment Summary	Response
Unknown speaker / Galo Jackson	41, 5	The whole ocean?	Yes, ma'am.
Alice Keyes / Galo Jackson	42, 22	The long-term monitoring that you described in every single one of the alternatives does not include marine mammals or include terrestrial animals. Additional studies should be conducted to determine the extent of the contamination. The Sapelo study, I understand it's beyond your purview but for public record I would like to get it in that we need additional studies to determine the extent of the contamination. What you have proposed in Alternative 6 is not enough. Capping these contaminates will not clean up the LCP Super fund site. We oppose the development of another alternative that removes more sediment, cleans it up, and looks at additional treatments such a bioremediation. It doesn't have to return to its existing site. We just want the stuff cleaned out of there. We would like for EPA and our potential responsible parties to work with us as citizens of this community to come up with a better solution. We know there's a better solution out there that can clean this up. It's dependent on our health, our children's health, and our health as a community in coming up with a better alternative. So, we look forward to continuing this conversation with you. Again, we appreciate the extension to the public comment period, but before I sit down I want to submit for the public record a report that was released earlier this year. It's called the Dirty Dozen. It was developed by the Georgia Water Coalition, a group of over 250 organizations and businesses who identify the most outrageous situations throughout our state, the most egregious	
Kate Cidar / Galo Jackson	57, 21	Why is there not a management plan in place right now? If this was a site on land there'd be a fence around it. It's in the marsh, and I understand that's more tricky, but there are Superfund sites that are water bodies that are settling under	Well, the removal did remove 39,000 tons of contaminated sediment, and as we saw in a couple of slides it has dropped. It has brought the concentrations down dramatically, but as far as isolating this, yeah, you're right. There is no

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Summary of Public Meeting Comments and Responses

Name/Agency	Location Page#, Line	Comment Summary	Response
		active water bodies under tens if not dozens of feet of water. In an intertidal zone… I mean, we live in an area with tons of historic impoundments. We see water being managed for waterfowl, for agriculture, and this site needs to be maintained similarly to keep in those contaminates from getting into the next generation of people who live here. So, where has that been? In what alternative does that management-step occur?	alternative for something like that. That would be a good comment.
Peter deFur / Galo Jackson	63, 7	Did I hear you say at the beginning you would have a time for official public comment, or is just now?	You're talking about tonight? Yes. This is questions and comments, but the comment period does not -- I wanted to make that clear -- doesn't stop tonight. It's through February 2nd. Everything that comes in will be noted.
Comments Regarding the HHRA			
David Kyler / Galo Jackson / Mr. Koporec	28, 12	But it's obvious from the report that the plan -- that the assessment of human health risk had a fish consumption rate that is a fraction of the rate that people have revealed through this sample commonly exhibited. So, whereas you estimated 40 meals a year, they're eating twice or three times a week which would be 100 to 150 meals a year. So, that being the case won't you have to completely re-evaluate the human health assessment because of the much higher rate of consumption? Actual consumption being two and a half to three times the rates you assumed in your health assessment.	The human health risk assessment was based on -- the consumption rate was based on a study done some years ago that was site specific, and that's -- Kevin, you might be able to --- The human health risk assessment assumed fish consumption rates based on a survey of people in this area, how much fish in the area they said they would eat if there was not a consumption advisory in place, and those were the assumptions used in the health risk assessment. It amounted to -- for the recreational fish consumption that we saw it was 26 meals per year for the adult and a corresponding number of meals -- based on each meal being about half a pound of fish per meal. And then for the high-quantity fish consumer that assumed about 43 meals per year. What we would say to that is there are fish consumption advisories in place because we know contaminate levels are above where we would like them to be. We all acknowledge that. So, we would recommend you follow the fish consumption advisories.

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	30, 10	That doesn't answer my question. What my point was --my question was given the consumption is at least two and a half to three times the rate you assumed, and there are already fish consumption advisories in place of certain types -- I'm not sure exactly how much they correspond with those in your study, but advisories are in place and plenty of them thanks to DNR, but will you now have to reassess human health risks because we know for a fact that consumption is two and a half to three times what you assume?	We've already triggered the need for remedial action. That was the function of the human health risk assessment. It's already been triggered.
Unknown speaker / Galo Jackson / Mr. Koporec	31, 1	What does trigger mean?	We have already got --we have -- EPA has legal license now to require a cleanup. It won't change anything. That means the levels of the fish are high enough that we know there's an unacceptable risk for people that eat the fish. We already know that. The goal is to get those levels in the fish down, and the target is to hope to do that by reducing the -- you can't clean up the fish directly, of course, but if we clean up the sediment the assumption is that that will reduce the levels in the fish over time.
David Kyler / Mr. Koporec	31, 15	The higher risk revealed by the higher consumption does not alter the remedy or the amount of money being spent to implement a more comprehensive remedy?	Well, we'll be following -¬I mean, the State has fish consumption guidelines based on number of meals per week or per month, or they have a graduated approach of looking at fish consumption guidelines. So, those numbers are going to stay in place, and the State, based on what data they have from what they collect and from what others give them, they will adjust those guidelines to say if the levels go up or down in the fish. The levels go up and down in the fish over time whether that's shellfish or finfish or whatever, but as Galo mentioned it's already triggered the need for action, and monitoring is a very important part of the remedy --of any remedy that ends up being selected here.

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Name/Agency	Location Page#, Line	Comment Summary	Response
David Kyler / Mr. Koporec	32, 18	l' m looking for a succinct answer. In other words, the level of risk revealed by actual testing of human consumption is far higher than the assumed level of consumption in your human health assessment does not alter the proposed remedy which means the amount you're willing to invest and the comprehensiveness and intensity of the remedy; So, we will continue to monitor both the sediment levels as well as the fish levels and talking to people, that's part of -- the State's job is to talk to people about how much fish they eat or how much fish they would eat if there weren't consumption guidelines or whatever -- or how much fish they eat even with consumption guidelines	Well, I'm not selecting the remedy, but if you have that comment that comment is on the record now, and that will be considered in the remedy selection as well.
	33, 6	So, it could?	Yeah, it could, it could.
Bob Killian / Galo Jackson	33, 10	It sounds like you're saying that the fish advisory will continue in perpetuity because DNR on behalf of assisting the State will not require Allied Chemicals and Honeywell to clean up the levels for the fish advisories; is that correct? Why do we not clean up? Sure, but why don't we start removing it all so we no longer have a fish advisory as quick as possible? I don't want fish advisories to still be here when my great grandchildren are alive. I want the fish advisories to be three years, five years, ten years, but it looks like that's not even a goal. My question was why not? Why not clean it up? Why not clean it up so we have no more fish advisories?	It probably will last many years realistically. Even if it were removed today -- all of it were removed today. Keep in mind the PCBs are being removed from the majority of in the creeks are being removed. They're being dredged out of there.
	34, 18	You know that's not true. You know how widespread they are. You know that they spread out into the ocean. Why tell us something that's not true, or do you not know the truth? I understand that, but we can clean up as much of the source as possible.	We can't clean up the ocean.
Unknown speaker / Galo Jackson	35, 9	And it's a lot deeper than 18 inches too. We know that. It was in 1990.	We've got -- the remedial investigation -- the Appendix A has some vertical profiles, and the contamination drops off significantly after the first couple of inches, and it's

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			Appendix A of the remedial investigation which is in the Reading Room.
Kim Purvis / Galo Jackson	35, 17	I grew up here in Brunswick, Georgia and spent my teenage years in Ellis Point which is located, if you Google Map, about midway between where the creeks feed out from LCP and the Brunswick Wood Preserving Plant. In that area of Ellis Point -- and this was without research, just the people that I know. Two ladies before the age of 30 diagnosed with breast cancer, myself and another young lady diagnosed at the age of 40 with breast cancer, and another woman 50 years old with breast cancer on the same road in Ellis Point. These are just people that I know personally, not doing research in the area. I don't recall seeing any type of public survey or invitation to come be part of the testing that took place with the residents of Sapelo Island. Is there a way for people to volunteer to be tested for these levels of PCBs and such other carcinogenic agents?	As I mentioned in the early slides we -- EPA is restricted to determining nature and extent of contamination and cleanups. That's the -- what you're asking about is something that is the responsibility of the Agency for Toxic Substances and Disease Registry, and I believe they've done studies here and, in fact, a couple years ago when I first became involved with this site with LCP they were consulted through the County and ultimately the State to look for cancer clusters, and my recollection is they didn't find anything. I can pass that on. Now that we've got your name I can pass it on to the Agency for Toxic Substances and Disease Registry.
Other			
Larry Lawrence / Galo Jackson	39, 5	That water flowing from the LCP plant and all surrounding areas goes from there to Sapelo Island. That means it passes through St. Simons, Sea Island, every island you can think of between here and there. What are these people or their property going to do with a situation like this? Are they going to correct it or not? In Step 3, you've got -- what is your environmental people up in Atlanta that have to do with taking care of the.. I'm sorry -- the people -- CDC or whatever it is -- disease control, are these people working on it? Are they being made aware of -- are they following step-by-step what you're doing down here to see if it's correct and at a correct enough speed. You know, we've seen very little -- other than a PowerPoint we've	That's a question for CDC.

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		seen very little of the CDC, and I don't think it's been scrutinized yet. It's just been made available.	
Alice Keyes / Galo Jackson	42, 11	I know that you've located the material here at the Brunswick Library 24 hours ago. That's not enough time for us to absorb and inspect and get back to you guys.	You've got two months actually. The public comment runs to the beginning of February. Sixty days.
Tommy Brown / Galo Jackson	45, 11	Can I make a fair assumption that because this is in the Sapelo area -- or Island that these things are found in Sapelo Sound as well as the other sounds, right? Would that be fair? MR. BROWN: Sediment. Well, what I've seen over the last 20 years is a decline in the crabs, a decline in the fish. We built fisheries -- DNR built fisheries out there, and you can't buy fish. Crabs are no longer down there because your crab will eat around the septic tank, but he won't eat in it. What I propose to -- just now propose -- I got a letter back from the commissioner -- was that we open the sounds to a limited amount of trawling. He didn't like that idea. I've talked to shrimpers that said we'll take our nets off. We'll just drag drag-lines through there and get the crap out of our sounds, move it out. Like the gentleman said earlier, the 43 acres ain't going to fix this. We got a major problem, I think, in all of our estuaries, and the shrimpers if y'all would call on them, they would be willing to help y'all. Sure they'd like to drag the sounds for shrimp but they'll take -- they're willing --a lot of them are willing to take the nets off and just drag the stuff out of here, and it needs to go. It really needs to go I think.	The Sapelo was you know -- are you talking about sediment or fish? I don't know enough about the sediment quality in Sapelo.
Tommy Brown / Galo Jackson	47, 17	That money is gone now. BP pays for the study of the dolphins in the Gulf of Mexico. That's it. So, if you don't propose some money for this cleanup we won't know in a year or two whether it's working or not.	
James Paulin / Galo Jackson	48, 15	Have y'all looked at Andrews Island down in the depths of that of what's there? I know what leachates out of there.	Well, that's what -- we're proposing that, and we explain the reasoning in the long version of the proposed plan fact sheet.

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		There's metals coming out of Andrews Island through the leachate, and 48 acres -- you better look at this whole darn thing. I've crabbed this river. I've fished this river for 30 years or more, and I don't think y'all can do what you're trying to even say you're going to do. How did we come up with these alternatives? You're talking about Alternative 6 is best. Who decided that?	
	49, 6	Quite frankly -- you know, I don't personally have zillions of dollars, but I wish that we would extend this program out and look a little bit further because how did people up on Sapelo Island get sick from what we did down here in Brunswick? That's a long ways --you know. I agree that fish travel but we've got fish crabs in our traps. They generally just kind of maintain themselves in this sound and these beaches. They don't like to go up to Sapelo. How do they get up there?	
Wendy Brown / Galo Jackson	62, 2	Are you familiar where Coffin Park is? The fence came down. What was there? Was that residual from the marsh? Well it's on public record that kids were playing in that contaminated environment and my son was one. I want us to be able to be tested, and that's what I request as a citizen.	I really don't know. Okay.
Comments Directed at Honeywell			
Steve Day / Galo Jackson	50, 12	Who is here from Honeywell? Sir, you asked the question about money. This really shouldn't be taxpayer money. Sir, how much did Honeywell earn last year, fiscal year 2013? You should. It's $3.9 billion net revenue. $3.9 billion in gross sales. I can tell you this. $3.9 billion and you're talking about $28 million, I would say that their attorneys in Washington are better than your attorneys because they're getting up in front of -- and their lobbyists, and where does	I have no idea. This went to the National Remedy Review Board because it went over the $25 million threshold which meant Washington and others in the country.

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		the plan come from? Does it come from Washington, or does it come from Region 4? Did it really come from you guys, or did it come from higher up?	
	51, 14	So, they sought input from the stakeholders, in this case Honeywell.	And the Glynn Environmental Coalition.
	52, 9	Can you answer that question? Why are they not here?	UNKNOWN SPEAKER: They are here. They just don't want to be recognized.
	52, 18	Can you tell us why you're only willing to spend $28 million and work with the EPA for $28 million versus doing a complete cleanup?	We have worked with EPA as have the other responsible parties. Honeywell's not the only responsible party.
Steve Day / John Morris	52, 25	Who are the majority?	And we've been working with the Agency in a cooperative manner without attorneys to follow a Superfund process in a way that Galo has described, and we're standing here ready based on 20 year's-worth of scientific studies.
	53, 7	Is Honeywell willing to stand up to the plate and really commit to really doing a complete cleanup rather than just piecemeal?	We're not slinking in the background. This is the process that is followed. I am not here to answer questions. This is not my public meeting. This is the EPA's public meeting. If you would please honor that and direct your questions to the people who are here to answer them.
Unknown speaker / John Morris	54, 14	Where do you live, Mr. Morris? Are you a resident of this community or in town for this meeting?	No. I am in town. I come from the corporate office, and I am here because this site is important to Honeywell. We want to get this site cleaned up. We are cooperating with the Agency. We are not fighting with the Agency. We are here to say that this plan is based upon sound science, and it has evaluated the risks, and we are here ready to implement the plan.
Unknown speaker / John Morris	55, 2	Would you object to taking it to a higher level assuming that the community doesn't feel like capping is a complete answer? Would you be willing to go back to your board and say we need more revenue to get this done properly and be good corporate citizens?	We are ready to encourage the public to put your comments on the record, and the process requires EPA to evaluate those comments and respond, and that's what's going to occur here, and we support that process.

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Mercury/Contaminants			
Unknown Speaker / Galo Jackson	59, 10	I'm curious about mercury. Can you quantify how much mercury was discharged, where and when, how much has been recovered? I ran across an article in the Atlanta Constitution a couple days ago. Back in 1993 they reported 35 pounds of mercury that was released over a five-day period. We know mercury is a real heavy metal. It likes to sink down low. So, it's probably not going to be sitting on the top 18 inches of marsh. It's probably sunk down deep. What types of mercury were discharged? Was it solid metal – Is that soluble form or what?	It was methyl mercury. The discharge was elemental mercury, but in the marsh it methylates, but only -- I may have mentioned too quickly that only a tiny fraction has methylated. As far as volume and mass of mercury there are estimates that I have in the record. I know I can come up with those.
Unknown Speaker / Galo Jackson	60, 8	Can you estimate how much mercury is left in the 28 acres that you want to dredge given the concentrations that you said, 12 milli-grams per kilogram? Can we get a figure on how much was emitted, how much was left, how much was recovered, and where else the rest of the mercury might have gone? I'm just curious because it didn't go anywhere. It didn't disappear. It's out there.	Yeah, you probably could. I agree with you.
Carl Brown / Galo Jackson	87, 19	Dealing with the PCBs, the type that we're dealing with where's the toxicity level? Is this something that is more toxic than some of the other types, or is it less?	The Arclor-1268 is the PCB compound that -- or mixture that1s prevalent here that we're worried about. The testing that's been done showed it to be less - somewhat less toxic than the most toxic one that we have well-established toxicity information on - and that's Aroclor-1254 -- and so, we used the toxicity information from 1254 to evaluate 1268. Even though we think it's probably less toxic we don't have enough information for its own toxicity value, but basically it's an EPA database. It's a probable human carcinogen. We have some information about causing cancer, not enough human information about it causing cancer to be a known carcinogen like other compounds are, and from a non-carcinogenic toxicity standpoint at higher exposure levels it's been shown to cause immune system problems and other

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			effects on the blood system, effects on the central nervous system sometimes. So, things like that could happen at higher exposure levels. That's where we're at with that.
Hydrodynamic Model			
John McQuown / Galo Jackson	60, 22	You in your 54-page report -- of which 20 percent is forms and pictures -- you do make extreme use of a hydrodynamic model. It's not footnoted. Its design, its authorship, or anything else is nowhere referenced in that report. Googling produces no result. That report needs to be there. That model needs to be challenged. As I understand it the feasibility study wasn't delivered until 36 hours ago.	Again I would remind you that you we have set up an electronic EPA has set up an electronic Reading Room. All you have to do is Google LCP Chemicals Electronic Reading Room, and the report you're looking for is there -- a couple of drafts and, in fact, those drafts have all -- the risk assessments have been there for multiple years now. Starting shortly after I got involved with the site. There are drafts of it there with substantially the same thing. Remember you've got two months left.
Peter deFur / Galo Jackson	63, 7	Now as to the substance. The higher actual fish consumption rate does, in fact, affect the cleanup because if lower cleanup numbers are needed in order to accommodate a higher fish consumption rate then the remedy must accommodate lower concentrations of the contaminants in the site cleanup. That's just simple math, and it's a calculation that is done throughout the nation. The boundaries of the site are not clearly established as evidenced by two pieces of data. Number 1 is the dolphin data indicating that PCB-1268 -- which we know originates from the LCP site --is found in dolphins that are both residents of the river and residents of the nearby area.	

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Peter deFur / Galo Jackson		Second of all, the other set of data are the Sapelo Island data that we've seen indicating that again PCB-1268 is not restricted to the narrow marsh area, so I think it's incumbent upon evaluation to do a broader consideration of samples farther afield. Hence the boundaries have not been clearly established. The other limitation or problem that I see with the evaluation of the site is the evaluation of the salt marsh grass itself. Salt marsh grass has multiple components, and in order to accurately understand how the contaminates are separated between the plants and the sediment they have to measure all the different parts of the plants including not just the leaves but the stems and the roots as well as the rhizomes of those roots. So, those data have not been collected. In addition, even though the report indicates that dioxin is a known co-contaminate and a known product of the process that occurred at the LCP site I don't find dioxin data in any of the reports. So, those data are needed. It's not obvious or necessary that the dioxide is all and exclusively collocated with PCBs or mercury or PAHs or lead. The dioxins may occur in other places, and we don't know about that. As to the remedies there are a couple of comments that I think need to be made and I will elaborate on these at great detail and length. The thin-layer cap is a problem because of a couple of things, one of which was already noted here, and that is that we don't have a long experience with thin-layer caps. That is we don't have 30, 40, or 50 years. We do have a longer experience with some other remedies.	
Mr. Parshley	69, 11	My question is the gradient being observed across the Brunswick peninsula a result of air transport of the PCBs? We see a PCB gradient. This same gradient that we observe across the Brunswick peninsula extends toward Sapelo Island, and that is why we are seeing PCBs in seafood and	*Note: The comments read by Mr. Parshley at the public meeting were similar to those submitted in writing. They are responded to in the responses to written comments of this Responsiveness Summary.*

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		people and sediments towards Sapelo Island. We also see the same distribution across tidal modes going in other directions down to the Sapelo River, and so it makes -- it appears from the sediment data that has been issued with the Sapelo Island Report that there's a strong indication of air deposition. If you go into the library, Volume Number 38 goes into	
Roger Murray / Mr. Parshley	70, 8	how many pounds of each chemical were released, and that would be again to the soils, to the marsh, and to the air. Please identify how many pounds to the marsh will be removed of those that you've identified. This is called a mass calculation. Please provide the mass calculations for the site. I could not find them in any document.	
	71, 7	Who determined the physical damage for the proposed toxins in the feasibility study? What projects have the authors of the proposed options in the feasibility study completed in spartina marsh ecosystems? How many companies who have been working in estuaries and marshes were consulted for the estimates presented for remedial options in the feasibility study and proposed plans? Please provide a list of the projects they have done and the success of those projects. What institutional controls has the EPA implemented over the past 20 years? Who conducted these institutional controls? What is the budget for these institutional controls, and what institutional controls does the EPA anticipate implementing as far as the proposed plan? As part of that please describe the institutional controls in detail. Who will be implementing the institutional controls, and please provide an evaluation of your last 20 years of institutional controls since you've been aware of the problem for the past 20 years. I'm sure since you're going to depend on that to protect human health and welfare and to meet your	

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		regulatory-required protection of human health and the environment that's going to be very important. The proposed plan lacks any monitoring plan. In particular mink are not found within the area. Mink is an apex species, and it's indigenous. So, the only conclusion can be that the dead zone for mink around the LCF site extends to where the mink population has been established. Please explain in the response to the study the work that the EPA has done to identify the mink habitat and the area of reproductive failure. Please describe the frequency of testing the EPA is proposing for the marine mammal population and for the mink population, and also for the individual fish species. The EPA does mention goals, but the goals do not have any timeline for evaluation. It mentions evaluation, but it doesn't state what the evaluation criteria are. Please clearly state in your response to the summary what are the evaluation goals, at what date and time would those evaluations take place? What are the action items the evaluation will use to determine if additional action is needed, and what will the additional actions be to meet those goals? Please make those specific dates, specific goal criteria, specific evaluation criteria so we'll know how it's going to be evaluated. I will submit the rest of my comments and the peer review journal studies in support of my comments here this evening at a later date.	
Linda Strong / Galo Jackson	74, 18	Can you tell me how this plan protects the aquifer?	Right now there's -- they were doing work on the caustic brine pool which is out there, and they're bringing that mix from a pH of about 11 or 12 to neutral, and it's working quite well.

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			That will immobilize the mercury because at high pHs mercury becomes much more volatile as well as other heavy metals.
Mr. Killian / Galo Jackson	75, 4	Does it give concern to DNR that Honeywell is so happy with your plan?	I don't know how to answer that.
	75, 9	Does anybody from DNR have any concern about how happy Honeywell is?	Not that I'm aware of.
Damon Click / Galo Jackson	75,14	I guess the question I heard from a couple people is if Honeywell is putting up any of their own money to help the community, or is just government funds?	Honeywell funded the removal that occurred in the 1990s. There were two on-scene coordinators here overseeing it. In fact, all the uplands removal was overseen by the funding was done by not just Honeywell but the other responsible parties as well.
	75, 24	And for the additional remediation?	It's exactly the same.
	76, 6	Also, does anyone know if there's any of our local representatives here tonight? What's his name?	One city commissioner, and he's right back there. Johnny Cason.
Joel Wooten / Galo Jackson	76, 16	What do you mean by long-term monitoring; 50 years, 100 years, 200 years?	Long term, decades, until it's determined to have met the goals.
	76, 21	What are the goals?	There are goals for sediment concentration as well as fish tissue concentrations also, and those are prescribed by the State of Georgia regulations.
	77, 1	Do you know how much mercury was discharged at the Allied Chemical plant, Honeywell plant? What records are those? Plant manager? Didn't he testify that over one million pounds of mercury was unaccounted for and potentially discharged? The one that was taken up in Jessup?	I have run recent estimates, but they're -- I know the records are incomplete, but there are some records that we've been looking at. Generally depositions from some of the former people. I have not read the deposition recently so Correct.
	77, 23	You've done testing on fish. You've done testing on herons. You've done testing on mammals, but there's been no testing whatsoever on humans or substantive fishermen in the Turtle River area, the Blythe Island area, St. Simons,	There was an ATSDR health study done more than ten years ago. It's kind of vague in my memory.

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	78, 15	Are you the person that's most informed about what's been going on?	This has decades of history. I don't recall every nuance immediately.
	78, 19	Do you recall any testing of PCB levels and mercury levels in residents of Glynn County to see what the PCB levels or the mercury levels were that were-- in the Turtle River area?	No, I don't recall.
	79, 2	Wouldn't that be the gold standard; to find out whether or not there's mercury in residents in that area?	I would imagine so.
Mary Freund / Galo Jackson / Mark Springer	79, 21	So, my question is why is there no bioremediation being explored? So, that's your answer?	PCBs -- I think to bioremediate would create difficulty. Actually Mark is the sediment expert. PCB degradation and bioremediation, people have been working on it for 20-plus years starting with the Hudson River. The primary researcher from Rensselaer is at the point where she can degrade in the laboratory some of the higher chlorinated compounds. The problem, especially with 1268, is it's primarily higher chlorinated content. It's a slow process, and quite frankly we're not at the point where we can do it as a treatability. We can do it in the laboratory. If you want to follow it actually Tierra Solution which is a conglomerate or coalition of responsible parties on the Passaic River site in New Jersey which is PCBs and dioxins from the Diamond Shamrock site, they proposed to do an in situ project to evaluate whether or not they could do it. That's in the works. It's being addressed. I do bioremediation of contaminates. Doing PCBs as a treatment technology, as far as I know were not there yet.
Unknown speaker / Galo Jackson	84, 14	How much contamination would have to be present for the EPA then to decide to get another agency involved on their own instead of having the people in the community be the one that drives that? It's not that we shouldn't drive it, but when does the EPA decide to drive it?	I've not been confronted with that.

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	86, 10	Will you have to go back out for a public comment period with a new component of the remedy that includes, for example, Steve's method or the one that Joe has talked about, or one that I'm going to explain to you? Do you have to start over? Can you include that even though it's not been part of the feasibility study. All over or do you simply have to take it out to public hearing?	I have not thought that through. I'm not sure. I'd have to get back to you on it. It's starting another feasibility study.
	87, 8	I would just like to comment that I think there should more health risk assessment and testing of the residents in the area -- all of the area, and I think that the fish consumption advisories should be more prevalent. I bought a fishing license this year. No one said a word to me about what I should and shouldn't eat or how much and how often I should and should not eat that fish.	

RESPONSIVENESS SUMMARY

ATTACHMENT 1

Comment and Response Index

Attachment 1 – Comments and Response Index

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Glynn Environmental Coalition (GEC) letter March 16, 2015		
Baseline Ecological Risk Assessment (BERA) Comments and Questions		
Comments regarding Cordgrass (*Spartina Alterniflora*)		
GEC 3.1	Why does the BERA fail to describe the marsh ecosystem in a manner that shows an understanding and knowledge about the movement of nutrients and Chemicals of Concern (COCs) within the ecosystem?	The BERA acknowledges the highly productive ecosystem of the salt marsh and associated tidal creeks with general discussion of the relationship of various animals dependent on detritus (mostly from Spartina). The BERA discusses movement of the bioaccumulative chemicals (mercury and PCBs) through the tidal system and the food web. The exposure models for various receptors used in the BERA reflected this by using data related to organisms such as crabs and mummichogs that depend on the detrital matter. Even the "sediment" samples were largely comprised of detrital material and less of the mineralized portion, therefore reflecting the importance of detritus in the marsh.
GEC 3.2	Why, in the entire 1002 page BERA, is *Spartina alterniflora* detritus potential to transport COCs not mention even once?	
GEC 3.3	Has *Spartina* been identified and an initial vector for mobilization of sediment bound chlorinated hydrocarbons, such as PCBs, into the estuarine food chain (Mrozek, 1982)?	Yes.
GEC 3.4	Have studies shown *Spartina* to be a key factor in bioaccumulation of PCB in detritus and an important means of entry for this pollutant into estuarine food webs (Marinucci, 1982)?	Yes. See response to GEC 3.1.
GEC 3.5	Does the statement from the LCP Marsh Remedial Investigation indicate the authors understood the importance of *Spartina* to the bioaccumulation and transport throughout the ecosystem and movement through the food web?	Yes. *Spartina* was evaluated as a food source to herbivorous mammals such as the marsh rabbit in the BERA and the manatee in the 1997 EPA and 1998 PTI Environmental Services (PTI) ecological risk assessments.
GEC 3.6	If so, why were steps to sample all parts of the *Spartina* plant not taken during the remedial investigation?	Please see responses to GEC 4.10 below.
GEC 3.7	Has scientific literature noted a differentiation between the root rhizome stem and leaves and their ability to bioaccumulate PCBs?	Yes.
GEC 4.1	Did Sustainable Development in the Southeastern Coastal Zone note .33 ppm in *Spartina* shoots, 2.80 ppm in roots (Army Corps of Engineers)?	Yes.

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Comments regarding Cordgrass (*Spartina*) and Mercury		
GEC 4.2	Why did the BERA limit testing for mercury to a section of the leaf 15 cm above the sediment?	See response to GEC 4.10.
GEC 4.3	Does *Spartina* testing most frequently and routinely sample the root, rhizome, stem, leaf, and detritus due to the selective bioaccumulation noted with Spartina (Mrozek, 1982; Windham, 2001)?	No. Depends on the objectives of the investigation.
GEC 4.4	What was the decision-making process used to limit sampling to just a small section of the leaf, which is know from literature to be the part of the plant with the least bioaccumulation potential?	See responses below for GEC 4.10 and GEC 5.4
GEC 4.5	Were the BERA authors aware that in the fall, the root-rhizome material makes up 78% of the total live biomass and by spring this decreases to 53% (Schubauer and Hopkinson 1984)?	Yes.
GEC 4.6	Did the authors of the BERA consider the Manatee has been seen grazes on the *Spartina* in the LCP Site area?	Yes.
GEC 4.7	What was the decision-making structure used to limit the *Spartina* sampling to the leaf 15 cm above the sediment?	See responses below for GEC 4.10 and GEC 5.4.
GEC 4.8	Were stakeholder agencies consulted such as the National Oceanographic and Atmospheric Association (NOAA) or U.S. Fish and Wildlife consulted before this *Spartina* sampling plan was limited to just the leaf 15 cm above the sediment?	Yes. For purposes of the BERA.
GEC 4.9	What peer reviewed journal articles were used to support the decision to limit *Spartina* sampling to 15 cm above the sediment?	It may not be possible to determine this at this juncture.
GEC 4.10	Did the BERA consider the potential for *Spartina* to bioaccumulate metals like mercury from sediment and excrete them from the leaf (Weis, 2003; Windham, 2001)?	The Remedial Investigation and BERA tried to convey the importance of detrital material and various forms of organic carbon (OC) on their ability to sorb PCBs and to show that it reduces the availability of PCBs to bio-accumulate when bound tightly to OC. Although this occurs, the food web models assumed 100% bioavailability. It is well known that plants differentially uptake and compartmentalize various contaminants in different parts of the plant and that various researchers attempt to identify contaminant movements within the plant itself. However, for risk assessment purposes, sampling *Spartina* shoots

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		(up to 15 cm above the sediment) was considered to provide a central tendency or average concentration in the plant for exposure evaluation (e.g., to the marsh rabbit that is assumed to feed solely on *Spartina*). It was not a goal of the BERA to understand the mechanisms of *Spartina* accumulation and excretion of mercury or PCBs.
GEC 5.1	What would the implications of *Spartina* growing on top of mercury contaminated sediments?	Uptake of contaminants into *Spartina*.
GEC 5.2	Would removing the *Spartina* from mercury contaminated sediments result in less transport from sediments into the ecosystem?	See responses to GEC 4.10 and GEC 5.4.
GEC 5.3	Did the BERA examine mercury transport via *Spartina* (Weise, 2003; Windham, 2001)?	No. See response to GEC 5.4.
GEC 5.4	What was the reasoning of the BERA to exclude this critical fact about the excretion and bioaccumulation properties of *Spartina*?	It is recognized that *Spartina* and other plants and animals uptake, sequester, and excrete chemical contaminants such as mercury and PCBs. In a sense, some mercury is removed from the sediment, stored and excreted from plant tissues. As the plants decay, some mercury returns to the substrate. The critical aspect of this is to avoid chemical uptake that would not only be detrimental to the plant but to consumers of the plant. The BERA focused on the consequences of elevated concentrations of contaminants in *Spartina* that may cause toxic effects rather than on the ultimate fate of contaminants within plants.
GEC 5.5	Did the authors of the BERA do their due diligence and research to identify the potential of the biota to bioaccumulate and transport identified COCs? If not, why not?	Yes.
GEC 5.6	Did any stakeholder agencies comment about the apparent selective use of data or data appeared to be censored?	No.
GEC 5.7	Could the oversight of including mercury excretion along with salt from *Spartina* leaves be interpreted by a reasonable individual as the selective use of data or the censorship of data?	No. The data objective for the BERA was to collect *Spartina* tissue to assess exposure to consumers of *Spartina*.
GEC 5.8	What is the EPA's explanation for such a critical piece of information, such as mercury excretion, being excluded from the BERA?	See responses to GEC 4.10 and GEC 5.4.
GEC 5.9	How would the exclusion of mercury excretion impact the risk calculations used to develop the Feasibility Study?	Detailed research into the uptake, compartmentalization, and excretion of each contaminant in *Spartina* or many other organisms is not a critical

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		objective of the ecological risk assessment. The BERA focuses on the concentrations of contaminants in sediment, water, and biota that are expected to result in adverse effects. The nature and extent of mercury excretion from *Spartina* is not considered a data gap or a censorship of facts. It may be useful information, but it provides minimal enlightenment to our knowledge of how to reduce adverse effects and exposures.
GEC 5.10	Would mercury levels in *Spartina* leaves be a critical piece of information for evaluating the potential impact to marine mammals like Manatees that use this plant as a primary food source?	See response to GEC 5.11 below.
GEC 5.11	Being that the St. Simons Sound and Turtle River are documented Manatee calving grounds, what significance is mercury in the Manatee's primary food source while lactating?	Manatees may be found in the Turtle River area and even more infrequently in Purvis Creek and may graze occasionally on *Spartina* containing elevated concentrations of mercury. Manatees feed on a wide variety of submerged, emergent, floating, and shoreline vegetation. The BERA focused on top carnivorous indicator species because they tend to accumulate more mercury in the more toxic form of methylmercury from their prey (mummichogs, crabs, finfish). In addition, these food items contain much higher methylmercury (MeHg) concentrations (up to 100%) than *Spartina*, which only contains about 10% MeHg relative to mercury. It was determined in the planning process that if the top level carnivorous species could be protected, this would also be protective of species that would likely have lower doses of MeHg. For these reasons, the manatee was not selected for quantitative exposure analysis in the BERA. Risks to the manatee were evaluated by EPA (1997) and PTI (1998).
Comments regarding Cordgrass (Spartina) and Aroclor 1268		
GEC 5.12	The BERA appears focused on Aroclor 1268. Were the following Aroclors found at the LCP Site – Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, and Aroclor 1260 (ATSDR, 2014a)?	See response below for GEC 6.9.
GEC 6.1	What PCB congeners are present in Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, Aroclor 1260, and Aroclor 1268?	There are 209 PCB congeners and many of them are found in various Aroclor mixtures.
GEC 6.2	Do the PCB congeners found in Aroclor 1016, Aroclor 1221, Aroclor 1248, Aroclor 1254, Aroclor 1260, and Aroclor 1268 include those with dioxin and furan properties?	PCB congeners are found in all Aroclor mixtures. The Administrative Record's key documents (in this specific case Appendix J of the BERA and Section 8.3 of the HHBRA) contain much of the information sought.

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		The only PCB congeners present in Aroclor 1268 with dioxin/furans-like properties are IUPAC No. 77, 105 and 126. They are present at concentrations of 0.38%, 0.38% and 0.07%, respectively. Table 27 of the HHBRA contains the percent composition of the dioxin-like PCBs in Aroclors 1016, 1254 and 1268. Note Aroclor 1221 was analyzed in sediment 1,058 times and detected only 10 times at a maximum concentration of 0.2 mg/kg.
GEC 6.3	Were the non-dioxin-like and dioxin-like effects of the specific PCB congeners analyzed in the BERA, or was only a general Aroclor 1268 analysis conducted?	The BERA evaluated risk from Aroclor 1268. For the most part only Aroclors were analyzed and evaluated in the BERA. A limited number of congener analyses were run on invertebrate, sediment and cordgrass samples during the mid-1990s. Congener analyses results are included in the Administrative Record. Due to the limited number of samples, those results were discussed only qualitatively in the BERA.
GEC 6.4	Were the EPA BERA protocols for analysis of PCB dioxin and non-dioxin-like effects conducted as part of the 2003 BERA for the LCP Site marsh (EPA, 2003)?	The EPA 2003 guidance was taken into consideration during the planning process. The 2003 draft of the BERA was not approved by the EPA, hence it is not included in the Administrative Record. The EPA's remedy decision is not based on the 2003 draft document.
GEC 6.5	Were all congeners of PCBs detected at the LCP Site measured in the *Spartina* samples collected 15 cm above the sediment?	No.
GEC 6.7	Was the PCB congener analysis limited to those found in Aroclor 1268?	
GEC 6.8	What is the significance of the BERA focusing on Aroclor 1268?	When sediment and biota samples were collected in the late 1990s and early 2000s, the other Aroclors were virtually non-detected or at very low concentrations; therefore subsequent investigations focused on Aroclor 1268. PCB congeners were also analyzed in the late 1990s. The results indicated that the total hepta-, octa- and nona-PCB congeners made up approximately 97% of the total PCBs in sediment. These heavy chlorinated congeners correlated well with Aroclor 1268. In addition, samples were collected and analyzed for dioxins and furans. The results were similar in that the heavy chlorinated congeners dominated in sediment and biota samples. The results confirmed that analysis of Aroclor 1268 would be highly representative for evaluating exposures. Therefore, analysis of Aroclor 1268 was adopted as best representing PCBs in the marsh. It also provided a cost-effective way to obtain lots of samples, relative to the high cost of congener analysis.
GEC 6.9	Was the BERA limited to an analysis of Aroclor 1268? If not, where can the chemicals with similar modes of physiological action, like the other Aroclors, dioxin, and furans be found?	

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GEC 6.10	Was a Toxicological Equivalency Factor (TEF) developed for all the PCB Aroclors, dioxins, and furans found in *Spartina*? If not, why not?	Species-specific TEFs are not conducted for risk assessments as they would require enormous amounts of data. The COCs in sediment were selected based on a screening process (Appendix B of the BERA) where chemical concentrations could pose unacceptable adverse risk to ecological receptors via direct contact or through bioaccumulation. Specific toxicological effects were then evaluated for the COCs. Of the 31congeners evaluated in a cordgrass sample, only the following four congeners were detected: 202, 206, 207 and 209. They were detected at concentrations of 0.78, 6.3, 0.71 and 0.73 µg/kg, respectively. None of these congeners have dioxin-like properties.
GEC 6.11	What was the reasoning used to limit the COCs examined in *Spartina*?	See previous responses to GEC 6.8 through 6.10.
GEC 6.12	Were toxicological effect found in organisms at levels lower than expected when the toxicological factors were limited to just the three factors: mercury, Aroclor 1268, and lead?	Effects were based on the three COCs, not on all detected chemicals that may be present in the LCP Chemicals marsh.
GEC 7.1	Why is the crucial nutrient recycling system the *Spartina alterniflora* serves for the estuary noticeably missing from the BERA?	Based on previous responses, the BERA evaluates potential toxic risk to various indicator receptors and does not examine nutrient recycling mechanisms.
GEC 7.2	The BERA is devoid of any discussion about the PCB bioaccumulation properties of *Spartina* in marsh environments.	As mentioned in the above responses, the risk assessment focused on the potential toxicity of the COCs to a variety of organisms in the local marsh ecosystem. This included the collection and analysis of COCs in *Spartina* where the data were used in relevant food web exposure models. The sediment samples contained plenty of detrital matter, composed largely of processed and decayed *Spartina*. The sediment data were also used in food-web models to assess the effects of bioaccumulation from the base of the food web. Substantially more PCB and methylmercury accumulates in animal lipid tissue (e.g., in crabs that feed among the *Spartina*) which then moves rapidly through the food web, more so than just from plant tissue.
Comments regarding Fiddler Crabs (*Uca minax* or red-jointed, *Uca pugnax* or mud fiddler, *Uca pugilator* or sand fiddler)		
GEC 7.3	Why does the BERA limit reporting of PCBs in fiddler crabs to Aroclor 1268 (BERA, pg. S-5)?	See response to GEC 6.8 and 6.9.

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GEC 7.4	Why does the BERA report found that they were fiddler crabs present in numbers (200 young and adult crabs per square meter) that might be expected to occur in a relative pristine marsh, but not quantify the amount of sediment brought to the surface on an annual basis?	See response below for GCE 8.3.
GEC 7.5	Is the amount of sediment excavated from the sediments by Fiddler Crabs important information for remedies using capping of marsh sediments?	See response below for GCE 8.3.
GEC 7.6	Why were Fiddler Crabs sampled at a location previously remediated (BERA, Pg. 55)?	See response below for GCE 8.3.
GEC 7.7	Was the BERA data concerning fiddler crab abundance biased by sampling in a previously remediated area?	See response below for GCE 8.3.
GEC 7.8	Can the encountering of the membrane at 40 cm be used to infer the minimum depth of the fiddler crab burrows are 15.75 inches (BERA, pg. 55)?	See response below for GCE 8.3.
GEC 8.1	Does the BERA state "these burrows, which often extend to 2 ft in depth …. (BERA, pg. E-2)? What are the implications of sediment excavation activity by fiddler crabs to remedies involving placement of capping material over the marsh?	Yes. Some bioturbation of soft capping materials will occur.
GEC 8.2	What is the quantity of sediment brought to the surface annually by over 200 fiddler crabs per square meter?	This was beyond the scope of the BERA.
GEC 8.3	What is the quantity of sediment brought to the surface annually by the remaining biota (other than Fiddler Crabs)?	As mentioned previously, Aroclor 1268 is the most representative form of PCBs for assessing exposures in the marsh. The fiddler crab abundance study occurred at an active seep area that has relatively high concentrations of COCs that would be expected in crab tissue. Uncertainties of this study were presented in the BERA. Quantifying the volume of sediment excavated by benthic organisms such as crabs was beyond the objectives of the risk assessment. However, for determining if a cap would be protective, the alternatives and the proposed remedy (excavation, capping, and thin-layer cap) took into account the potential effects of bioturbation, especially by fiddler crabs. The conclusion was that bioturbation would have a negligible effect on the excavation or permanent armored cap portions of the proposed remedy. With respect to the thin-layer cap, it was concluded that some mixing of the thin cap and bioturbed sediments may occur over a long period of time, but that the

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		overall mixed sediment concentrations would not exceed the cleanup levels.
Comments regarding Mink (*Mustela vison*)		
GEC 8.4	Does the EPA intend to make identification of the mink range within the Turtle River's system and the St. Simons sound estuary a priority?	No, the EPA does not intend to identify the mink's range in the region.
GEC 8.5	If the EPA is can make mink range a priority what is the timeline for collection of this data?	
GEC 8.6	After identifying the Mink as an indigenous species missing from the ecosystem surrounding the LCP Chemicals Superfund site, why did the EPA eliminate the species from the baseline ecological risk assessment when it was obviously one of the most impacted species?	Please see response at end of this mink subsection (GEC 10.1).
GEC 8.7	Is the EPA aware that mink are a species susceptible to adverse impacts from PCB exposure and a good indicator species for measuring ecological impacts?	Yes.
GEC 8.8	What is the EPA's rationale for elimination of the mink from the BERA?	See response at GEC 10.1 below.
GEC 8.9	What is the EPAs explanation for the absence of mink from the LCP Site?	
GEC 9.1	Does the EPA intend to identify the "dead zone' around the LCP Site where mink are absent?	There is no reason to suspect that mink are not present in LCP Chemicals marsh area. The commenter does not provide evidence of a "dead zone".
GEC 9.2	Does the EPA intend to define the area where mink are absent, and delineate where viable and sustainable mink populations can be found?	No. See also response to GEC 8.4.
GEC 9.3	If the EPA does determine the extent of the area where the contamination has eliminated the mink population, and will mink be used as a monitoring criterion to assess the Remedial Action?	See response to GEC 9.1 above.
GEC 9.4	If the EPA does intend to use the mink and a monitoring indicator, will this be placed in the Record of Decision and Consent Decree for the LCP Site?	The EPA does not plan to monitor mink in the LCP Chemicals marsh.
GEC 9.5	Will the EPA recommend mink be used as monitoring criteria for assessment of the remedial action? If not, why not?	No. Please see response at end of this mink subsection.

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GEC 9.6	Why should the EPA use otters when mink are an indigenous species and the indicated as the proper species to use?	See response to GEC 10.1.
GEC 9.7	Does the EPA agree that if an exposure model can be applied from the mink to the dolphin, the model can be applied from the dolphin to the mink?	Each receptor has its own exposure model and specific assumptions, thus applying the same model to different species would be inappropriate.
GEC 9.8	Is the EPA aware that PCBs have been associated with low mink kit survival and mink are a sensitive population to the toxic effects of PCBs (Bursian 2006; Bursian, 2013)?	Yes.
GEC 10.1	Will the EPA consult literature and establish a remedial action level that will result in the recovery of the mink population at the LCP Site?	It is not the objective of the ecological risk assessment to evaluate risk to dozens of individual species. The objective is to select likely indicator species as surrogate representatives of potentially affected feeding guilds. The river otter was observed in the LCP marsh system and selected as the piscivorous mammal at most risk. This does not mean that mink are not present in the marsh or that there is a dead zone for mink. The food-web model assumed the otter would consume not only mummichogs and finfish, but crabs as well. Due to the limited use of the LCP marsh by mink and their presumed dietary needs relative to the otter, it was conservatively assumed that risks to the otter would be similar to the mink. In addition, extra conservatism was used, in that any potential toxicological effects to the otter would be based on reproductive effects in mink exposed to Aroclor 1254 which is considered more toxic than Aroclor 1268. Monitoring contamination in mink from the LCP marsh would not be cost-effective and would likely result in undue harm to them. Monitoring the anticipated contaminant reductions in river otter and mink dietary components is more measurable and effective. The proposed cleanup levels for mercury and Aroclor 1268 are considered to be protective of consumers of fish and shellfish (carnivorous and piscivorous mammals, including humans).
Comments regarding Dolphins		
GEC 10.2	What is the EPA's explanation for not including the dolphin data in the BERA?	The EPA appreciates concerns regarding sensitive species such as mink and dolphins. The EPA fully recognizes the latest data collected over the past several years on the bottlenose dolphin in the region. The BERA was based on data between 2000 and 2007. Much of the dolphin data were unavailable at that time for meaningful quantification of dolphin exposure in the LCP marsh. However, to be conservative, both the

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		BERA and the human health baseline risk assessment (HHBRA) used very conservative exposure and effect assumptions to account for uncertainties where exposure to other potential indicator receptors may be unknown. The data and conclusions in the BERA and the BHHRA were used to develop cleanup goals in sediment that are expected to reduce COC fish concentrations to levels protective of humans, river otters, dolphins, and herons.
GEC 10.3	Did the EPA failed to communicate with the stakeholder agencies, including the Georgia Department of Natural Resources, the National Oceanic and Atmospheric Administration, and the US Fish and Wildlife Service concerning the dolphin sampling and analysis?	The EPA has been aware of the on-going dolphin studies.
GEC 10.4	Was the EPA oblivious to the fact that the same people that were producing data on the LCP Chemicals Superfund site were also doing sampling and analysis on the resident dolphin population for PCBs associated with the LCP site?	No.
GEC 11.1	Will the EPA include the large volume of data on the coastal Georgia resident and transient dolphin population into the BERA? If not, why not?	See response below at GEC 12.4.
GEC 11.2	Does the EPA understand the implications to human health from the dolphin data? Does the EPA understand that dolphins and humans eat the same fish species?	Yes.
GEC 11.3	Will the EPA incorporate the dolphin data into the HHBRA? If not, why not?	No. Please see responses below in this dolphin subsection.
GEC 12.1	Does the EPA intend to incorporate the large volume of dolphin data into their decision- making process for the propose plan for the marsh at the LCP Chemicals Superfund site?	Please see response below to GEC 12.4 and GCE 13.6.
GEC 12.2	Will the EPA established a maximum allowable level of 5.1 parts per billion (PPB) in fish as the goal for the LCP marsh cleanup?	No.
GEC 12.3	What is the rational for inclusion of the dolphin studies in the HHBRA to argue for only Aroclor 1268 sampling and not including them in the BERA?	There were no dolphin studies used to assess human risks in the HHBRA. The HHBRA and BERA was not limited to only Aroclor 1268 data.

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GEC 12.4	Will the EPA utilize all the dolphins studies identified in these comments and the corresponding references to formulate Remedial Action levels protective of the resident dolphin population?	The BERA and HHBRA were completed in 2011 and formed the basis of the Feasibility Study and Proposed Plan. The dolphin data (e.g., tissue concentrations of Aroclor 1268 in dolphins) are not inconsistent with the data presented in the risk assessments. Potential adverse risks from exposure to Aroclor 1268 primarily through dietary intake was documented for humans, river otters, herons and several other indicator receptors. Even though a site-specific food web model was not performed for the dolphin, EPA has assumed that the dolphins are also at risk, similar to humans. The primary local source of Aroclor 1268 contamination is in the LCP marsh sediment, so the proposed remedy seeks to remove much of the contamination to reduce exposure from the base of the food chain up to consumers of fish. This includes dolphins. It would be counter-productive at this time to spend additional time and resources to come to a similar conclusion with other researchers that dolphins are at risk. The proposed remedy and sediment cleanup goals are expected to protect all upper trophic-level consumers of fish.
GEC 12.5	Were Aroclor 1254 found in 81 samples (9%), and Aroclor 1260 found in 37 (4.1%) in upland samples (ATSDR, 2014a)?	Yes.
GEC 12.6	If Aroclor 1254 and Aroclor 1260 were found in upland samples, what was the EPA's rational for eliminating these PCB Aroclors from the COC to be sampled for in the LCP marsh?	See responses to GEC 6.2 and GEC 6.8.
GEC 12.7	Were other PCB Aroclors found in upland samples at the LCP Site, and if so, what was the EPA's rational for eliminating these from the COC to be sampled for in the LCP marsh?	As mentioned previously, Aroclor 1268 is the most predominant form of PCBs in the marsh sediment and biota, with negligible amounts of the other Aroclors. The analysis of Aroclor 1268 does not eliminate any PCB congeners in the sample, so if there are any dioxin-like PCB congeners in the sample, they are included in the total concentration reported for Aroclor 1268.
GEC 12.8	Was PCB congener 206 established as the one defining Aroclor 1268 contamination from the LCP Site in coastal Georgia (ATSDR, 2014b)?	Yes, PCB congener 206 is prevalent in Aroclor 1268.
GEC 12.9	Is PCB congener 206 the most prevalent, or dominant, in Aroclor 1268?	Yes.

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GEC 12.10	Has a gradient of PCB congener 206 been found emanating from the LCP through sediment samples taken in coastal Georgia (ATSDR, 2014b)?	Apparently, according to ATSDR 2014b.
GEC 13.1	Using PCB congener 206 as an indicator of the boundaries of the LCP Site contamination, what are the geographical boundaries of the contamination from the LCP Site (ATSDR, 2014b)?	See response below for GCE (2) 2.2.
GEC 13.2	Did ATSDR compare and contrast total PCBs in fish between the Brunswick Georgia and Sapelo Island area (ATSDR, 2014b)? If so, what were the findings (differences quantified)?	The ATSDR 2014b study provides its own conclusions.
GEC 13.3	Was the purpose of the ATSDR study to "Compare results in people with what is known about dolphins" (ATSDR, 2014b)?	Yes.
GEC 13.4	Does the ATSDR study imply what is known about dolphins could be utilized to predict impacts to people eating the same fish species (ATSDR, 2014b)?	The ATSDR study is preliminary and unpublished. Conclusions, including its implications, are not currently available.
GEC 13.5	Did ATSDR report, "We did find that human and dolphin specimens contain qualitatively similar environmental contaminants" (ATSDR, 2014b)? Does this statement imply the dolphin data is very important to understanding chemical exposure to people from the LCP Site?	It is not surprising that the PCBs 206 and 209 are found in both dolphins and humans. Dolphin data cannot be used to assess human health risks.
GEC 13.6	What are the implications to the HHBRA from the BERA not having included the dolphin data and studies identified in these comments to the EPA on the BERA?	The ATSDR 2014b citation was a summary presentation of data. It is known that a major local source of Aroclor 1268 and its dominant PCB congener (206) is from the LCP marsh area. Congener 206 is not listed as part of the dioxin-like PCB congeners, nor does it appear to contribute to non-cancer toxic effects (last slide of the ATSDR 2014b presentation). The EPA risk assessments largely assumed that Aroclor 1268 had similar toxicity to Aroclor 1254, which contains many of the dioxin-like PCBs. This conservatism was carried through in the development of the sediment cleanup levels. It is expected that the proposed cleanup in the LCP marsh will substantially reduce adverse exposures to Aroclor 1268 and mercury to fish, wading birds, mammals, dolphins, and humans.
Comments regarding The BERA and Dioxin/Furan		
GEC 13.7	Are the TECs (a.k.a TEQ) reported 2 to 4 orders of magnitude higher than the EPA screening level of dioxin of 2.5 ng/kg?	The 2.5 ng/kg is only for 2,3,7,8-TCDD, and not for all TEQ dioxin/furan congeners. In addition, none of the TECs calculated for the sediment

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		samples were four orders of magnitude above the EPA screening value of 2.5 ng/kg. This includes the samples from the Former Facility Disposal Area (FFDA), which were removed and properly disposed of in the late 1990s. Ten sediment samples had calculated TECs greater than two orders of magnitude above the EPA screening value, however, all were removed during the late 1990s removal, or will be removed during the execution of the Selected Remedy, as they were located in either the LCP Ditch or Eastern Creek.
GEC 14.1	Was any effort whatsoever made by the EPA to obtain existing dioxin/furan data from the St. Simons Sound in which the LCP Site is located?	Yes, the September 2, 2014 Dioxin Memo: LCP Chemicals National Priorities List Site presents the data from the river sediment sampling stations covered areas of the Turtle River, St. Simons Sound and tidal tributaries along the eastern boarder of the Brunswick Peninsula. The memo notes that the TEC totals ranged from 11.4 to 20.4 ng/kg. The memo further notes that the detection limits in that dataset were elevated, relative to those reported earlier by EPA. The detection limits in the St. Simons Sound dataset were generally ten times higher than those achieved earlier. As a consequence, even with the re-calculation of all the 1995 dioxin TECs using the WHO TEF of 2005, the total TECs calculated from the BCS reflect artifact of using one half the detection limit for the dioxin congeners which were not detected. See also response below for GEC 14.10.
GEC 14.2	Did the EPA ask Stakeholder Agencies if they had collected Dioxin/Furan data for the St. Simons sound estuarine system?	The EPA was aware of the most recent dioxin/furans data available and included it in the September 2, 2014 Dioxin Memorandum.
GEC 14.3	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder and Black Drum (both whole and filet) in Turtle River in 1989 (GADRN, 1989)?	See response at GEC 14.10.
GEC 14.4	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, and Hardhead Catfish (filet) in Turtle River in 1990 (GADRN, 1990)?	
GEC 14.5	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, (whole and filet) in Turtle River in 1991 (GADRN, 1991)?	See response below at GEC 14.10. In its review of the 2011data from the former Altamaha Canal, the EPA did not that one sediment sample exceeded the PRG for TCDD TEQ of 72 ng/kg (now reduced to 50

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GEC 14.6	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Atlantic Croaker, and Gafftopsail Catfish (whole and filet) in Turtle River in 1992 (GADRN, 1992)?	ng/kg). Note that three of the congeners analyzed had associated method blank contamination.
GEC 14.7	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum, and Hardhead Catfish (whole and filet) in Turtle River in 1993 (GADRN, 1993)?	
GEC 14.8	Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, and Stripped Mullet, (whole and filet) in Turtle River in 1993 (GADRN, 1993)?	
GEC 14.9	Did the EPA consider the four samples for Dioxin/Furan taken in the Altamaha Canal south of the LCP Site in 2011 with results above the 2.5 NG/KG TEC (a.k.a TEQ) of 62, 130, 68, and 20 ng/kg (EPA, 2011)?	
GEC 14.10	Did the EPA consider the December 1995 EPA Community Based Environmental Project's 14 sediment samples from the Turtle River/St. Simons Sound area?	Yes, in selecting the remedy for the LCP Chemicals marsh, the EPA did consider the Turtle River and the 1995 Community Based Study. All these data are contained in the Administrative Record. Specifically, the Turtle River data are presented in Attachment 4 to the September 4, 2014 Dioxin Memorandum. An October 1997 Turtle River ATSDR Health Consultation presented dioxin/furans Turtle River fish data from 1989 through 1994. The fish data presented in the report were acquired by Georgia-Pacific from two Turtle River stations, one immediately above the confluence of Purvis Creek with the Turtle River and the second near the confluence of the East River with the Turtle River. Fish tissue dioxin data for the Chattahoochee and Oconee Rivers, and the Sapelo Sound are also presented in the report for the sake of comparison. The Health Consultation concluded that fish dioxin/furans concentrations were higher in the Turtle River than in comparison areas; however, the dioxin levels found were well below the Food and Drug Administration tolerance levels for dioxin/furans in fish. As mentioned above, the 1995 Community Based Study's 14 dioxin/furans results are presented in the same September 2, 2014 memo, with a discussion of the effects of elevated detection limits.

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GEC 14.11	In light of all the above Dioxin/Furan sampling conducted by the EPA or one of the LCP Chemicals Superfund Site Stakeholder agency, why should anyone, or the court who considers the Consent Decree, believe the EPA when it states, "Therefore, potential risk cannot be adequately evaluated in this assessment based on the three sediment samples collected in 2000, but will be discussed further in the uncertainty section"?	The quote taken from the 2011 BERA did not recognize the remaining PCDD/PCDF data available. The September 4, 2014 memorandum consolidated all available sediment, soil surface water and biota data PCDD/PCFD data available for the LCP Chemicals Site and reached conclusions about the human health and environmental risks posed by the concentrations found at the Site. The memorandum acknowledges that the PCDD/PCDF data is limited, and proposed acquisition of additional data during the remedial design, thereby reducing the uncertainty related to PCDDs/PCDFs. Furthermore, the stakeholders agreed that the data considered in the 2011 BERA would be from samples collected between years 2000 and 2007. The older dioxin/furan data between the late 1980s and mid-1990s were not considered for risk assessment purposes in the BERA. Dioxins in sediment samples collected in 1995 and 1996 were evaluated in the 1997 EPA ecological assessment.
GEC 15.1	The EPA has interjected data from the lake Onondaga LCP site located near Syracuse, New York, into the Proposed Plan for the LCP site in Brunswick Georgia. Unlike the LCP site located in Brunswick Georgia, there was a significant amount of dioxin data collected at the LCP site located in New York (USEPA, 2002). Was whole fish sampling for dioxin and furan in juvenal and adult fish conducted at the LCP site in Brunswick Georgia, or only at the Lake Onondaga Site?	It was not the EPA's intent to introduce the PCDD/PCDF data from the two Upstate New York Superfund sites. No data has been cited. The intent was to communicate that, due to the costs associated with PCDD/PCDF analyzes (currently in the range of $400 and $500 per sample), in all sites researched, not all samples are routinely analyzed for these analytes, rather an informal survey shows that between 20 and 80 percent of the samples are analyzed for PCDDs/PCDFs. In the case of the Onondaga Lake Superfund Site, about 27% of the sediment samples were analyzed for PCDDs/PCDFs. Further, at the Onondaga Lake Superfund Site, while dioxins/furans were determined to be both human health and ecological risk drivers, as a result of fish consumption in Onondaga Lake, they were not found to be widespread in lake sediments. The areas where dioxins/furans are elevated are generally co-located with areas that exceeded the lake cleanup criteria for other contaminants, which are being addressed under the lake remedy. A similar situation existed with the Ninemile Creek Superfund Site, with a similar approach was used. PCDDs/ PCDFs also contributed to Site risks. These locations were to be remediated based on concentrations of other detected contaminants (e.g., mercury). Therefore, Site preliminary remediation goals for PCDDs/PCDFs in sediments were not developed.

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		The following is excerpted from the September 2, 2014 LCP Chemicals Dioxin Memorandum: In addition, Kannan et al. (1999) analyzed organ and muscle tissue from clapper rail, mottled duck, boat-tailed grackle, red-winged blackbird, stripped mullet, yellow tail, sea trout, Atlantic croaker and blue crab for TCDD/TCDF. All were found to be uniformly below the detection limits of 10 ng/kg. In May and June1998, the U.S. Fish and Wildlife Service collected killifish (*Fundus heteroclitus*) tissue from mid-way along the LCP Ditch. Along with other parameters, the whole body tissue was analyzed for dioxins/furans. Attachment 5 contains documentation of the 1998 U.S. fish and Wildlife killifish sampling, as well as the TEF calculation spreadsheets for the two whole fish tissue killifish samples collected in 1998. Note that almost all dioxin/furan congeners were found to be below detection limits. Consequently, because the calculated TECs assume each congener is present at one-half the detection limit, the results are an overestimation of actual tissue levels. In addition, the concentrations of dioxin/furan in the whole fish tissue samples were taken from killifish collected from the LCP Ditch during the marsh removal, which also represented worst case conditions. The TEC mammal concentration in samples KF0513MD and KF071MD are 6.5 and 7.1 ng/kg, respectively, also assuming one-half the detection limit for the non-detected dioxin/furan congeners. The TEC fish concentration in samples KF0513MD and KF071MD are is 8.1 and 8.2 ng/kg, respectively. The one-half detection limit concentration predicts no NOAEL-level or LOAEL-level risk to the river otter. Overall, the concentrations of dioxin/furans measured in the fish collected from the Site are low and do not appear to present unacceptable risk to the environment. Hence, seven fish specimens from the LCP Chemicals Site have been analyzed for PCDDs/PCDFs. In contrast, the Lake Onondaga Site's BERA (Table 18-4) shows that 18 whole fish samples were analyzed for PCDDs/PCDFs.

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GEC 15.2	Do the dioxin and furan sampling at the Lake Onondaga site in New York find risks to wildlife from dioxin and furans (USEPA, 2002)?	The commenter is referred to the Lake Onondaga Lake Bottom Record of Decision available at: http://www.dec.ny.gov/chemical/34481.html
GEC 15.3	If the risk from wildlife from dioxin and furans was found at the Lake Onondaga site, with those risks be applied to the wildlife at the LCP site in Brunswick Georgia? If not, why not?	Each site has its own levels of concentrations in sediment and biota, so risk assessment pathway models at the New York site should not be applied to risk estimates at the LCP Chemicals marsh. Furthermore, Section 1 of the Feasibility Study for the Lake Onondaga Lake Bottom Site observed that principal component analysis in their RI report also identified a source pattern for PCDD/PCDFs consistent with atmospheric deposition of byproducts from incineration. This source is very different from the PCDD/PCDFs at the LCP Chemicals Site, where they are believed to have been generated at the graphite anodes in sludge.
GEC 15.4	If the EPA is using data from the Lake Onondaga Site for decision-making concerning sampling of dioxin and furan at the LCP site in Brunswick Georgia and to delay such sampling until after the Record of Decision and Consent Decree, why not use the same reasoning to utilize the data for estimating risk in Brunswick from the observations at the New York site?	The EPA is not using data from the Lake Onondaga Lake Bottom Site. PCDD/PCDF data from the LCP Chemicals Site is used. The Lake Onondaga and Ninemile Creek Sites were cited in the November 2014 LCP Chemicals Proposed Plan as examples of other chlor-alkali sites where PCDD/PCDFs were found to be co-located with other site contaminants and, as described in the Ninemile Creek final Remedial Design Report, "a preliminary remediation goal for PCDD/PCFDs in sediment was not established, and the areas where PCDD/PCDFs are elevated are generally co-located with other chemical parameters of interest (CPOIs) that would be address under the selected remedy."
GEC 15.5	Will the EPA order whole fish sampling for dioxin/furan in juvenal and adult fish from Turtle River to obtain the same quality data as used at Lake Onondaga, New York?	As discussed above in response to GEC 15.1, seven fish specimens from the LCP Chemicals Site's OU1 have been analyzed for PCDDs/PCDFs. None have contained concentrations of PCDD/PCDFs at or above levels of concern. The 1997 ATSDR Turtle River Dioxin Health Consultation, which evaluated data from 1989 through 1994 concluded that the dioxin levels found in 48 fish composite samples collected in the Turtle River were well below Food and Drug Administration tolerance levels for dioxin in fish. Finally, the September 2, 2014 Dioxin/Furans Memorandum makes the point that the PCDD/PCDF concentrations in sediment collected in the Turtle River and Purvis Creek were extremely low, most undetected. The preceding does not support additional PCDD/PCFD analyses on fish samples from the Turtle River.

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GEC 15.6	Did the BERA include the dioxin and furans within the Turtle River area in their calculations for PCBs, dioxins, and furans TEQ or the hazard quotient or the hazard index?	See response to Technical Comment #5.
Comments regarding Manatees		
GEC 15.7	Did the USFWS find a need to examining the roots and note cleaning of the *Spartina* could result in an underestimation of the exposure scenario of herbivores like the Manatees, and the others in residents year round (USFWS, 1996)?	The 1997 EPA and 1998 PTI ecological risk assessments included incidental ingestion of sediments as a component of dietary intake.See responses to GEC 16.1 and GEC 37.5.
GEC 15.8	What was the EPA's rationale for not including the Manatee in the Baseline Ecological Risk Assessment?	See response below for GEC 16.2 at end of this subsection.
GEC 15.9	Is EPA aware that the Manatee is an endangered and protected species?	Yes.
GEC 16.1	What action is the EPA taking at the LCP Chemicals Superfund site to assure the Manatee is not consuming excessive amounts of PCBs, mercury, and dioxin via the cordgrass (*Spartina*)?	Cordgrass (*Spartina*) from OU1 has been analyzed for the following analytes: Aroclor 1268, PCB congeners, mercury, methyl mercury, lead and PAHs. The Aroclor 1268, mercury and methyl mercury data is the most abundant. Dioxin/furans analyses were not run on cordgrass samples. As indicated in the response to Comment GEC 16.2, uptake in the cordgrass is not very efficient. No PAHs were detected in cordgrass. The manatee is reported to feed on the upper third of the plant and has a wide feeding range. Given these facts, it is unlikely that the manatee is at risk from consuming cordgrass in the LCP Chemicals marsh. Furthermore, it is expected that cleanup of sediments will also reduce uptake of the contaminants by *Spartina* and thus reduce manatee exposure.
GEC 16.2	Did the EPA make an estimation about how much sediment the Manatee would consume while foraging on the cordgrass (*Spartina*)? If not why not?	The endangered Manatee may infrequently enter Purvis Creek and may graze occasionally on Spartina containing elevated concentrations of mercury and Aroclor 1268. Manatees were evaluated in the 1997 EPA ecological risk assessment and the 1998 PTI ecological risk assessment for the marsh, and predicted hazard quotients were less than 0.01. As mentioned previously, the BERA focused on top carnivorous indicator species because they tend to accumulate more methylmercury from their prey. In addition, these food items contain much higher MeHg concentrations (up to 100%) than *Spartina*, which only contains about 10% MeHg relative to mercury. It was determined in the planning process that, given the PTI conclusion, if the top level carnivorous

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		species can be protected, then this would also be protective of the manatee, and therefore the manatee was not selected for detailed exposure analysis in the BERA.
Comments regarding Diamondback Terrapin		
GEC 16.3	In light of the wasting syndrome reproductive problems identified with the Terrapin, how did the BERA come to the conclusion that there is a hazard index or hazard quotient less than one?	It is unclear what report the commenter is referring to with respect to wasting syndrome and how it is linked to the LCP Chemicals marsh contaminants.
GEC 16.4	Is it possible to have reproductive failure and a hazard quotient or hazard index less than one?	It is possible; however, conservative exposure/toxicity assumptions built into the assessment try to limit this uncertainty.
GEC 16.5	Is it true that the levels of PCBs observed in the Terrapin eggs was in excess of 600 ppm (USEPA, 1997)?	Yes. The Aroclor 1268 concentrations in seven eggs from one female (DD-5) ranged from 390 to 610 mg/kg. The mean Aroclor 1268 concentrations in eggs from 2 other females were 29.7 and 28.6 mg/kg.
GEC 16.6	Were the eggs examined for reproductive viability?	Yes.
GEC 16.7	What were the results of the examination of the Terrapin eggs for reproductive viability?	Eggs from female DD-5 were not incubated. The five eggs from female DD-4 did not hatch with mean Aroclor 1268 levels at 28.6 mg/kg and mean mercury levels at 2.2 mg/kg, and all seven eggs from female BD-1 did hatch with mean Aroclor 1268 levels of 29.7 mg/kg and mercury concentrations of 0.87 mg/kg. No reasons were given as to why hatching did not occur in the one clutch. It may be a combination of in-utero egg collection and subsequent incubation problems, contaminations levels, or other physical issues. Caution should be used in drawing definitive conclusions from the small sample size of eggs from two female terrapins.
GEC 16.8	Will the Terrapin be included in the species used for monitoring and evaluating the remedial action efficacy?	Results of the conservative food chain models for the diamondback terrapin in the BERA, in the 1997 EPA ERA, and in the 1998 PTI ERA resulted in no significant adverse effects. These assessments used a toxicological reference value from a study on Caspian terrapin exposure to Aroclor 1254, generally a more toxic form than Aroclor 1268. The long-term monitoring plan is not expected to include terrapins. Fish and other dietary items of the terrapin (e.g., mummichogs and crabs) are more statistically easier to monitor for trends in contaminant tissue concentrations than collecting and analyzing many terrapins.

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Human Health Baseline Risk Assessment Comments and Questions		
GEC 17.1	What programs has the EPA implemented to raise awareness about fishing advisories among residents and healthcare providers?	See response below for GEC 18.5.
GEC 17.2	What were the dates of the EPA initiatives to raise awareness with health care providers about the seafood advisories?	
GEC 18.1	What improvements did the EPA make to the fishery advisory signs so they are more easily seen? How many fish advisory signs has the EPA had placed in the community?	
GEC 18.2	Where are the fish advisory signs the EPA has placed in the community located?	
GEC 18.3	What is the EPA's budget for fish advisory signs?	
GEC 18.4	What is the EPA's budget to maintain the fish advisory until the source of contamination is removed?	
GEC 18.5	What is the EPA's budget for continuing public education regarding the hazards of consuming mercury and PCB contaminated seafood?	The EPA and ATSDR provide assistance to the State of Georgia regarding implementation of fish advisories. EPA does not make signs or set the fish advisory levels. The EPA, ATSDR and Georgia Environmental Protection Division (GAEPD) have been active in providing community awareness of the current advisories and recent studies regarding potential fish consumption by Georgia coastal residents. Each agency also maintains web sites where information regarding fish advisories, other data, and resources regarding potential health effects of mercury and PCBs may be accessed by the public. It has been recognized that mercury and PCBs are global contaminants found in humans and dolphins. Not all mercury and PCBs in tissues of humans and dolphins in the Brunswick area originate from the LCP Chemicals marsh, although it is evident that elevated levels of these chemicals are found locally. The human health baseline risk assessment was conducted according to guidance and included data from local anglers on fish species caught and consumed.

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GEC 18.6	How does the EPA focusing on pregnant and nursing women, children, the elderly, and those with compromised immune systems?	This comment is too general for a response related to the human health baseline risk assessment.
GEC 18.7	Will the EPA require an appropriation or appropriate funding to implement the already identified activities to better protect human health and the environment?	See response below at GEC 18.8.
GEC 18.8	Will the EPA expedite the appropriation of funds to implement the recommendations intend to help protect human health?	The EPA, GAEPD and the responsible parties have committed resources and funds to clean up the LCP Site in the upland portion as well as in the marsh. There have been several cleanup actions at the Site to reduce risks and protect human health and the environment. This site is funded the same way as other sites with commensurate risk.
GEC 18.9	Are the fish samples collected from Turtle River being prepared according to the appropriate protocols and the skin and belly flap left on the filet?	The fish samples used in the HHBRA and those collected for monitoring the fish advisories use existing guidelines and protocols. Unlike ecological receptors, humans do not consume all parts of a fish. Whole fish sampling is not part of the protocols for assessing human health exposure.
GEC 19.1	Was whole fish sampling conducted in order to determine the range of exposures human consumers might encounter?	
GEC 20.1	Did the EPA review their own demographic data for the area around the LCP Chemicals Superfund site when reviewing the HHBRA (EPA, 2015)?	The HHBRA did not incorporate the EPA 2015 data.
GEC 20.2	Did the EPA advise the authors of the HHBRA that they could find more accurate demographic data and household income data on the EPA's website (EPA, 2015)?	See response below at GEC 20.3.
GEC 20.3	Will the EPA utilize the income data from their website to modify the HHBRA to indicate there's a high likelihood of a significant numbers of subsistence fishers within close proximity to the LCP site?	The HHBRA was finalized in August 2011 using available data at that time. The discussion of income levels was only a fraction of the uncertainty analysis regarding the sensitive population of likely subsistence fish consumers that would harvest all of their fish from Zones D (Turtle River from GA Highway 303 to Channel Marker 9), H (Purvis Creek), and I (Gibson Creek), every year for 30 years. Although the ATSDR (2014) and EPA (2015) data provide updated information on demographics and potential fish consumption, the assumptions used in the HHBRA regarding harvesting and consuming fish only from these specific zones remain conservative.

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GEC 21.1	Does the EPA agree that the definition of Aroclor 1268 presented in Pulster, 2005 and Pulster, 2008 was used in the HHBRA to define PCBs associated with the LCP site? Does EPA agree that the same PCB profile described in Pulster, 2005 and Pulster, 2008 was used to define an associate the PCBs found in humans sampled in the Sapelo Island area (ATSDR, 2014b)?	The HHBRA evaluated the potential risks from exposure to Aroclor 1268 and mercury to consumers of fish caught in Zones D, H and I of the Turtle River-Brunswick Estuary (TRBE). The PCB profile described by Pulster et al. (2005) and Pulster and Maruya (2008) are consistent with EPA's knowledge of Aroclor 1268. Dolphin tissue data are informative but are not appropriate for assessing non-cancer hazards and cancer risks to humans.
GEC 21.2	Will the more current data (ATSDR, 2014b) collected in coastal Georgia rather than the discredited data that's now 20 years old (DHHS, 1999)?	No. See response below at GEC 21.4.
GEC 21.3	Will the EPA set the annual number of seafood meals consumed by the high quantity consumer at 156 or higher?	
GEC 21.4	Will the EPA increase the size of the meal to reflect those consumed by African-Americans as reported in the Public Health Assessment (ATSDR, 2014a)?	The ATSDR data is based on a small sample size of only nine individuals in the Sapelo Island study whose fishing areas span various coastal and interior waterways around the island. The activities of the nine individuals in that study may not be reflective of those who catch and eat all their fish from Zones D, H, and I of the TRBE every year for 30 years with no assumed change in fish tissue concentrations over time. In addition, the HHBRA assumed 27 grams/day or 9,855 grams/year at an average meal size of 134.6 grams; which results in 73 meals/year from the affected zones. If the meal size were larger, then the number of meals would decrease. The important point is that the HHBRA did not include additional seafood meals originating elsewhere along the Georgia coast or inland waterways. This is consistent with one of the conclusions of the Brunswick fish study, which stated that most study participants did not fish in the restricted area.
GEC 22.1	The actual seafood consumption habits are far different than the assumptions used in calculating risk, which were based upon filets only, and did not consider fish egg (roe) consumption.	The four out of nine people surveyed who occasionally consume fish eggs during a seafood meal is informative but lacks statistical power to replace fish consumption advisory guidance and methodologies issued by the EPA and GAEPD.

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GEC 24.1	Will the EPA utilize existing dioxin and furan in fish data and incorporated into the HHBRA risk analysis (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)? If not, why not?	These reports are not available in the EPA's files. Inquiry with the GADNR has not turned them up either. It may be that these data are the same evaluated in the 1997 ATSDR Turtle River Health Consultation. The years mentioned in the comment cover the same years presented in Tables 1 through 6 of the 1997 Health Consultation. If so, then these data have been evaluated and are available in the Administrative Record.
Remedial Investigation Comments and Questions		
Fish Consumer Scenarios		
GEC 25.1	How many signs have been posted by the GADNR in the area and where are the signs located?	Posting of fish advisories is the responsibility of the Georgia Department of Natural Resources. This information should be available thought their offices.
GEC 25.2	Has the high quantity fish consumer meal assumption of 40 meals per year been discredited (ATSDR, 2014a)?	There exist errors in the October 2012 OU1 RI and the November 2014 Proposed Plan mentioning a 40 meal per year fish consumption rate. Overall consumption depends on the number of meals and meal size. The HHBRA used a consumption rate of 73 meals per year and an adult meal size of 135 grams (4.75) ounces. This is based on the derivation of the ingestion rates for the high quantity fish consumer shown on Table B-1 (Appendix B) of the HHBRA. The issue is the total number of grams per day that are consumed only from Zones D, H, and I, rather than the number of meals or size of meals.
GEC 25.3	Are a more appropriate number of meals for the high quantity fish consumer closer to 156 per year (ATSDR, 2014b)?	No. The source of the 156 meals per year originates in the September 2014 ATSDR slide presentation (slide #21), where it appears that ATSDR or CDC sought to find nine Sapelo Island residents who had lived in the community for at least five years and who had eaten at least two-to-three meals of locally-caught seafood each week. The ATSDR investigator then multiplied three times the 52 weeks in a year and arrived at 156 meals per year. This was not a study. This was one line on one slide of a PowerPoint presentation, which has yet to be published. A "study" based on nine individuals from Sapelo Island, located about 25 miles from Brunswick, with a vague question, is not defensible. In addition, the Sapelo individual fish all around the island – not like somebody only fishing in Zones D, H, and I of the TRBE, who theoretically consume fish every year for 30 years with no change in fish tissue concentrations.

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Shellfish Consumer Scenario		
GEC 25.4	Does the EPA actually believe the data presented in the RI for shellfish consumption in light of catching crabs and casting for shrimp being recreational activities in coastal Georgia?	Yes. The HHBRA, developed by the responsible parties and overseen by the EPA and GAEPD, evaluated the recreational adult consumer scenario assuming that two and a half meals of shellfish per month, from Zones D, H and I of the St. Simon's estuary, based on upper-end of EPA defaults for recreational fishing in Southeast United States.
GEC 25.5	Has either the EPA or the Responsible Parties noticed all the docks along Turtle River and the crab trap lines extending onto the water?	A review of a December 2014 Google Earth aerial photograph shows no docks in Purvis Creek, where the most recent (2011) blue crab tissue data show exceedances of the weekly consumption guidelines for mercury and Aroclor 1268. Four docks are visible in the neighborhood north of where the creek forms a channel. The monthly guidelines were not exceeded in Purvis Creek. With regards to the middle part of the Turtle River (Zone D), the 2011 data show mercury and Aroclor 1268 to be below both the weekly and monthly advisory concentrations. The December 2014 aerial photograph shows five docks along Zone D (the middle Turtle River).
GEC 25.6	Did the authors of the RI make any attempt to observe seafood harvest and consumption patterns along the Georgia Coast or are all the assumptions in the RI averages of the entire population of the United States?	Yes, Table B-1 (Appendix B) of the HHBRA, entitled "Derivation of Ingestion Rates for High Quantity Fish Consumption" contains four footnotes. The footnotes demonstrate the extent to which the HHBRA attempted to use as much site-specific data and values as possible.
GEC 25.7	Is the EPA aware of just how dangerous applying data from national consumption pattern is when determining risk to a local population from a locally contaminated food source?	Please see immediately preceding response (25.6).
GEC 25.8	What does the FDA recommend to do when a locally contaminated food source is encountered?	The EPA, ATSDR and Georgia State agencies have been active over the past decade in dealing with contaminated seafood, independent of FDA actions.
8.2.6 Characterization of Uncertainties		
GEC 26.1	What is the study cited in support of the conclusion "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?	The GADNR issues fish advisories to discourage consumption of significant amounts of contaminated seafood.
GEC 26.2	Are the authors of the RI citing a study or opinion when they state "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?	The general consensus of state fish advisories issued throughout the country is that they serve as a deterrent.

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GEC 26.3	What is the definition of the LCP estuary and what are the geographical boundaries?	The marshlands shown on Figures 2 and 3 of the ROD show the boundary of the OU1.
GEC 26.4	Is the "LCP estuary" defined by the extent of contamination from the LCP Site in coastal Georgia?	The November 2014 Proposed Plan and the Record of Decision have corrected the inherited nomenclature. The LCP Chemicals marsh is part of the St. Simons estuary. The contaminant concentrations posing risk have been found within marshlands delineated by the purple line shown on Figures 2 and 3.
GEC 26.5	Does the Georgia Department of Natural Resources seafood consumption advisories encompass the entire "LCP estuary"?	This information is available at: https://epd.georgia.gov/sites/epd.georgia.gov/files/related_files/site_page/FCG_2014_073114_EAB.pdf
GEC 26.6	Have any agencies questioned the need to extend the extent of seafood consumption advisories due to the spread of contamination from the LCP Site (ARSDR, 2014b)?	Seafood consumption advisories are the responsibility of GADNR. Apparently the ATSDR was not aware of the existence the 2011 fish data, which are presented in Appendix F of the final FS, during the September 2014 meeting referenced. GADNR has had the 2011 fish data for some time now.
GEC 26.7	Have any recommendations or suggestions been made concerning expanding the sampling and analysis in the ecosystem and humans to more fully identify the extent of LCP Site contaminants spread (ATSDR, 2014b)?	Testing of humans is the responsibility of ATSDR and the CDC.
Chemicals of Potential Concern (only mention of dioxin in the RI)		
GEC 26.8	Were the chemicals detected in a small number of samples or were they identified for analysis in a small number of samples?	Detected in a small number of total sediment samples. For example, dichlorodiphenyltrichloroethane (4,4'DDT), dioxin/furan congeners, bis(2-ethylhexyl)phthalate, 3,4-methylphenol, butylbenzylphthalate, and hexachlorobenzene have been analyzed approximately 237, 45, 284, 307, 284 and 290 times, respectively.
GEC 26.9	How many samples were taken in the LCP Site marsh, and how many were specified for dioxin and furan analysis?	Over 5,500 mercury, Aroclor 1268, lead and PAH analyses were run on approximately 1,650 sediment samples. Of those, 45 sediment samples were analyzed for dioxin/furans. A limited number of dioxin/furans analyzes were run on surface water and biota samples. Details of the dioxin/furans results are contained in the December 2, 2014 Dioxin/Furans Memorandum.
GEC 26.10	What is the difference between qualitative and quantitative when establishing risk in a document like the BERA?	In general, quantitative risk is based on acceptable protocols where site data is relatively statistically robust; whereas, qualitative risk is often based on generalizations, observations and non-statistical relationships.

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GEC 27.1	How was risk established through a qualitative discussion of dioxin and furan in the BERA?	The September 2, 2014 Dioxin/Furans Memorandum consolidated into one document all the known dioxin/furans data available for the Site. It also evaluated the risk posed by the dioxin/furans still in place, following the removals. The memo concluded that the dioxin/furans are very likely co-located. To confirm this, the ROD's Selected Remedy requires additional sampling during the remedial design (RD) to confirm this belief. Should co-location not be confirmed by the RD sampling, the ROD will have to be amended to address any locations that may pose unacceptable risks.
GEC 27.2	Did the quality and completeness of the sampling and analysis for dioxin and furan in the RI a hindrance to evaluating risk in the BERA and HHBRA?	Due to the cost of dioxin/furans analyses ($400-to-$500 per sample), these analyses are typically run on a subset of the samples analyzed. For example, at the LCP Chemicals (New Jersey) NPL Site, about 19% of the samples were analyzed for dioxins, at the Onondaga Lake Bottom NPL Site, about 27% of the samples were analyzed for dioxins, at the Geddes Brook/Ninemile Creek Site, about 81% of the samples were analyzed for dioxins. The percentage of dioxin analyses at the LCP Chemicals Site is about 3%, which is recognized to be low. For this reason, the Selected Remedy requires the collection of additional dioxin/furans data to confirm the belief that the dioxin/furans are co-located with the Aroclor 1268 and that remediating the latter will remediate the former. The dioxin/furans are reported to have been created in the graphite anodes, which were in use from the time the plants started-up in late 1956 until December 1976, when the graphite anodes were replaced with the DSA anodes, composed principally of titanium. Since the dioxin/furans were generated only in the graphite anodes, which were impregnated with Aroclor 1268 starting in January 1962, this further supports that the dioxins/furans are co-located. The available Aroclor 1268 and dioxin/furans sediment data substantiates this.

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8.3.5.8 Piscivorous Mammals (Assessment Endpoint 7)		
GEC 27.3	Would the conclusion "….BERA Report concluded that the potential risk to the viability of piscivorous mammalian species utilizing the LCP estuary is minimal" if the dophin data was added to the BERA (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?	Likely not. See also responses to comments regarding the dolphin under the BERA Comments and Questions Section.
GEC 27.4	What impacts to dolphin health were found in the studies (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?	The research papers speak for themselves regarding impacts to dolphins, and the EPA fully respects their work. It is noted that mercury and Aroclor 1268 were not the only contaminants found in dolphins but also chemicals such as toxaphene congeners, chlordanes, DDTs, mirex, etc.
GEC 27.5	Were the health effects found in dolphins "minimal" (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?	The authors made their own conclusions irrespective of the BERA, which did not evaluate dolphins for the reasons mentioned earlier. In addition, the EPA is unaware of any attempt at minimizing the health effects found in dolphins by the Hollins Marine Institute, working on behalf of the NRDA claim. On the contrary, the BERA does acknowledge this work, which at the time the BERA was being concluded, was still ongoing.
GEC 27.6	Were the chemicals found in the dolphins linked to the LCP Site (ATSDR, 2014b)?	Although Aroclor 1268 was detected in the dolphin blubber, other toxicants listed above were also detected. The majority of these other contaminants are not related to the LCP Chemicals Site.
GEC 27.7	Would the EPA find the absence of an indigenous species like the mink from the LCP Site significant	The following are excerpts from a Georgia DNR Fact Sheet: "In Georgia, mink most commonly are found in the Piedmont, Ridge and Valley, Blue Ridge Mountains, and Atlantic Coast Regions while absent in much of the Upper and Lower Coastal Plain." "However, uncontrolled use of DDT, PCPs, DDE and other pesticides in the 1950s and 1960s caused widespread pollution throughout America's waterway systems that resulted in extremely low wild mink populations." Mink have been collected in Glynn County (See Osowski et al., 1995), and there is no evidence offered by the commenter that mink do not exist in the LCP Chemicals marsh.
GEC 27.8	Would the absence of a viable mink population indicate there is a dead zone where mink cannot survive around the LCP Site?	See the immediately preceding response on the mink population.

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GEC 27.9	Would a dead zone where mink cannot survive be described by the EPA as "minimal risk"?	See the preceding comment on the mink population. See also the responses to mink comments in the BERA Section.
GEC 27.10	Would the EPA agree that the observations in the dolphin population indicate the models referenced in the RI are significantly flawed and do not agree with the observed ecological impacts? If not, why not?	No, the EPA does not agree the models used in the BERA are significantly flawed. See responses related to mink and dolphins in the BERA comment section.
GEC 28.1	What is the definition of "minimal risk" used in the RI?	The following is taken from section 5.7 of the BERA: "The sole measurement endpoint for evaluating the viability of piscivorous mammals utilizing the LCP estuary consisted of HQs derived from food-web exposure models for river otters (*Lontra canadensis*). The modeling study for river otters generated site-related NOAEL HQs for Aroclor 1268 (based on a TRV for Aroclor 1254) that ranged from 0.01 to 3.94 (Table 4-30). No LOAEL-based HQ for Aroclor 1268 was greater than unity (1). In addition, no potential for risk was associated with mercury or lead. The potential for adverse risk to the viability of piscivorous mammalian species utilizing the LCP estuary is judged to be minimal." In this context, minimal risk is defined as no LOAEL-based HQ for Aroclor 1268 greater than unity (1) and NOAEL HQs for Aroclor 1268 ranging from 0.01 to 3.9. In addition, there was no risk associated with mercury or lead.
GEC 28.2	Does the empirical evidence documented prove the models in the BERA and RI do not hold up when compared what is known about ecosystem on the Georgia coast and the impacts from the chemicals associated with the LCP Site (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012, ATSDR, 2014b)?	This comment is too unspecific to respond to.
Feasibility Study Comments and Questions		
GEC 31.1	In light of the EPA, Georgia Department of Natural Resources, and the Potentially Responsible Parties failure to implement recommendations by the ATSDR to protect human health since issues 21 years ago, why should anyone believe	These two questions are too vague to merit a cogent response.

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	any of these agencies or parties are capable or will now do so at this time?	
GEC 31.2	Is it arrogant to suggest the Potential Responsible Parties have the power to guide or modify human behavior?	
GEC 31.3	What evidence (studies or reports) are presented to suggest there has been any success in implementing Institutional Controls over the past 20 years?	One of the conclusions of the late 1990s Brunswick fish study was that, "The majority of study participants do not fish in the restricted area; the few that do, however, state that they are aware of the advisory."
GEC 31.4	What is the budget for implementing Institutional Controls until the cleanup goals are reached?	Institutional control costs are included In the October 2014 FS as a single lump-sum cost item for each alternative; costs are assumed to be consistent between alternatives and are not expected to vary significantly based on remedy footprint or construction methodology. The present day net worth of institutional controls is estimated to be $250,000. This net present worth estimate used a 7% discount rate.
GEC 31.5	What has been the budget for these Institutional Controls over the past 20 years?	Since the Georgia Department of Natural Resources implements the State's fish advisories, this question is better directed to this agency.
GEC 32.1	Does the EPA agree the authors of the FS are interjecting opinion with statement like, "because anglers do not consume the whole-body fish samples, only the edible tissues"?	The above-quoted February 9, 2004 memorandum from the late Dr. Randall O. Manning, with the Georgia Department of Natural Resources, is reproduced in Appendix F of the October 2014 FS. The memo addresses only edible fish tissue. The BERA analyzed the effects of whole fish. For this reason the EPA not consider the quote as an opinion, rather a matter of State of Georgia policy.
GEC 32.2	Does the EPA agree that people in coastal Georgia do eat the whole fish, and not just the filet?	Undoubtedly a small fraction of the population does consume whole fish. Ever a smaller fraction of the coastal Georgia population may consume the whole fish, including the organs with the highest concentrations of contaminants, such as the hepatopancreas. Unfortunately, it does not appear that the 1999 ATSDR Glynn County seafood consumption survey inquired as to what percentage of the population consumed whole fish. It is however likely, that the whole fish consumers are not consuming tissue with the concentrations shown in Section F.4 of the October 2014 FS Appendix F, since the graphed results show analytical results for muscle, organ and bone, appropriate for an ecological risk assessment but not a human risk assessment. The "whole fish" dataset, excluding organ and bone, may not exist.

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GEC 32.3	Does the EPA realize the fish eggs potentially have significantly higher levels of LCP Site COCs than the fish filet?	The four out of nine people surveyed who occasionally consume fish eggs during a seafood meal is informative but lacks statistical power to replace fish consumption advisory guidance and methodologies issued by the GAEPD and the EPA.
GEC 32.4	Did the FS or other LCP Site documents evaluate the consumption of fish eggs or other high lipid content seafood?	See immediately preceding response (32.3).
GEC 32.5	Was the EPA aware of the cultural seafood consumption practices in coastal Georgia such as fish eggs (roe), whole fish, and other methods of cleaning and preparation? If not, why not?	The 1999 ATSDR Glynn County seafood consumption survey did not consider the consumption of fish roe. It should be noted that the GEC was one of eight members of the Seafood Advisory Board, involved in the development of the 1999 Glynn County seafood consumption survey.
GEC 32.6	Would the findings about cultural seafood consumptions patters be significant and warrant inclusion in the HHBRA?	No. Since whole fish consumers are unlikely to consume organs and bones and the percentage of the population consuming fish roe is very likely low, the HHBRA correctly assessed the risks posed by consuming fish tissue.
Proposed Plan Comments and Questions		
Introduction		
GEC 33.1	Was there a compelling reason for the EPA to exclude data collected after 2012? Why not include data to date?	2012 is the year that the most recent sediment data was acquired.
Site History		
GEC 33.2	Honeywell contends in their Fact Sheet the paint contained Aroclor 1268. What documentation does the EPA have to support the contention that Aroclor 1268 was an ingredient in paints manufactured by Dixie Paint and Varnish Company?	The purpose of this Responsiveness Summary is to respond to comments on the November 2014 Proposed Plan. This question is beyond the scope of the Proposed Plan and supporting documents.
Public Participation		
GEC 33.3	Does the EPA maintain a mailing list for the LCP Chemicals Superfund site?	The EPA maintains mailing lists with returned mailings, sign-in-sheets from public meetings/availability sessions and upon requests from interested parties.
GEC 33.4	Does the EPA use the returned newsletters to update the LCP Site mailing list?	Yes.
GEC 33.5	If not, how does the EPA maintain the mailing list and keep it current, and maintain continuity in community participation at the LCP Site?	The EPA maintains mailing lists with returned mailings, sign-in-sheets from public meetings/availability sessions and upon requests from interested parties. A local community group was awarded the Technical Assistance Grant (TAG) and one of their requirements is to assist the EPA in notifying the community of participation opportunities, availability of site updates, reports and any other site related documents

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		including the Proposed Plan and also notify the community of any public meetings/availability sessions.
GEC 33.6	How many EPA quarterly newsletters have been sent out over the past three years at each mailing, and what were the dates of the mailings?	This was an error in the Proposed Plan. The newsletters were never intended to be mailed quarterly. The purpose of the newsletter was to update the community on the Superfund sites in Brunswick. The newsletters were mailed out a couple times a year. Approximately 385 were mailed, but many of those were returned at each mailing. The following gives the dates the Brunswick newsletters were mailed. This does not include the newsletter prepared during the removal period. The newsletters started as quarterly but, as is evident, soon became periodic. Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (March 2008), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, EPA Region 4 and the Georgia Environmental Protection Division (November 2008), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (December 2008), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (April 2009), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (October 2009), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (March 2010), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (August 2010), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (February 2011), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (August 2011), Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (February 2012),

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		Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (October 2012), and Brunswick Environmental Cleanup Newsletter, Brunswick, Georgia, USEPA (June 2014)
GEC 34.1	When the LCP Proposed Plan was released, how many were mailed to the community?	Approximately 290 Proposed Plans were mailed to the community. In addition to mailing the proposed plans, many were emailed to those who had requested it. Copies of the Proposed Plan were handed out at the public meeting held in December 2014. The TAG recipient also received a copy of the Proposed Plan in hopes to help assist with distribution to their mailing list. In addition, the Proposed Plan (two versions) were posted in the World Wide Web.
GEC 34.2	In light of the report from Ms. Miller that the LCP mailing list has been deleted, how did the EPA formulate the mailing list to send out the Proposed Plan?	The LCP mailing list was not deleted; it was revised with current census data.
GEC 34.3	Was the Proposed Plan sent to all the people who have signed up for on the EPA's mailing list for the LCP Site? If not, how many (what number) of the people who have previously signed up to the LCP Site EPA mailing list did not receive the Proposed Plan mailing?	The Proposed Plan was mailed to approximately 290 local residents, many were also distributed via email and the TAG recipient received a copy in hopes to help assist with distribution to their mailing list.
GEC 34.4	What are the EPA's plans to assure future continuity in the mailing list for public participation at the LCP Chemicals Superfund site?	The EPA mailing lists will be updated using sign-in-sheets from public meetings/availability sessions and upon requests from interested parties.
GEC 34.5	Is it possible for the EPA to recover the deleted mailing list and updated with returned newsletters or other mailings concerning the LCP Chemicals Superfund site, or other Superfund sites, in Glynn County?	The mailing list was not deleted; it was revised with current census data. The EPA maintains mailing lists with returned mailings, sign-in-sheets from public meetings/availability sessions and upon requests from interested parties.
GEC 34.6	How many addresses were on the list that was deleted?	The original mailing list was not deleted; it was revised with current census data. The original mailing list had approximately 385 addresses and the revised version has approximately 290 and will be updated with the recent sign-in-sheets from the public meeting/availability sessions.
GEC 34	Does the EPA keep a record of the Glynn County Superfund Site the person has signed up to receive information about from the EPA?	Interested parties are added to the mailing list upon request.

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GEC 34.7	Can the EPA assure that there will be a mailing list for the community participation in the decision-making process for the citizens of Glynn County from now and into the future, and will be available for the other propose plans and records of decisions that will be coming up for the Superfund sites in Glynn County?	The EPA mailing lists will be updated using sign-in-sheets from public meetings/availability sessions, returned mailings and upon requests from interested parties. And as a requirement of the TAG recipient, they are to assist in informing the community of the participation opportunities, availability of Proposed Plans and any public meetings/availability sessions.
GEC 34.8	Does the EPA feel it is appropriate to allow 3.3 seconds per page for the public to read the documents the EPA provided?	Beginning in early 2010, drafts of key site documents were posted on the World Wide Web's LCP Chemicals Reading Room. For example, by the date the comment period for the Proposed Plan started, the final drafts of baseline human health and ecological risk assessments had been available to the public 42 and 40 months, respectively. Similarly, the final drafts of the remedial investigation and feasibility study had been available 24 and 6 months, respectively, before the comment period for the Proposed Plan started. Currently, about 80 LCP Chemicals documents are posted on the web site.
GEC 34.9	How much time does the EPA feel is appropriate for the community to review 8700 pages, prepare comments, and be ready for the EPA Public Comment Meeting to submit comments to be taken down by a court recorder?	See the immediately preceding comment (GEC 34.8).
GEC 34.10	Was the purpose of releasing 8700 pages 24 hours before the Official EPA Public Comment Meeting to thwart any meaningful community comments at the Official EPA Public Comment Meeting?	The EPA held a public meeting on the same day the comment period started (December 4, 2014), but extended the comment period for a total of 102 days (March 16, 2015). The purpose of the public meeting is to present the Proposed Plan to the community in a way that they will understand and be able to provide comments within the comment period. The purpose of the comment period is to provide the community an opportunity time to review the documents and submit comments via email or regular mail as long as the comments are postmarked on the last day of the comment period. The EPA encouraged the community to review all of the documents and provide comments, the reason for extending the comment period out 102 days. The EPA generally gives 30 days to comment, but because of the volume of documents it was extended well beyond 30 days.
GEC 35.1	How many requests for another EPA public comment meeting have been received by the EPA?	Immediately after the public meeting in December 2014, the EPA planned an availability session for February 26, 2015, to help the community understand the details of the preferred cleanup alternative, show graphics of what has already been cleaned up under a removal

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		action, and addressed questions and concerns that they had regarding the Site.
GEC 35.2	Have the Congressional representatives of Glynn County requested the EPA provide a public comment meeting for the LCP Chemicals Superfund site marsh proposed plan?	The EPA held a public meeting on December 4, 2014 to discuss the preferred alternative to clean up the LCP Chemical marsh. No requests are necessary because the EPA is required to hold a public meeting to discuss the Proposed Plan.
GEC 35.3	Does EPA feel it is appropriate to limit participation in decision-making process to those with access to the internet, email, or innate ability to write comments to participate in the decision-making process?	The EPA advertised the public meeting through local newspapers, public service announcements through a local radio station, email and phone calls to local groups throughout the community. And as a requirement of the TAG recipient, they are to assist the EPA in informing the community of participation opportunities, availability of site related documents including the Proposed Plans and opportunities to attend public meetings/availability sessions.
1.3 Setting and Hydrodynamics of the Marsh		
GEC 35.4	What data is presented in support of this statement? How much sediment has accumulated or eroded from the LCP Site?	The passage is taken from the final remedial investigation report. The RI report cites two references: Cundy et al. 1997 and Fox et al. 1999. The following is taken from the RI report: "Whereas the site is net depositional, deposition rates are low. Thus there has not been substantial historical burial of surface sediment deposits over time, making it difficult to discern historical time trends."
GEC 35.5	If the LCP marsh has a net deposition of particles, what is the annual deposition rate?	The following is taken from the FS: "A study of a coastal Georgia marsh located approximately 25 miles northeast of the Site found that net sedimentation rates varied from 2 to 6 millimeters per year (mm/yr) within the marsh." (Letzsch, W.S. and R.W. Frey, 1980)
GEC 35.6	Are these tides consistent with an area with "low current velocities"?"	The range of tides and current velocities are not related.
GEC 35.7	What are the tidal ranges for the St. Simons sound estuary under storm conditions such as a northeast wind?	Section 3.3 (Sediment Remedy Alternatives: Hurricane Storm Surge) of the FS Appendix B discussed the modeled effects of storm conditions on the marsh.

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GEC 35.8	How does the wind affect currents in the estuary and on the tidal flats?	The following is taken from Section 3.3 (Appendix B) of the FS: "Additional simulations for storm surges with rarer recurrence intervals (e.g., 500-year event) may be considered during the design phase of the study to evaluate model sensitivities. However, based on experience from other sites of similar characteristics, the incremental effects of higher frequency storm surges on marsh sites such as the Brunswick LCP Site is not expected to be considerable. The 2010 Georgia Hurricane Readiness Plan (GEMA 2010) establishes procedures for state employees to follow in the event of a hurricane. The document presents a range of wind speeds and storm surges for Category 1 to 5 hurricanes, as well as typical effects of each category. It also provides a brief, though unsubstantiated, anecdote from 1898 in which a Category 4 hurricane caused a 16-foot storm surge in the city of Brunswick and surrounding communities."
Figure 1, Figure 2		
GEC 35.9	Why is the Salt Dock area not shown as part of the LCP Site?	The Salt Dock was sold to Brunswick Cellulose in 2014, hence it is shown excluded from the property currently owned by Honeywell International, Inc. As far as the LCP Chemicals CERCLA Site is concerned, it remains part of the Site and will be evaluated as part of OU3 (the Uplands).
GEC 35.10	How were the LCP Site boundaries shown in Figure 2 determined?	The purple line in Figure 2 of the November 2014 Proposed Plan, describe as "LCP Property" in the figures legend shows the boundary of the property currently owned by Honeywell International, Inc.
GEC 35.11	With the boundaries of the LCP Chemicals Superfund site determined by land ownership or by the extent of the contamination?	Superfund site boundaries are determined by extent of contamination.
GEC 35.12	Are Superfund sites boundaries supposed to be determined by the extent of contamination or the surveyed ownership lines?	
Past Actions		
GEC 36.1	Why is marsh removal and re-vegetation with native marsh grasses not part of the Proposed Plan?	Marsh restoration has been added to the remedy.
GEC 36.2	Were coffer dams used during past actions?	The October 1999 Marsh and Railroad Removal Close-Out Report, documenting the marsh removal work, does not mention cofferdams.
GEC 36.3	If coffer dams were used in the past, why was this technology not considered in the Feasibility Study?	See preceding comment (GEC36.2).

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GEC 36.4	What was the decision-making matrix that leads the exclusion of all technologies deployed from the uplands or utilizing dry excavation techniques?	Section 4 of the FS (Identification and Screening of Remedial Technologies) contains the discussion of the technology screening process.
GEC 36.5	Is there only "highly contaminated…" and "low level threat…" wastes at the site?	During the late 1990s removal, the higher concentrations of mercury and Aroclor 1268 were removed, leaving low level concentrations. To illustrate: the average pre-late 1990s removal mercury and Aroclor 1268 concentration were about 104 and 134 mg/kg, respectively. The current (post-removal) average mercury and Aroclor 1268 concentrations are 5.4 and 9.9 mg/kg, respectively.
GEC 36.6	Who made the determination that the remaining wastes are "…low-level threat waste"?	See the discussion regarding Principal Threat Waste in Part 2 of the Record of Decision.
GEC 36.7	What is the definition of low-level threat waste?	That which in not Principal Threat Waste.
GEC 36.8	What is the difference between waste and COCs?	See the text box on page 9 of the November 2014 Proposed Plan for a discussion of the LCP Chemicals marsh COCs. Section 7 of the baseline human health risk assessment also has a discussion of COCs.
GEC 36.9	How does the EPA quantify low-level threat waste and what is the threat level to humans and wildlife?	Principal and low-level threat wastes are wastes are discussed in the November 1991 Guide to Principal Threat and Low Level Threat Wastes (Superfund Publication 9380.3-06FS), available on the World Wide Web. The threat to humans and the environment is evaluate in the baseline human health and ecological risk assessments.
GEC 36.10	What are the numerical differences between low level, mid-level, and high level wastes for the Chemicals of Concern (COC) at the LCP Chemicals Superfund site?	See preceding responses in this subsection regarding principal and low-level threat wastes at the LCP Chemicals marsh.
GEC 36.11	Where can the low, mid, and high levels of waste threats definitions be found in EPA rules and regulations?	
GEC 36.12	How does the EPA define residual contamination and how is that numerically quantified?	"Residual contamination" is not a defined term and thus has no numerical quantification.
GEC 36.13	Would contamination that has resulted in documented sick Dolphins within this estuary qualify under the definition of residual contamination?	See above response (GEC 36.12).
2.0 SITE CHARACTERISTICS		
GEC 37.1	Were the COCs that have synergistic and similar modes of action considered, or were COCs like dioxin/furan excluded, even if they should be considered along with PCBs?	Dioxins and furans were not directly evaluated in the RI. However, the EPA 2014 Dioxin Memorandum provides data and analysis.

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GEC 37.2	Were all PCBs included or were the others excluded and only Aroclor 1268 included? If so, why? If not, why is the data missing?	In contrast to the uplands, almost all (98%) of the Aroclors found in the marsh was Aroclor 1268. The maximum sediment concentration of Aroclors 1016, 1221, 1232, 1242 and 1248 was 0.2 mg/kg. One exception to this was Aroclor 1260, which was detected 21 times. The following are the highest five detections of Aroclor 1260: 1,400, 180, 11, 3.6 and 0.99 mg/kg.
2.1 Distribution of COCs in Sediment		
GEC 37.3	Why was sampling limited to 6 or 12 inches?	This sampling interval represents the most biologically active zone for benthic invertebrates.
GEC 37.4	Was the EPA or the PRPs unaware of the biosphere depth in the estuary that inhabits the marsh sediments?	The EPA and PRPs were fully aware of sediment depths influenced by biota and contamination. In addition, most of the contamination in the marsh is highest in these intervals, thus providing conservative estimates of exposure to sediment.
GEC 37.5	Did the US Fish and Wildlife Service (USFWS) advise the EPA that sampling to only 12 inches was insufficient to delineate contamination in the LCP Marsh (USFWS, 1996)?	Indeed the USFWS through their November 21, 1996 comment letter did indicate that sampling sediment to a depth of 18 inches was not sufficient. Appendix A of the RI Report contains the vertical profile data collected in the marsh. Note that it is almost impossible to avoid cross-contamination when collecting sediment samples in an environment such as the LCP Chemicals marsh. The comments regarding a November 1996 USFWS comment letter have to be looked in the context of where the Site was close to 20 years ago. A lot has been done since and most of the comments in the letter are no longer relevant.
GEC 37.6	Did the USFWS advise the EPA to conduct whole body fish analysis?	It is assumed that the question refers to the November 1996 USFWS letter. The following is taken from that letter: "Use of edible tissue data is essential to evaluate human health concerns, however, to be conservative regarding environmental impacts it would be prudent to use individual samples (whole body) to assess potential bioaccumulation of the COC's."
GEC 37.7	Has the EPA assured whole body fish analysis has been conducted?	All the fish data used in the BERA were whole fish data.
GEC 37.8	Did the USFWS note the *Spartina* root bed extends to 18 inches and COCs at this depth might have a higher propensity to be bioavailable (USFWS, 1996)?	The following is taken from the 1996 USFWS letter to the EPA: "Sediment testing within the "marsh" to a depth of 18" is not sufficient. The report indicates that "PCB concentrations increased from 0.25 mg/kg at the surface to 5.4 mg/kg at depth." without specifying the depth. It is assumed the depth was to the 18" level. Interestingly enough this is the same approximate depth that the root bed and mat of the *Spartina*

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		extends. It would seem reasonable that degradation of the PCB's, PAH's and possible methylation of mercury could occur within this depth and that actions requiring the elimination of this layer may yield contaminants at higher levels. Furthermore, the products found within this layer may have a higher propensity to be bioavailable. Deeper sediment testing would be recommended to further identify and characterize the nature and extent of the COC's as well as sub surface water flow and potential transport of the COC's. The core sample from Purvis Creek indicated the mercury concentration increased with depth. This is an important finding when looking at the overall health and activities within the potential area of concern. That is, dredging activities are being planned and are occurring within the potential area of concern. This coupled with the releases occurring for many years would lead to a hypothesis that depositional zones could contain high levels of COC's and future activities may cause a bolus release of these through re-suspension and disturbance." The observations made in the above 19 year old paragraph are hypothetical with little scientific merit. There is limited evidence that contaminants would be more bioavailable at depths of 18 inches. See Appendix A.1 of the RI Report which suggests a relatively thin (<one foot) veneer of sediment contamination on the marsh flats. The paragraph assumed contamination extends to 18 inches or deeper. The Selected Remedy includes dredging of contaminated sediments to 18 inches and replacement with fill material.
GEC 37.9	How would the greater bioavailability of COCs at a depth of 18 inches affect a cap remedy?	There is no evidence that the COCs in marsh sediment are more bioavailable at 18 inches depth.
GEC 37.10	Did the USFWS recommend in 1996 the EPA total "dioxin" levels reported for the nature and extent of the contamination within the marsh?	The comment is too unclear to provide a response.
GEC 38.1	In light of the data collected since 2012, does the EPA agree the Reference Stations are likely, if not confirmed, to be within the radius of contamination deposition from the LCP Site (ATSDR, 2014b)?	The EPA does not agree that both reference stations have been impacted by the LCP Chemicals marsh. The following tables in the BERA demonstrate that these areas have not been impacted: Table 4-2a, 4-2b, 4-3a and 4-3b.
GEC 38.2	If the EPA disagrees, what data does the EPA have to support continued use of the Reference Stations?	See response to immediately preceding comment (GEC 38.1).

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GEC 38.3	Does the EPA agree that there is only one sample of methylmercury for approximately every 4.5 acres of the LCP Site march? (640 acres/ 150 samples)	The correct answer is one methylmercury result sample every 4.3 acres. However, sampling was focused in more contaminated areas based on likely contaminant migration pathways and exposure routes.
GEC 38.4	Is the reason a small fraction of the mercury was methylmercury because it readily bioaccumulates? If not, why not?	Methylmercury does bioaccumulate in organisms; however, methylation of mercury occurs more readily in animal tissues such as in crabs and fish (mean methylmercury/mercury ratios up to 100%) than in sediment (< 1%) and Spartina tissue (~10%). See also Appendix F in the BERA.
Figure 4 – Aroclor 1268 Concentrations in LCP Marsh Sediments		
GEC 38.5	Why is there a high level of Aroclor 1268 reported at the Salt Dock in Figure 4?	This appears to be an isolated detection of Aroclor 1268 in the Turtle River, with a concentration of 25 mg/kg. Table 1 of the ROD shows that Aroclor 1268 concentrations were generally below 1 mg/kg.
GEC 38.6	Does this indicate dioxin/furan could have been transported to this area since the EPA and Honeywell argue the PCBs and dioxin/furan are co-located?	The December 2014 Dioxin Memo observes the following regarding the observed rapid decline in dioxin/furans concentration in sediment, away from the Former Facility Disposal Area: "As noted in the 1997 ERE, sediment dioxin TECs declined from an average of about 6,768 ng/kg [range 2,640 to 12,761 ng/kg] in the vicinity of the removed Former Facility Disposal Area to 138 ng/kg at dioxin station 111, located over half way down the LCP Ditch, at the confluence of the Eastern Creek with the LCP Ditch, to a TEC of 6.9 ng/kg at dioxin sampling station 117, where the LCP Ditch enters Purvis Creek, (Figure 1). This represents a 1,000 fold reduction of TECs from the removed source area (the former facility disposal area) to Purvis Creek. With exception of dioxin station 100, the Purvis Creek sediment dioxin TECs remain at single digit parts per trillion downstream of where the LCP Ditch enters Purvis Creek, until the confluence of Purvis Creek with the Turtle River. All the Turtle River sediment TECs remained in the single digit part per trillion range (Table 1)."
GEC 38.7	Why were fish not tested around the LCP Site and in Turtle River like they were at Lake Onondoga (whole, filet, juvenal and adult) and include dioxin and furans (USEPA, 2002)?	As mentioned in the response to comment GEC 15.1, the October 1997 ATSDR Turtle River Health Consultation evaluated dioxin/furans fish tissue concentration in the Turtle River from 1989 through 1992 and, though described to be higher in the Turtle River than in the comparison areas, the levels were well below the tolerance levels for dioxins in fish. Additionally, the U.S. Fish and Wildlife Service analyzed killifish tissue, collected during the removal action, mid-way along the most

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		contaminated portion of the marsh, the LCP Ditch. Overall the dioxin/furans concentrations detected in the two fish samples were low and do not appear to present unacceptable risk to the environment. Table 5 of the ROD contains additional and more recent information on the dioxin concentrations in fish from the Turtle River.
What Is Risk and How Is it Calculated?		
GEC 38.8	If the BRA is an analysis of current and future conditions, why does it use data 20 years old (DHHS, 1999)?	The data used in the BERA and the HHBRA spanned the years 2000 to 2007.
GEC 38.9	Did the ATSDR Public Health Assessment discredit the study used to establish the annual number of seafood meals used to determine risk (ATSDR, 2014a)?	No. The 2014 ATSDR Public Health Assessment in no way discredited the modeled fish consumption rate. See response to GEC 40.1 below.
Exposure Assessment		
GEC 38.10	If the BRA is an analysis of current and future conditions, why is it using data 20 years old (DHHS, 1999)?	See response above at GEC 38.8.

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GEC 38.11	Did the ATSDR Public health Assessment discredit the use of DHHS, 1999 with the following statement? "And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study. A study of fishers along the Savannah River showed that African-Americans • Eat more fish meals per month than whites (average, 5.4 vs. 2.9), • Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and • Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces). It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African Americans in the Brunswick area for those reasons." (ATSDR, 2014a).	See response to Technical Comment #3. Also see response to GEC 40.1.
GEC 38.12	Did the Sapelo Study of Chemicals in seafood consumer find an annual consumption rate closer to 156 meals per year (ARSDR, 2014b)?	The reference to the September 2014 ATSDR presentation cannot, under any circumstances, be interpreted as a study. The 156 meals/year is one line on one slide from this ATSDR slide presentation (#21) where ATSDR appears to have asked nine individuals if they eat two-to-three meals/week and they all said "yes". This "study" based on nine individuals with a vague question is not scientifically defensible.
GEC 40.1	Does the EPA now realize the Baseline HHRA is seriously flawed?	A goal of the HHBRA is to develop reasonable maximum exposure scenarios to contaminants from a specific hazardous waste site. The purpose of the HHBRA is not to assume exposure on a regional scale but on a site-specific basis. The consumption rates used in the HHBRA (27 grams/day for the high quantity fish consumer) are very specific to assessing exposure to contaminated fish caught in the near vicinity of the

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		LCP Chemicals marsh (Zones D, H, and I from the TRBE). The EPA recognizes that the same anglers who fish in these three zones also fish elsewhere in the TRBE, including upstream in the Turtle River or in the Sapelo Island area. Any additional grams/day that the angler would obtain from those areas are not included in the site-specific risk assessment. The HHBRA does not account for every fish meal that a person eats over the course of a 30 year period, but rather provides a reasonable maximum exposure (RME) related to the Site. Even though the dominant PCB signature of Aroclor 1268 in fish may extend to a much wider geographic area, the HHBRA does not use fish tissue data from afar. Similarly, even though local subsistence people may consume more seafood, not all of it is assumed to come from an area of approximately two square miles. To apply much higher consumption rates based on this small area would be over-conservative. Conversely, to expand the geographic area to be more reflective of local fishing patterns would be less conservative because the concentrations of mercury and PCBs in fish are generally lower than those caught in Zones D, H, and I. The anglers in the Sapelo Island area fish at various locations around the island. It is assumed that this behavior applies to most anglers in coastal Georgia. In addition, the EPA recognizes that there are differences in seafood consumption rates throughout the southeast coastal region and the value that these studies provide to our understanding of fishing behavior and consumption of seafood. However, consumption rates need to be applied at a RME scale specific to a contaminated site. Therefore, the higher fish consumption rates based on the Savannah River study (Berger et al., 1999) or the ATSDR 2014 study of nine individuals do not change the conservative RME consumption rates used in the HHBRA. Remaining grams/day obtained elsewhere may provide a more complete assessment of regional exposure but would not be very informative to develop site-specific cleanup levels of sediment in the LCP Chemicals marsh. The 2011 HHBRA was conducted according to EPA's guidance and the available scientific data. The 2014 ATSDR Public Health Assessment (which mentions the higher fish consumption rates mentioned above) has

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		confirmed that fish/shellfish consumers (especially the high quantity fish consumers) are at adverse risk from exposure to mercury and PCBs (Aroclor 1268). The conclusions of the HHBRA and the ATSDR report findings are consistent with each other and support the fish advisory for the TRBE and the need for cleanup action in the LCP Chemicals marsh. This collective information does not necessitate further investigations or more reports, but for managers to use this information to make cleanup decisions along with a robust monitoring program to ensure that the contaminants in fish tissue decrease to acceptable levels.
Toxicity Assessment		
GEC 40.2	Why is the additive effect from dioxin and furan not included in the discussion of associated uncertainties (EPA, 2000)?	Dioxins/furans were not assessed in the HHBRA; consequently an evaluation of uncertainties related to dioxins was not presented. See the Dioxin Memorandum and response to GEC 40.4.
GEC 40.3	Does EPA guidance instruct to include dioxin and furan in the analysis of the carcinogenic and non-carcinogenic effects of PCBs like Aroclor 1268 and the other PCBs found at the LCP Site (EPA, 2000)?	Aroclor 1268 is overwhelmingly the only PCB found in the marsh. In contrast, other PCBs were detected in the LCP Chemical uplands.
GEC 40.4	Was the dioxin and furans known to be present in seafood and sediment evaluated in included in the Toxicity Assessment?	The finfish data are presented in the September 2, 2014 Dioxin Memorandum evaluated the available fish and other biota data. The memorandum concluded the following: "Tables 1 through 4 identify those PCDD/PCDF sampling stations which either have already been removed or will be removed. The range of sediment concentration to remaining in-place after the proposed remedy is between 2.7 and 53.6 ng/kg dioxin TEC. The maximum concentration is well below the dioxin-TEC concentration protective of the child, below the protective level for protection of the omnivorous mammal and below the protective level for protection of 90% of fish species. The maximum concentration is moderately above the highly conservative PRG protective of 95% of fish species. Due to the uncertainty related to limited sediment samples analyzed for dioxin/furans, it is recognized that additional PCDD/PCDF sampling will be required to confirm the dioxin/furans conceptual Site model, i.e. that Aroclor 1268 and dioxin/furans are co-located and that remediating the former will reduce dioxin/furans concentrations to acceptable levels. The additional sampling of the areas not proposed for either removal or covering should take place during the remedial design."

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GEC 40.5	Does the EPA acknowledge the above statement is incorrect and there are cancer risks associated with dioxin and furans found in the LCP Site area and in Turtle River (EPA, 1996)?	Table 5 of the ROD presents the total toxic equivalent concentrations (TEC) in fish tissue for the Turtle River between the years 1989 and 2005. Station 1 was located immediately upstream of the former Arco Dock (see ROD Figure 3). Station 2 was located near the northern end of Andrew's Island, downstream of the Brunswick Cellulose Mill. The November 2014 EPA Region III Risk-Based Concentration Screening Table for fish tissue shows that the carcinogenic risk of 1E-4 corresponds to a 2,3,7,8- TCDD fish tissue concentration of 3.2 nanograms per kilogram (ng/kg). TCDD was rarely detected in the fish samples, suggesting minimal risk. If the 3.2 ng/kg was applied as a TEC for all dioxins/furans in fish tissue, then risks could occur. If the Region III fish tissue screening level for a hexachlorodibenzo-p-dioxin mixture of 67 ng/kg (for 1E-04 cancer risk) is used, then cancer risk would be well within the acceptable risk range. Based on Site data, this heavier chlorinated dioxin mixture appears to be more representative as a screening level than 2,3,7,8-TCDD alone.
GEC 40.6	Were these levels of risk based upon the discredited 40 meals per year (DHHS, 1999; ATSDR, 2014a)?	No, following a closer scrutiny of the HHBRA, the Proposed Plan was in error in only citing the 40 and 26 meals per year fish consumption rate for the high quantity and recreational fish consumer, respectively. The following is a more detailed description of the assumptions used in the HHBRA: • The adult high quantity consumer scenario was assumed to consume, on average, 27 grams of finfish per day. Assuming a fish meal size of 0.3 pounds (135 grams), this translates to 73 meals/year, or approximately six meals per month (from Zones D, H and I), based on self-identified high-quantity consumers in an area-specific creel survey. Assuming a larger fish meal (0.5 pounds) fish meal size, this translates to about 43 meals per year, or a little less than four meals per month; • The recreational adult consumer was assumed to consume, on average, about 16 grams of finfish per day. Assuming a fish meal size of 0.3 pounds, this translates to about 38 fish meals per year, or about three and a half meals of finfish per month. Assuming a larger fish meal size (0.5 pounds), this translates to about 26 meals per year, or about two meals per month. For shellfish consumption, the adult recreational fisher was assumed to catch and eat about 12 grams per

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		day, on average. This translates to about one and a half meals per month for a 0.5 pound meal or about two and a half meals of shellfish per month for a 0.3 pound meal size. These finfish and shellfish consumption quantities are based on upper-end of EPA defaults for recreational fishing in Southeast United States. The HHBRA assumes that these consumption amounts are for fish caught in the same area; and • The area-specific creel survey was the basis for the high quantity fish consumption rates used in the baseline HHRA, conducted by the federal ATSDR (Center for Disease Control) and the Glynn County Health Department, which surveyed 211 Turtle River anglers. The creel survey covered racial/ethnic groups representative of area population. The NOAA fisheries information was used to assign site-specific weighting factors to the various species of fish caught and eaten. From the survey, Table 7 in the ROD shows the average percentage of the various species of fish caught by coastal Georgia anglers between 2001 and 2005. Fish filet tissue data used in the HHBRA from the GADNR Zones D, H and I. Zone D is considered to be the middle of the Turtle River. Zones H and I are Purvis Creek and Gibson Creek, respectively. Figure 23 in the ROD shows the GADNR Fish Consumption Guidelines Zones. The most recent fish fillet data (2011) shows that fish caught in Zone H (Purvis Creek) had the highest mercury and Aroclor 1268 concentrations in 56% of the species sampled. Hence, the HHBRA estimated the risks posed by consuming fish from the most contaminated zones in the St. Simon estuary. See also previous response at GEC 40.1.
GEC 40.7	Was dioxin furan data available to the EPA utilized in the Toxicity Assessment and factored into this statement?	Yes, after a review of the available data as discussed in the 2014 Dioxin Memorandum.
GEC 41.1	Does the existing dioxin/furan data exceed the EPA allowable levels in seafood (GA DNR 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?	No. The October 1997 ATSDR Turtle River Health Consultation evaluated dioxin/ furans fish tissue concentration in the Turtle River from 1989 through 1992 and, though described to be higher in the Turtle River than in the comparison areas, the levels were well below the tolerance levels for dioxins in fish.

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GEC 41.2	Is Table 3 based upon the discredited data (DHHS, 1999; ATSDR, 2014a)?	The data presented on the "current average" column of Table 3 is the same average presented on Table 3 of the HHBRA. As such, it is now dated since year 2011 data are now available. The 2014 ATSDR assessment provided an update of potential fish consumption rates in the TRBE area based on more recent information from surveys conducted in the Savannah River area. The update of the new assumptions by ATSDR is welcome but does not disrepute prior local data used in the HHBRA.
4.2 Ecological Risks		
GEC 41.3	Was available dioxin and furans data included in the evaluation? If not, why not?	A limited amount of dioxin data was discussed in the BERA. It was agreed that the dataset for the BERA would include data between 2000 and 2007. At the time the BERA was concluded, the majority of the dioxin/furans data was only available in hardcopy format. Since most of the data handling for the BERA was electronically, this historical data was overlooked. In addition, there was a lack of sensitivity within the Region that chlor-alkali sites are associated with dioxin/furans. Once this was realized, the entire LCP Chemicals file was reviewed for dioxin data. These data were consolidated in the December 2, 2014 Dioxin Memorandum and interpreted.
GEC 41.4	In light of the toxicity sampling by the US National Park Service at Fort Puaski and Cumberland Island that did not find toxicity, does the sampling from the Reference Stations indicate they are toxic due to chemicals from the LCP Site, or failure of the lab to use appropriate protocols?	Recording of toxic expression in reference samples is not uncommon even when appropriate protocols are followed, and may be due to a variety of causes, such as pathogens in the sample, other organisms feeding on the test organisms, or other chemical factors such as redox conditions.
GEC 41.5	When questionable results are encountered, it is appropriate to repeat the test or do an analysis of the sediment to identify the toxic chemical or pathogen?	The specific toxicity tests on reference samples were not immediately repeated, but have been repeated over several years as part of an annual sediment toxicity program.
GEC 41.6	Did the EPA find any significance in the sediments being toxic to both burrowing and non- burrowing biota?	There were some statistical differences for some calculated COC sediment effect concentrations (SECs) between amphipods and grass shrimp. For example, the AET SEC for mercury was much lower for grass shrimp than for the amphipod (Table 22 in the ROD).
GEC 42.1	Is it scientifically acceptable to the EPA to use data with a less than 50% chance of being correct to establish preliminary remedial goals?	As stated in the ROD, some of the SECs were considered unreliable and were therefore not used to develop preliminary remedial goals. The far right column in Table 22 of the ROD is an average accuracy for the five SECs. Those highlighted in the table had higher accuracies. When there is much uncertainty, conservatism is used along with other lines of evidence such as results from the benthic community assessments.

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GEC 42.2	Is the likelihood of the Proposed Plan working less than 50%?	These two questions are too vague for a response.
GEC 42.3	If the data used has a likelihood of being less than 50% correct, how can a Proposed Plan based upon that data be any more correct or likelihood of success be any more than "less than 50%"?	
GEC 42.4	When questionable science is encountered, is the normal procedure to repeat the experiment to find the variables causing the low chance of being correct?	The sediment toxicity tests that were performed over several years were based on established protocols and not questionable science as purported. Results of such tests are facts that may or may not have definitive causes or explanations of their outcome. It is not the goal of toxicity testing to repeat tests ad infinitum until there is an ultimate cause(s) of the observation or until an exact SEC is defined.
GEC 42.5	Is it correct to conclude the EPA saying the data being used has much less than a 50% chance of being correct?	No. It was simply reported that only some of the data had poor accuracy and reliability.
GEC 42.6	What are the persistent low-level chronic effects expected to be present in the LCP Site marsh?	This comment is related to effects to finfish. Tissue residue hazard quotients were greater than 1 for several species of fish suggesting likely effects on finfish reproduction from both methylmercury and Aroclor 1268.
GEC 42.7	How many marsh rabbit, raccoon and river otter were sampled?	None. Estimating chemical exposure using dietary food chain models is a common accepted practice of ecological risk assessment and it avoids unnecessary killing of receptors to obtain statistically reliable tissue data.
GEC 42.8	How many studies documented the population dynamics of marsh rabbit, raccoon and river at the LCP Site? If none were conducted, why not?	None. An evaluation of population dynamics of various receptors is not a common practice in ecological risk assessment methodology.
GEC 42.9	Does the EPA have any empirical evidence or baseline monitoring to compare with the LOAEL HQs?	Yes. There are numerous baseline tissue data for finfish, crabs, mummichogs, and clapper rail to compare to.
GEC 42.10	How does the EPA propose to evaluate the Remedial Action?	This was provided in Section 7 of the Proposed Plan and is presented in Sections 10 and 13 of the ROD.
GEC 42.11	Has any data been collected to evaluate the upcoming Remedial Action or is all the data presented for the decision-making based upon models and assumptions?	Yes. See responses to previous two comments (GEC 42.9 and 42.10). The ROD is based on all of the baseline data in the RI/FS including risk assessments and all their associated uncertainties.

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GEC 42.12	If models and assumptions, when will baseline data (Baseline monitoring data) be collected for evaluating the remedy effectiveness?	Some data such as sediment dioxins/furans will be collected in the remedial design phase. A long-term monitoring plan will also be developed prior to implementation of the remedy to assess remedy effectiveness.
Table 5. Summary of Risks to Wildlife Receptors		
GEC 43.1	Please explain how the EPA can conclude a HI or HQ less than 1 when empirical data reported reproductive failure (EPA, 1997)?	The conservative dietary exposure models for the diamondback terrapin used in the BERA and in the 1997 and 1998 ecological risk assessments resulted in HQs < 1. See responses to GEC 16.4 and 16.7.
Uncertainties Related to the BERA		
GEC 43.2	Why is data that is "highly uncertain with poor accuracies" being used in the proposed Plan?	See responses to GEC 41.5 through 42.5.
GEC 43.3	When science is unreliable, is the appropriate action to repeat the data collection, analysis, or experiment?	The toxicity tests and other approaches used in the BERA followed established scientific methodologies and protocols. Many of these tests were repeated annually and the results are factual. See also responses to GEC 42.1 and 42.4.
Uncertainties Related to the Dioxin and Furans		
GEC 43.4	Why does this section ignore and not report the large volume of dioxin and furan data available for this area of Turtle River (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?	See responses to GEC 41.3 and GEC 14.10 through 15.1.
GEC 43.5	Why does the EPA feel it is so important to avoid dioxin and furan sampling until after the Proposed Plan, Record of Decision, and the Consent Decree is entered into and approved by the court?	To date, the EPA has generated a limited amount of dioxin/furans data. The remedy includes sampling during the remedial design to confirm that the Aroclor 1268 and the dioxin/furans are co-located. Should that not be the case, the ROD will have to be amended. To date, all indications are the two contaminants are co-located, likely because they were generated in the graphite anodes.
GEC 43.6	How will the EPA know what the "Remedial Footprint" is without the dioxin and furan data?	The dioxin/furans analyses to be conducted during the remedial design will confirm that the footprints developed for Aroclor 1268, mercury, lead and PAHs include any footprint developed by the RD dioxin/furans analyses. Should that not be the case, the ROD will require an amendment.
GEC 43.7	Would the dioxin and furan data be additive to the PCB risk assessment data for humans and wildlife?	Yes. Although the September 2, 2014 Dioxin Memorandum has evaluated the existing dioxin/furans data, any additional data obtained

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		during the remedial design will be evaluated and the risk assessments amended, if necessary.
GEC 43.8	How could this dioxin and furan data significantly change the Proposed Plan?	Since sampling during the mid-1990s took place predominantly in the former facility disposal area, where the graphite anodes were disposed of (see ROD Figure 20), the highest dioxin/furans concentrations were evaluated in the 2014 Dioxin Memorandum. It is very unlikely that different congeners and/or higher concentrations will be found elsewhere in the OU1 marsh.
GEC 43.9	Could the unexpected toxicity observed be due to the very toxic dioxin and furan?	It is unclear what the unexpected toxicity observed is referring to. Based on the concentrations of the dioxin congeners measured, their toxicity is low relative to the more toxic TEC congeners.
GEC 44.1	Could dioxin and furan be the variable that is accounting for the "…generally much less than a 50% chance of being correct…" noted in Section 4.2 Ecological Risks? If not, what is the factor causing the large disparity?	No. Dioxins/furans are relatively non-toxic to aquatic invertebrates. Only certain dioxin congeners are variably toxic to fish, birds, and mammals. See also responses to GEC 42.1 through 42.5.
GEC 44.2	Since this Onondaga Lake site is being used as a comparison site and as an argument to NOT test for dioxin and furan until after the Record of Decision and Consent Decree, why did the EPA NOT use the human health and ecological risk drivers found at Onondaga Lake in the LCP Site in Brunswick Risk Assessments?	See response to GEC 15.1.
GEC 44.3	Why did the EPA NOT do the same sampling at the LCP Site in Brunswick as at the Onondaga Lake Site?	It is assumed that the comment is inquiring why the EPA did not require the PRPs to conduct much more dioxin/furans analyses, as was done at the Onondaga Lake Bottom NPL Site, where about 27% of the sediment samples were analyzed for dioxin/furans. The initial ecological risk assessment conducted by the EPA did acquire the majority of the existing dioxin/furans data. Following the initial effort, the focus of the data acquired through the sampling of about 1,650 sediment samples focused on Aroclor 1268 and mercury. Relatively minor subsequent dioxin/furans data were acquired subsequent to this. It is believed that while the additional sediment data was acquired, there was a lack of sensitivity of the fact that dioxin/furans may be present at chlor-alkali sites where graphite anodes were used and disposed of.
GEC 44.4	Unlike Lake Onondaga, was dioxin and furan found widely distributed in the Turtle River and the St. Simons Sound estuarine system sediments (USEPA, 1995b)?	No. The September 2, 2014 Dioxin Memorandum, specifically Attachments 2 and 4, clearly demonstrates that only very low concentrations of dioxin/ furans were detected in the Turtle River and St.

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		Simons Estuary. In fact the memo observes the following with regards to the data acquired for the 1995 Brunswick Community Study: "Table 2 shows that the TEC totals ranged from 11.4 to 20.4 ng/kg. It is also apparent in Attachment 2 that the detection limits in the Brunswick Community Study were elevated, relative to those reported in the 1997 ERE. The detection limits in the BCS were generally ten times higher than those achieved in the 1997 ERE. As a consequence, even with the re-calculation of all the 1995 dioxin TECs using the WHO TEF of 2005, the total TECs calculated from the BCS reflect artifact of using one half the detection limit for the dioxin congeners not detected."
Relationship between Dioxin/Furans and Chlor-alkali Sites		
GEC 45.1	Why has the EPA failed to apply the risk found at the LCP site in New York to the ecological and human health baseline risk assessments for the LCP site in Brunswick, Georgia?	Each site has its own levels of contamination and site-specific exposure scenarios; consequently there is no direct application of risks from one site to another.
GEC 45.2	Are the two Sites really similar and if so in what ways? - What are the similarities or differences in salinity ranges at the Lake Onondaga site when compared to the Brunswick Georgia site? - What is the title range at the Lake Onondaga New York site compared to the Brunswick Georgia site? - What is the rainfall at the Lake Onondaga New York site when compared to the Brunswick Georgia site? - One of the water temperature ranges at the Lake Onondaga New York site when compared to the Brunswick Georgia site? - What is the annual temperature ranges for the Lake Onondaga New York site when compared to the Brunswick Georgia site? - Are the fish species found at Lake Onondaga New York site the same as those found at the Brunswick Georgia site? - Does Lake Onondaga in New York have a Spartina marsh like at the LCP site in Brunswick Georgia? - What is the water current speed in Ninemile Creek in New York and the current speed in Purvis Creek at the LCP site in Brunswick Georgia?	No, the two sites are very different.

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	- Do people fish from Lake Onondaga in New York and from Turtle River near the LCP site in Brunswick Georgia?	
GEC 45.3	Does the EPA agree the only similarity between Lake Onondaga and Turtle River is people catch and eat fish from both locations?	No. Some of the contaminants are similar and both the Lake Onondaga and LCP Chemicals sites were chlor-alkali operations. Also see response to GEC 44.3.
GEC 45.4	Does the EPA agree the dioxin and furan is more widely distributed in the Turtle River area than at Lake Onondaga, and the EPA's data documents this dispersion (USEPA, 1995b)?	No. See response to GEC 44.4.
GEC 45.5	Will the EPA add the risks found from dioxin and furan in fish to the BERA and HHBRA for the LCP Site in Brunswick, Georgia? If not, why not?	The EPA will evaluate the complete suite of dioxin/furans data, which will be supplements during the RD and, document its analysis in addenda to the risk assessments.
GEC 46.1	Does the noted uncertainty, "…the potential contribution of TEC dioxins to existing risk is unknown", still exist?	The uncertainty has been reduced since the time this excerpt from the BERA was written. The September 2014 Dioxin Memorandum consolidated all the existing dioxin data and evaluated it. A more comprehensive evaluation will take place after the acquisition of additional dioxin data during the RD.
GEC 46.2	Since the EPA has proposed a plan to remediate the LCP site in Brunswick Georgia without any dioxin furan data or any dioxin furan risk calculations for wildlife or people who consume the seafood, will the risk data from the Lake Onondaga site be used at the Brunswick Georgia site to better estimate the additive risk of dioxin and furan to the existing PCB contamination?	The comment is incorrect in stating there are no dioxin/furan data that exists. Lake Onondaga Lake Bottom NPL Site data will not be used to estimate risk posed by the LCP Chemicals Site.
5.0 REMEDIAL ACTION OBJECTIVES (RAOS) AND PRELIMINARY REMEDIAL GOALS (PRGS)		
GEC 46.3	What data does the EPA have to support the statement that the LCP Site is "…otherwise functioning marsh…"?	The point being made in the statement is that, as a result of the risk modelled in the HHBRA, it was estimated that almost 700 acres would have to be impacted to reduce risks to 1E-06.
GEC 46.4	How large is the entire marsh in the Turtle River (St. Simons Sound)?	This question is beyond the scope of the November 2014 Proposed Plan and supporting documentation.
GEC 46.5	Would remediating to 1E-05 result in removing the entire marsh, or just the contaminated areas adjoining the LCP Site?	The estimate of the acreage involved in remediating down to 1E-05 excess cancer risk was 586 acres or about 77% of the entire marsh.
GEC 47.1	How did the EPA and GAEPD come to the conclusion that achievement of a mercury SWAC PRG of 1 mg/kg for the	The genesis of 33 acres mentioned in the above quote is described below. Thiessen polygons were created, based on the sampling density. See Appendix K of the October 2014 FS for more detail on Thiessen polygon construction. Since, as is reasonable given the size of the marsh, sampling

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	entire marsh would not be appropriate and what were the decision-making metrics?	density was greater in the domains closer to the discharge points (Domain 1) than those more removed from discharge points (Domains 3 and 4), the polygons were considerably larger in the polygons located in Domain 4. Hence, during development of the FS, a decision was made to exclude from consideration for remediation the 33 acres located west of Purvis Creek, consisting of larger polygons, represented by marginally elevated single data points. To illustrate, on Figure K-6 of the FS, a single data point with a total PAH concentration greater than 4 mg/kg, contributes substantially to the 33 acre total.
GEC 47.2	What timeframe did the EPA and GAEPD consider long-term ecological harm?	Likely decades, though the modelling has not been attempted. The value of such modelling is questionable.
GEC 47.3	How long will the mercury remain in the marsh and continue the methylation process?	The mercury available for methylation in the areas targeted for removal or capping will be eliminated within an estimated two years after the start of remediation. This will remove a substantial portion of the mercury available for methylation.
GEC 47.4	How long will it take to remove the mercury contaminated marsh and complete the restoration process?	
GEC 47.5	When comparing leaving the mercury in place and the continued methylation process or removing the mercury contaminated sediments and restoring the marsh, which alternative results in the shortest impact to the marsh and estuarine system when considered over the long-term?	The latter part on this question is confusing. The impacts of removing mercury contamination, which is present in thicknesses of less than six inches in the marsh flats, will be significant not only because, besides the obvious disturbance caused by dredging, roads must be built and equipment transported, further causing disturbance. This disturbance will require long periods to return to its current state.
6.0 DESCRIPTION OF ALTERNATIVES		
GEC 48.1	What was the rationale of the EPA in excluding technologies that utilized coffer dams sheet piling or similar technologies to confine the area, reduce sediment dispersion, and facilitate dewatering of the sediments needing removal?	Cofferdams are discussed in Section 4.2.6 of the October 2014 FS.
GEC 48.2	Did the EPA compare technologies utilizing dredging versus coffer dams or sheet piling?	
GEC 48.3	If the EPA did compare the technologies, why were technologies that left contamination in place or that have a high probability of recent spending sediments selected?	This comment is too unclear for a response.
GEC 48.4	Did the EPA consider accessing the marsh via an upland route instead of by barge?	The October 2014 FS discussed accessing the marsh by various means, depending on the area under consideration.

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GEC 48.5	Was a barge used previously for the EPA Emergency Response and Removal or was the marsh accessed via the uplands?	The following is taken from Section 5.3.2 of the October 1999 Marsh Close-Out Report: "Excavation of sediment within the impacted channels involved the use of three removal approaches: (i) long reach hydraulic excavators; (ii) custom built bucket ladder barge with concrete pump; and (iii) long reach hydraulic excavator mounted on pontoon tracks (marsh buggy). Articulated off-road dump trucks and High Density Polyethylene (HDPE) piping were utilized to transport the excavated material to the processing area."
7.1 Overall Protection of Human Health and the Environment		
GEC 48.6	How many years is "…after a few generations of fish lifespans"?	Most of the fish modelled in the HHBRA have lifespans of around four-to-eight years. The exceptions are the black drum, the red drum and the sheepshead. Those fish have lifespans of around 20-to-30 years.
GEC 48.7	Which fish species are being used to determine "fish lifespans"?	
7.3 Long Term Effectiveness and Permanence		
GEC 48.8	What example of a similar marsh or estuary with *Spartina alterniflora* is being referenced as the example? Do the "…sites similar to the LCP Chemicals marsh" have tides in excess of 9 feet, Fiddler crabs, and other burrowing birds and animals?	Appendix I of the FS (Review of Technical Issues: Thin-Cover Placement in Spartina Marsh and Potential Bioturbation Effects) contains the case studies sought. The following is the abstract for one of the references cited in FS Appendix I: "A study of the capability of high salt marsh to recover from disposal of dredged material indicates that smothering high marsh could be a feasible disposal alternative but should be used with caution and should only be employed when other alternatives are economically or physically infeasible. The study investigated the impact of smothering short form *Spartina alterniflora* in Glynn County, Ga., with three types of dredged material (coarse sand, sand and clay mixed, and clay), at six depths (8, 15, 23, 30, 61, and 91 cm), and at different stages of plant growth (February, July, and November) over two growing seasons. *Spartina alterniflora* was able to penetrate up to 23 cm of each type of dredged material and exhibited biological growth and production nearly equal to that in undisturbed marsh. These depths, being within the elevation range of the marsh, indicate that accurate tidal and elevation data should be collected before disposal on a marsh and that deposition should not exceed the elevation limit of the existing marsh. The study also assessed the impact of smothering on selected species of crabs and snails. Crabs

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		were able to recolonize areas covered with up to 23 cm of clay dredged material and 15 cm of sand. Snails rapidly recolonized material placed 8 and 15 cm deep. Faunal recovery may depend on the proximity of the disposal area to natural populations and the extent of the smothered areas."
GEC 49.1	How will the cap reducing exposures to the benthic community with the 200 Fiddler Crabs per square meter, documented in the BERA, burrowing to a depth of 36 inches?	This question is unclear. The EPA has acknowledged that some bioturbation may occur in thin cap areas but that the overall concentrations of COCs in the sediment are not expected to exceed the cleanup levels.
GEC 49.2	Will the cap be compromised by approximately 8% per year?	It is unclear where the 8% comes from.
GEC 49.3	If not by approximately 8% per year, how much sediment will be brought to the surface each year by the 200 Fiddler Crabs per square meter?	
GEC 49.4	What are the other burrowing animals that will further compromise the cap materials?	The commenter is directed to Appendix I of the FS for detail. Besides fiddler crabs, oligochaetes and polychaetes are expected to borrow.
GEC 49.5	How often is the monitoring schedule to take place at the site and what will this entail?	Appendix A of the ROD contains the framework of the Long-Term Monitoring Plan. Specifics of the monitoring plan will be further developed during the RD.
GEC 49.6	How often will maintenance be performed and how will the areas be accessed?	Operation and Maintenance will be performed by the responsible parties with oversight from the EPA and GAEPD, pursuant to the Consent Decree between the United States and the responsible parties.
GEC 49.7	Will funding be in place to conduct the monitoring and maintenance or will it be contingent upon approval and appropriations by the PRPs or in the case of the EPA, Congress?	As part of the Consent Decree process, the PRPs will have to demonstrate an ability to pay and post the appropriate bond.
GEC 49.8	How much money will be set aside for the monitoring and maintenance program?	
GEC 49.9	Does the EPA the description of the monitoring and maintenance program in detail is critical to the success of the remediation?	Long-Term Monitoring is an absolutely vital aspect of the remedy. An indication of the importance the EPA gives to this monitoring is the fact that a monitoring framework has been included in the ROD and not let entirely to the RD.
GEC 49.10	If so, please do describe in detail and include in Responsiveness Summary and the Record of Decision.	

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GEC 49.11	How can the EPA claim "…long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?	The following is excerpted from Attachment I-3 (Appendix I) of the October 2014 FS. It has been abbreviated to focus on fiddler crab burrowing depths, as determined by the various investigators. • McCraith et al. (2003) explored the effect of fiddler crab burrowing on sediment mixing in a South Carolina salt marsh by looking at the distribution of two isotopes (210Pb and 137Cs) in salt marsh sediments. Burrow densities ranged from between 40 and 300 burrows per m^2 with the highest densities reported to be by the creek bank. Results indicated that crab burrowing mixed the top 8 to 15 cm (3 to 6 inches) of salt marsh sediment thereby influencing sediment composition and salt marsh biogeochemistry. • Bertness (1985) demonstrates the importance of fiddler crabs to *Spartina* primary production at a salt marsh in Rhode Island. The authors found that burrows typically extended 5 to 25 cm (approximately 2 to 10 inches) below the surface in salt marsh sediments with densities between 224 and 480 burrows per m^2. • Katz (1980) studied *Spartina* marsh sediment turnover rate and the amount of surface area increase due to fiddler crab burrowing in a Massachusetts salt marsh. Quantitative measurements of burrow volume and surface area were measured in three 5-m^2 quadrats. Depth of fiddler crab burrows were predominantly 15 cm (6 inches) or less. With an average adult crab density of approximately 42 crabs per m^2, it was estimated that over 18% of the sediment in the upper 15 cm (6 inches) was turned over by crab burrowing. • Allen and Curran (1974) examined the sedimentary structures produced by fiddler crabs in protected lagoon and salt marsh environments near Beaufort, North Carolina. Results indicate that crab distribution was determined primarily by substrate characteristics, salinity, and vegetation cover in the intertidal zone. Fiddler crab and other crab burrows were reported to be up to 15 to 20 cm (6 to 8 inches) deep. Dimensions and shapes of burrows were variable depending on the species. This evaluation supports the conclusion that the majority of studies show that fiddler crabs burrow in the upper 15 cm (six inches) of the sediment column.

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7.4 Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment		
GEC 50.1	Does the EPA have whole fish sampling in support of the statement, "In Purvis Creek, there is evidence that mercury fish and shellfish tissue concentrations have decreased over time," or is this an opinion or based upon data that is not comparable or obtained by different sampling and analysis methods?	Yes, it is found in Appendix H of the October 2014 FS. Mercury declines in Zone H (Purvis Creek) were noticed in the fillet data, not the Aroclor 1268 fish fillet data. With regards to whole body analyses, only six out the 11 species analyzed as fillet were also analyzed as whole body. Of these, three species (blue crab, spotted seatrout and striped mullet) showed a decreasing mercury trend. The blue crab and striped mullet showed a decreasing Aroclor 1268 trend. Whole body silver perch showed increasing trends for both mercury and Aroclor 1268. It should be noted that the limited number of data do not permit a statistically defensible comparison. This is only an observation of trends with the limited available data.
GEC 50.2	What is the source of the data of "evidence" the EPA is citing?	
GEC 50.3	What are the two data sets being compared to conclude there is evidence of COC reduction in fish and shellfish to make this conclusion and where can they be found in the LCP Site documents?	
GEC 50.4	Was the data collected used to conclude there is evidence of a reduction using EPA approved protocols?	The planning for all the fish data acquired until 2011 was conducted under the supervision of the late Dr. Randall Manning, with the GADNR.
GEC 50.5	Was both whole fish and filet sampling conducted?	Yes. See Appendix F of the October 2014 FS.
GEC 50.6	Where can the EPA's calculations for the bioturbation beyond the cover depth be found in the Feasibility Study?	See Appendix J of the October 2014 FS.
GEC 50.7	Is the thin cover based upon data or what is expected?	Appendix J describes the modelling work undertaken.
GEC 50.8	Who is defining "what is expected" and what are their credentials to do so?	Anchor QEA, LLC undertook the modelling work for the caps and thin layer cover. This work was reviewed by the U.S. Army Corps of Engineers at the request of the EPA.
GEC 50.9	How much sediment is brought to the surface each year by 200 Fiddler Crabs per square meter?	See response to GEC 49.1 and GEC 49.11.
GEC 50.10	What is the volume of sediment brought to the surface each year by the other burrowing animals in the marsh?	
GEC 50.11	How can the EPA claim "… isolate COCs and reduce bioavailability and mobility through burial with clean material.", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?	

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GEC 50.12	What is the cap annual failure rate calculated by the EPA, and the associated reintroduction of COC to the biota?	The long-term monitoring will determine this.
7.5 Short-term Effectiveness		
GEC 51.1	Was on-site treatment, the use of coffer dams of sheet pilling considered by the EPA or stakeholder agencies (USFWS, 1996)?	Temporary cofferdams have been used to control tidal waters during excavation. The FS does not exclude the use of temporary cofferdams as they may be needed in some situations depending on remedial design. Also see response to GEC 48.1 and 48.2
GEC 51.2	Were coffer dams used by the EPA during the removal action for the LCP Site dump during the Emergency Response and Removal Action?	
GEC 51.3	Are coffer dams a proven technology at the LCP Site?	
GEC 51.4	Did the EPA use coffer dams during the Emergency Response and Removal Action to keep sediments from entering the marsh and spreading further?	
GEC 51.5	Did the EPA use coffer dams during the Emergency Response and Removal Action to control and contain tidal waters?	
8.0 PROPOSED CLEANUP LEVELS		
GEC 51.6	Were ecological receptors such as dolphin, manatee, diamondback terrapin and mink considered in the derivation of the ecologically-based CULs? If not, why not?	Yes, indirectly through evaluation of surrogate representative receptors such as humans and river otters.
GEC 51.7	Does the EPA realize the dolphin, manatee, and mink are either species very susceptible to the COCs from the LCP Site protected species, or both susceptible and a protected species?	Yes.
GEC 51.8	Was the EPA aware of the large amount of peer reviewed journal data concerning COCs in dolphins and people prior to the release of the Proposed Plan (ATSDR, 2014b)?	Yes.
GEC 52.1	Where can the "Harm/Benefit" analysis be found?	Table 6-2 of the October 2014 FS contains information towards addressing this point.
GEC 52.2	What was the timeline utilized to evaluate harm verses benefit?	It is not clear what the commenter is attempting to convey.
GEC 52.3	Was short-term harm and restoration evaluated against the alternative of no action and long term risk to the ecosystem and human health?	Yes. The comparative analysis section of the ROD addresses this.
GEC 52.4	What were the specific decision-making metrics used for the harm/benefit analysis?	The October 2014 FS explains the logic used. To illustrate, the following is paraphrased from Section 5.1.2 of the October 2014 FS: Sediment

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		management areas are not solely defined by remedial goals. Remedies must weigh contaminant risk reduction against ecosystem impairments—in this case, including destruction of benthos, marsh vegetation, and wildlife habitat. Because remediating 33 of the 81 acres would cause significant damage to the marsh while providing minimal contaminant risk reduction (Table 5-1), the SMA-1 footprint is defined as 48 acres rather than 81 acres. The green shading on Figure 5-2 identifies areas that were excluded from the 81-acre remediation footprint.
GEC 52.5	What technologies were explored for these isolated high levels of COCs areas or areas that exceed remedial action goals?	The 33 acre "excluded areas", as the term was used in the FS, were not areas with high levels of COCs. To illustrate and referring to FS Figure 5-2 and proceeding in a north to south direction, the northern-most area excluded area had two data points with mercury concentrations of 6.8 and 6.5 mg/kg. The next excluded area had a single data point with a mercury concentration of 4.7 mg/kg the third excluded area had a data point with mercury concentrations of 4.6 mg/kg. Finally, the excluded area on the Turtle River has a total PAH concentration of 10.8 mg/kg, adjacent to another sampling point with a concentration of less than 1.5 mg/kg. The preceding attempts to illustrate that the excluded areas were not characterized by "high levels of COCs", rather moderately elevated levels, which brought into question the merit of constructing roads to access these areas the impact of removal or capping.
GEC 52.6	Did it occur to anyone in any of the stakeholder agencies that there is likely another COC causing the observed extreme range in toxicity?	It is unclear what the commenter is referring to as "observed extreme range in toxicity". The SECs are mathematical algorithms to help determine COC concentrations that could be used to predict specific effects. Also see responses to GEC 42.1 and 42.4.
GEC 52.7	What does a "robust monitoring program" entail? How often would the "robust monitoring program" be conducted? Where are the sampling locations for the "robust monitoring program"?	The framework of the monitoring program is presented in Appendix A of the ROD. The Long-Term Monitoring Program will be finalized during the Remedial Design.
GEC 52.8	When would the sampling and analysis start, and how long would the "robust monitoring program" be continued under the Record of Decision and Consent Decree?	
GEC 52.9	Will dolphins, mink, and manatees be part of the "robust monitoring program"?	They will not likely be monitored.

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GEC 52.10	Has the EPA or the PRPs done the needed baseline monitoring over the past 20 years needed for a "robust monitoring program"?	The 2000 through 2007 data contained for the most part in the BERA will form the baseline for the monitoring as well as the fish data collected by GADNR.
GEC 52.11	If not, why should anyone believe the EPA or PRPs will start to do so now?	
GEC 53.1	What does the EPA or PRPs have to show for work over the past 10 years to indicate they are competent to perform a "robust monitoring program"?	See the BERA including its appendices for this information.
GEC 53.2	Has the EPA or PRPs collected the baseline data for a monitoring program? If not, why not?	See response to GEC 52.10.
GEC 53.3	Does a monitoring baseline need several data points to track changes, which requires several sampling events over time to establish the baseline?	Yes. This is brought-out in the framework of the monitoring program contained in Appendix A of the ROD.
GEC 53.4	What is the time period for attainment of the RAOs?	The period of time to attain the RAOs may be lengthy. Implementation of the Long-Term Monitoring Program, which has built-in triggers for additional work, will determine whether remedy is performing as expected.
GEC 53.5	When will the effectiveness of the remedy be evaluated?	The remedy will be evaluated at least every five, during the remedy's formal Five Year Review.
GEC 53.6	What is the time period, specific goals, the decision-making metric by which the goals will be determined, and follow-up that will be implemented if goals are not reached?	The detail sought in this question is presented in Appendix A of the ROD, the frame work of the Long-Term Monitoring Program.
GEC 53.7	Why are the goals not specified in the Proposed Plan?	The proposed Clean-Up Levels for mercury, Aroclor 1268, lead and PAHs are presented on page 42 of the November 2014 Proposed Plan.
GEC 53.8	Why are the goal decision-making metric by which the goals will be determined and triggers for additional action implementation, or the actions to be taken, not specified in the Proposed Plan?	See Appendix A of the ROD.
GEC 53.9	Why is there no baseline monitoring to use in establishing goals to be reached? Why has there been no baseline monitoring over the past 20 years?	The accumulated baseline monitoring will indeed be used for developing the Long-Term Monitoring Program. Also see response to GEC 52.10.
GEC 53.10	Will the time period to reach the goals be specified in the Record of Decision?	See response to GEC 53.4.
GEC 53.11	What specific actions will be taken if the goals are not reached?	It depends on which goal(s) are not reached as evidenced by results of the long-term monitoring data.

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GEC 53.12	Has an analysis been conducted to compare the cost of conducting a remediation that will have a higher likelihood of success verses the cost of a "…robust monitoring program…" and the highly likely need to remobilize and conduct another remedial action due to minimal removal and significant unknown toxicity found during toxicity tests?	The analysis described in the comment has not been performed. A cost analysis of potential remedy failure can only be determined if long-term monitoring indicates further action may be needed for the remedy to be successful.
GEC 54.1	Will multiple remedial actions shave a greater impact on the marsh than one comprehensive removal action and restoration?	This all depend on the scale of each action.
Glynn Environmental Coalition letter of February 13, 2015		
GEC (2) 1.1	Did the EPA evaluate air transport and deposition of PCBs from the LCP Site as part of the LCP Marsh Remedial Investigation, Baseline Ecological Risk Assessment, or Human Health Baseline Risk Assessment?	No, the air transport of PCBs through air was not investigated in the remedial investigation for OU1 (the marsh), nor required by the EPA or the GAEPD. Since impregnation of the anodes with Aroclor 1268 ended in the early 1970s, the creation of Aroclor 1268 vapors would have ended at that time. The air monitoring work during the removal action is contained in the Administrative Record for the removal response action.
GEC (2) 1.2	Does the EPA agree that the gradient of PCBs documented across the Brunswick Peninsula is a result of air releases from the LCP Site? If not, what is the mechanism for the formation of a PCB gradient of congeners of PCBs associated with the LCP Site?	The current response action contemplates work in the LCP Chemical marsh. Research into PCB gradients across Brunswick is beyond the scope of this operable unit.
GEC (2) 1.3	Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh?	Yes. The Aroclor 1268-impregnated anodes were placed in the Outfall Pond, among other locations. From these locations the tides dispersed some of the PCB into more distant parts of the marsh and beyond.
GEC (2) 2.1	Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh and likely the deposition is according to wind direction?	See response to GEC (2) 1.1 above.
GEC (2) 2.2	Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends to Sapelo Island and is an explanation for how PCBs associated with the LCP Site crossed tidal nodes, rivers, and other natural hydrological boundaries? If not, what is the explanation for the PCBs crossing hydrological boundaries and barriers?	The extent to which Aroclor 1268 is found in the southeastern coast of the United States may be appreciated by mapping the two principal congeners found in Aroclor 1268, PCB 206 and 209. Both congeners have been found at considerably higher concentrations in Pamlico Sound. North Carolina, a distance of 450 miles from Brunswick, than at Sapelo Island. This is likely because Aroclor 1268 was used in multiple ways. Aroclor 1268 was used not only as a dielectric sealant (the use at this site) but also as: a) in marine varnish, b) for dipping gloves to impart chemical

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		resistance, c) as a flame retardant in silicon rubber, and d) in asphalt as a flame retardant coat on paper. In addition, U.S. Navy submarines and surface ships used a mixture of the Aroclors 1254, 1260 and 1268 in various ways. The highest concentrations have been found in double backed adhesive tape, ventilation bedding components, aluminized paint, ventilation gaskets and ventilation cooling coil insulation, etc. Note that, on the basis of testimony and available records provided by former Allied Chemical employees, Allied Chemical purchased about 40,000 pounds of Aroclor 1268 per year for use at the Site. Monsanto's, Inc. (the producer of Aroclor 1268) limited available records reflect the following pounds of Aroclor 1268 produced: Year — Pounds Produced 1953 — 254,985 1954 — 163,055 1955 — 63,202 1963 — 315,556 1970 — 384,000 In a study entitled "Temporal Trends of Aroclor 1268 in the Taunton River Estuary: Evidence of Early Production, Use and Release to the Environment" (Cantwell *et al*, 2006), dated sediment cores showed the presence of PCBs, including the Aroclor 1268 congeners, appearing in about the year 1929 and peaking in concentration around 1955. The Taunton River Estuary is over 1,000 miles from Brunswick.
GEC (2) 2.3	Have PCBs been found past the Reference Stations at Troup Creek and Crescent River?	Yes, Aroclor 1268 has been found in both reference stations. Tables 1and 2 of the ROD contains the concentrations of Aroclor 1268 in sediment and surface water in both reference stations. The BERA contains sediment data for both reference stations. Note that Table 2 shows, with time, as detection limits decrease, PCBs have become detectable at extremely low concentrations. PCBs are persistent and widespread in the environment.
GEC (2) 2.4	Were dioxins and furans found at the Reference Stations? If so, could the source be the LCP Site?	Table 1 of the ROD shows the dioxin toxicity equivalency concentrations (TECs) in sediment at the reference stations. No surface water samples from the reference stations were analyzed for dioxins. Dioxins are

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		ubiquitous in the environment and may or may not be related to the Site. Note that sediment samples in the St. Simons Estuary analyzed for dioxins/furans showed extremely low, almost non-detectable amounts of those contaminants. Please review Attachment 2 of the September 2, 2014 Dioxin/Furans: LCP Chemicals Superfund Memorandum for more information on dioxin/furans in the St. Simons estuary.
GEC (2) 2.5	Could the source of observed toxicity at the Reference Stations be from the air transport of toxic compounds from the LCP Site? If not, why not? What additional efforts were made to identify the cause of toxicity at the Reference Stations?	It is highly unlikely because invertebrates are known to be insensitive to dioxins due to the general lack of the AhR receptor, in contrast to fish, birds and mammals. Further, it is highly improbable that particulates as heavy as Aroclor 1268 could be transported by air from the Site to the reference stations. Correlations with various chemical concentrations were used to identify causes of toxicity, but no statistical correlations were found. Mortality in reference stations is not uncommon due to a combination of chemical and non-chemical stressors.
GEC (2) 2.6	Did the EPA look at nearby toxicity sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski? If not, why not?	No. The toxicity work was limited to the Site and the two reference stations.
GEC (2) 2.7	Will the EPA consider using the sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski as the Reference Stations for the LCP Site?	Yes, the EPA could consider using the Cumberland Island and Ft. Pulaski stations as reference stations. Note that a quick search on the World Wide Web reveals that neither of these U.S. National Park sampling stations have escaped anthropogenic impacts.
GEC (2) 2.8	Did the EPA ever consider the Reference Stations were within the area where chemicals and other compounds were released from the LCP Site? If not, why not?	There are very few reference stations, if any, where PCBs, mercury, and dioxins would not be detected. What is important is that the sediment and surface water data shown on Tables 1 and 2 of the ROD are non-detect to very low. With improvement in analytical techniques, detection limits have dropped to less than one part per trillion for Aroclor 1268 and mercury.
GEC (2) 2.9	If the EPA did evaluate air transport and deposition, what was the estimated volume of PCBs distributed via air transport?	See response to GEC (2) 1.1 above. The EPA does not believe that 45 years after the end of anode impregnation and creation of Aroclor 1268 fog, the evaluation of air releases in the RI/FS would significantly affect or improve the development of a remedy for the sediments in the LCP Chemicals marsh.
GEC (2) 2.10	Did the EPA evaluate the extensive record of air releases recorded by the Georgia Environmental Protection Division and documented in the LCP Site Removal Administrative Record?	
GEC (2) 2.11	Does the GAEPD a documented air releases in the LCP Site Removal Administrative Record discuss the high temperature	

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	of the gasses released? What was the composition of the gasses released?	
GEC (2) 2.12	Can heavier than air chemicals like PCBs and Dioxin/Furan be air transported in a release of heated gasses?	The Site file does contain records describing an "Aroclor fog" created during anode impregnation, however, the same records indicate that the fog was carried only several hundred feet before the wind dispersed it.
GEC (2) 2.13	What is the EPAs explanation for the gradient of PCB congeners associated with the LCP site that extend out from the Site?	The most likely transport mechanism was the twice-a-day tides that dispersed the Aroclor 1268 in the disposed anodes during the period when Aroclor 1268 initially was used in the early 1960s and the present. Since the early 1960s, the tides have come in and out about 39,000 times.
Environmental Stewardship Concepts Comments/Responses		
ESC 1.1	What sampling will be undertaken to determine the full extent of contamination in the Turtle River estuary system as a result of the LCP facility activities? This question is based on the data showing Aroclor 1268 congener profiles on Sapelo Island sediments, human tissues and in dolphins from the Turtle River?	In the mid-1990s, as part of the Brunswick Community Based Study, the EPA sampled the sediment in rivers and the marshes of the St. Simons Estuary. The results are documented in the February 1997 report entitled Characterization and Spatial Distribution of Contaminants in Surface Water, Sediments and Fish Within the Tidal Reaches Surrounding Brunswick, GA. Ninety Five sediment samples collected from the Turtle River Brunswick Estuary (TRBE) were analyzed for purgeable organic compounds, extractable organic compounds, pesticides/PCBs and metals. A subset of the sediment samples were analyzed for dioxin and furans. Since the comment focuses on Aroclor 1268, this response will be tailored to address the Aroclor 1268 in river and marsh sediments. The mid-1990s, sediment sampling showed that, of the 95 Aroclor 1268 results, 32 were non-detects, with an average detection limit of 0.43 mg/kg. The average concentration of the 57 sediment samples with detected Aroclor 1268 was 0.25 mg/kg. More recently, work performed by Wirth, et al. 2014, reports that the geometric mean concentration of total PCBs, including Aroclor 1268, in the Brunswick area is 0.079 mg/kg. The geometric mean for Sapelo Island sediment samples is 0.00021 mg/kg. The historically low and more recent lower concentrations of Aroclor 1268 do not argue for expansion of the sampling program to Sapelo Island, where other investigators are monitoring the sediment quality. With the exception of long-term monitoring of fish and shellfish in the TBRE and sediment sampling of dioxins, there currently are no plans for

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		additional sampling. The focus is to remove the most contaminated sediments located in the LCP Chemicals marsh in order to reduce any further contaminant migration and to reduce human and wildlife exposure to acceptable levels.
ESC 1.2	How will EPA incorporate new methods for cleaning up contaminated sediments that have not been considered in the FS?	The FS documents the technologies screened and retained. Without more specificity as to which methods are being referred to, it is not possible to properly respond to this question.
ESC 1.3	What corrections will EPA make to the Human Health Risk Assessment to account for the errors and omissions in human exposures and toxicity of contaminants, considering that site use is greater than estimated, fish consumption is greater than the value used and that dioxin contribution has not been included in the toxicity of site contaminants?	The HHBRA was conducted according to guidance and utilized local data regarding fish consumption rates consistent with other studies in the region. The high quantity fish consumer was assumed to eat 73 meals per year, with 4.75 ounces per meal (Appendix B of the HHBRA). Although the number of meals per year is higher than the Savannah River study (see Table 4 in Berger et al. (1999), which suggests a yearly consumption rate of 64 meals/year, the quantity eaten per serving in the 1999 study is about 13oz (similar to eating two 6.5 oz cans of tuna fish per serving). The ATSDR 2014 interview of nine individuals from Sapelo Island suggests higher consumption rates but is lacking in statistical power relative to the Berger et al study. The HHBRA only evaluates risks from fish caught from Zones D, H, and I of the TBRE (about two square miles) and does not include consumption of fish caught in other zones of the TBRE or elsewhere in the local area. The EPA has reviewed available dioxin data and consolidated it in the September 2, 2014 Dioxin/Furans Memorandum. It also evaluated with the risk posed by the dioxin/furans still in place, following the removals. The memo concluded that the dioxin/furans are very likely co-located. To confirm this belief, the ROD's Selected Remedy requires additional sampling during the remedial design (RD) to confirm this belief. Should co-location not be confirmed by the RD sampling, the ROD will have to be amended.

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ESC 1.4	How does the Proposed Plan address the contamination of dolphins and other marine life that are not now included in the BERA or in another aspect of the RI/FS?	Detailed dolphin data were not available at the time of the HHBRA; however the results of the HHBRA and the BERA (effects on the river otter) provide a range of risks that are assumed to apply to dolphins. The EPA considers the bottlenose dolphin to also be at risk and believes that the proposed cleanup action in the LCP Chemicals marsh will reduce risks to acceptable levels. A long-term monitoring effort of fish and shellfish concentration trends will help ensure the tissue goals are met. If they are not met, then additional measures may be taken to further reduce risks. See also responses to Glynn Environmental Coalition regarding dolphins.
ESC 1.5	What additional sampling or analysis will EPA conduct in order to account for the omission of fate and transport of PCBs and other contaminants by Spartina grasses?	No additional data collection is planned for contaminants in Spartina. The EPA (1997) and PTI (1998) ecological risk assessments concluded that there were no adverse risk to manatees which were assumed to eat Spartina. The 2011 BERA included Spartina tissue data in the transport through the food chain to marsh rabbits and also concluded no adverse risks. See also responses to Glynn Environmental Coalition regarding Spartina.
ESC 1.6	Will EPA require ecological risk evaluation of dolphins, based on all mammalian data, such as mink and other marine mammals and evaluate the toxicity to mink and river otter on the effects (toxicity) of PCBs as congeners?	See response to ESC 1.4 regarding dolphins. The river otter was used in the BERA as a surrogate species for mink for exposure to Aroclor 1268. The limited PCB congener data in sediment and tissues were not used. An important factor is that none of the non-ortho or mono-ortho PCB congeners (those congeners on the World Health Organization toxicity equivalence factors list that likely generate most toxicity) were identified in samples from the site area. The BERA used toxicity of Aroclor 1254 (which does contain more toxic congeners) to assess effects to the river otter, which resulted in lowest-effect hazard quotients at 0.4 and no-effect hazard quotients at 4, suggesting some risk to the river otter. This information was used to develop remedial goals.
ESC 1.7	The toxicity evaluations of the sediment have not adequately captured the anticipated toxicity, thus, how will EPA re-evaluate the sediment toxicity to account for this information?	The comment is unclear what is meant by “anticipated toxicity” or what “this information” is. The BERA evaluated over 200 sediment toxicity tests to benthic organisms in relation to contaminant concentrations and other potential stressors in the sediment samples. Numerous sediment samples were also use to estimate bioaccumulation factors into various biota (i.e., fiddler crab, blue crab, mummichog, finfish and Spartina) to assess potential toxicity through the food web to various receptors.

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		Potential toxic effects from incidental ingestion of sediment by humans were also evaluated.
ESC 1.8	Will EPA require measurement and assessment of dioxin in the site contaminants, EPA having included reference to the cleanup at Lake Onandoga that has both PCBs and dioxins, and obviously admits the occurrence of dioxins in this type of site.	The dioxin memorandum (EPA 2014) provides information on available dioxin data in the site area and suggests that dioxin congeners are co-located with Aroclor 1268. Thus, cleanup of Aroclor 1268 is also assumed to capture any associated dioxins. The EPA will require sediment sampling of dioxins in the LCP Chemicals marsh during the remedial design phase to confirm this co-location relationship.
ESC 2.1	Will EPA require alteration of the assessment of damage to the marsh to account for the factual errors present in the statements of damage to the marsh based on out-dated methods that are not used in working in salt marshes?	It is assumed that this comment refers to physical damage to the marsh from remedial actions. The Feasibility Study provided the number of acres that would be disturbed for each alternative to meet preliminary remedial goals, including disturbances to the marsh to access the removal areas. It is unclear which factual errors the reviewer is referring to or what out-dated methods that are not used. It is not simply the number of acres that could be remediated but the level of commensurate risk-reduction that would be achieved between the 48 and 18-acre alternatives. The proposed remedy achieves the threshold of environmental protection while providing less disturbance to the existing marsh. The EPA acknowledges that there are various techniques that can be used to minimize construction disturbance to salt marshes and will encourage the use of such techniques in the design phase.
ESC 2.2	What provisions in the Record of Decision will EPA make for the consequences of rising sea-level and climate change on the remedy and the site?	The hydrodynamic modeling that was conducted (Appendix B of the FS) to assist in the design of stream bed and sediment cap stability, took into account effects that could occur during maximum spring flood tide conditions, 100-year flood conditions, and during a hurricane storm surge. These data were used to assist in remedy selection. Climatic conditions stronger than the 100-year flood, rising sea levels or a stronger storm surge were not modelled. See also response to SELC 14.1 (IV, C).
ESC 3.1	**Sediment Removal vs. Capping**	The EPA agrees that actual removal of contaminated sediment from the marsh is more permanent. However, the available vertical profile data, presented as figures in the ROD, demonstrate that contaminant concentrations drops to very low concentrations within nearly six inches of the marsh surface on the marsh flats. In addition, contaminant concentrations on the marsh flats that flank the tidal creeks are far lower than the creeks themselves. Hence, the rationale for where thin-layer covers can be reasonably successfully used is where sediment

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		contaminant concentrations are a relatively thin veneer overlying the marsh surface and where concentrations are also relatively moderate. It is also acknowledged that thin-layer covers will be subject to bioturbation, which is why there will be a monitoring program to ensure that this aspect of the remedy is effective. Thin-layer covers will only be applied to very low energy environments (i.e., in areas of minimal tidal/storm surge areas). This portion of the remedy is not to eliminate contamination, but to substantially reduce toxic exposures and contaminant mobility. Armored caps are only proposed in the tidal creeks, and they have been successfully used in major tidal rivers that are also subject to substantial flooding.
ESC 3.2	**Salt Marsh Grasses**	The 2011 BERA and previous risk assessments (EPA 1997 and PTI 1998) collected Spartina tissue for use in contaminant transport food chain models into consumers of salt marsh grass. The pathway of contaminant movement via Spartina resulted in minimal risk to the receptors evaluated. See also responses to GEC's concerns with Spartina. The EPA has added a requirement for salt marsh restoration to disturbed areas. Spartina re-plantings are a likely outcome of the restoration plan that will be developed in the remedial design stage.
ESC 4.1	**Estuary Use by People**	Although the LCP Chemicals marsh is not readily accessible for recreational use, there are people that do visit, trespass and/or fish within the Site. It was never assumed that people do not use the area. In fact, the HHBRA utilized local information about fishing patterns in the TRBE and assumed that a person could eat about five meals/month from Zones D, H, and I of the TRBE alone. These three zones comprise about 15% of the TRBE.
ESC 4.2	**Dolphins**	EPA agrees that fish, humans and dolphins are likely at adverse risk from mercury, PCBs, and other contaminants. The remedy selected to remove and cap sediments in the LCP Chemicals marsh is expected to reduce exposure to mercury and Aroclor 1268 to acceptable levels. Long-term monitoring is included in the ROD to ensure that the remedy is effective.
ESC 4.3	**Human Health and Ecological Risk Assessments**	The limited available dioxin data was not used to quantify numerical risk estimates in the HHBRA. The EPA (2014) dioxin memorandum evaluated dioxin data and has determined that it is largely co-located in sediments with Aroclor 1268. Thus, removal of Aroclor 1268 is expected

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		to also remove any co-located dioxins. Additional sediment dioxin data will be collected during the remedial design phase to confirm this. In the HHBRA, the high quantity fisher was modelled to consume 73 meals/year from Zones D, H, and I of the TRBE (Appendix B of the HHBRA), not the frequency of 40 meals/year mentioned in the FS. Other meals that a person obtains from other zones of the TRBE or elsewhere were not included because the result would be less conservative (e.g., include fish caught is larger areas upstream in the TRBE) and not site-specific enough to assess exposures likely related to contaminants in the LCP Chemicals marsh. It is not accurate to assert that the Troup Creek reference station is equally as contaminated as the LCP Chemicals marsh without supporting information. Data presented in the RI/FS and BERA clearly indicate otherwise. It is acknowledged that mercury and PCBs have been detected at very low levels in Troup Creek. This is not surprising as mercury and PCBs are contaminants that can be detected throughout the world. The Crescent River reference station also has been an appropriate reference location. With respect to cleanup levels (CULs), the Proposed Plan and Record of Decision acknowledge that not all segments of the marsh and creeks will achieve CULs and that residual risks may occur. It is required to implement a long-term monitoring plan when residual contamination is left in place. The ROD includes a framework of the monitoring plan that will be developed with stakeholder input during the remedial design phase. It is expected that virtually all monitoring components will occur more frequently than once every five years. The five-year review process is a mandated review to document if the remedy is protective and whether other measures should be taken to achieve decision goals.
ESC 5.1	**Total Acreage of Cleanup**	The 81 acres represented the maximum area that could be affected if the CUL for mercury was 1 mg/kg in sediment (for PCBs the number of acres was much less). However, the concentration of 2 mg/kg mercury in sediment is also considered protective of all receptors. The comparative evaluation in the FS was to determine the spatial variability of where potential residual mercury concentrations less than 2 mg/kg could occur.

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		The concentration of 1 mg/kg mercury in sediment is not "high level" from the perspective of the risk assessments. In addition, it is important to understand the genesis of 81 acres mentioned in the comment. Thiessen polygons were created, based on the sampling density. See Appendix K of the October 2014 FS for more detail on Thiessen polygon construction. Since, as is reasonable given the size of the marsh, sampling density was greater in the domains closer to the former discharge points (Domain 1) than those more removed discharge points (Domains 3 and 4), the polygons were considerably larger in the polygons located in Domain 4. Hence, during development of the FS, a decision was made to exclude from consideration for remediation the 33 acres located west of Purvis Creek, consisting of larger polygons, represented by marginally elevated single data points. To illustrate, on Figure K-6 of the FS, a single data point with a total PAH concentration greater than 4 mg/kg, contributes substantially to the 33 acre total. Hence the largest remedial footprint considered in the FS was 48 acres (or 81 minus the 33 acres).
ESC 5.2	**Sapelo Island**	The selected remedy, removal/capping of contaminated sediments in the LCP Chemicals marsh, is expected to result in lower concentrations of PCBs and mercury in local seafood. Finally, in contrast to comment's assertion that the residents of Sapelo Island have "dangerously high levels of PCBs in their bodies", scientists with the Center of Disease Control have publicly stated the following: • The total levels of PCBs in the nine participants who participated in their study were similar to national averages, based on a person's age; • Some specific types of PCBs in the participants were higher than the national average, and some were lower than the national average; and • The total PCB levels **were lower than those known to cause health problems**.

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Institutional Controls at the Site		
ESC 8.1	**Issues with Institutional Controls**	The EPA agrees that ICs do nothing to reduce contamination. The one sentence referred to in the Proposed Plan should have only mentioned the long-term monitoring plan and should not have included ICs. The EPA works cooperatively with States on health issues related to federal hazardous waste sites, but does not issue fish advisories. The State of Georgia is responsible fish consumption advisories and recommendations to provide for a more meaningful advisory for the TRBE should be directed to the GADNR. The HHBRA and the ATSDR 2014 Public Health Assessment support the need for the advisory to deter (not prevent) unlimited consumption of seafood from the TRBE before, during and after implementation of the remedy, until such time when mercury and PCB concentrations in seafood fall within acceptable levels.
Fish Consumption Advisories at the Site		
ESC 13.1	**The Solution**	See previous response above (ESC 8.1).
Site Boundaries at the Site		
ESC 16.1	**Table 1: OU1 acreage estimates**	The existing OU1 boundary has been sufficiently characterized to select a remedy to clean up contaminated sediments in the LCP Chemicals marsh. It is recognized that contamination has migrated due to tidal action over the decades. However, the ROD is currently focused on OU1 so that cleanup can occur, rather than delay for more expanded studies over a larger geographical area. The long-term monitoring plan will assist in determining how successful the OU1 remedy will be in reducing exposures to acceptable levels. If unsuccessful, then other actions will need to be implemented to achieve the remedial action objectives. Most of the differences in the OU1 acres have been between earlier estimates in the late 1990s and 2000s of marsh and creeks based on topographic maps and GPS data, and the more recent LiDAR data collected during the FS. The more accurate acres calculated in the FS (~662 acres of vegetated tidal marsh and ~98 acres of tidal creeks) will be used in the ROD.

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		Finally, the extent to which Aroclor 1268 is found in the southeastern coast of the United States may be appreciated by mapping the two principal congeners found in Aroclor 1268, PCB 206 and 209. Both congeners have been found at considerably higher concentrations in Pamlico Sound. North Carolina, a distance of 450 miles from Brunswick, than at Sapelo Island. This is likely because Aroclor 1268 was used in multiple ways. Aroclor 1268 was used not only as a dielectric sealant (the use at this Site) but also as: a) in marine varnish, b) for dipping gloves to impart chemical resistance, c) as a flame retardant in silicon rubber, and d) in asphalt as a flame retardant coat on paper. In addition, U.S. Navy submarines and surface ships used a mixture of the Aroclors 1254, 1260 and 1268 in various ways. The highest concentrations have been found in double backed adhesive tape, ventilation bedding components, aluminized paint, ventilation gaskets and ventilation cooling coil insulation, etc. Note that, on the basis of testimony provided by former Allied Chemical employees, Allied Chemical purchased about 40,000 pounds of Aroclor 1268 per year for use at the Site. Monsanto's, Inc. (the producer of Aroclor 1268) limited available records reflect the following pounds of Aroclor 1268 produced: Year — Pounds Produced 1953 — 254,985 1954 — 163,055 1955 — 63,202 1963 — 315,556 1970 — 384,000 See also responses to GEC (2) 2.2.
Modern Construction Methods for Salt Marsh Remediation		
	Use of Alternative Technologies	See Response to Technical Comment #7.

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Southern Environmental Law Center Comments/Responses		
SELC 3.1 (I)	The potentially responsible parties have drawn the boundaries of the area that needs to be addressed by the LCP Chemical Site cleanup too narrowly.	See response to Technical Comment #1. In addition, it is EPAs policy that at large/complicated sites where some decisions can be made, the Site is broken into Operable Units (OUs) to facilitate site remediation. This has been done at the LCP Chemicals Site. In addition, EPA policy at sediment sites promotes the idea of "remove source first" (OSWER Directive 9285.6-08, Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites). The concept is that until the sources have been remediated, other remediation (including natural processes) cannot effectively result in contaminant reductions. Again, this approach has been followed at LCP, starting with the marsh removal action and continuing with the current proposed remedial action in the marsh, designated as OU1. The other relief suggested by SELC, such as establishing food banks for the subsistence fishers and cancer victims is not within the EPA's authority. With respect to the natural resources damage assessment (NRDA), this is part of the CERCLA process but it is not within the legal jurisdiction of the EPA as the Agency is not a natural resource trustee. The NRDA and any liability settlements are the responsibility of the State of Georgia, the NOAA, and DOI/FWS, as well as other natural resource trustees. The EPA's role in the NRDA process is only to "coordinate" our RI/FS studies with the Trustees such that when possible the EPA has generated data in such a way as to be useful to the Trustees in the NRDA process. The EPA has satisfied all requests from the federal and State trustees in a timely manner.
SELC 5.1 (II)	Sampling density is inadequate, especially in Purvis Creek.	The EPA contends that the determination of the extent of contamination (EOC) is sufficient for the RI/FS and therefore for remedy selection. The goal of the sampling within the marsh area is to understand the nature and extent of the marsh contamination and to evaluate risks through the risk assessments. The nature and extent along with the risk assessments are then used to evaluate remediation alternatives in the FS. The EPA believes that these goals have all been met.

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		Marsh sampling has been ongoing since 1994, with a combination of grid node sampling and subsequent sampling directed by the results of the grid nod sampling or other directed marsh sampling which suggested a source area or concentration gradient. The marsh sampling included water surface sampling, but focused upon sediment sampling and organism tissue sampling (biomonitoring). The data historically generated led to the identification of source material along the marsh border, which was removed as part of the 13-acre removal action. The data generated to date, both sediment data and biomonitoring/tissue data, support the conclusion that the nature and extent of contamination of the four COCs is known within the marsh. It is believed that additional sampling would identify the presence of site COCs particularly Hg and PCBs, as suggested by the comment, however, the EPA believes that the concentrations found would be similar and/or consistent with the concentrations of those contaminants in the area of the sampling.
SELC 5.2 (III)	Exposure levels do not adequately protect human health and the environment.	The EPA has conducted the human health risk assessment in accordance with Agency policy and guidance. For the fish consumption scenario, EPA has evaluated two human receptors: 1) recreational fishing – used consumption rates from EPA guidance based on data for the southeastern U.S.; and 2) high-quantity fish consumer – used site-specific consumption rates based on the creel survey done for the Brunswick area. The consumption rates for both receptors conservatively assume that the fish consumption advisories (issued by GADNR) are not followed by area anglers.
SELC 6.1 (III, A.1)	The Human Health Baseline Risk Assessment (HHBRA) underestimates the consumption of contaminated food.	The HHBRA assumed that all of the fish consumed was caught from Zones D, H, and I of the Turtle River/ Brunswick Estuary (TRBE) every year for 30 years with no assumed change in fish tissue concentrations over time. In addition, the HHBRA assumed that the high quantity fish consumer eats 27 grams/day or 9,855 grams/year at an average meal size of 134.6 grams; which results in 73 meals/year from the affected zones (Appendix B of the HHRA). This did not include additional seafood meals originating elsewhere along the Georgia coast or inland waterways. This is also consistent with one of the conclusions of the Brunswick fish study, which stated that most study participants did not fish in the restricted area and the few that did were aware of the advisory. The

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		ATSDR Sapelo Island work likely does not rise to the level of being called a study because of the small sample size of only nine individuals that fished in various coastal and interior waterways around the island. The activities of the nine individuals in the study may not be reflective of those that catch and eat all their fish from the affected TRBE zones. The EPA agrees that fishing advisories may not keep certain community members from eating contaminated food, which is why cleanup of the most contaminated sediment portions of LCP Chemicals marsh is proposed. The cleanup, along with a robust monitoring program, is to ensure that the contaminants in fish tissue decrease to acceptable levels.
SELC 7.1 (III, A.2)	The assumption that there has been a decrease in fish contamination is flawed.	Appendix F of the Feasibility Study (FS) was an attempt to decipher any trends in fish/shellfish concentrations. Since 1991, over 700 composite samples of more than 2,600 individual fish have been collected in the TRBE. Appendix F focused on Zones D, H, and I of the TRBE, and the EPA agrees that not all species show a decline in Aroclor 1268 and/or mercury, and that statistical power is limited for these particular zones (which is where data for the HHBRA were used). However, the general decline in mercury tissues since 2002 is encouraging. The long-term monitoring plan is expected to include sufficient tissue sampling for greater statistical analyses of trends so that achievement of tissue target levels will have good confidence.
SELC 7.2 (III, A.3)	Groundwater, surface water and Operable Unit 3 (OU3) have not been taken into account.	Appendix A of the FS provides details of the potential for hydraulic connection between contaminated groundwater from the uplands area (OU3) and the marsh. When there were filtered and unfiltered samples, the model used unfiltered data in the calculations. The model suggests that there may be some small level of potential re-contamination of the LCP Chemicals marsh, but that it is insignificant with respect to selecting a cleanup remedy. The proposed remedy of sediment removal (with clean layer placement) and capping took into account the potential for groundwater re-contamination through the removed areas and caps. The long-term monitoring plan will include monitoring of surface water and sediment quality so that the remedial action objectives and cleanup goals are met. Potential cumulative risks from multiple pathways of exposure (e.g., upland soil, groundwater, fish and shellfish) could occur; however,

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		individuals fishing in the TRBE are not likely to drink contaminated groundwater from the upland site. Similarly, most contamination in upland soil has been removed, and access restrictions remain in place. A person briefly trespassing through the upland Site areas today would receive negligible exposure to contaminants relative to fish consumption measured on a daily basis for 30 years. Fish and shellfish are addressed separately because it is assumed that only shellfish is consumed for 30 years or that only fish is consumed for the duration. If they were combined, then the HHBRA would have had to assume some dietary fraction to account for the percent of fish versus the percent of shellfish consumed during each seafood meal.
SELC 8.1 (III, B)	The ecological exposure levels are not protective enough.	The EPA does not dispute the findings that PCBs, which include congeners consistent with Aroclor 1268 (e.g. PCBs 206/209), which are present at the LCP Chemicals Site, have been found distant from the LCP Chemicals Site. What is not known is what fraction of the PCBs in dolphins is actually from the LCP Chemicals Site. While this information does not change the exposure of dolphins to PCBs or any risks posed by that exposure; the information is relevant to directing actions at the Site. Regarding the use of dolphin within the BERA, CERCLA ecological risk assessments do not and are not intended to "predict" actual risk. They are done to provide an objective evaluation of risk such that the EPA may conclude that the existence of risk is real or probable; which gives the EPA statutory authority to conduct the FS and direct appropriate remediation. Secondly, the BERA provides an objective means of evaluation the remedial alternatives. The conclusions of the BERA generally provide the basis for the remediation goals. The BERA meets these objectives. It would be unlikely that the use of the dolphin as a model for PCB exposure and Site risk would result in a conclusion of greater ecological risk than already exists, and it would not be expected to affect the remediation selection process. Undoubtedly, the final conclusion would be that there is some degree of risk posed to the dolphins which feed in Purvis Creek and nearby in the Turtle River. Back calculations on these exposure models, a common way of calculating a preliminary remediation goals (PRGs), would be anticipated to result in less stringent sediment contaminant levels because of the limited exposure periods directly to the Site. The EPA contends only that

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		the use of dolphins or other highly mobile species with large home ranges in risk assessment models, contributes to high uncertainties when making localized site-specific action decisions. The selected remedy will reduce concentrations in sediment and fish in the Site vicinity.
SELC 9.1 (III, C)	The exposure range selected is not acceptable.	Regarding fish consumption, see response to SELC 6.1 above. Regarding sediment exposure, the HHBRA conservatively assumed that people do occasionally go out into the marsh and incidentally ingest sediment, even though the softness of the marsh sediment prevents regular access by foot. The risk estimate of 2E-04 for the high quantity fish consumer does indeed exceed EPA's risk range of 1E-04, so this exceedance resulted in "triggering" a remedial action. The 2E-04 risk estimate was used to develop sediment remedial goal options as described in the EPA's letter to Honeywell dated November 30, 2011 regarding Human Health Risk Assessment for the Estuary, OU1 (See Appendix G of the Feasibility Study). The sediment remedial goal options were set at a cancer risk of 1E-04 and a non-cancer hazard index of 1.0.
SELC 10.1 (III, D)	The potentially responsible parties want to leave contaminant hot spots in the marsh.	Surface weighted averaging can be misused in exposure assessments by diluting specific exposure areas of high concentrations with low concentrations. However, achieving CULs in sizeable wetland or creek areas is better served by meeting risk-based SWACs rather than examining individual point-by-point exceedances. A few isolated individual sample "hot spots" may be tolerated, provided that overall risk reduction goals are achieved at the proper spatial scale without commensurate disturbance to the ecosystem, or to simply reduce costs, or to avoid actions in difficult locations.
SELC 10.2 (IV, A)	The site is a volatile marsh environment unsuitable for a thin layer cover.	As noted by these comments, the marsh at the LCP Site has areas of high water velocity and potential for erosion. In addition, there is the potential for storms, including hurricanes, which can significantly impact the area. However, with respect to the placement of the thin layer cap, the areas targeted for these caps are lower energy areas within the marsh where scouring is not anticipated (see ROD Figure 29 and FS Appendix B). The areas targeted for thin layer capping are also areas of intermediate

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		contamination levels where the contamination is generally limited to the upper 4-to-6 inches. The sediment concentrations, along with the limited depth of contamination, mean that, while the surface concentration may be of concern, the total mass of contamination present is not great. This is an important point relative to thin layer cap functioning. The comments suggest that the goal of the thin layer cap is to isolate the contamination, analogous to the use of a standard in-situ cap. Complete or permanent isolation of the contaminants is not anticipated to be the result of the use of the thin layer cap. Rather, it is anticipated that the organisms present in the marsh such as fiddler crabs, will burrow through the cap material and that the resulting "bioturbation" will mix the thin layer cap material into the existing marsh sediments. The result of the mixing will be a decrease in the surface sediment concentrations of the site contaminants, not an isolation of the contamination. It is anticipated that the long term stability of the marsh surface will not change with the addition of the thin layer cap material because it will be incorporated into the marsh. The incorporation will take time, and the progress and status of the thin layer cap will be monitored post construction to insure that it functions as anticipated. If the thin lay cap fails, because of storm erosion for example, the PRPs will be responsible for repairing the cap or potentially implementing a different remediation strategy for these areas. The alternative to thin-layer covering (or conventional capping) is the destruction of an additional 28 acres (see FS Table 6-2) of marsh.
SELC 13.1 (IV, B)	The integrity of the thin layer cap will be compromised by bioturbation.	The comment appears to confuse in-situ capping, which is an isolation remediation strategy, with thin-layer capping, which anticipates and may actually desire the mixing which occurs with bioturbation. As discussed above, the thin-layer cover proposed for areas within the marsh does anticipate the mixing, which as the comment notes, will occur by marsh organisms such as fiddler crabs. It is expected that the mixing of contaminants with the clean cap will not exceed the sediment cleanup levels.
SELC 14.1 (IV, C)	Sea-level rise has been ignored.	The impacts of sea level rise are difficult to predict on a local scale; and the comment is correct in that the effects of sea level increases were not explicitly made. However, since contaminants are being left in place by the proposed remediation CERCLA requires that the Site be reviewed every five years to assess the status of the remedy. Should sea level rise,

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		or other factors which alter the hydrodynamics of the marsh or alter the ecosystem or the physical status of the remedy, the five year review plan will be the means by which the EPA can address these issues.
SELC, 15.1, (IV, D) - Summary of Flaws with Thin Cap Technology		
	Destruction of capping/cover material by scouring due to tidal action.	The thin layer cap is to be used in low energy locations within the marsh (see ROD Figure 29 and FS Appendix B). In addition, the integrity and performance of the thin layer cap will be monitored and repaired if necessary, and if it does not perform as anticipated with respect to contaminant reductions in biota, this portion of the remediation will be reassessed.
	Destruction of capping/cover material by hurricane type storms.	Catastrophic events such as a hurricane could damage the thin layer cap. The Site monitoring program will assess the remediation at a minimum through the five year review program. In addition, it is common for the EPA to assess the status of sites and remedies when events, such as a hurricane, impact an area.
	Destruction of capping/cover material by changing hydraulic conditions due to sea-level rise.	Sea level changes and other factors could alter the hydrodynamics of the marsh and alter the ecosystem or the physical status of the remedy. The five year review plan will be the means by which the EPA can address these issues.
	Destruction of capping/cover material by changing environmental conditions typically associated with meandering creeks within delta systems.	The physical status of the marsh relative to the remediation will be part of the monitoring program. Factors could alter the hydrodynamics of the marsh and alter the ecosystem or the physical status of the remedy. The five year reviews will be the means by which the EPA can address these issues.
	Destruction of capping/cover material by sediment dwelling organisms.	Bioturbation will not destroy the thin layer cap. The functioning of the thin layer cap anticipates and actually relies upon the action of the sediment dwelling/burrowing organisms of the marsh.
	Lateral movement of contaminants within the subsurface sediment has not been addressed.	This comment appears to be directed at the potential for ground water discharging within the marsh to either be a source of sediment contamination (the ground water is contaminated) or a means of transporting existing sediment contamination (becoming contaminated). The areas targeted for thin layer capping are marsh surfaces (not channels or low points in the marsh). While there are areas where groundwater is discharging to the marsh, it is unlikely that the areas targeted for thin layer capping include areas of groundwater discharge because they are marsh surface just off channels. There is no information which suggests

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		that these areas are active release areas of contaminants to the marsh system. The distribution of contaminants in the marsh suggests that the areas targeted for thin layer capping are depositional areas, and were contaminated by historical surface water transport mechanisms.
SELC 15.2 (VI)	The Draft Feasibility Study is incomplete because it does not include any alternatives that incorporate marsh restoration.	Marsh restoration has now been included in the ROD. In addition, this comment appears to focus on issues which may be described as net ecological benefit analysis (NEBA). A NEBA balances what is known about existing risk (current contaminant risks), what environmental impacts are likely to occur as a result of actions (remediation – dredging – thin layer capping etc.), what residual risks may exist (residual contaminant risks), and the anticipated environmental recovery from both actions and residual risk attenuation. As noted in the comment, statements were made by the PRPs regarding aspects of impact of remediation alternatives; however the comparisons of alternatives in the FS did not quantitatively incorporate these contentions made by the PRPs. The EPA evaluated the remedy alternative independently of the PRPs, while also considering the environmental impacts which may occur as a result of the different remediation alternatives. The following outlines the thought process which selects thin layer capping (over dredging and backfilling) in targeted areas. The EPA is required by the CERCLA to select a "protective remedy"; a remedy that reduces contaminant (chemical) risk such that the EPA can explain or justify its' conclusion that the remedy is protective of human health and the environment. Remediation alternatives that meet this criterion are then evaluated for "cost effectiveness" and evaluated for environmental impacts which may result from the remediation itself. Relative to dredging: dredging of soft bottom areas (e.g. open channels) is anticipated to have limited environmental impacts (unless the hydrodynamics of the location is changed) as silts and muds will deposit in the area. Hard bottom channels can be replaced with hard structure which will resist the water flow and will be recolonized by organisms using that structure. The marsh surface is different, marsh surface removal over significant areas (acres) requires the construction of "roads" to get the heavy equipment to the areas and to remove the excavated sediment and bring in clean material. These areas and the area to be

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		remediated would need to be isolated from tidal water for a number of reasons, with the net effect being that the areas contaminated and uncontaminated will need to be dewatered during operations. In addition, excavation equipment removes approximately 12 inches of material at a minimum; therefore a minimum of 12 inches of clean material will be required at all dredged/ excavated areas to return the surface to the original elevation. As noted above, soft bottom channel material is not necessarily unique and can return readily depending upon the system, and hard bottom channel material can be acquired and placed in locations; however, marsh surface sediments/soils are fairly unique and cannot be obtained from suppliers. Material of similar organic content, and particle sizes can be constructed, but these constructed soils are not the same as the material removed. As the comment notes, the reconstruction of the 13 acres is viewed as a success. Spartina grass is re-established; however, functional measures of this area indicate that it has not recovered all of the functions of the original marsh surface. A comparison of the potential or anticipated environmental impacts of dredging vs. thin layer capping in the targeted areas suggest the following: both will result in some alteration in the functioning of the marsh within the footprint of the thin layer capping area – one because the original marsh soil has been removed and replaced with an engineered soil, the other because additional material has been added to the marsh surface which will affect the marsh elevation in this area and may change some of the physical characteristics of the marsh soil. Dredging/marsh removal will also impact an undermined amount (acreage) of marsh which is not scheduled to be remediated for the construction of road access to the contaminated areas. (This was not the case for the remediation of the 13 acres as the access was constructed through areas which required remediation.) This additional impact to the marsh will be short term as the road access would be removed upon completion of the project, and marsh soil should not be removed. The EPA believes that the risk reduction (reduction in contaminant exposure and bioaccumulation) which can be achieved through dredging and thin layer capping to be similar to that of wholesale marsh

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		restoration. The EPA also believes that the long term effectiveness of the thin layer capping will be comparable to that of the removal of the contaminated marsh surface. The EPA therefore contends that the two alternatives have comparable risk reduction, comparable long term effectiveness, and comparable marsh functioning post remediation; however, the thin layer capping is less costly and will result in less direct impacts to the marsh.
SELC 17.1 (VIII)	The Proposed Plan and the Draft Feasibility Study provide for inadequate information on monitoring.	As the comment suggests, long term monitoring (LTM) plans are an important element of site remedies which leave some contamination in place, such as with the use of thin layer capping. The Agency will commit to a LTM plan within the ROD. However, specific details on the plan will be provided during the Remedial Design phase. As noted, it is important that decision criteria be developed in conjunction with the LTM plan to insure that the appropriate data are generated such that conclusions on remedy effectiveness can be made, either success or failure.
SELC 17.2 (IX)	The cap-in-place alternatives should be discarded because they do not provide a permanent solution.	The EPA acknowledges the expressed concern for remedy permanence. However, the EPA believes that the use of a thin layer cap in the targeted areas will result in a permanent remediation, because the targeted areas are not high energy areas, bioturbation is part of the thin layer cap functioning, and the LTM plan and the remedy review process will be in place should there be a failure of the thin layer cap. The EPA has selected dredging as part of the overall remediation of the marsh area, both the past 13 acre removal action and the areas currently proposed for sediment removal as part of the remedy. These actions are the final portion of removal of contaminant "source" material. Once this portion of the remedy is completed, redistribution of the residual contamination (including the potential for failure of the thin layer capping areas during catastrophic events) is unlikely to result in increases in substantive recontamination of remediated areas or increases in sediment contaminant levels in other areas. The EPA believes that the rationale presented for the use of the thin layer capping technology in targeted areas, non-source areas, is appropriate, but as the comment suggests,

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		monitoring will be require to document the effectiveness and permanence of the remedy. As noted in the comments, the preference for permanence is one of the balancing criteria for remedy selection. There are two threshold criteria: (protectiveness of human health, welfare, and the environment; and compliance with ARARs). There are five balancing criteria, which include the concept of preference for permanent remedies and the selection of cost effect remedies. The EPA believes that the use of thin layer capping for targeted areas can be a permanent remedy as this technology does not rely upon isolation. Also, the EPA believes that the thin layer capping technology is cost effective in this instance, recognizing that the costs for this remedy do include the cost of monitoring the remedy. While the final costs are evaluated, the EPA has not selected any portion of the proposed plan for the marsh remediation based upon the dollar value of a technology application.
Attachment A. Review by Philip B Bedient, P.E., Ph.D. March 13, 2015.		
PB 4.1	The cap/thin sand coverings are subject to erosion/scour and/or failure given the volatile tidal regime in the area.	Thin layer covering technology has been selected as part of an overall marsh remediation effort which has included the removal of contaminated sediment and marsh surface of 13 acres historically and will be supplemented by the dredging and removal of additional highly contaminated sediments. Thin layer covering is to be utilized in targeted areas of lower/intermediate contamination where the current hydrodynamics of the marsh system indicate that the potential for erosion and/or scour are low. While the EPA believes that the potential for failure of the thin layer cover through material loss is low; monitoring of the thin layer cover for loss or other measures of failure will be part of the remediation plan.
PB 4.2	The cap/thin sand covering concepts are subject to disturbance by sediment dwelling organisms that inhabit the marsh area.	The thin layer cover, as proposed, actually desires the burrowing activity of marsh organisms. The activity of these organisms will result in the dilution of the contamination which exists at a location with the overall goal of reducing the contaminant exposure level. The objective of this thin layer cover is not to isolate the contaminated sediments.
PB 4.3	The cap/thin sand covering concepts are subject to increased inundation due to sea level rise.	The EPA acknowledges that environmental factors such as the potential for sea level rise can affect the performance of selected remedies. However, at a local level it is not possible to predict what changes could occur in the hydrodynamics of the marsh area. The EPA will monitor the

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		effectiveness of the thin layer cover and will evaluate the need for additional assessments triggered by environmental factors such as sea level rise or catastrophic events.
PB 5.1 (4)	The cap/thin sand covering concepts will require long-term monitoring to ensure effectiveness.	The EPA concurs with this comment. A LTM Plan will be an important component of the marsh remediation. Not only because of the use of thin layer covering in targeted areas, but also to evaluate the total performance of the marsh remediation. The EPA plans to include the framework of an LTM Plan as part of the ROD; however, there will be limited details within the ROD as there are many technical issues which must be resolved before a final LTM Plan can be completed. These technical details include how the collected data will be interpreted and what criteria will be used to make decisions from the data, such as concluding whether the remediation was successful or if it is failing.
PB 5.2 (5)	Movement of contaminants from under the thin sand layer is possible given the interaction of groundwater with the surface water in the marsh and the fluctuation of the tides in this area.	The EPA is not clear on the intent of this comment, whether the comments is arising from concerns for groundwater releases, which may be transporting contamination into the marsh; concern that "clean" ground water is being contaminated by the contamination in the marsh and being transported to uncontaminated sediments or to the water column; or concern that surface water moves in and out of the marsh sediments/soils being contaminated and transporting the contaminants out of the marsh sediment/soils to the surface waters. Regardless of the comment's intent, the use of the thin layer cover technology is not dependent upon isolation and does not attempt to stop all exposure to contaminants, or transport of contaminants within the marsh. Rather the goal of the thin layer cover is to reduce the exposure to a tolerable level.
PB 5.3 (6)	Previous experience at other sites not similar to this site given its volatile tidal regime in relation to the topography.	The EPA agrees that there are unique and relatively extreme tidal actions within the marsh at the LCP Chemicals Site. The EPA also agrees that the area where thin layer cover is proposed is physically different from those of areas of sites where thin layer covers have been successfully used. However, the EPA does believe that thin layer covering can be effectively utilized in the marsh area as part of the overall marsh remediation. The areas targeted for thin layer covering are areas which contain lower contaminant concentrations and limited contamination depth (see ROD Figures 19 and 20), and therefore limited contaminant total mass. In addition, these areas are not subject to the strong currents

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		and tidal actions within the marsh (see ROD Figure 29 and FS Appendix B). Catastrophic events such as hurricanes are always a concern. However, whether an event would cause failure of the thin layer cover technology cannot be predicted. Therefore, long term monitoring and reassessment will be necessary should a catastrophic event occur at the site.
PB 5.4 (7)	The proposed cap areas along Purvis Creek seem to be selected based on limited sampling.	Sampling of sediments and marsh soils throughout the marsh area of the LCP Chemicals Site began in the mid-1990s (more intensive sampling was initiated in 1995), and iterative sampling to refine our knowledge of the distribution of contaminants has occurred since that time. Sampling has been conducted by EPA as well as the PRPs directed by the EPA. As noted in the comment, sampling density is not uniform throughout the marsh system, and the overall or collective sampling locations is a result of a mixture of sampling designs including, systematic sampling efforts and directed sampling efforts. Collectively, the EPA is confident that there is sufficient understanding of the distribution of contaminants within the marsh system (creeks, and marsh surfaces) to make informed decisions on the placement of caps and to direct dredging. However, it is anticipated that additional data will be generated during the design phase of the marsh remediation. This additional data will be used to make any adjustments to the areas proposed for specific remediation actions (dredging, capping, etc.).
PB 6.1 (8)	Dredging is a more permanent solution than the cap/thin sand covering concepts.	The EPA agrees that capping and thin layer covering remediation technologies do not remove contamination and can be subject to failure. However, the EPA does not believe that these remediation technologies cannot be permanent when successfully implemented. Capping, isolation of contaminated sediments in depositional areas, can be effectively permanent. While it is plausible that catastrophic events could impact a cap or change conditions such that the area becomes non-depositional (subject to erosion), capping experience has not demonstrated this to be a common problem. Thin layer covers, such as those being designed for the LCP Chemicals marsh are not isolation caps. It is anticipated that the covering material will be incorporated into the existing sediment/marsh soil. The goal of this thin layer cover is to accelerate the natural processes accretion; as such this technology can be viewed as permanent.

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Attachment B. Review by Loren H Raun, Ph.D. March 13, 2015.		
LR 2.1 Development of Remedial Goals	There are multiple junctures where decisions were made which result in underestimation of risk and RGOs. The overarching concern is that RGOs be protective in spite of the uncertainties and that remediation attains these RGOs.	As indicated by this comment, the threshold criteria for remedy selection includes that the remedy must be protective of human health and the environment. The function of the risk assessments is to inform the remedy decision making process such that remedy options may be compared to the threshold standard and to each other relative to the potential for risk reduction. These actions take place with knowledge of the uncertainties within the risk assessments. The use of screening criteria and/or screening level risk model parameters is the starting point for risk assessments, the most conservative risk estimation. If based upon these conservative evaluations, an informed, reasonable and justifiable remediation decision can be made, the risk assessment may stop, as the goals of the risk assessment has been met. This scenario exists within the overall investigation, risk assessment and decision making in the LCP Chemicals marsh. However, reasonable and justifiable remediation decisions in other areas of the marsh could not be made using screening level risk assessments. For these areas, addition risk assessment was conducted using justifiable, less conservative assumptions and actual field data to refine the risk estimates. There are uncertainties within all risk assessments. These uncertainties can be conservative in nature, increasing the calculated risk, or be lack of information which could result in risk calculations either increasing or decreasing. The EPA believes that it has selected a remedy that meets the threshold criteria for remedy selection. The EPA has made this determination based upon an evaluation of the risk assessments conducted, which vary in refinement, and an understanding of the potential effect of the uncertainties on the risk calculations.
LR 3.1	Failing to add risk from OU3 when estimating the RGO for OU1.	Although the EPA has segregated exposures by operable units, the risk assessments have followed all EPA protocols and guidance on conducting the risk assessments. By assessing the OUs separately in the HHRA, the exposure/risk is higher than if it was assumed the human receptor(s) were exposed to OU1 and OU3 in the same timeframe.
LR 3.2	Failing to add the risk from exposure to surface water or sediment.	As stated in the HHBRA, the maximum detected surface water concentrations were well below cancer and non-cancer screening levels and were not evaluated further for incidental ingestion of marsh water. Sediment ingestion was evaluated in the HHRA and resulted in negligible

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		non-cancer hazards (0.08) if added to the fish consumer. The cancer risk from exposure to sediment was 1E-05. Assuming the trespasser exposed to the LCP Chemicals marsh sediment also consumed recreationally-caught fish, the risk would be 1.1E-04, which when rounded is still 1E-04 for the overall risk estimate. This added uncertainty did not change the overall development of the RGOs.
LR 3.3	Underestimating consumption of contaminated food by relying on default exposure factors especially given a large portion of the local community is below the poverty level (exposure frequency, ingestion rate), and likely a sensitive subpopulation.	The HHBRA assumed consumption of fish based on the area-specific survey. The consumption rate assumed for the high-quantity fish consumer was higher than the EPA default rates used for the recreational consumer.
LR 4.1	Misrepresenting concentration levels by not including statistical confidence.	Per EPA guidance, the risk assessments used either the maximum concentration or the 95th upper confidence level (95UCL) to estimate exposures. From the risk assessments, the health-based RGOs already incorporate the conservative 95UCL. It would be inappropriate to apply another 95UCL associated with sediments to the RGO. Surface weighted area averages (SWACs) were applied spatially to various exposure domains and creeks to determine where sediment concentrations may exceed RGOs. SWACs also are not true means because they use a geographic algorithm to relate concentrations between different points. SWACs are commonly used to assess variability in spatial contamination and are often more informative than non-spatial averages with confidence limits.
LR 4.2	Basing decisions on small sample sizes without enough statistical power.	As noted in the comment, a formal power analysis was not conducted as part of the RI/FS for the LCP Chemicals marsh area. However, the Agency does not see how the added statistical rigor would change any of the conclusions made from the data. The EPA has concluded that both human health and ecological risks exist within the marsh area and that remediation is both appropriate and necessary under CERCLA. The proposed remediation is believed to be appropriate and will result in reduction of risks and does ultimately result in a protective remedy. Since there are uncertainties, as noted in the comment, and since some contamination is being left in place, the EPA is including a monitoring plan within the ROD as part of the remedy, so that remedy can be evaluated for success or failure.

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LR 4.3	Misrepresenting decreases in concentration which are not statistically significant.	It is not clear which data is being referred to by this comment. However, the EPA agrees that trend analyses must be interpreted carefully so that data variability or sampling artifacts are not misinterpreted as data trends.
LR 4.4	Screening out COCs which did not exceed screening levels/standards or were present in the background.	The health-based screening values used for surface water, and for PAHs in sediment ensure that the contribution to health risk is not significant based on the EPA risk range. When the health risk is insignificant, then chemicals below the screening levels are also assumed not to significantly impact RGOs.
LR 5.1	Groundwater was not included in the risk assessment or evaluation of the remedy although it is heavily contaminated and in contact with the surface water.	The potential for recontamination is of critical concern to the EPA as this could result in remedy failure and thereby a failure to protect human health and the environment. The EPA will continue to assess the data to evaluate the threats from recontamination. The LTM Plan, which is being required within the ROD, will be a tool by which the EPA can determine if recontamination is occurring. If the assessments conducted by the PRPs are incorrect and recontamination occurs, the PRPs may be required to take additional remediation actions in the re-contaminated areas. Groundwater releases to the marsh are complicated and are a difficult issue. The EPA does not believe, and has no information which would suggest, that the proposed remedy would aggravate contaminant releases through seeps. It is anticipated that collectively, the actions taken by the EPA in both the upland areas and in the marsh will result in the remediation of seep contaminant discharges.
LR 7.1	In Appendix F there are not enough fish tissue samples to detect a difference between the 2007 and 2011 concentrations (i.e., not enough statistical power).	The EPA agrees that the interpretation of fish tissue trend data must be done with caution. It should be noted that, during the period of time noted in the comment, there was not active remediation in the marsh itself, so declines in the fish tissue levels would not be expected to be substantial.
LR 7.2	In Appendix F the comparison between concentrations in seafood between years does not consider statistical confidence.	The graphs in Appendix F do provide the mean and confidence intervals bars. It is agreed that one should not be visually subjugated by the colored bars themselves, but to interpret the confidence intervals appropriately.
LR 8.1	The comparison between concentrations in seafood to the advisory threshold does not consider statistical confidence.	
LR 8.2	The seafood advisories appear to consider only one contaminant at a time, when a fish could actually contain mercury, lead and PCBs. Therefore, additive risks from multiple contaminants are not considered.	The EPA does consider the potential for "additive risk" the risk which may exist as a result from exposure to multiple contaminants which do not individually cause the same or similar adverse effects. When our knowledge of the toxicology of contaminants permits us to combine the

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		risks from individual contaminants, the EPA does this, as with lifetime cancer risk estimates. However, for non-cancer risk, there are only a limited number of contaminants for which our understanding of the toxicology indicates that risk estimates should be combined into a single "cumulative risk estimate". With regards to State fishing advisories, in general, it is important to keep in mind that, if more than one contaminant is found in a species, the guideline is based on the chemical with the most restrictive consumption frequency. Also, the consumption recommendations are based on health risk calculations for someone eating fish with similar contamination over a period of 30 years or more.
LR 8.3	In development of the RGOs the only pathway that the EPA considers is consumption of fish. The risk from a local resident or trespasser exposure to OU3 or sediments from OUI should be added to the ingestion of contaminated food (finfish, clapper rail and shell fish). If the trespasser or resident also ate contaminated food, the carcinogenic risk would increase by as much as 3.3E-6, and 5.2E-5, respectively. These additions would result in a lowering of the sediment RGOs.	As mentioned previously, much of the contaminated upland soil in OU3 has been removed, meaning and that occasional inadvertent ingestion of soil or sediment is of lesser concern than consumption of seafood. If the marsh trespasser obtains a cancer risk of 1E-05 and obtains a risk of 2E-04 as a high quantity fish consumer, then the overall cancer risk would be 2.1E-04 or rounded to 2E-04. With all of the conservative assumptions built into the risk assessment, this addition did not substantially change the RGO ranges that were developed.
LR 9.1	Attachment A presents the method to calculate area weighted average. While spatial weighting between the areas is reasonable, use of the average to represent an area is not statistically appropriate. There is not enough information provided to determine if the underlying distribution of the sediment data are normal. The data are likely not normal and contain high concentration outliers therefore, more sophisticated statistical methods should be employed within each area.	See responses to Technical Comment #4.

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LR 9.2	In the case of calculating the RGO, the *lower confidence limit* should be used.	The Aroclor 1268 sediment concentration of 3.408 mg/kg results in a clapper tissue concentration of 19.42 mg/kg. If the sediment concentration was lower we would expect a lower tissue concentration. For example, if the sediment concentration was 2.2 mg/kg (from Table 5-1 of the FS), then this would result in a corresponding clapper rail tissue concentration of 12.54 mg/kg (19.42/3.408 = x/2.2), assuming a linear relationship. This lower tissue concentration would result in less risk, not more as suggested in the comment. Statistical confidence is already built into the maximum tissue concentration in the rail, which is conservative. The minimum and mean concentrations of Aroclor 1268 in the 14 clapper rail samples were 0.19 and 5.02 mg/kg, respectively. In addition, the RGO approach assumes that 100% of the contaminant tissue concentration in each receptor is due to site-related sediment concentrations, even though the receptor may visit other off-site marsh areas or creeks.
LR 10.1	The cost savings from avoiding adverse health should be considered. Choosing a remedy which will provide the fastest route to safe levels with limited uncertainty should be the main objective. The most reliable remedy is removal. Considering the uncertainty in this assessment, the more protective RGOs should be applied.	The EPA is aware and has made Site management decisions in light of the environmental justice issues at the LCP Chemicals Site. The Agency believes that the time required for contaminant levels in fish time to decline to an unrestricted use (no fish advisories) for PCBs and mercury, will not significantly change with reasonable but more aggressive contaminant removal within the marsh remediation. However, as this is an uncertainty, a monitoring plan is being required, and the need for the plan will be documented in the ROD. A goal of this plan is to evaluate the decline in fish tissue body burdens relative to the marsh actions taken, and to evaluate the longer term reductions in contaminant bioaccumulation. If the proposed remedy does not achieve the anticipated goals, then additional actions in the marsh may be taken.
LR 10.2	The report indicates that the dredging would be more damaging to the habitat than other remedial measures, however, the previously remediated area recovered much sooner than anticipated (two years). In addition, the contamination is on the surface of the sediment, not at depth. Therefore, the contaminants should be removed and the marsh replanted in the same manner as the previously remediated area.	There are multiple issues with additional marsh surface (vs. channels and banks). First, the EPA's Proposed Plan did considered the impacts of removal of marsh surface areas, but the primary consideration was the ability of the proposed plan to meet the threshold criteria of "protection of human health welfare and the environment". Only remedial alternatives that passed the criteria were considered for selection. The comment suggests that the remediation of additional marsh surface can be done in the same way that the removal in the 13-acre area was

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		done, with similar results. There is no question that the marsh removal can be physically done. However, it cannot be done in the same way. The 13-acre removal area did not require crossing of marsh creeks and drainages. The technological approach was to build access through the area to be remediated and work backwards towards the shoreline. This cannot be done in the additional marsh areas. Access to the additional areas for heavy equipment is not practical via water access and therefore would need to be constructed through areas which are not targeted for active remediation. Further, while the 13-acre remediation is a success, the area is not completely the same as the surrounding marsh because the replacement material is not the same as the material removed. While it may be a point of debate as to whether or not the differences are important, the larger the area of the marsh that is affected by being a different marsh sediment/soil, the greater that overall impact is.
Trustees Comments/Responses		
T 1a	The subject PP concludes that Alternative 6 is the preferred alternative for remedial action in the LCP Marsh. The three major components of this alternative are: 1) dredging 7 acres of the LCP Ditch and Eastern Creek, 2) installation of armored caps in 6 acres of tidal creeks, 3) application of a thin-layer sand cap (6-9 inches) over 11 acres of marsh largely along either side of the Eastern Creek. For reasons given below, the Trustees believe this remedial action may not restore the injured natural resources as quickly as the other alternatives that were considered. Moreover, Alternative 6 may not represent a permanent solution to environmental contamination at the LCP Marsh and the larger Turtle-Brunswick River Estuary. The LCP Ditch and Eastern Creek were dredged in 1998-1999 along with approximately 13 acres of saltmarsh in Domain 1. Now, 15 years later, the LCP Ditch and Eastern Creek must be	The late 1990s work performed under the EPA's Emergency Response authority was never intended to achieve the sediment cleanup goals proposed under this action. While the 13 acres of marsh addressed in the late 1990s, located in the Former Facility Disposal Area (FFDA), have remained generally uncontaminated (see Figures 3 through 6 of the November 2014 Proposed Plan), the Eastern Creek and the LCP Ditch were different. As documented in the October 1999 Marsh and Railroad Area Close-Out Report, the approach for the removal in the Eastern Creek and LCP Ditch was source control, with excavation depths between one-to-two feet below channel surface (See ROD Figure 5). At times, the on-scene coordinators (OSCs) could see the prills (droplets) of elemental mercury in the marsh sediment. Using the available data, the OSCs performed a mass distribution and cost analysis and estimated that they could target the depths and portions of the channels, thereby removing somewhere between 85-95% of the Aroclor 1268 and mercury, yet disturb only about 16 acres of marsh. The OSCs calculated that if they targeted the next "tier", they would remove another 2-6% of the

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	dredged again. Without a more comprehensive remedial action (i.e., Alternative 2 in the PP), the Trustees are concerned that re-dredging these tidal creeks now may not restore the marsh to its baseline condition.	Aroclor 1268 and mercury, spend an additional $15-25 million, and destroy substantially more of the marsh. The OSCs thought it prudent to wait and see how the system responded before doing any further work, especially given the destructive nature of the sediment removals. This seemed to be especially reasonable given that the remedial program was very likely to do a much more extensive investigation of the marsh ecosystem and would more thoroughly vet cleanup technologies thru the RI/FS process. The Selected Remedy includes backfilling dredged areas in the creeks to isolate any residual contamination that may occur. Long-term monitoring of the dredged/backfilled areas and the caps will be conducted to ensure that any residual contamination remains isolated.
T 1b	PP describes armoring material for the capped tidal creek areas as "coarse sand and/or gravel". This appears to be inconsistent with the descriptions in Appendix H of the 2013 Feasibility Study which specify an "armor stone layer for erosion protection" (§3.3.1) or an "armor stone cap" (Table H-4). Furthermore, the placement of an armored stone layer (or any hard substrate) on top of 6 acres of capped tidal creek areas, will likely result in the development of oyster reef communities similar to those currently found on large pieces of concrete that line the LCP Ditch. While oyster reef communities can provide important ecological services, in this particular case, a 6-acre attractive nuisance will likely be created if Alternative 6 is implemented. This is because oysters efficiently bioaccumulate site contaminants such as mercury, lead and Aroclor 1268 thus making these contaminants available to higher trophic level organisms; e.g., blue crabs, black drum. As a result, capping 6 acres of tidal creeks under Alternative 6 may actually enhance entry of site contaminants into the marsh food web. This possibility must be studied as part of the post-remedial monitoring plan.	During the remedial design phase the details of the caps will be determined. Regarding bioaccumulation potential post remediation, the EPA believes that the exposures/contaminant flux after the remedy has been completed will not result in an attractive nuisance. However, concerns for the degree of exposure reduction which will be achieved, along with the requirement for the EPA to monitor the Site because contaminants are being left in place, result in the EPA including the framework of a Long-Term Monitoring Plan within the ROD. The EPA hopes that the trustees will be able to play an active role in the design of this monitoring plan, which will include biomonitoring.
T 1c	The arguments presented in support of installing a thin layer (6-9 inches) sand cap over 11 acres of LCP salt marsh as a	The EPA acknowledges the concerns expressed in this comment. The EPA plans to include monitoring to evaluate the effectiveness of the thin-

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	method of reducing the risk to the benthic community are unconvincing. At the very least, placing sand over silty vegetated marsh surface may alter the benthic community and hydrology in ways not foreseen by the modeling that was performed.	layer cover (TLC) to reduce exposure to benthic organisms living on or within the TLC, and to evaluate impacts to the marsh surface, as changes in the vegetation or other aspects to the marsh surface could result in destabilization. Monitoring of the benthic community composition could compare capped areas to uncapped areas. Again, input from the trustees on the design and monitoring of the TLC will be solicited.
T 1d	The PP (page 29) provides a justification for the thin layer cap saying, "Thin-cover placement is best suited for wetlands or marsh environments where tidal energy and potential erosion is at a minimum." This minimal tidal energy requirement seems inconsistent with the LCP marsh's 7-10 foot semi-diurnal tidal range and periodic high energy storm events. EPA's National Remedy Review Board expressed a similar view in their March 28, 2014 Memo saying, "The Board is concerned about the long-term permanence aspects of the proposed thin cover placement" (page 5, March 28, 2014 Memo). "Long-term effectiveness and permanence" is the first Primary Balancing Criteria that EPA is required to use when evaluating remedial alternatives. Dredging certainly meets this criterion especially when compared to the more questionable thin layer (≈6-9 inches) capping in a system experiencing large daily tidal fluctuations and periodic high energy storm events. EPA's National Remedy Review Board echoed this same concerns when they recommended to EPA Region 4 that they "consider a contingent remedy approach due to the uncertainty regarding the long-term permanence aspect of the proposed thin cover and capping components of alternative 6" (page 5, March 28, 2014 Memo). The permanence and effectiveness of the thin layer capping will need to be studied as part of the post-remedial monitoring.	The EPA acknowledges these concerns. The areas proposed for TLC are low energy areas with low-to-intermediate surficial contamination and contamination generally limited to the upper six inches. As such, these areas a believed to contain a limited mass of contaminant. This limited contaminant mass combined with a low energy area and the potential for significant bioturbation leads the EPA to believe that the use of a TLC will be successful in reducing exposures over time. As noted in the comment, monitoring of the performance of the TLC will be critical.
T 1e	It is not exactly clear in the PP how Preliminary Remedial Goals (PRGs) and Cleanup Levels (CULs) were derived and whether they are protective of human health and the environment. For example, the ranges of PRGs for the protection of the Benthic Community (page 22 of the PP) are greater than the ecologically protective Remedial Goal	See response to Technical Comment #2.

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	Objectives (RGOs) initially developed in the Baseline Ecological Risk Assessment (BERA) (see page 92 of the BERA and the values below). The recommended CULs in the PP are higher still (page 42 of the PP and below). These CULs represent the highest value in the range of PRGs in the PP. The PP does not clearly explain how these PRGs and CULs can drift ever higher, yet still be protective of the benthic community. Further, the PP does not explain whether a similar progressive relaxation of PRGs and CULs was allowed for fish and wildlife receptors. [*all values below reported in ppm (mg/kg)*] **COC** **BERA RGOs → PP PRGs → PP CULs** Mercury 1.4 - 3.2 4 - 11 11 Aroclor 1268 3.2 - 12.8 6 - 16 16 tPAH 0.8 - 1.5 4 4 Lead 41-60 90-177 177	
T 2	As noted above, approximately 13 acres of saltmarsh were excavated and backfilled with clean material in 1998-1999. Visual observations afterwards suggested very rapid recovery of the saltmarsh vegetation (see 2-year post-removal photo in Figure 2-10 of the 2013 OU1 Feasibility Study). Despite this site-specific experience of rapid recovery, the subject PP opts for other less permanent methods of remediation. The PP also repeatedly states that additional dredging and excavation would create unnecessary "destruction", "unwarranted harm" and "significant damage", which is not supported by the evidence. EPA's National Remedy Review Board reached a similar conclusion stating, "The PRPs do not provide any site-specific information to indicate that marsh restoration at this site is particularly difficult and, in fact, earlier removal actions have excavated and restored wetlands at the site already." (pages 6-7, March 28, 2014 Memo). In their Memo, the Remedy Review Board recommended dredging the 6 acres of tidal creek currently slated for capping under Alternative 6.	Although excavation/removal of contaminated sediments may be more permanent, capping in low-energy environments minimally affected by tidal action effectively isolates contaminated sediment from contact with human and ecological receptors. In addition, capping prevents mobility of contaminants to spread further in the marsh or into the creeks. Capping and thin-cover placement also create a clean sediment surface for natural or enhanced recovery by vegetation and biota. The past removal action referred to was excavation of near shore sediment in a low energy environment with reasonable recovery of saltmarsh on the backfill. However, recovery of marsh grass to a significant density with sufficient root mass to firmly hold sediment took longer than two years. Excavation and backfilling the marsh sediment surrounding Eastern Creek, the LCP Ditch and closer to Purvis Creek involves more complex hydraulic energy dynamics, elevation differences and tidal flows. Dredging versus capping in the isolated low-energy areas of Purvis Creek is an engineering consideration as it relates to permanence in a tidal creek which does not completely drain. Hydraulic velocities are lower than in the LCP Ditch and Eastern Creek, which are completely drained at low tide except for a few standing pools.

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T 3	The above comments are offered from the perspective of the LCP NRDA Trustees, which differs slightly from that of EPA. At Superfund sites, the Trustees are charged with: 1) restoring ecological services back to baseline (if possible) and 2) compensating the public for interim losses through restoration projects. As a general rule, more thorough cleanups at a Superfund site translate into smaller interim losses and a more rapid return to baseline. Consequently, the LCP NRDA Trustees would rather see implementation of a more aggressive remedial action. However, the NRDA Trustees also recognize that important uncertainties are always present in ecological risk assessments and evaluations of remedial alternatives. Therefore, if Alternative 6 is implemented, the Trustees strongly urge that a comprehensive, science-based monitoring plan be designed and implemented. The plan should be capable of quantifying the rate of recovery (return to baseline) soon after the remedial action. Additionally, the plan should incorporate specific numerical "triggers" for further clean up action as described in §8.0 of the PP. The importance of post-remedial monitoring was also cited in EPA's National Remedy Review Board's March 28, 2014 memo. The Trustees concur with the Board's recommendation to develop a fish tissue monitoring plan using extant EPA guidance; i.e., Sediment Assessment and Monitoring Sheet (SAMS) #1 " Using Fish Tissue Data to Monitor Remedy Effectiveness" (2008) which can be found at http://www.epa.gov/superfund/health/conmedia/sediment/documents.htm	The monitoring plan will contain specific numerical target goals for acceptable tissue levels in finfish and shellfish that are considered protective of human health, such as those presented in Table 3 of the Proposed Plan and the State of Georgia fish consumption advisory levels for the Turtle River/Brunswick Estuary. Achievement of protective tissue levels will take time through annual monitoring and through the 5-year review process. Other triggers would include measureable goals for recovery of disturbed salt marsh vegetation, benthic community indices relative to reference conditions, and specific physical measurements related to maintaining cap integrity (including thin-layer). It is expected that the monitoring plan will include statistically significant sample populations for various abiotic and biotic parameters such as tissue data from key 1st level food chain organisms that are needed to accurately reflect the impact of remediation on food-chain uptake to fish, birds and wildlife.

Comments/Responses from Community Members		
P - Jessica Ahl P – Virginia Balboana P – Beth Barker P – Becca Bartkovich P – Rachel Brand P – Kolin L Bryant P – Patti Clauson P – Gary B Cook P – Jeremy Cook P – Valentina Cook P – Veda Cook P – Sam Corson P – Wesley Deverger P – Cora Lee Hannah P – Marla Henderson P – Antle M. Jeb P – Amanda Kline P – Cheryl Knight P – Helen Ladson P – Chuck Latham P – John Mahas P – Sarah McInnis P – Barbara Miller P – Kyle O'Keefe P – James Patrick Wilson P – Debra Patterson P – Carolyn Rader P – Jovan Sage P – Joan and Charles Shellito P – Madeline Smith P – Monica Smith P – Pat Smith P – Shirleen Thomas P – Alice Vick P – Drew Weldon P – Margaret Wheat P – Mishaunda Wooten	A large number of community members submitted requests that the EPA thoroughly cleanup toxic chemicals from all media, particularly the wetlands (marsh). The general concern appears to be that the proposed remedy is not extensive enough or does not cover a large enough area. A number of people noted that the cleanup needed to be sufficient to protect the food chain to ensure children and families are protected.	The Selected Remedy balances the need to remove from the marsh system the contaminants posing risk to human health and the environment, while limiting the impacts to the areas with lower concentrations of contaminants. The two areas with the highest mercury and Aroclor 1268 concentrations in the LCP Chemicals marsh are the Eastern Creek and LCP Ditch. Both of these tidal channels, which are scoured twice daily by the tides, have contaminants present at elevated concentrations to depths of about 18 inches below the channel surface. Under the Selected Remedy, both of these tidal channels will be excavated and backfilled with clean sand, thereby removing the highest concentrations of mercury and Aroclor 1268 from the marsh system. Available vertical profiles suggest that the marsh surface immediately flanking the tidal channels (presumably contaminated over the decades of incoming and outgoing tides overtopping the channels) is contaminated to depths of six inches or less. The concentrations in these areas that flank the tidal channels are appreciably lower than in the channels themselves. For these reasons, thin-layer covering, rather than removal, is specified under the Selected Remedy for this estimated 11-acre area. Excavation of the lower concentration area would disturb not only the 11 acres, but also the additional acreage necessary to construct the roads to permit the access for the heavy equipment. The EPA believes that the Selected Remedy is sufficient to protect the food chain to ensure children and families are protected.

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P – Joseph Iannicelli	An officer for a company selling an alternative technology recommended that an alternative be added to evaluate the technology he represented for use at the site.	The material has been received and forwarded to the EPA Emergency Response Team in Edison, New Jersey for evaluation.
P – Michael Gowen S – Rep. Alex Atwood P – Penn Clarke L – Satilla Riverkeeper	One community member and one member of the Georgia State House of Representatives requested that the comment period be extended for 60 day and end on March 31, 2015. Several others community members questioned why a longer comment period was not provided. One community group criticized the EPA for releasing the Administrative Record only 26 hours before the public comment meeting took place, and suggested that a proper public meeting and advertising be provided	The comment period, which started on December 4, 2014, was extended to March 16, 2016. Regarding the length of time the Administrative Record was available, it was available during the entire public comment period, which was extended to more than three times the length required by law. Further, beginning in early 2010, drafts of key Site documents were posted on the World Wide Web's LCP Chemicals Reading Room, which is available to the public and which was expressly promoted to the community group funded by a site-specific Technical Assistance Grant. For example, by the date the comment period for the Proposed Plan started, the final drafts of baseline human health and ecological risk assessments had been available to the public 42 and 40 months, respectively. Similarly, the final drafts of the remedial investigation and feasibility study for OU1 had been available 24 and six months, respectively. Review drafts of these documents were posted on the Reading Room years earlier. Currently, over 80 LCP Chemicals documents are posted on the web site.
GEC (Daniel Parshley)	The community group requested that the EPA include four documents into the administrative record for consideration in selecting a remedy. Those documents include: • Health Consultation, Organic Chemical Residue in School Yard Soils, Goodyear and Burroughs-Mollette Elementary Schools and Risley Middle and Edo-Miller Park/Lanier Field City of Brunswick, Glynn County, Georgia, March 22, 2005 (ATSDR 2005). • Wind Rose for Glynn County (GLYNCO Wind Rose). • Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, September 3, 2014, by Lorraine C. Backer, PhD; David Mellard, PhD; Health Studies Branch, National Center for Environmental	The Administrative Record should contain documents which supports the reasoning the EPA used in arriving at a Selected Remedy. None of the documents listed above pass that test and are therefore not included in the Responsiveness Summary. The third document is cited in a numbers of specific comments is included in the Responsiveness Summary.

	Health, Eastern Branch, Agency for Toxic Substances and Disease Registry (Backer, 2014). • "Determination of Toxaphene in Brunswick (GA) Public Access Area Soils by Immunoassay and Gas Chromatography," by Marco Frohlick and Dr. Keith A. Maruya, 23 October 2002.	
L – Brunswick-Golden Isles Chamber of Commerce C – Atlantic Richfield	The community group and the company support the proposed remedy.	The EPA acknowledges this support from Brunswick-Golden Isles Chamber of Commerce and the Atlantic Richfield Company.
P – Jill Jennings-McElheney P – John McQuown	Supported the remedy proposed by the Glynn Environmental Coalition.	It is not clear from the comments submitted on March 16, 2015 that the GEC supports any of the alternatives evaluated in the feasibility study. In comments on the Proposed Plan, the GEC suggests that additional sampling be undertaken and, if need be, available data be used to articulate the need for a Time-Critical Removal Action. The EPA has determined that the existing sampling data is sufficient to support the selection of a remedy. The EPA has also determined that the size and scope of the cleanup to be done at OU1 warrants a Remedial Action rather than a Time-Critical Removal Action, which would not provide sufficient tools for the long-term monitoring that will be necessary at the Site.
P – Debra Ann Strong	Supported Alternative 2 in the Proposed Plan.	Alternative 2, which entails excavation of 48 acres, plus an additional 11 acres in access roads beyond the remedy footprint, for a total of 59 acres was judged to be too disruptive to the marsh for the benefit gained. Other, less disruptive methods at achieving the same risk reduction were preferred and ultimately selected.
P – John McQuown	The community member noted that a hydrodynamic model was used by the EPA to test the proposed and recommended remediation design. He noted that the two models available on the EPA website are for rivers. • Does the EPA think these models are applicable to the LCP Site and why? • What is the authorship, ownership, and revision level for the hydrodynamic model used to evaluate the proposed remedy in the	Appendix B (Hydrodynamic Modeling) and Appendix J (Effectiveness Evaluation for Thin Cover and Chemical Isolation Cap) detail the modeling work to support use of thin covers and chemical isolation capping. Briefly, the RMA-2 [1] hydrodynamic model was used to simulate changes in water depth, current velocity, and bed shear stress over space and time. The hydrodynamic model was developed and calibrated using Site-specific data to the extent feasible. A boundary-fitted numerical grid with relatively high resolution in the Site was used to represent spatial variations in geometry and bathymetry throughout

	proposed plan? • What are the parameters that were used and what data set(s) was used in the hydrodynamic model when testing the recommendations in the proposed plan. • Were the sample sites predicted by the hydrodynamic model's estimate of where pollutants spread since the initial remediation? Is this why the sampling was performed at the LCP site? If so, how well did the hydrodynamic model predict the spreading? If not, why not? • What does the hydrodynamic model predict into the long future? What time horizons have been tested on the hydrodynamic model? Will the results be reported in the Final Plan document? • Based on the HDM modeling, how complex and how frequent will future sampling be required?	the estuary. The model reproduced four key characteristics of hydrodynamics within the Site: • Amplitude and phase of water surface elevation; • Qualitative differences in the symmetry (asymmetry) of tidal currents during ebb and flood tide between Turtle River and Purvis Creek; • Changes in the magnitude of a long-channel velocity during the neap-spring tidal cycle; and • Flooding and drying of secondary channels and intertidal marsh areas. Existing conditions and two remedial scenarios were simulated for the following three hydrodynamic conditions: • typical tidal conditions over a spring-neap tidal cycle; • 100-year flood; and • hurricane storm surge The latter two events were modeled to simulate the expected behavior of the Site under extreme events. Note that the 100-year flood and the 100-year storm surge were used, as it is a consistent standard practice at Superfund sites to evaluate extreme event influence. Additional simulations for storm surges with rarer recurrence intervals (e.g., 500-year event) may be considered during the design phase of the project to test sensitivities. Based on experience from other sites of similar characteristics, the incremental effects of higher-frequency storm surges on marsh sites such as the Brunswick LCP Site is not expected to be considerable. In general, the change in the areal extent of intertidal inundation due to either remedial scenario was less than 4%, which indicated that the remedial scenarios would not have a significant effect on the circulation and marsh inundation within the Site. Overall, only relatively minor increases in maximum current velocities (relative to existing conditions) were predicted to occur for the two remedial scenarios, indicating that implementation of the remedies will not influence the general hydrodynamic characteristics of the marsh and tidal creeks.

		The modeling work was overseen by the U.S Army Corps of Engineers. [1] RMA2 is a two dimensional, depth averaged, finite element, hydrodynamic, numerical model. It computes water surface elevations and horizontal velocity components for subcritical, free-surface flow in two dimensional flow fields. RMA2 computes a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flows. Friction is calculated with the Manning's or Chezy equation, and eddy viscosity coefficients are used to define turbulence characteristics. Both steady and unsteady state (dynamic) problems can be analyzed.
P – Jane Fraser L - Satilla Riverkeeper	A community member recommended that the EPA include an evaluation of how PCB contamination affects women's health, particularly in regard to endometriosis. (Will the EPA include information about how the chemicals at the LCP Chemicals Superfund Site can hurt a woman's health? Will the EPA plan a cleanup that will reduce these chemicals to levels that will not cause endometriosis in women? Will the EPA call in experts to assist the EPA in finding the level to cleanup that will end the risk of endometriosis from the LCP Chemical Superfund Site use experts to determine what level is protective of endometriosis? Will the EPA include the following studies in the LCP Superfund Site documents and use these documents to plan a cleanup that not only protects men, but women, too? • Potera C. "Women's Health: Endometriosis and PCB Exposure." Environmental Health Perspectives, July 2006; 114(7): A404. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513298/ • Bruner-Tran, K.L. and Kevin G. Osteen, "Dioxin-Like PCBs and Endometriosis." Systems Biology in Reproductive Medicine, April 2010; 56(2): 132-146. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2867352/).	An oral reference dose, such as that used to guide the development of remedial goal options for the LCP Chemicals Superfund Site in Brunswick, GA, is an estimate of an exposure (including in susceptible populations) that is likely to be without an appreciable risk of adverse health effects over a lifetime (U.S. EPA, 2002). The oral reference dose is intended to represent a lifelong exposure level at which a person is unlikely to experience any health effect as a result of the exposure – even if the person is a member of a susceptible population or life stage (e.g., women, children, the elderly). In order to determine a level of exposure to a chemical unlikely to increase health risk, EPA analyzes data from studies in which health effects have been observed in humans or animals exposed to the chemical at known doses. For PCBs, data are available from many different studies investigating a wide array of health outcomes in humans and various laboratory animals (e.g., monkeys, rats, mice, rabbits, guinea pigs, mink). The oral reference dose for Aroclor 1016, a PCB mixture, was used to develop remedial goal options for the LCP Chemicals Superfund Site. The oral reference dose for Aroclor 1016 is 0.07 μg/kg-day and is based on the finding of decreased birth weight in infant rhesus monkeys that were born to mothers exposed to Aroclor 1016 for 7 months prior to breeding until offspring were weaned at age 4 months (Schantz et al. 1989). There have been no animal studies evaluating the occurrence of endometriosis following exposure to Aroclor 1016. Human studies have provided limited evidence that dietary or environmental PCB exposure affects female reproductive endpoints, including endometriosis. Some studies have reported a positive association between blood PCB levels and the incidence of endometriosis (Heilier et al. 2005; Porpora et al. 2006; Quaranta et al. 2006; Reddy et al. 2006; Tsuchiya et al. 2007; Porpora et al. 2009; Roya

	Another community group asked if the EPA considered that three congeners, PCBs 138, 153, and 180, were particularly high in women with endometriosis. If not, why not?	et al. 2009), while other studies found no such association (Lebel et al. 1998; Pauwels et al. 2001; Fierens et al. 2003; De Felip et al. 2004). As noted by Bruner-Tran and Osteen (2010), the reasons behind these inconsistencies may include differences in control populations, different analytical methods used to assess PCB exposure, and differences in statistical analyses. Whether or not PCBs can cause endometriosis has also been evaluated in a study conducted by Health Canada using rhesus monkeys exposed to another PCB mixture, Aroclor 1254 (Tryphonas et al. 1989; Tryphonas et al. 1991; Tryphonas et al. 1991; Arnold et al. 1993; Arnold et al. 1993). This study utilized a range of PCB doses (5-80 μg/kg-day) that was among the lowest that have ever been tested for any PCB mixture, allowing for the identification of sensitive effects of PCB exposure. Effects that occurred at the lowest dose included inflammation of the eye, nail lesions, and decreased immune function. Endometriosis was not observed even at the highest exposure level tested (80 μg/kg-day). U.S. EPA has derived an oral reference dose of 0.02 μg/kg-day for this PCB mixture by dividing the lowest dose (5 μg/kg-day) by an uncertainty factor of 300, accounting for (1) the possibility that some people may be more sensitive to the effects of PCBs than other people, i.e., susceptible populations, (2) the possibility that humans may be more sensitive than monkeys, (3) the fact that the study did not identify a dose at which there was no effect, and (4) the study duration, which was less than a lifetime of exposure (6.5 years). If one divides the highest dose (80 μg/kg-day) by the same uncertainty factor of 300, then doses up to approximately 0.3 μg/kg-day may be considered unlikely to result in endometriosis in humans based on this analysis. Since the reference dose for Aroclor 1016 (i.e., 0.07 μg/kg-day) that was used to develop the remedial goal options is lower than the highest exposure level for Aroclor 1254, adjusted for uncertainty, where endometriosis was not observed (i.e., 0.3 μg/kg-day), then use of the oral reference dose for Aroclor 1016 may be expected to protect against the development of endometriosis related to PCB exposure given the available data.

P – Jimmie Ann Abner	Asked what the medical risks to women is for the contamination not being cleaned up (residual contamination).	Contaminant levels remaining after the completion of the cleanup will all be within or below the EPA target health risk range for all receptors. The target range (as stated in EPA Superfund regulations) for excess cancer risk is 1 in a million to 1 in 10 thousand. For non-cancer toxicity, the cleanup levels are set at levels resulting in chronic, daily exposure for humans (including sensitive subpopulations) determined by the EPA to be without appreciable risk of deleterious effects during a lifetime. If monitoring shows that target risk based levels are not achieved for contaminants in edible fish, additional remediation may be needed.
C – Atlantic Richfield Company	Disagree with the EPA's assertion regarding potential benthic invertebrate risks in that various studies clearly demonstrate that there is no difference between the OU1 results and those from a reference/ background study site.	Between 2000 and 2006, the potentially responsible parties (PRPs) conducted over 300 sediment toxicity tests with amphipods and grass shrimp to assess risks to the benthic community. In contrast, only two benthic community surveys were conducted. One in 1999 and one in 2000. Appendix G of the Feasibility Study provides information related to the selection of benthic community remedial goal options based on the uncertainties associated with the toxicity tests and the two benthic community assessments. Appendix L of the FS provides a summary of major uncertainties associated with the benthic data. Several of the sediment toxicity tests conducted in both the Crescent River and Troup Creek reference areas resulted in significant toxic responses that were unexpected. No explanation was given by the PRPs in their toxicity test reports (Appendix C of the BERA). These toxic results at very low contaminant concentrations were considered highly uncertain. However, an analysis of toxicity at high COC concentrations was far more certain. Comparable toxicity in some reference area samples is not a justification to say there is no difference between OU1 data and reference data (e.g., see Table 4-23 in the BERA). With respect to the two benthic community assessments, a similar trend was noted in that one or two of the OU1 sampling stations had similar benthic indices as the reference station, but other OU1 stations did not. As another example of uncertainty, annual toxicity tests with indigenous grass shrimp also displayed toxicity in some samples collected from the main canal (LCP Ditch) and Eastern Creek while others did not. Sediment concentrations that displayed toxicity (for DNA strand damage, which is not a very sensitive endpoint) ranged from 1.2 – 86.6 mg/kg Hg and between 1.7 and 88 mg/kg Aroclor 1268. Sediment concentrations that were non-toxic ranged from 0.8 – 11

		mg/kg Hg and between 1.1 and 31 mg/kg for Aroclor 1268. There is significant overlap between toxic and non-toxic concentrations. Likely causes for these results were not presented in the PRPs test reports. As stated in the BERA, a number of potential non-measured factors could have contributed to the observed responses including substrate type, organic carbon and sulfide content. Given the above lines of evidence, along with the calculation of five different sediment effect concentrations for each test endpoint, the EPA concluded that there is a protective range of sediment concentrations to the benthic community that should be evaluated in the FS, and that an exceedance of the low end of the range did not mean definitively that the benthic community would be impaired. However, based on all the lines of evidence and uncertainties, the EPA believes that the majority of the benthic data clearly indicate that the most contaminated portions of the LCP Chemicals marsh do affect the benthic community and are not considered equivalent to the reference areas.
C – Atlantic Richfield Company	Disagree with the inclusion of polycyclic aromatic hydrocarbons (PAHs) and lead (Pb) as Risk Management Issues for OU1 in the Proposed Plan because PAHs and Pb do not pose a bioaccumulative (food web) unacceptable risk to humans, fish or wildlife of any kind or by any means of exposure. PAHs and Pb are identified as contaminants that create possible risk to benthic invertebrates. The commenter claimed that Site-specific testing shows toxicity levels and community metrics are comparable with the reference/ background area, meaning that no further response for PAHs and Pb is warranted.	The EPA acknowledges that the contamination of sediments by PAHs and lead are not widespread and exceed benthic cleanup levels in only a few areas. The EPA disagrees that these smaller areas of contamination should be ignored and disagree that the OU1 sediments are comparable with reference areas (see immediately previous response). The Selected Remedy addresses the highest PAH and lead contaminated areas.
L - Satilla Riverkeeper	This community group asked if the EPA considered containment of the contaminated areas with a coffer dam and complete removal as one of the alternatives in the Feasibility Study. If not why, not? Would a coffer dam or other containment structure facilitate removal without reintroducing the contaminated sediments to the estuary?	Removal of the entire marsh was not formally evaluated within the FS. Since a significant area of the marsh contains lower contamination levels than the cleanup goals, there is not a risk-based reason to remove the entire marsh surface. The goal of a remedy under CERCLA is to achieve protection of human health and the environment, and do so in a cost effective manner.

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L - Satilla Riverkeeper	The group asked if the EPA modelled reintroduction of contaminants into the marsh via benthic organisms and the Spartina lifecycle. If not, why not?	No specific modeling of mercury re-contamination via benthic organisms or *Spartina* was conducted. The Remedial Investigation and BERA tried to convey the importance of detrital material and various forms of organic carbon (OC) on their ability to sorb PCBs and that it reduces the availability of PCBs to bioaccumulate when bound tightly to OC. Although this occurs, the food web models used to assess exposure assumed 100% bioavailability. It is well known that plants differentially uptake and compartmentalize various contaminants in different parts of the plant and that various researchers attempt to identify contaminant movements within the plant itself. However, for risk assessment purposes, *Spartina* shoots were sampled to provide an average concentration in the plant for exposure evaluations. Understanding *all* aspects of contaminant movement or compartmentalization within an estuary was not an objective of the RI.
P – Penn Clarke	The community member notes that a thin layer cap failed in Seattle Bay, Washington.	This appears to be a reference to the Wyckoff Eagle Harbor Site. There is a section within the near shore (within the tidal area) where the thin layer cap did not achieve the remediation goal. However, the reason for the thin layer cap not being effective in these particular locations was because there were active releases in this spots. It is a creosote site with large amounts of subsurface non-aqueous phase liquid "stringers" that exist through the soils which result in localized seeps within the intertidal zone. The situation between this Region 10 site and the LCP Site are quite different. However, Region 10 is doing additional containment work, and may continue to use thin layer capping in the intertidal zone.
P – Janice Browning	Asked if just a small portion of the contaminated area was being cleaned up. She further commented that he did not see the point of cleaning up a small portion. She said that the EPA's goal should be to see healthy fish, dolphins, turtles, and animals freely roam this marsh and water.	The Selected Remedy will remove and properly dispose of the most contaminated portion of the LCP Chemicals marsh. The lower contaminant concentrations will be thin-layer covered or capped. These measures will be followed by an aggressive monitoring program, which will track the performance of this work. Should the response of the marsh and biota not perform as anticipated the EPA will have the legal tools at its disposal to require additional work to correct the situation. The EPA's specific remedial action objectives for the Site do include: 1. Reducing to acceptable levels piscivorous bird and mammal population exposure to contaminants of concern (COCs) from ingestion of prey exposed to contaminated sediment in the LCP Chemicals marsh, considering spatial forage areas of the wildlife

		and movement of forage prey; 2. Reducing risks to benthic organisms exposed to COC-contaminated sediment to levels that will result in self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas; 3. Reducing finfish exposures to COCs, through their ingestion of prey and contaminated sediment in the LCP Chemicals marsh, to support conditions within OU1 that do not cause unacceptable adverse effects in fish; and 4. Restoring surface water COC concentration to levels which are protective for recreational users, high quantity finfish consumers and ecological receptors.
P – Frank and Luanne Lea P – Jimmie Ann Abner	Several community members asked what the measurable goals and timelines of the cleanup are. One wanted to know whether it is possible to have healthy wildlife, fish, and dolphins when the cleanup is done. Another wanted goals that include seafood safe to eat, mink once again living at the LCP site and dolphins health improving.	The sediment cleanup levels for the LCP Chemicals marsh are specified in the ROD and it is expected that the remedial action objectives listed in the immediately preceding response will be met. Appendix A of the ROD provides a framework of goals for the long-term monitoring plan (LTMP). Specific measurable goals for the LTMP will be developed during the remedial design phase. With regards to whether it is possible for the wildlife at the Site to become healthy, among other things, the LTMP tissue data will be imported into the BERA risk models to determine the levels of protectiveness to fish and wildlife. Similarly, edible tissue data collected during the LTMP will be compared to the target tissue levels stated in the ROD. The timelines are difficult to predict; however, it will likely be a minimum of several years post-remediation.
P – Janice Browning	Asked what fiddler crabs will do to the thin layer cap?	Appendix I of the feasibility study includes a survey of bioturbation caused by fiddler crabs, among other organisms. The burrowing activity of fiddler crabs is a type of bioturbation, and burrowing can occur up to depths exceeding 12 inches. However, the majority of fiddler crab burrows have been reported to be within six inches. The deeper burrows are breeding burrows that are maintained and defended, so once established, there is little additional movement of sediment. In addition, the crabs forage and feed at the sediment surface, not at depth, so they do not cycle sediment from depth to the surface as part of feeding activities. In addition, vertical profiles suggest that, on the marsh flats, contaminant concentrations decline to near non-detectable levels at depths of greater than six inches.

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P – Jimmie Ann Abner	Noted that it is understood that the marsh around the site is contaminated with mercury and PCBs, and thinks the whole marsh should be removed.	It is not practicable to remove the entire marsh, nor would that remove all of the mercury. The basis for this is that since the construction of the chlor-alkali plants in the late 1950s, the tides in the LCP Chemicals marsh have advanced and retreated over 42,000 times, thereby dispersing the mercury, and to a lesser extent, the Arcolor 1268, over a very large area, making complete removal not practicable.
P – Clay Montague L – Satilla Riverkeeper	The community member and group asked what lasting risks to human health will remain after remediation? Who will be responsible for these and what remedies or recourse will they have? How safe will the environment be? Will children be safely able to swim and boat in Purvis Creek or in the nearby open waters of Gibson Creek and Turtle River? Will people be able to safely eat shellfish caught in the vicinity? Will warning signs be needed, and if so, who will be responsible for the warnings?	One of the objectives of the remedial action is to restore surface water concentrations of COCs to levels which are protective for recreational users of the marsh and high quantity consumers of finfish. However, such restoration will take time. Removing the remaining long-term sources of contamination, such as those present in the Eastern Creek and LCP Ditch, will address the remaining areas with high concentrations. A framework for the Long-Term Monitoring Plan (LTMP) is included in the ROD to measure the efficacy of the remedy. During the Remedial Design details of the LTMP will be developed. As a consequence, performance of the remedy will be monitored by the EPA and GAEPD through implementation of the LTMP, as well as the statutorily-required Five Year Reviews, which obviously will occur every five years, until the Site no longer poses a risk to human health and the environment. Should a problem be found with meeting the cleanup levels, the remedy may need to be amended or supplemented to allow for additional work. Warning signs related to fishing have been constructed on Purvis Creek. The State of Georgia is responsible for the warning signs.
P – Clay Montague L – Satilla Riverkeeper	The community member and group asked how it was determined that only 81 acres of the 670+ acres of marshland at the LCP site needed remediation. They asked if it is true that 33 of these target 81 acres were not chosen for remediation because of concern over temporary damage to restorable wetlands. If these 33 acres were included despite the damage to the marsh that might result, how would the amount and timeframe of damage to the marsh compare to the risk to people that remains from leaving LCP-contaminated sediments in those 33 acres? Has this comparison of risk been the subject of a scientific risk assessment?	During development of the FS, a decision was made to exclude from consideration for remediation the 33 acres located west of Purvis Creek. The genesis of 33 acres mentioned in the comment is described below. Thiessen polygons were created, based on the sampling density. See Appendix K of the October 2014 FS for more detail on Thiessen polygon construction. Since, as is reasonable given the size of the marsh (+670 acres), sampling density was greater in the domains closer to the discharge points (Domain 1) than those more removed discharge points (Domains 3 and 4), the polygons were considerably larger in the polygons located in Domain 4. Hence, the 33 acres consisted of larger polygons represented by marginally elevated single data points. To illustrate, on Figure K-6 of the FS, a single data point with a total PAH concentration greater than 4 mg/kg, contributes substantially to the 33 acre total.

P – Clay Montague L – Satilla Riverkeeper	The community member and community group asked what assurances can be given that capping contaminated sediments in place (rather than removing them) can withstand storm intensities at least comparable to that required for coastal construction. Does storm preparedness for coastal construction require structures to withstand FEMA-determined flood levels, and 120 mph wind speed? What similar storm preparedness standards will be required for the capping project? Even with capping, might a storm with upland flooding and 120 mph winds suspend contaminated sediments in the LCP-contaminated sediments and spread them over the upland landscape into residential neighborhoods and businesses? During a flooding storm, would contaminated sediments settle onto roadways, where they could be further spread on the tires of roadway traffic, and suspended as dust into the air? Will construction criteria for a contaminant cap include even stricter minimum storm standards (based on higher flood levels and more powerful winds) in order to address the public risk of contaminant exposure during and after a storm? If a storm pene-trates the cap, would contaminants spread far and wide once a bolus of contaminated sediments is suspended in coastal waters? Could any and all of the contaminants be spread by a storm, including mercury, lead, Aroclor 1268, PCBs, PAHs, dangerous dioxins, and others? If not, which would not be spread by a storm?	Appendix B of the FS (Hydrodynamic Modeling) details the numerical modeling work performed to simulate three conditions: 1) typical tidal conditions over a spring-neap tidal cycle, 2)100-year flood and 3) hurricane storm surge. This work was overseen by the U.S. Army Corps of Engineers. The following is excerpted from Appendix B. The latter two events (100-year flood and hurricane storm surge) were modeled to simulate the expected behavior of the Site under extreme events. Note that the 100-year flood and the 100-year storm surge were used for the modeling, as it is a consistent standard practice at Superfund sites to evaluate extreme event influence. Additional simulations for storm surges with rarer recurrence intervals (e.g., 500-year event) may be considered during the design phase of the project to test sensitivities. Based on experience from other sites of similar characteristics, the incremental effects of higher-frequency storm surges on marsh sites such as the LCP Chemicals Site is not expected to be considerable. In general, the change in the areal extent of intertidal inundation due to either remedial scenario was less than 4 percent (%), which indicated that the remedial scenarios would not have a significant effect on the circulation and marsh inundation within the Site. Overall, only relatively minor increases in maximum current velocities (relative to existing conditions) were predicted to occur for the two remedial scenarios, indicating that implementation of the remedies will not influence the general hydrodynamic characteristics of the marsh and tidal creeks.
P – Clay Montague L – Satilla Riverkeeper	The community member and group asked if among the contaminants allowed to remain in sediments at the LCP site, are any mutagenic or teratogenic, as well as carcinogenic. If so, what will be the risk of mutations and birth defects from human exposure to LCP-contaminated	PCBs (e.g., Aroclor 1268) are classified by the EPA as probable carcinogens. Benzo(a)pyrene (a typical component of PAHs) is also classified as a probable human carcinogen. No mutagenic or teratogenic chemical were identified as chemicals of concern in LCP sediments; therefore, mutations and birth defects are not expected. The human health risk assessment provides cancer risk estimates (prior to

	sediments, water, or seafood collected from impacted waters?	remediation) from exposure to these chemicals, and are summarized in Tables 11, 15, 16, and 17 in the ROD. It is expected that the current fish advisory will remain in place during and after implementation of the Selected Remedy until such time that long-term monitoring demonstrates that the advisory is no longer needed. The toxicity assessments for both mercury and PCBs do consider developmental effects; thus the remedial levels will be protective for these effects. Edible finfish, shellfish, and clapper rail are the media of concern for human health risks from the marsh. Direct contact with sediment and surface water do not pose unacceptable health risks for humans. Sediment, however, is a transfer medium which is proposed for remediation in order to reduce the contaminant levels in edible fish and birds.
L – Satilla Riverkeeper	The community group stated that it is unlikely that the marsh will be fully restored in two years, as assumed in the proposed plan. Have marsh vegetation restoration efforts been conducted at the LCP Site? If so, were they successful and should be repeated?	The Proposed Plan mentioned that the duration of construction will take two-to-four years, depending on the alternative. The Plan does note on page 44 that fish tissue concentrations are expected to be reduced within several years after construction. Marsh restoration was successful after the late 1990s removal in 13 acres of marsh; however, it did take about two decades. Similar marsh restoration will be required and is included in the cost estimate.
P – John McQuown	Asked why the cheaper Alternative (#6) was selected when a cheaper per acre option (#2) would provide more remediation.	The cost per acre for Alternative 2 is estimated to be about $1.35 million per acre, as opposed to the similar cost for Alternative 6, which is $1.19 million per acre. This notwithstanding, the cost per acre is not the sole consideration. Effectiveness of the remedy and impacts to the marsh must also be weighed.
P – John McQuown	He noted that signs are required around the capped area and to warn fishermen about consumption. Who is going to check and maintain the signage? Who is going to remind DNR to keep warning fishermen	The ROD contains a description of the measures that will be required to monitor the effectiveness of Institutional Controls (IC) such as fish advisories. Specifically, part of the Selected Remedy will be the development of an IC Implementation Assurance Plan (ICIAP). An ICIAP is a document designed to systematically: (a) establish and document the activities necessary to implement and ensure the long-term stewardship of ICs; and (b) specify the organizations that will be responsible for conducting these activities. As such, ICIAPs can be useful tools for planning and, in turn, for assuring effective implementation, maintenance, and enforcement of ICs because they can serve as a single-source of concise site-specific IC information.

P – John McQuown	He noted that the EPA should continue to take proactive steps to make the Brunswick City Council and Glynn County Commission aware of the hazardous and development restrictions at the site after each general election. Additionally, police and game wardens need to be periodically reminded of site dangers.	Five-Year Reviews of the remedy require outreach to local officials about the status of the remedy.
P – Janice Browning P – Jimmie Ann Abner P – Penn Clarke P – John McQuown	A number of community members and groups commented on the need to monitor biota long-term for mercury and PCBs, and to provide a schedule for monitoring as well as a schedule for monitoring goals to the community. In some cases, there was concern that only fish and shellfish would be monitor, instead of dolphins. One community member noted that sampling needs to be done to check that the remediation is working. This could be on a four or five year cycle. Superfund money should be allocated but it would be more sustaining if the State carried out the sampling. The results should be reported to the community. One community member asked if the EPA will require annual monitoring for mercury and PCBs in all fish (whole and filets) that people eat and also that dolphins, mink, raccoon, otters, estuarine turtles, snails, and fiddler crabs eat. If not, why, not?	The Performance Standards Verification Plan (PSVP) will be developed during Remedial Design along with the LTMP. The PSVP and LTMP will define the sampling needed to monitor the remedy. The data collected in accordance with the PSVP will be used in the Five-Year Reviews of the remedy which is made available to the public. See also responses to GEC March 16, 2015 regarding monitoring.
P – Janice Browning	Asked what monitoring has the EPA conducted on a regular basis for the past 20 years?	The BERA analyzed the biota data acquired between the years 2000 and 2007. The data is presented in the body of the report, as well as its appendices. There exists more recent fish tissue data, with the most recent tissue data having been acquired in 2011. The majority of this data has been made available to the EPA, the State of Georgia and interest groups, such as the Glynn Environmental Coalition.
P – Janice Browning	Asked what monitoring data the EPA is using to compare before and after the cleanup and cover up of the contamination?	The existing data described immediately above will form the basis for baseline conditions. Note that the framework of the LTMP included in the ROD specifies acquisition of baseline data, should the existing data not be adequate.
P – Janice Browning	Asked when the EPA will evaluate the cleanup (dates for evaluation, and how frequent will the	The framework of the LTMP, contained in Appendix A of the ROD, outlines the requirements of the monitoring program. The full LTMP

	EPA evaluate), what will be the specific evaluation factors (numerical goals) and specifically what will be done if the numerical goals are not reached.	will be finalized during the Remedial Design. The numerical goals (cleanup levels) for sediment and fish tissue are contained in the ROD. In addition to the LTMP, the EPA is required to evaluate the effectiveness of the remedy every five years in a Five-Year Review.
P – Clay Montague L – Satilla Riverkeeper	The community member and group asked what warning signs have been posted in the estuary and at boat ramps to keep people from consuming fish and shellfish in the vicinity of the LCP site, and to keep boaters and swimmers from coming into contact with contaminated sediments. Who is responsible for these signs? The community group further asked how many signs the EPA posted in the 20 years since the serious threat to human health was identified. Where are the EPA posted signs located? What is the EPA budget to maintain the signs over the past 20 years, and for sign placement and maintenance required until seafood is safe to eat?	Posting of fish advisories is the responsibility of the Georgia Department of Natural Resources. This information should be available thought their offices.
P – Clay Montague L – Satilla Riverkeeper	The community member and group asked if contaminated crabs are still entering the public food supply. Are the sets of floats that are sometimes visible in waters adjacent to the LCP site from commercial or residential crab traps?	The most recent Purvis Creek blue crab data (2011) indicated that mercury concentrations remain above the one meal per week advisory of 0.23 mg/kg but below the one mean per month advisory of 0.71 mg/kg. Similarly, the 2011 blue crab data show that Aroclor 1268 is above the 0.10 mg/kg weekly advisory but below the monthly advisory of 0.30 mg/kg. This information is found in Appendix F of the feasibility study. The ICIAP described above will improve on measure designed to minimize the possibility that these crabs are entering the food supply.
P – Clay Montague L – Satilla Riverkeeper	One community member and one community group asked if the people most likely to have been contaminated by LCP-tainted seafood been tested. Have sufficient numbers of people been tested for LCP contaminants? Has testing included those who eat large amounts of fish and shellfish from St Andrew Sound, Jekyll Sound, Jointer Creek, Christmas Creek, and the Satilla River estuary? How many people have consumed large quantities of fish and shellfish from those waters during the decades of contamination at	The Agency for Toxic Substances and Disease Registry (ATSDR) tested Brunswick residents in the late 1990s. The July 1999 ATSDR report may be found at: http://www.atsdr.cdc.gov/hac/PHA/ArcoQuarry/consumption_seafood_final_report.pdf. (Note that the link to the July 1999 report contains "ARCOQuarry" in the link. This report does not contain any information in the ARCO Quarry, which is a later ATSDR consultation and report). The following are the conclusions of the 1999 ATSDR report:

	the LCP site? Has an effort been made to warn those people and to suggest that they be tested?	• Participants in the target group reported a higher number of statistically significant symptoms compared with participants in the comparison group; • Respondents generally under-estimated their amount of seafood consumption as reported in the questionnaire when compared to the amount they reported actually consuming as measured by the two-week dietary diary; • Seafood comprised a smaller proportion of protein in study participants' diets than anticipated; • The current GDNR risk-based seafood consumption guidelines are protective for the general public because individuals are not consuming more seafood per meal than values used in calculating the consumption guidelines; • The majority of study participants do not fish in the restricted area; the few that do, however, state that they are aware of the advisory; • All study participants had urine mercury concentration levels below the reference level of 20 micrograms mercury per gram creatinine; and • There is evidence that the target group consumed seafood from the restricted area, without evidence of high mercury burden.
P – Clay Montague L – Satilla Riverkeeper	One community member and one community group asked if the spin of the Earth (Coriolis Effect) tend to turn local river discharges southward, which over the decades could have put contaminated sediments suspended at the LCP site into these areas, and along the beaches of Cumberland Island and into Christmas Creek?	Aquatic systems do tend to have circulation patterns which are driven by external forces, the earth's rotation being one such force, wind driven currents are another as are patterns driven by land masses that redirect water movement. We are not aware of any study which specifically looked at water circulation patterns within the Turtle River system, although one may exist. While the earth's rotation undoubtedly has some effect, it is likely that prevailing winds and the location of land masses determine the water circulation. In either case, it would be mud areas which are depositional rather than beaches which could retain any contamination which may be transported through the system.
L – Satilla Riverkeeper	The community group wants the site boundary to be extended to include Sapelo Island and the Satilla River due to detections of PCB 206.	Please see previous responses to comment # GEC (2) 2.2.

Attachment 1 – Response References

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RESPONSIVENESS SUMMARY

ATTACHMENT 2

Letters and emails Submitted During the Public Comment Period

GEC
Glynn Environmental Coalition

P.O. Box 2443, Brunswick, GA 31521

March 16, 2015

Mr. Galo Jackson, Ms. Shelby Johnston
Remedial Project Manager
South Superfund Remedial Branch
U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Mr. Jackson and Ms. Johnston,

The purpose of this letter is to request information, and submit questions and comments to be included in the official record for the LCP Chemicals Superfund Site Marsh Proposed Plan, Operable Unit One (1).

The Feasibility Study is built off the information contained in the Baseline Ecological Risk Assessment (BERA), Human Health Baseline Risk Assessment (HHBRA), and the Remedial Investigation (RI). The following comments will strive to address the LCP Marsh Feasibility Study (FS) by covering comments, questions, and concerns about these documents, and finally the Feasibility Study and the Proposed Plan (PP).

The period of time, 20 years, over which the LCP Site data were collected presents challenges of its own just related to the long period over which the data and studies were produced. These include: 1. Changes in Potentially Responsibility Party's Consultants and staff; 2. Continuity of EPA On-Scene Coordinators and Remedial Project Managers; 3. Demographic and socio-economic changes within the surrounding community; 4. Advances in scientific knowledge; and, 5. New and relevant research, studies, and reports concerning the marsh, estuary, and sound system in which the LCP Chemicals Site is located. Similarly, the institutional knowledge within the stakeholder agencies has undergone changes as key people retired, new hires came on and attempted to read the documents and get a grasp of the site conditions. Meanwhile, the sampling and analysis efforts declined and the existing data became dated and increasingly of limited value. Within this landscape of challenges, new agency personnel, and a feeling of urgency to get a Feasibility Study completed, the Proposed Plan for the LCP Marsh Operable Unit One (1) was produced.

The LCP Site documents reflect the challenges identified above. The following comments, questions, and studies and reports are presented to increasing the robustness and accuracy of the Feasibility Study and Proposed Plan, fully knowing the challenges the authors were encountering.

In the final analysis, the prudent course of action might be to use this point in time to develop a sampling and analysis plan, and a firm timeline for completion. There is an urgent need to obtain the information needed to produce complete BERA, HHBRA, and RI data needed to produce a viable FS and Proposed Plan with a measurable monitoring criteria to track and measure obtainment of remedial goals on a set timeline. The Proposed Plan should also establish follow-up actions to be taken if the remedial goals are not met at set points in time. Since the Potentially Responsible Parties (PRPs) have failed to produce the data needed to complete a viable remedial plan over an extended period of time measured in decades, the EPA is strongly urged to obtain the services of a competent contractor, such as Black & Veatch, to complete data collection needed and proceed with the Remedial Action without further delay. If need be, the EPA should use the available data to articulate the need for an "EPA Emergency Response and Removal Action" and designate the LCP Site a "Time Critical Action". The data identified in the following comments will support and articulate the need for a time critical action by the EPA.

With a full understanding of the challenges encountered during the 20 years leading up to the release of the proposed plan, the following comments are respectfully submitted. We trust the comments will help formulate a plan to develop a Proposed Plan that will obtain a timely cleanup and end the risk to human health and the ecosystem upon which the economic future of Brunswick and Glynn County, Georgia, depend.

Sincerely,

Daniel Parshley, Project Manager

Enclosures

INDEX

Baseline Ecological Risk Assessment (BERA) Comments and Questions

Cordgrass (*Spartina Alterniflora)*

The Baseline Ecological Risk Assessment (BERA) recognized Spartina as key to the functioning of the estuarine system, and the burden of Chemicals of Potential Concern (COPCs) were higher than biota at reference stations. Literature identifies Spartina as the base of the nutrient sharing system, and as such a key component to all life cycles in the estuarine system. Also noted was the Site is primarily vegetated with Spartina, which is also known as cord grass and marsh grass.

The BERA fails to identify why the marsh ecosystem is important, and in particular the nutrient transport system with *Spartina alterniflora* as the key species.

Why does the BERA fail to describe the marsh ecosystem in a manner that shows an understanding and knowledge about the movement of nutrients and Chemicals of Concern (COCs) within the ecosystem?

Why, in the entire 1002 page BERA, is *Spartina alterniflora* detritus potential to transport COCs not mention even once?

Has Spartina been identified and an initial vector for mobilization of sediment bound chlorinated hydrocarbons, such as PCBs, into the estuarine food chain (Mrozek, 1982)?

Have studies shown Spartina to be a key factor in bioaccumulation of PCB in detritus and an important means of entry for this pollutant into estuarine food webs (Marinucci, 1982)?

Did the LCP Marsh Remedial Investigation reported:

> "Sorption to organic carbon is the primary mechanism controlling the mobility and bioavailability of PCBs and PAHs in sediment, and also one of several mechanisms affecting bioavailability of divalent metals, including lead and mercury. Organic carbon is abundant in marsh habitat (e.g., detritus within the Spartina mud flats and dissolved organic carbon (DOC) from plant exudates, specifically fulvic and humic acids within the root zone of sediments). Sorption to soot, pitch, coke, and other black carbon forms can greatly decrease bioavailability of many hydrophobic organic compounds compared to amorphous organic carbon (Cornelissen et al., 2005)."

Does the statement from the LCP Marsh Remedial Investigation indicate the authors understood the importance of Spartina to the bioaccumulation and transport throughout the echo system and movement through the food web?

If so, why were steps to sample all parts of the Spartina plant not taken during the remedial investigation?

Has scientific literature noted a differentiation between the root rhizome stem and leaves and their ability to bioaccumulate PCBs?

Did *Sustainable Development in the Southeastern Coastal Zone* note .33 ppm in Spartina shoots, 2.80 ppm in roots (Army Corps of Engineers)?

Cordgrass *(Spartina)* and Mercury

The BERA noted:

> "Cordgrass (Spartina alterniflora) was characterized by concentrations of total mercury that ranged from a mean of 0.02 mg/kg (dw) in the Purvis Creek area to a mean of 0.147 mg/kg (dw) in the Main Canal area vs. 0.005 mg/kg in the Troup Creek reference location (Table 4-6a). Methylmercury frequently could not be detected in cordgrass and, when detected, averaged just 9.93 percent of concentration of total mercury (Appendix F)."

Why did the BERA limit resting for mercury to a section of the leaf 15 cm above the sediment?

Does Spartina testing most frequently and routinely sample the root, rhizome, stem, leaf, and detritus due to the selective bioaccumulation noted with Spartina (Mrozek, 1982; Windham, 2001)?

What was the decision-making process used to limit sampling to just a small section of the leaf, which is know from literature to be the part of the plant with the least bioaccumulation potential?

Were the BERA authors aware that in the fall, the root-rhizome material makes up 78% of the total live biomass and by spring this decreases to 53% (Schubauer and Hopkinson 1984)?

Did the authors of the BERA consider the Manatee has been seen grazes on the Spartina in the LCP Site area?

What was the decision-making structure used to limit the Spartina sampling to the leaf 15 cm above the sediment?

Were stakeholder agencies consulted such as the National Oceanographic and Atmospheric Association (NOAA) or U.S. Fish and Wildlife consulted before this Spartina sampling plan was limited to just the leaf 15 cm above the sediment?

What peer reviewed journal articles were used to support the decision to limit Spartina sampling to 15 cm above the sediment?

Did the BERA consider the potential for Spartina to bioaccumulate metals like mercury from sediment and excrete them from the leaf (Weis, 2003; Windham, 2001)?

What would the implications of Spartina growing on top of mercury contaminated sediments?

Would removing the Spartina from mercury contaminated sediments result in less transport from sediments into the ecosystem?

Did the BERA examine mercury transport via Spartina (Weise, 2003; Windham, 2001)?

Notable is the BERA fails to mention the same glands that excrete salt do excrete mercury. What was the reasoning of the BERA to exclude this critical fact about the excretion and bioaccumulation properties of Spartina?

Did the authors of the BERA do their due diligence and research to identify the potential of the biota to bioaccumulate and transport identified COCs? If not, why not?

Did any stakeholder agencies comment about the apparent selective use of data or data appeared to be censored?

Could the oversight of including mercury excretion along with salt from Spartina leaves be interpreted by a reasonable individual as the selective use of data or the censorship of data?

What is the EPA's explanation for such a critical piece of information, such as mercury excretion, being excluded from the BERA?

How would the exclusion of mercury excretion impact the risk calculations used to develop the Feasibility Study?

Would mercury levels in Spartina leaves be a critical piece of information for evaluating the potential impact to marine mammals like Manatees that use this plant as a primary food source?

Being that the St. Simons Sound and Turtle River are documented Manatee calving grounds, what significance is mercury in the Manatee's primary food source while lactating?

Cordgrass *(Spartina)* and Aroclor 1268

The BERA noted:

> Aroclor 1268 concentrations in cordgrass from the Site ranged from a mean of 0.096 to 0.261 mg/kg, in comparison to 0.0134 mg/kg at the reference location. The maximum concentration of 0.614 mg/kg occurred in Domain 1 at the AB Seep Location.

The BERA appears focused on Aroclor 1268. Were the following Aroclors found at the LCP Site – Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, and Aroclor 1260

(ATSDR, 2014a)?

What PCB congeners are present in Aroclor 1016, Aroclor 1221, Aroclor 1248. Aroclor 1254, Aroclor 1260, and Aroclor 1268?

Do the PCB congeners found in Aroclor 1016, Aroclor 1221, Aroclor 1248, Aroclor 1254, Aroclor 1260, and Aroclor 1268 include those with dioxin and furan properties?

Were the non-dioxin-like and dioxin-like effects of the specific PCB congeners analyzed in the BERA, or was only a general Aroclor 1268 analysis conducted?

Were the EPA BERA protocols for analysis of PCB dioxin and non-dioxin-like effects conducted as part of the 2003 BERA for the LCP Site marsh (EPA, 2003)?

Were all congeners of PCBs detected at the LCP Site measured in the Spartina samples collected 15 cm above the sediment?

Was the PCB congener analysis limited to those found in Aroclor 1268?

What is the significance of the BERA focusing on Aroclor 1268?

Was the BERA limited to an analysis of Aroclor 1268? If not, where can the chemicals with similar modes of physiological action, like the other Aroclors, dioxin, and furans be found?

Was a Toxicological Equivalency Factor (TEF) developed for all the PCB Aroclors, dioxins, and furans found in Spartina? If not, why not?

> "The BERA limited Chemical of Concern (COCs) in Spartina (sp.) were limited to three - Mercury, Aroclor 1268, and lead."

What was the reasoning used to limit the COCs examined in Spartina?

Were toxicological effect found in organisms at levels lower than expected when the toxicological factors were limited to just the three factors: mercury, Aroclor 1268, and lead?

BERA Appendix E states:

> Smooth cordgrass occurs in all of the above-identified marsh zones, in great part because of its special adaptations that allow it to live where few other plants could survive. These adaptations include a tough and well-anchored root system, as well as narrow, tough blades and special glands that secrete excess salt, permitting it to withstand high heat and daily exposure to salt water.

The Spartina alterniflora nutrient recycling system, critical to the estuarine marsh system,

is notably missing from the BERA.

Why is the crucial nutrient recycling system the Spartina alterniflora serves for the estuary noticeably missing from the BERA?

The BERA is devoid of any discussion about the PCB bioaccumulation properties of Spartina in marsh environments. The potential for Spartina to be a significant reservoir of PCBs in the environment has not been identified or quantified, which would be a major factor in FS to identify areas for removal and determining total PCB mass calculation. As a major, if not the most primary and basic mechanism for transporting PCB in to biota at the base of the food chain, the lack of any information in the BERA is a glaring shortcoming in the report. Failure to be cognoscente of the potential for Spartina to bioaccumulate PCBs and incorporate them into the base of the food chair raises doubts about the technical expertise of the authors of the BERA work plan, or points to development of a work plan design to produce predictable results with the intent to under reporting actual levels of COCs. Regardless of the reason or intent, the fact remains that a major flaw in the BERA needs to be rectified.

Fiddler Crabs (*Uca minax* or red-jointed, *Uca pugnax* or mud fiddler, *Uca pugilator* or sand fiddler)

> "The greatest mean number of crabs, 196 individuals / m2 of substrate, was reported in a habitat characterized by medium-sized *Spartina* (0.5 -1.49 m in height), while 176 and 94 individuals / m2 were observed, respectively, in short *Spartina* (<0.5 m tall) and on essentially barren substrate (absence of vegetation)."

Why does the BERA limit reporting of PCBs in fiddler crabs to Aroclor 1268 (BERA, pg. S-5)?

Why does the BERA report found that they were fiddler crabs present in numbers (200 young and adult crabs per square meter) that might be expected to occur in a relative pristine marsh, but not quantify the amount of sediment brought to the surface on an annual basis?

Is the amount of sediment excavated from the sediments by Fiddler Crabs important information for remedies using capping of marsh sediments?

Why were Fiddler Crabs sampled at a location previously remediated (BERA, Pg. 55)?

Was the BERA data concerning fiddler crab abundance biased by sampling in a previously remediated area?

Can the encountering of the membrane at 40 cm be used to infer the minimum depth of the fiddler crab burrows are 15.75 inches (BERA, pg. 55)?

Does the BERA state "these burrows, which often extend to 2 ft in depth …. (BERA, pg. E-2)? What are the implications of sediment excavation activity by fiddler crabs to remedies involving placement of capping material over the marsh?

What is the quantity of sediment brought to the surface annually by over 200 fiddler crabs per square meter?

What is the quantity of sediment brought to the surface annually by the remaining biota (other than Fiddler Crabs)?

Mink *(Mustela vison)*

Even though mink are indigenous and wide-spread in coastal Georgia, mink are noticeably missing from the Site marsh indicating reproductive failure. Furthermore, no mink analysis is presented in the BERA. The reasonable assumption is the Chemicals of Concern (COCs) levels are sufficiently high around the Site to prevent reproductive viability in mink. **The range of mink should be established as a baseline before the Estuary Remedial Action (RA) is implemented.** The RA should sufficiently reduce COCs to allow, at a minimum, a viable reproducing mink population in the Site area.

Does the EPA intend to make identification of the mink range within the turtle River's system and the St. Simons sound estuary a priority?

If the EPA is can make mink range a priority what is the timeline for collection of this data?

The BERA notes the presence of mink in the estuary and notes these are animals found in the estuary. But, in the case of the LCP Site, and the BERA, the absence of any mink in the area is glaringly noticeable. Mink are sensitive to the chemicals present at the LCP Site, such as PCBs. It is unknown why the authors of the BERA or the EPA did not understand the significance of the absence of mink or make note of this fact, even though the absence was noted by the EPA previously (USEPA, 1997).

After identifying the Mink as an indigenous species missing from the ecosystem surrounding the LCP Chemicals Superfund site, why did the EPA eliminate the species from the baseline ecological risk assessment when it was obviously one of the most impacted species?

Is the EPA aware that mink are a species susceptible to adverse impacts from PCB exposure and a good indicator species for measuring ecological impacts?

What is the EPA's rationale for elimination of the mink from the BERA?

What is the EPAs explanation for the absence of mink from the LCP Site?

Does the EPA intend to identify the "dead zone' around the LCP Site where mink are absent?

Does the EPA intend to define the area where mink are absent, and delineate where viable and sustainable mink populations can be found?

If the EPA does determine the extent of the area where the contamination has eliminated the mink population, and will mink be used as a monitoring criteria to assess the Remedial Action?

If the EPA does intend to use the mink and a monitoring indicator, will this be placed in the Record of Decision and Consent Decree for the LCP Site?

Will the EPA recommend mink be used as monitoring criteria for assessment of the remedial action? If not, why not?

The BERA note (Section 6.2.2.5):

> An important source of uncertainty associated with this assessment endpoint is how well the river otter exposure model that represents a top-level piscivorous mammal could be extrapolated to dolphins and whether the TRV (based on Aroclor 1254 effects to mink) could reasonably be applied to dolphins.

Why should the EPA use otters when mink are an indigenous species and the indicated as the proper species to use?

Does the EPA agree that if an exposure model can be applied from the mink to the dolphin, the model can be applied from the dolphin to the mink?

The lack of a viable reproducing mink population does not indicate no problem, but rather quite the opposite. Alarms should be going off when an indigenous species shown to be sensitive to the chemicals released from the LCP Site is missing. The only conclusion can be a dead zone is surrounding the site. The baseline monitoring plan should use the mink as an indicator of marsh and estuary recovery. The area without a viable mink population should be delineated and help define the area of reproductive failure. The argument that a key species in the estuary is "just not present in this area" should not be accepted. The correct observation is "this is the only area where the mink is not present". The mink was suggested as an indicator of dolphin health by the Potentially Responsible Parties via dosing with Aroclor 1268. Notable is the lack of any mink sampling within the Turtle River estuary, which would have produced a real life's samples to use as an indicator of dolphin health. But these mink samples are not needed as an indicator of dolphin health because there is a wealth of data that has been collected from the resident dolphin population in coastal Georgia. It is now known dolphins are sick and lack of any reporting concerning this situation greatly questions to credibility or viability of the BERA as a decision-making document.

Is the EPA aware that PCBs have been associated with low mink kit survival and mink are a sensitive population to the toxic effects of PCBs (Bursian 2006; Bursian, 2013)?

Will the EPA consult literature and establish a remedial action level that will result in the recovery of the mink population at the LCP Site?

Dolphins

As previously noted, the lack of any information concerning the resident dolphin population in Turtle River and coastal Georgia is a glaring omission from the BERA. This omission is so glaring as to question the motives of the authors of the BERA. Since at least 2004, is been known that though dolphin population is grossly contaminated and this fact is been well documented. Furthermore stakeholder agencies have collected samples from the resident dolphin population, analyze the samples, and even conducted health assessments on the dolphin population. But the authors of the BERA have chosen to ignore this wealth of data.

What is the EPA's explanation for not including the dolphin data in the BERA?

Did the EPA failed to communicate with the stakeholder agencies, including the Georgia Department of Natural Resources, the National Oceanic and Atmospheric Administration, and the US Fish and Wildlife Service concerning the dolphin sampling and analysis?

Was the EPA oblivious to the fact that the same people that were producing data on the LCP Chemicals Superfund site were also doing sampling and analysis on the resident dolphin population for PCBs associated with the LCP site?

Notable are people who were sampling the dolphins and producing peer reviewed journal articles had also worked with EPA On-Scene Coordinators at the LCP Chemicals Superfund Site. It stretches the imagination to think that the EPA was not aware of the gross contamination in the resident dolphin population.

Inshore resident dolphin (T. truncates) populations exhibit long-term fidelity to specific estuaries and making them excellent sentinels for assessing the impact of stressors on coastal ecosystem health (Pulster, 2008). It is not surprising that the implications to human health were obvious to those studying the dolphins and they questioned the impact to the people who regularly and habitually consumed fish from the same waters (Schwacke, 2012).

The plight of the dolphins in Turtle River has been known since at least 2004. It was noted in the PCB levels were 10 times higher than those noted in the Savannah area dolphins (Pulstera, 2008). Literature reports 102 bottlenose dolphin blubber samples being analyzed from animals in Georgia (Balmer, 2011). The researchers noted that the levels of PCBs in the dolphins was associated with a point source near Brunswick Georgia or the LCP Chemicals Superfund site. The study was robust and photo identification was used to identify individual dolphins. Also noted were that the male dolphins in Turtle River had the highest concentrations of PCBs reported for any marine mammal, worldwide. The Aroclor 1268 levels were noted to be highest in the Brunswick Georgia area and decreasing with distance (Balmer, 2011).

The dolphins in the Turtle River estuary system were given a physical examination in addition to being sample for levels of PCBs. The result of the examination was the identification of anemia, hypothyroidism, and immune suppression associated with PCB exposure (Schwacke, 2012).

A high proportion of the sample dolphins suffer from anemia (26%), which is a finding previously reported being observed with Aroclor 1254. Furthermore the dolphins showed reduced thyroid hormone levels which were negatively correlated with PCB concentrations measured in the blubber. There was a correlation between immunity decrease and blubber PCB concentrations, which is suspected to increase susceptibility to infection and disease. Contrary to the assertions of the Potentially Responsible Parties that Aroclor 1268 is less toxic than other forms of PCBs, the re-searchers found the PCB mixture dolphins were exposed have substantial toxic potential and potential impacts on other top-level predators. Humans were identified as one of those other top-level predators consuming the same as fish species from the same estuary (Schwacke, 2012). **The significance of this empirical evidence and implications to human health appears to have been ignored by the EPA. At a minimum, the EPA has not conducted due diligence by conducting a basic literature search for the Superfund Site name for data and studies pertinent to the Site and the EPA decision-making process.**

The other notable impacts to the dolphins in Georgia coastal waters were skin disease, and specifically lesions. Again, the Brunswick Georgia site was found to have the highest incidence of skin lesions in bottlenose dolphins when compared to Sapelo Island Georgia and Sarasota Bay Florida (Hart, 2012).

The dolphins in the Turtle River estuary having the highest PCB concentrations required for any Marine mammal has raised considerable concern for both the dolphins and humans consuming seafood from this region of the Georgia coast. Dolphin densities were compared for the Brunswick Georgia area and the Sapelo Island area. The researchers noted that dolphin density in total abundance were sadistically higher in the Sapelo Island area than in Brunswick. Furthermore, anthropogenic stressors were identified as an important factor and potentially the cause of the differences in abundance density and habitat use observed (Balmer, 2013).

Research was done to establish the level of PCBs in fish that would result in tissue levels below the health effects threshold in dolphins. The model developed estimated that a dietary PCB concentration that did not exceed 5.1 ng/g (parts per billion or ppb) would be required to be protective of 95% of the dolphin population (Hickie, 2013). Very notable is how close the proposed maximum dietary PCB concentration is to the level that is protective of human health and the high quantity seafood consumer.

Will the EPA include the large volume of data on the coastal Georgia resident and transient dolphin population into the BERA? If not, why not?

Does the EPA understand the implications to human health from the dolphin data?

Does the EPA understand that dolphins and humans eat the same fish species?

Will the EPA incorporate the dolphin data into the HHBRA? If not, why not?

Does the EPA intend to incorporate the large volume of dolphin data into their decision-making process for the propose plan for the marsh at the LCP Chemicals Superfund site?

Will the EPA established a maximum allowable level of 5.1 parts per billion (PPB) in fish as the goal for the LCP marsh cleanup?

Notable is dolphin studies were not included in the BERA but were utilized in the Human Health Baseline Risk Assessment (HHBRA) to argue the Aroclor 1268 at the LCP Site is distinct and recognizable (Pulster, 2005; Pulster 2008).

As noted in the HHBRA:

> "Polychlorinated Biphenyl (PCB) homologue analysis of sediment and biota were presented in Kannan et al. (1997) and Kannan et al. (1998). The homologue proportions are substantially similar to the proportions in Aroclor 1268. More recent work indicates the same conclusions (Sajwan et al., 2008; Cumbee et al., 2008; Pulster and Maruya, 2008; Pulster et al., 2005)."

What is the rational for inclusion of the dolphin studies in the HHBRA to argue for only Aroclor 1268 sampling and not including them in the BERA?

Will the EPA utilize all the dolphins studies identified in these comments and the corresponding references to formulate Remedial Action levels protective of the resident dolphin population?

The HHBRA discusses using the dolphin data in the rationalizing for limiting sampling to Aroclor 1268 (Pulster, 2005; Pulster, 2008).

Were Aroclor 1254 found in 81 samples (9%), and Aroclor 1260 found in 37 (4.1%) in upland samples (ATSDR, 2014a)?

If Aroclor 1254 and Aroclor 1260 were found in upland samples, what was the EPA's rational for eliminating these PCB Aroclors from the COC to be sampled for in the LCP marsh?

Were other PCB Aroclors found in upland samples at the LCP Site, and if so, what was the EPA's rational for eliminating these from the COC to be sampled for in the LCP marsh?

Was PCB congener 206 established as the one defining Aroclor 1268 contamination from the LCP Site in coastal Georgia (ATSDR, 2014b)?

Is PCB congener 206 the most prevalent, or dominant, in Aroclor 1268?

Has a gradient of PCB congener 206 been found emanating from the LCP through sediment samples taken in coastal Georgia (ATSDR, 2014b)?

Using PCB congener 206 as an indicator of the boundaries of the LCP Site contamination, what are the geographical boundaries of the contamination from the LCP Site (ATSDR, 2014b)?

Did ATSDR compare and contrast total PCBs in fish between the Brunswick Georgia and Sapelo Island area (ATSDR, 2014b)? If so, what were the findings (differences quantified)?

Was the purpose of the ATSDR study to "Compare results in people with what is known about dolphins" (ATSDR, 2014b)?

Does the ATSDR study imply what is known about dolphins could be utilized to predict impacts to people eating the same fish species (ATSDR, 2014b)?

Did ATSDR report, "We did find that human and dolphin specimens contain qualitatively similar environmental contaminants" (ATSDR, 2014b)? Does this statement imply the dolphin data is very important to understanding chemical exposure to people from the LCP Site?

What are the implications to the HHBRA from the BERA not having included the dolphin data and studies identified in these comments to the EPA on the BERA?

The BERA and Dioxin/Furan

The BERA States:

> Dioxins/furans were collected from three sediment samples in October 2000 at C-6, C-8, and C-15 in the LCP estuary. Two additional samples were collected from the Troup Creek and Crescent River reference stations. Using the mammalian toxicity equivalency factors for each of the dioxin/furan congeners (U.S. EPA, 2008a), the toxicity equivalence concentrations (TECs) at the LCP estuary stations ranged from 54 ng/kg to 1,878 ng/kg. At the two reference stations the dioxin TEC concentrations were less than 10 ng/kg. The EPA Region 4 sediment screening-level for dioxins is 2.5 ng/kg which are based on the most toxic form of dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD]). The maximum concentration of TCDD in the reference samples was 1.7 ng/kg while the highest concentration of TCDD from the three estuary samples was 53.7 ng/kg at C-6. Therefore, dioxins/furans are of concern. However, no further sediment or biota samples were analyzed for dioxins/furans during the monitoring program. **Therefore, potential risk cannot be adequately evaluated in this assessment based on the three sediment samples collected in 2000, but will be discussed further in the uncertainty section. (emphasis added)**

Are the TECs (a.k.a TEQ) reported 2 to 4 orders of magnitude higher than the EPA screening level of dioxin of 2.5 ng/kg?

Was any effort whatsoever made by the EPA to obtain existing dioxin/furan data from the St. Simons Sound in which the LCP Site is located?

Did the EPA ask Stakeholder Agencies if they had collected Dioxin/Furan data for the St. Simons sound estuarine system?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder and Black Drum (both whole and filet) in Turtle River in 1989 (GADRN, 1989)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, and Hardhead Catfish (filet) in Turtle River in 1990 (GADRN, 1990)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum. Sheephead, (whole and filet) in Turtle River in 1991 (GADRN, 1991)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Atlantic Croaker, and Gafftopsail Catfish (whole and filet) in Turtle River in 1992 (GADRN, 1992)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, Black Drum, and Hardhead Catfish (whole and filet) in Turtle River in 1993 (GADRN, 1993)?

Did the EPA take into consideration the Dioxin/Furan sampling of Southern Flounder, and Stripped Mullet, (whole and filet) in Turtle River in 1993 (GADRN, 1993)?

Did the EPA consider the four samples for Dioxin/Furan taken in the Altamaha Canal south of the LCP Site in 2011 with results above the 2.5 NG/KG TEC (a.k.a TEQ) of 62, 130, 68, and 20 ng/kg (EPA, 2011)?

Did the EPA consider the December 1995 EPA Community Based Environmental Project's 14 sediment samples from the Turtle River/St. Simons Sound area?

In light of all the above Dioxin/Furan sampling conducted by the EPA or one of the LCP Chemicals Superfund Site Stakeholder agency, why should anyone, or the court who considers the Consent Decree, believe the EPA when it states, "Therefore, potential risk cannot be adequately evaluated in this assessment based on the three sediment samples collected in 2000, but will be discussed further in the uncertainty section"?

The EPA has interjected data from the lake Onondaga LCP site located near Syracuse, New York, into the Proposed Plan for the LCP site in Brunswick Georgia. Unlike the LCP site located in Brunswick Georgia, there was a significant amount of dioxin data collected at the LCP site located in New York (USEPA, 2002).

Was whole fish sampling for dioxin and furan in juvenal and adult fish conducted at the LCP site in Brunswick Georgia, or only at the Lake Onondaga Site?

Do the dioxin and furan sampling at the Lake Onondaga site in New York find a risks to wildlife from dioxin and furans (USEPA, 2002)?

If the risk from wildlife from dioxin and furans was found at the Lake Onondaga site, with those risks be applied to the wildlife at the LCP site in Brunswick Georgia? If not, why not?

If the EPA is using data from the Lake Onondaga Site for decision-making concerning sampling of dioxin and furan at the LCP site in Brunswick Georgia and to delay such sampling until after the Record of Decision and Consent Decree, why not use the same reasoning to utilize the data for estimating risk in Brunswick from the observations at the New York site?

Will the EPA order whole fish sampling for dioxin/furan in juvenal and adult fish from Turtle River to obtain the same quality data as used at Lake Onondaga, New York?

> "In mammals, learning behavior and development of the reproductive system appear to be among the most sensitive effects following prenatal exposure. In general, the embryo or fetus is more sensitive than the adult to dioxin-induced mortality across all species (ATSDR, 1998c, U.S. EPA, 1994a).
> Environmental exposure to dioxins includes various mixtures of CDDs, CDFs, and some PCBs. These mixtures of dioxin-like chemicals cause multiple effects that vary according to species susceptibility, congeners present, and interactions." (USEPA, 1994a)

Did the BERA include the dioxin and furans within the Turtle River area in their calculations for PCBs, dioxins, and furans TEQ or the hazard quotient or the hazard index?

Manatee

The Manatee, and endangered and protected species, is mentioned in the BERA but none of the work recommended by the US Fish and Wildlife Service (USFWS) has been completed. Again, the recommended work was centered on the keystone plant species in the LCP marsh, Spartina.

Did the USFWS find a need to examining the roots and note cleaning of the Spartina could result in an underestimation of the exposure scenario of herbivores like the Manatees, and the others in residents year round (USFWS, 1996)?

What was the EPA's rationale for not including the Manatee in the Baseline Ecological Risk Assessment?

Is EPA aware that the Manatees is an endangered and protected species?

What action is the EPA taking at the LCP Chemicals Superfund site to assure the Manatee is not consuming excessive amounts of PCBs, mercury, and dioxin via the cordgrass (Spartina)?

Did the EPA make an estimation about how much sediment the Manatee would consume while foraging on the cordgrass (Spartina)? If not why not?

Diamondback Terrapin

Early in the examination of the LCP Chemicals Superfund Site for ecological damage the diamondback terrapins were examined. The terrapins were found to be suffering from wasting syndrome and reproductive problems. The BERA appears to have drifted away from the empirical evidence presented to modeling impacts.

In light of the wasting syndrome reproductive problems identified with the Terrapin, how did the BERA come to the conclusion that there is a hazard index or hazard quotient less than one?

Is it possible to have reproductive failure and a hazard quotient or hazard index less than one?

Is it true that the levels of PCBs observed in the Terrapin eggs was in excess of 600 ppm (USEPA, 1997)?

Were the eggs examined for reproductive viability?

What were the results of the examination of the Terrapin eggs for reproductive viability?

Will the Terrapin be included in the species used for monitoring and evaluating the remedial action efficacy?

Human Health Baseline Risk Assessment Comments and Questions

The only appropriate way to start the review of the Human Health Baseline Risk Assessment is with the following two quotes from studies that do, unlike the EPA or the Potentially Responsible Parties, fully realize the serious and dangerous situation facing people residing around the LCP Chemicals Superfund Site, the need to evaluate the dolphin data, studies and reports; and, in particular anyone consuming seafood from the St. Simons Sound estuarine system.

> "Moreover, PCB signatures in dolphin blubber closely resembled those in local preferred prey fish species, strengthening the hypothesis that inshore T. truncatus populations exhibit long-term fidelity to specific estuaries and making **them excellent sentinels for assessing the impact of stressors on coastal ecosystem health** (Pulster, 2008)".

> "The severity of the effects suggests that the PCB mixture to which the Georgia dolphins were exposed has **substantial toxic** potential and further studies are warranted to

elucidate mechanisms **and potential impacts on other top-level predators, including humans, who regularly consume fish from the same marine waters** (Schwacke, 2011)."

When reviewing the Human Health Baseline Risk Assessment (HHBRA) is important to keep in mind the saying "garbage in garbage out". In case of the HHBRA, there was plenty of garbage to go around. But in spite of the tendency to make light of how bad the document is, the ramifications to Glynn County and the surrounding Brunswick community are real, serious, and have significant ramifications to the future health and welfare of the citizens of Glynn County, and anyone from the surrounding coastal Georgia Counties catching and consuming seafood from the contaminated areas. Furthermore, the area of contamination delineated appears incomplete and limiting the remedial activities the site property boundaries could be grossly inadequate. The failure to produce a viable document is a real threat to human health. Like the Baseline Ecological Risk Assessment, what is missing from the report is more notable than what is in the report. In addition to the dismal quality of the report, the EPA has a long history of less than competent efforts to protect human health and the environment around the LCP Chemicals Superfund site for the past 20 years. This indicates the EPA has never had a firm grasp on the seriousness of the problem at the LCP Chemicals Superfund Site. Further aggravating the problem is the numerous changes in s EPA Remedial Project Managers, which is not meant to reflect on the character of the Remedial Project Managers but rather another indicator of the EPA management's inability to put a lucid and comprehensive plan together for the LCP Chemicals Superfund Site and move the cleanup ahead in a timely manner.

Numerous action items were identified for the EPA to implement in the Brunswick, Glynn County, community to protect people from the risks from the LCP Chemicals Superfund Site. These include, but not limited to, following recommendations from the Agency for Toxic Substances and Disease Registry (ATSDR, 1994, 1996, 1999, 2014):

- Raise awareness about the fishing advisories among residents and healthcare providers.
- Improve the fishing advisory signs so that they are more easily seen.
- Maintain the fishing advisory until the source of contamination is removed.
- Continue public education regarding the hazards of consuming Mercury contaminated seafood with a focus on pregnant and nursing women, children, the elderly, and those with compromised immune systems. Evaluate the feasibility of developing a fact sheet based on the Georgia DNR guidelines for eating fish from Georgia waters, specific for fishing areas in Glynn County to be made available were fishing licenses are sold.

What programs has the EPA implemented to raise awareness about fishing advisories among residents and healthcare providers?

What were the dates of the EPA initiatives to raise awareness with health care providers about the seafood advisories?

What improvements did the EPA make to the fishery advisory signs so they are more easily seen?

How many fish advisory signs has the EPA had placed in the community?

Where are the fish advisory signs the EPA has placed in the community located?

What is the EPA's budget for fish advisory signs?

What is the EPA's budget to maintain the fish advisory until the source of contamination is removed?

What is the EPA's budget for continuing public education regarding the hazards of consuming mercury and PCB contaminated seafood?

How does the EPA focusing on pregnant and nursing women, children, the elderly, and those with compromised immune systems?

The EPA answering the above questions is critical in evaluating the Feasibility Study since institutional controls are be considered for protection of human health. The EPA's performance over the past 20 years in implementing recommendations protective of human health will be a very good indicator of what can be expected moving forward. Indications are the EPA is inept and does not have the management continuity to implement or manage a competent program of institutional controls. Therefore, at a minimum, the EPA should appropriate sufficient funding to have the appropriate actions implemented on the local level for as long at the threat from contaminated seafood remains.

Will the EPA require an appropriation or appropriate funding to implement the already identified activities to better protect human health and the environment?

Will the EPA expedite the appropriation of funds to implement the recommendations intend to help protect human health?

The stated goal of the HHBRA is: The overall goal of this risk assessment is to develop essential scientific information that can be used in decision-making regarding the LCP Chemicals Site estuary in support of an evaluation of the need for remedial action.

The guidelines for seafood sampling utilized for the HHBRA state:

> "For scaled fish, fillets should be scaled but left with the skin on. For fish without scales, the skin should be removed from the fillet " (GA-DNR) (FTAC, 1992).

Are the fish samples collected from Turtle River being prepared according to the appropriate protocols and the skin and belly flap left on the filet?

Was whole fish sampling conducted in order to determine the range of exposures human consumers might encounter?

> "For the fish consumption risk assessment, both RME and CTE exposure assumptions (Table 10) were developed from USEPA (1997a) and other sources (DHHS, 1999; Appendix B)."

Agency for Toxic Substances and Disease Registry (ATSDR) Public Health Assessment (PHA) found the 1999 Department of Health and Human Services (DHHS) report on seafood consumption from the turtle River area to be inappropriate for estimating risk to the African-American population in Brunswick and Glynn County Georgia. Specifically, ATSDR noted:

> "And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study.
> A study of fishers along the Savannah River showed that African-Americans
> • Eat more fish meals per month than whites (average, 5.4 vs. 2.9),
> • Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and
> • Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces).
> It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African Americans in the Brunswick area for those reasons." (ATSDR, 2014a)

Notable is that the EPA's own database found 72% the population within 1 ½ miles of the LCP site reported their race as black, or African American. In addition based on reported 1999 household income 32% reported under $15,000, and 18% under $25,000 (EPA, 2015).

The authors of the HHBRA put great weight in the average yearly income of the coastal Georgia residents in evaluating seafood consumption patterns. The HHBRA reports the average yearly income of coastal Georgia ZIP Codes as being $38,193. Obviously the EPA's own data indicates the actual income level of over 50% of the people is less than half that was what is reported in the report. The HHBRA stated:

> "There were very few consumers of Striped Mullet and Spot. Census data can provide the average income per zip code. The average income of the zip codes of anglers harvesting Spot and Striped Mullet were obtained from databases maintained by the Missouri Census Data Center (MCDC, 2006). The average yearly income of the zip codes of the coastal Georgia residents harvesting Spot from 2001 to 2005 was $35,240. The average yearly income of the zip codes of the coastal Georgia residents harvesting Striped Mullet from 2001 to 2005 was $37,847. The average yearly income of all the coastal Georgia zip codes was $38,193. These income values seem quite similar."

Did the EPA review their own demographic data for the area around the LCP Chemicals Superfund site when reviewing the HHBRA (EPA, 2015)?

Did the EPA advise the authors of the HHBRA that they could find more accurate demographic data and household income data on the EPA's website (EPA, 2015)?

Is obvious the authors of the HHBRA were struggling to find data. Even data points of the single fishermen appeared to be important to them. It is obvious the authors were struggling to find demographic data. As noted in the HHBRA:

> "It is interesting to note that of the group of nine anglers who harvested Spot from 2001 through 2005, **only one came from Brunswick** (emphasis added) whereas four came from Savannah. The average zip code income of this single Brunswick angler was $23,898. The average zip code income of the Savannah anglers ranged from $18,830 to $60,182. In addition, there may be income variability within a single zip code but income data for smaller areas are not available."

And,

> "It is possible that some subsistence anglers lived in the Savannah zip code in which the average income was $18,830. However, none of these anglers were from the Brunswick area and there remains no evidence that there were subsistence anglers in the Brunswick area."

If the authors of the HHBRA were using income as an indicator of whether fishermen were or were not subsistence anglers, 32% of people living within 1 ½ miles of the LCP Site having an annual household income of under $15,000 would have been very significant and the only conclusion that could be made is that there are a very significant number of subsistence fishers in Brunswick, Georgia, based upon the metrics utilized in the HHBRA.

Will the EPA utilize the income data from their website to modify the HHBRA to indicate there's a high likelihood of a significant numbers of subsistence fishers within close proximity to the LCP site?

Over and over the authors of the HHBRA utilize data from a relative small number of people. They found two Glynn County residents identifying themselves as subsistence fishers as being significant. As noted in the HHBRA:

> "Appendix B of the HHBRA - Because the ATSDR/GCHD seafood survey (DHHS, 1999) included two Glynn County residents who identified themselves as "subsistence" fishers, this risk assessment included an evaluation of hypothetical high quantity consumers of fish."

It was obvious while reading the HHBRA that the authors were going to great extent to disprove through data on income and demographics that they were not subsistence fishers. Long and detailed discussions about what was or was not a subsistence fish filled the HHBRA. It was obvious the authors lost site of the purpose of the HHBRA and that is to establish the likely amount in seafood being consumed by the local population. Furthermore the HHBRA should

utilize ecological data as an indicator of potential impacts to human health and the environment. The BERA appeared to selectively exclude data that would have provided the needed information through sentinel species such as dolphins. But the plight of the dolphins and its implication to human health and the environment is not lost on researchers in coastal Georgia (Schwacke, 2012). A great deal of research and study has been conducted on the resident dolphin population. The extremely high levels noted in the dolphins led to significant concerns about the human population consuming seafood in coastal Georgia. Sampling of nine humans did take place in the area of Sapelo Island and the results were reported to the personnel from stakeholder agencies and the EPA Remedial Project Managers working on the LCP Chemicals Superfund Site (ATSDR, 2014b). Without doubt the presentation was about the LCP Site since it specifically mentioned the LCP Site 25 times. Also notable is the authors of the HHBRA use the same dolphins studies that were used to link the PCBs found in humans to the LCP Site to define Aroclor 1268 (Pulster, 2005; Pulster 2008). Actually, the studies quoted by the HHBRA authors unequivocally identified the signature as being linked with the LCP site and noted his potential to harm human health and the environment.

> "Legacy organochlorine (OC) contaminants continue to pose a **potential risk to ecological and human health in coastal aquatic ecosystems of the southeastern United States." (**Pulster, 2005)

Does the EPA agree that the definition of Aroclor 1268 presented in Pulster, 2005 and Pulster, 2008 was used in the HHBRA to define PCBs associated with the LCP site?

Does EPA agree that the same PCB profile described in Pulster, 2005 and Pulster, 2008 was used to define an associate the PCBs found in humans sampled in the Sapelo Island area (ATSDR, 2014b)?

The September 3, 2014 presentation, *Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations,* to provide helpful information about the quantities of fish consumed in coastal Georgia. Based upon the surveyed fishermen, the appropriate annual number of seafood meals to be utilized for calculations in the HHBRA would be 156 (3 meals per week X 52 weeks = 156 meals per year) rather than the 40 utilized for risk-based calculations in the HHBRA. Notable is the 8 of the people sampled were from a community of 195 people and represent over 4% of the population. The high consumption consumer might exceed 156 meals per year the EPA should consider a greater number of meals per year than 156.

Will the more current data (ATSDR, 2014b) collected in coastal Georgia rather than the discredited data that's now 20 years old (DHHS, 1999)?

Will the EPA set the annual number of seafood meals consumed by the high quantity consumer at 156 or higher?

Will the EPA increase the size of the meal to reflect those consumed by African-Americans as reported in the Public Health Assessment (ATSDR, 2014a)?

As noted in real world survey of coastal Georgia fish consumers, the following consumption habits were documented (ATSDR, 2014b). The actual seafood consumption habits are far different the assumptions used in calculating risk, which were based upon filets only, and did not consider fish egg (roe) consumption.

- Filet with skin removed -11%
- Filet with skin on – 33%
- Whole fish (gutted) – 56%
- Whole fish (not gutted) – 11%
- Fish eggs – 44%

The cultural habits and preferences for seafood preparation and consumption are discussed further in the section - Feasibility Study Comments and Questions.

A considerable effort was made to obtain the sampling results and the reported high and low level of total PCBs observed in the nine sampled human subjects (ATSDR, 2014b). The numerical total PCB data in conjunction with the total PCB data from fish and shellfish could be utilized to better set maximum health-based remedial action goals. Good data is critical to accurate assessments through the calculations used to determine risk and set remedial action goals protective of human health and the environment. Even though quantitative results were presented at the September 3, 2014 meeting, the CDC and the agencies involved in producing the data have refused to provide the information critical to formulating a robust and protective cleanup plan and remedial action. Therefore, it became necessary to submit a Freedom of Information Act (FOIA) request to the Center for Disease Control (CDC). The FOIA was submitted in a timely manner that the CDC has been excessively recalcitrant and resistant to releasing any data. An Expedited Processing Request was submitted due to the limited time provided to submit comments to the EPA on the Proposed Plan for the marsh at the LCP site. At this time, it appears the EPA public comment period on the proposed plan will close without the requested data being received for inclusion two in the public participation and comment phase of the proposed plan decision-making process. At this time it is the intent of the Glynn Environmental Coalition to continue efforts to obtain the data critical to a robust and protective Proposed Plan, Remedial Design, and Remedial Action in the LCP marsh. Furthermore, the Glynn Environmental Coalition may exercise its right to challenge the Consent Decree when entered before the court and request the data be incorporated into the Proposed Plan, Record of Decision, and the Consent Decree.

The history of the effort of the Glynn Environmental Coalition to obtain the high and low levels of total PCBs observed in the human sampling study follows:

- September 3, 2014: ATSDR presentation “Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations” takes place.
- October 17, 2014: FOIA request to CDC/ATSDR for the underlying data, reports, or other information concerning Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, presented on September 3, 2014, by the Health Studies Branch, by Lorraine Backer and David Mellard, National Center for Environmental Health Eastern Branch, Agency for Toxic Substances and Disease Registry.

• October 22, 2014: FOIA responds acknowledging receipt – informs that they will not be able to comply within the 30 days max provided by statute (20 business days plus ten day extension).
• November 7, 2014: Glynn Environmental Coalition contacts FOIA in effort to speed up process. "Due to the need for a prompt response to Request Number: 15-00080-FOIA, we request communications concerning any charges be made via email or arrangements for pre-payment be arrange to avoid any delays."
• November 14, 2014: Update from CDC on progress of request.
• November 25, 2014: Glynn Environmental Coalition emails CDC to narrow request in effort to expedite response; Concerning the Study presented. The scope of the request can be narrowed to:
- The study Methods
- Individual analytical results with identifying information redacted
- Study maps
- Abstract or Summary Report
- Full report w/o identifying information about the participants
- References and bibliography

CDC acknowledges receipt and revised request was sent to appropriate program office for a new search – refused to provide date by which request would be completed.
• December 19, 2014: Glynn Environmental Coalition calls CDC re: FOIA request.
• January 6, 2015: Letter from CDC stating amended request was still being processed, that CDC is under backlog, and CDC cannot give a timeframe for when request would be completed.
• January 26, 2015: Glynn Environmental Coalition officially requests expedited processing for the request.
• February 2, 2015: CDC denies expedited processing request and 30-day appeal process begins.
• February 20, 2015: Appeal of denial for Expedited Processing sent to CDC FOIA Office.
• February 24, 2015: CDC Acknowledgement of Receipt of Administrative Appeal
• March 16, 2015: EPA public comment period expires on the LCP Chemicals Superfund Site Proposed Plan.

Extensive contamination of the turtle River area with dioxin and furans has been documented over a number of decades but is noticeably missing from the HHBRA. Failure to collect dioxin and furan data over a 20 year at the LCP site strains the credibility of EPA management and those conducting the investigation of the site. The EPA has clear and specific guidance for assessing risk from sites with chemicals with dioxin like and non-dioxin like risks such as PCBs and assessing the carcinogenic and non-carcinogenic risk (EPA, 2000).

> "Therefore, separate risk assessments should be conducted for the dioxin-like and nondioxin-like PCB congeners if the congener analysis indicates elevated concentrations of dioxin-like congeners relative to the typical commercial mixtures (IRIS, 1999; U.S. EPA, 1996c).
>
> Therefore, failure to evaluate the dioxin-like PCB congeners could result in underestimating cancer risk.

Dioxins have been shown to cause adverse developmental effects in fish, birds, and mammals at low exposure levels. Several studies in humans have suggested that dioxin exposure may cause adverse effects in children and in the developing fetus.

In mammals, learning behavior and development of the reproductive system appear to be among the most sensitive effects following prenatal exposure. In general, the embryo or fetus is more sensitive than the adult to dioxin-induced mortality across all species (ATSDR, 1998c, U.S. EPA, 1994a).

Environmental exposure to dioxins includes various mixtures of CDDs, CDFs, and some PCBs. These mixtures of dioxin-like chemicals cause multiple effects that vary according to species susceptibility, congeners present, and interactions.

Risk assessment of these complex mixtures is based on the assumption that effects are additive and there is some experimental evidence to support this (U.S. EPA. 2000).

Organochlorine pesticides, PCBs, dioxins/furans tend to concentrate in fatty tissues (Armbruster et al. 1989; Branson et al., 1985; Bruggeman et al. 1984; Gutenmann et al. 1992; Kleeman et al., 1986a, 1986b; Ryan et al., 1983; Skea et al., 1979; Sanders and Hayes 1988; U.S. EPA, 1995a). Many of these compounds are neither readily metabolized nor excreted and thus tend to biomagnify through the food web (Gardner and White, 1990; Lake et al., 1995; Metcalf and Metcalf, 1997; Muir et al., 1986; Niimi and Oliver, 1989; Oliver and Niimi, 1988; U.S. EPA, 1995a)."

Will the EPA utilize existing dioxin and furan in fish data and incorporated into the HHBRA risk analysis (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)? If not, why not?

Remedial Investigation Comments and Questions

The Remedial Investigation (RI) appears to present opining and unsubstantiated statements of fact. The quantity and quality of the data used in the RI appears to have flawed the remaining site documents. Significant data gaps need filling before a viable RI/FS can be produced for the LCP Site. As previously noted in comments from the stakeholder agencies, quantity of data should not be confused with quality of data.

8.2.3.2.2 Fish Consumer Scenarios

"The fish consumer scenarios are used to evaluate potential exposure to COPC in fish caught in areas of the estuary proximate to the LCP Site. Fish Consumption Guidelines (FCGs) have been established by GADNR for these areas (GANDR 2011) and these FCGs are made available to the public via the GADNR website. GADNR **also posts signage in areas subject to the FCGs to advise anglers about the potential hazards**

> **associated with consuming fish and shellfish from these areas**.(emphasis added) …. The recreational fish consumer scenario is used to evaluate exposure to recreational anglers who consistently consume fish from the LCP estuary over a long period of time (e.g., 26 meals per year for 30 years for adults). ….. The high quantity fish consumer scenario is used to evaluate exposures to individuals who consume more locally-caught fish than the typical recreational angler (e.g., 40 meals per year for 30 years for adults)."

How many signs have been posted by the GADNR in the area and where are the signs located?

Has the high quantity fish consumer meal assumption of 40 meals per year been discredited (ATSDR, 2014a)?

Are a more appropriate number of meals for the high quantity fish consumer closer to 156 per year (ATSDR, 2014b)?

8.2.3.2.3 Shellfish Consumer Scenario

> "The shellfish consumer scenario is used to evaluate potential exposure to COPC in shellfish (e.g., white shrimp and blue crab) caught in areas of the estuary proximate to the LCP Site. As described above for fish, GADNR also develops FCGs for shellfish. The shellfish consumer scenario assumes consistent and long-term consumption of shellfish directly from the LCP estuary (e.g., 19 meals per year for 30 years for adults). This scenario uses data on the amount of shellfish fish consumed by children, adolescents, and adults in the United States (EPA, 1997a)."

Does the EPA actually believe the data presented in the RI for shellfish consumption in light of catching crabs and casting for shrimp being recreational activities in coastal Georgia?

Has either the EPA or the Responsible Parties noticed all the docks along Turtle River and the crab trap lines extending onto the water?

Did the authors of the RI make any attempt to observe seafood harvest and consumption patterns along the Georgia Coast or are all the assumptions in the RI averages of the entire population of the United States?

Is the EPA aware of just how dangerous applying data from national consumption pattern is when determining risk to a local population from a locally contaminated food source?

What does the FDA recommend to do when a locally contaminated food source is encountered?

8.2.6 Characterization of Uncertainties

"… posted signage generally serve to discourage the consumption of significant amounts of seafood from the area, particularly given the number of meals assumed to be eaten consisting of fish caught in the LCP estuary;"

What is the study cited in support of the conclusion "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?

Are the authors of the RI citing a study or opinion when they state "….posted signage generally serve to discourage the consumption of significant amounts of seafood from the area…"?

What is the definition of the LCP estuary and what are the geographical boundaries?

Is the "LCP estuary" defined by the extent of contamination from the LCP Site in coastal Georgia?

Does the Georgia Department of Natural Resources seafood consumption advisories encompass the entire "LCP estuary"?

Have any agencies questioned the need to extend the extent of seafood consumption advisories due to the spread of contamination from the LCP Site (ARSDR, 2014b)?

Have any recommendations or suggestions been made concerning expanding the sampling and analysis in the ecosystem and humans to more fully identify the extent of LCP Site contaminants spread (ATSDR, 2014b)?

8.3.3.4 Chemicals of Potential Concern (only mention of dioxin in the RI)

"Several additional organic chemicals were detected in a small number of samples at concentrations above the conservative EEVs, including dichlorodiphenyltrichloroethane (4,4'DDT), dioxin/furan congeners, bis(2-ethylhexyl)phthalate, 3,4-methylphenol, butylbenzylphthalate, and hexachlorobenzene. These chemicals are not quantitatively evaluated for benthic or food chain risks, but are discussed qualitatively in the OU1 BERA."

Were the chemicals detected in a small number of samples or were they identified for analysis in a small number of samples?

How many samples were taken in the LCP Site marsh, and how many were specified for dioxin and furan analysis?

What is the difference between qualitative and quantitative when establishing risk in a document like the BERA?

How was risk established through a qualitative discussion of dioxin and furan in the BERA?

Did the quality and completeness of the sampling and analysis for dioxin and furan in the RI a hindrance to evaluating risk in the BERA and HHBRA?

8.3.5.8 Piscivorous Mammals (Assessment Endpoint 7)

> "One LOE was used to evaluate the viability of piscivorous mammals foraging within the LCP estuary: HQs derived from food-web exposure models for river otters. The following is a summary of the findings:
>
> • The modeling study for river otters generated Site NOAEL HQs for Aroclor-1268 (based on a TRV for Aroclor 1254) that ranged from 0.1 to 3.9. No LOAEL-based HQ for Aroclor-1268 exceeded 1. In addition, no risk of adverse effects was predicted for mercury or lead exposures. Based on these findings, the BERA Report concluded that the potential risk to the viability of piscivorous mammalian species utilizing the LCP estuary is minimal."

Would the conclusion "….BERA Report concluded that the potential risk to the viability of piscivorous mammalian species utilizing the LCP estuary is minimal" if the dophin data was added to the BERA (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

What impacts to dolphin health were found in the studies (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

Were the health effects found in dolphins "minimal" (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012)?

Were the chemicals found in the dolphins linked to the LCP Site (ATSDR, 2014b)?

Would the EPA find the absence of an indigenous species like the mink from the LCP Site significant?

Would the absence of a viable mink population indicate there is a dead zone where mink cannot survive around the LCP Site?

Would a dead zone where mink cannot survive be described by the EPA as "minimal risk"?

Would the EPA agree that the observations in the dolphin population indicate the models referenced in the RI are significantly flawed and do not agree with the observed ecological impacts? If not, why not?

What is the definition of "minimal risk" used in the RI?

Does the empirical evidence documented prove the models in the BERA and RI do not hold up when compared what is known about ecosystem on the Georgia coast and the impacts from the chemicals associated with the LCP Site (Balmer, 2011; Balmer, 2013a; Balmer 2013b; Hart, 2012; Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012, ATSDR, 2014b)?

Feasibility Study Comments and Questions

The Feasibility Study (FS) could not be fully evaluated for a number of reasons. Most frequently, there was an insufficient amount of information or the technologies previously identified for consideration by the stakeholder agencies were not carried through the FS evaluation process. Much of the data utilized over the 20 years the FS was produced became outdated or otherwise discredited. More current data was produced about the state and condition of the ecosystem, cultural seafood consumption preferences, and demographics of the populations most impacted from the Site. To a large extent, the current data was not incorporated into the LCP site documents, and therefore not utilized in the FS. The FS became dated, lost continuity of process over the extended number of years, and otherwise became disconnected with the realities of Site conditions and the surrounding community.

Significant deficiencies identified in the FS were:

- The seafood consumption data underlying risk calculations was discredited by ATSDR and new data became available to evaluate human exposure to Site COCs (ATSDR, 2014a; ATSDR, 2014b). The appropriate meals per year number appear to be closer to 156 than the 40 previously used. The assumption that people consume only the fish filet appears to be wrong, also. The recalculation of risk and cleanup goals could significantly change the scope of work and the technologies considered for remediation.

- Dioxin and furan chemicals were not tested for, nor did the LCP Site documents include available data. Without inclusion of the dioxin and furan data, an accurate risk assessment and remedial action plan cannot be completed. It appears the FS is based upon assumptions and not data concerning dioxin and furan, and ignores these chemicals would be additive to the cancer and non-cancer risks associated with PCBs due to the similar structure of the molecules and similar modes of action. Without the dioxin and furan data, the risk calculations can only be assumed to grossly understate the actual risks. Furthermore, with the addition of the observation that toxicity tests found unexplained levels of toxicity in the sediments, the incompleteness of the COC list might extend beyond dioxin and furans. At a minimum, the cleanup should be driven by the observed toxicity (empirical data) and not the modeling data. Empirical data always trumps modeling data. Modeling data should always be compared with the empirical data to

assure the model holds up to real world conditions at the Site. When sampling and analysis fail to identify the toxic compounds, the observed toxicity should drive the remedial decision-making.

- Technologies utilizing coffer dams, sheet piling, or other methods of confining sediments during remedial activities were not evaluated, even though the stakeholder agencies had identified these as preferred (NOAA, 2000). Furthermore, utilizing a containment structure and dry excavation method would have resulted in very significant changes in the approach to the remediation. 1.) Remedial Action mobilization and access to the marsh would have been from the uplands. 2.) "Marsh Disturbance Beyond Remedy (acres)" would have been minimized, as would the potential to re-suspend COCs and distribute throughout the marsh or remediated areas. 3.) The project could be accessed from a single access point and single decontamination of equipment point established. 4.) Technologies using other than dredging could have been evaluated and implemented. Notable is coffer dams were previously used at the LCP Site during the EPA Emergency Response and Removal. The proposed remedial activities adjacent to the existing coffer dam and can be accessed from these previously remediated areas, and new temporary coffer dam structure could be built off of the existing structures.

- Areas identified as Marsh Disturbance Beyond Remedy (acres)" were not described in the FS. While the authors of the FS argue minimal disturbance is needed to preserve the marsh ecosystem, the technologies selected and the methods of implementation are prone to marsh disturbance, and all proposed remedies "disturb" more acreage than is being remediated. Significant potential to disturbed COC contaminated sediments exists but could not be evaluated due to these areas not being identified.

- The source areas were not sufficiently described and significant data gaps were evident, including but not limited to the following:

- Spartina was not analyzed, investigated, or evaluated as a source of COCs in the marsh. Spartina is the base of the marsh food chain, known to bioaccumulate COCs present from the LCP Site, and appears to be intentionally avoided for remediation. Therefore, the FS appeared to be "fatally flawed" and detached from the realities of a Spartina-based marsh ecosystem.

- The depth of sediment samples was less than the expected depth of COCs in the marsh. It appeared the sampling was conducted with a maximum remedial depth already determined.

- The depth of bioturbidation was not accurately described or quantified. The authors of the FS did not appear to grasp the importance of knowing and identifying the biota causing bioturbidation, the depth of disturbance, and the quantity of sediment brought to the surface on an annual basis. Particularly with remedies considering capping, fully quantifying bioturbidation and the potential impact to the remedy is crucial. The lack of any such evaluation of bioturididation strains the credibility of the FS and questions the FS authors understanding if a Spartina-based marsh ecosystem inhabited by burrowing biota.

- Keystone ecological species are missing from the documents used to develop the FS. These include mink, dolphin, manatee, and diamondback terrapin. Notable is the large volume of data available on the resident and transient dolphin population, which is conspicuously missing from the FS decision-making process (Balmer, 2011; Balmer, 2013a; Balmer, 2013b; Hart, 2012;

Hickie, 2013; NOAA, 2013; Pulster, 2005; Pulster, 2008; Schwacke, 2012). The LCP Site documents utilize the dolphin data to argue for sampling and analysis of only Aroclor 1268 with the dolphin studies, but failed to also realize the ecological impact or include this data in the BERA. The selective nature of data usage throughout all the documents supporting the FS is very noticeable.

- Noticeable is the FS does not contain measurable goals for assessing the recovery of the eco-system or a timeline to take goal measurements and conduct evaluations. Even more noticeable is the exclusion of the keystone species by which a remedial action would be assessed and the recovery measured. These species include mink, diamondback terrapin, and dolphin, and would cover mammal marine mammal, and reptile. An avian and herbivore indicator species should also be included. A full suite for seafood species should be analyzed on an annual basis, and whole, filet samples of juvenile and adult specimens collected and analyzed for a full suite of COCs. Dioxin and furan should be analyzed routinely at every sampling event and included on the COCs list.

- The FS does not identify actions to implement if the remedy fails to meet remedial goals on a set timeline. There is a three-part problem:

1. No measurable goals for the remedial action.
2. No timeline or measurement metrics for evaluating the remedial action.
3. No identified actions to be implemented if the remedial goals are not met by a specific date.

There were other indications the authors of the FS were significantly disconnected from the realities of the LCP Site, the conditions present on and around the Site, and in the community. These "disconnects" have the potential to be a significant threat to public health, and should not be taking lightly by the EPA or the community. When those charged with a cleanup upon which the public health and welfare is dependent show a profound lack of understanding of the situation, the EPA should move quickly and decisively to remove remedial activities from the Potential Responsible Parties and into the hands of a competent contactor. Furthermore, the EPA should order the contractor to move ahead with all due diligence and speed. The following are two examples of failures to understand the public health crisis at the LCP Site.

<u>Example One:</u>

> "All alternatives include institutional controls such as fish consumption advisories."
>
> "Providing information that helps modify or guide human behavior and enhance protectiveness at a site, such as notices, signage, and fish consumption advisories that maybe required until RAOs are met."

The FS authors suggest they can modify or guide human behavior to enhance protectiveness. Again, the authors are either disingenuous or delusional (or both) in making this statement. If human health could be protected in such a manner, the only responsible action would have been to implement these measures (information, notices, signage, and fish consumption advisories) immediately upon learning about the risk to human health. As previously noted in comments on

the HHBRA, the EPA, Georgia Department of Natural Resources, and the Potentially Responsible Parties have failed, to implement the recommended action made by ATSDR over the past 20 years.

In light of the EPA, Georgia Department of Natural Resources, and the Potentially Responsible Parties failure to implement recommendations by the ATSDR to protect human health since issues 21 years ago, why should anyone believe any of these agencies or parties are capable or will now do so at this time?

Is it arrogant to suggest the Potential Responsible Parties have the power to guide or modify human behavior?

What evidence (studies or reports) are presented to suggest there has been any success in implementing Institutional Controls over the past 20 years?

What is the budget for implementing Institutional Controls until the cleanup goals are reached?

What has been the budget for these Institutional Controls over the past 20 years?

Example Two:

> **"Section F-1 Contents: Excerpt from GADNR Fish Consumption Advisory Threshold Memorandum**
>
> "This section is an excerpt from the GADNR technical memorandum identifying the dietary thresholds used by GADNR to establish fish consumption advisories for the TRBE. The edible fish and shellfish tissue data provided in Section F-3 are compared to these thresholds. These thresholds are not appropriate for comparing to the whole-body fish tissue data provided in Section F-4 **because anglers do not consume the whole-body fish samples, only the edible tissues."(emphasis added)**

As noted in real world survey of coastal Georgia fish consumers, the following consumption habits were documented (ATSDR, 2014b).

- Filet with skin removed -11%
- Filet with skin on – 33%
- Whole fish (gutted) – 56%
- Whole fish (not gutted) – 11%
- Fish eggs – 44%

It is clear the authors are interjecting opinion and not scientific fact into the FS for the sole purpose of reducing the apparent level of risk. Obviously, the real world scientific data from Coastal Georgia shows at least 56% of people eat the whole fish, and only around 11% eat fish in the manner described in the FS. Also noticeably missing from the LCP Site records are data about fish eggs, which are high lipid seafood prone to accumulating site COCs. Interestingly,

fish eggs were sampled and the results reported in the 2008 ATSDR Health Consultation for the Arco Quarry (ATSDR, 2008). In addition to Aroclor 1268 being found in the fish eggs, it was present at a level an order of magnitude (X10) than in fish tissue. Other notable coastal Georgia delicacies are smoked mullet and mullet roe, which also deserve sampling and analysis for the Site COCs, and are noticeable missing from Site documents. But the point of the above discussion and data is to clearly identify the need to accurately identify the human health risks at the LCP Site and produce a FS that stands up to the real world facts as they are. Currently, the situation is an imminent risk to human health and the environment, and the EPA and PRPs have failed to produce a viable remedial plan to rectify the situation.

Does the EPA agree the authors of the FS are interjecting opinion with statement like, "because anglers do not consume the whole-body fish samples, only the edible tissues"?

Does the EPA agree that people in coastal Georgia do eat the whole fish, and not just the filet?

Does the EPA realize the fish eggs potentially have significantly higher levels of LCP Site COCs than the fish filet?

Did the FS or other LCP Site documents evaluate the consumption of fish eggs or other high lipid content seafood?

Was the EPA aware of the cultural seafood consumption practices in coastal Georgia such as fish eggs (roe), whole fish, and other methods of cleaning and preparation? If not, why not?

Would the findings about cultural seafood consumptions patters be significant and warrant inclusion in the HHBRA?

Proposed Plan Comments and Questions

The following comments are on the full Proposed Plan. The quote from the proposed plan is followed by the comment or question for the EPA to respond to in the Responsiveness Summary for the LCP Chemicals Superfund Site for Operable Unity One, the Marsh. In addition, as a community member and one of the persons who has used Purvis Creek for recreation, and intends to continue to use Purvis Creek for recreation, the area needs to be cleaned up, made safe for all uses, and the seafood be safe to catch and consume.

Introduction

> "The Plan summarizes information that can be found in greater detail in the RI/FS reports and other documents, which present the results of sampling conducted from 1995 through 2012."

Was there a compelling reason for the EPA to exclude data collected after 2012? Why not include data to date?

Site History

> "The Dixie Paint and Varnish Company operated a paint and varnish manufacturing facility at the Site from 1946 to 1956."

Honeywell contends in their Fact Sheet the paint contained Aroclor 1268. What documentation does the EPA have to support the contention that Aroclor 1268 was an ingredient in paints manufactured by Dixie Paint and Varnish Company?

Public Participation

> "The Region also publishes the quarterly *Brunswick Environmental Cleanup Newsletter* to update the public on the cleanup progress at the LCP Chemicals Site and the three other Superfund sites in the Brunswick area."

The Glynn Environmental Coalition is very concerned about the public participation process at the LCP Chemicals Superfund site. At the December 4, 2014 EPA public meeting Ms. Angela Miller, EPA Community Involvement Coordinator, stated that the mailing list for the LCP site have been deleted. In light of this statement please list the dates of the quarterly *Brunswick Environmental Cleanup Newsletter*, and the number of people the newsletter was sent to. In addition, I asked Ms. Miller why I had not received a copy of Proposed Plan via postal mail. Evidently this was due to the EPA community participation mailing list being deleted. Ms. Miller indicated that there was a considerable number of newsletters sent by the EPA being returned as undeliverable. During the same period, the Glynn Environmental Coalition (GEC) has been sending out Technical Assistance Reports (TAR) produced under the EPA Technical Assistance Grant (TAG) program for the LCP Chemicals Superfund site. Like the EPA, the GEC does receive a few newsletters back after each mailing, which we used to update the mailing list and keep the current as is required by postal regulations for organizations using a bulk mailing permit. By doing so we enable to maintain the continuity of the TAG mailing list even though many of the people have moved over the 18 years we've administered the TAG.

Please describe the EPA procedures for maintaining their community participation program for the LCP Chemicals Superfund site, including:

Does the EPA maintain a mailing list for the LCP Chemicals Superfund site?

Does the EPA use the returned newsletters to update the LCP Site mailing list?

If not, how does the EPA maintain the mailing list and keep it current, and maintain continuity in community participation at the LCP Site?

How many EPA quarterly newsletters have been sent out over the past three years at each mailing, and what were the dates of the mailings?

When the LCP Proposed Plan was released, how many were mailed to the community?

In light of the report from Ms. Miller that the LCP mailing list have been deleted, how did the EPA formulate the mailing list to send out the Proposed Plan?

Was the Proposed Plan sent to all the people who have signed up for on the EPA's mailing list for the LCP Site? If not, how many (what number) of the people who have previously signed up to the LCP Site EPA mailing list did not receive the Proposed Plan mailing?

What are the EPA's plans to assure future continuity in the mailing list for public participation at the LCP Chemicals Superfund site?

Is it possible for the EPA to recover the deleted mailing list and updated with returned newsletters or other mailings concerning the LCP Chemicals Superfund site, or other Superfund sites, in Glynn County?

How many addresses were on the list that was deleted?

Does the EPA keep a record of the Glynn County Superfund Site the person has signed up to receive information about from the EPA?

Can the EPA assure that there will be a mailing list maintained for the community participation in the decision-making process for the citizens of Glynn County from now and into the future, and will be available for the other propose plans and records of decisions that will be coming up for the Superfund sites in Glynn County?

The EPA provided the documents and materials in support of the LCP Chemicals Superfund Site Proposed Plan to the repository at the Brunswick Library on December 3, 2014. The EPA held their public meeting the following day on December 4, 2014. This resulted in giving the community one day to review 8700 pages. Taking into account the average work days eight hours, this would've left 3.3 seconds per page for the public to read the document. This does not include the time it would take to prepare comments for submittal at the EPA public meeting.

Does the EPA feel it is appropriate to allow 3.3 seconds per page for the public to read the documents the EPA provided?

How much time does the EPA feel is appropriate for the community to review 8700 pages, prepare comments, and be ready for the EPA Public Comment Meeting to submit comments to be taken down by a court recorder?

Was the purpose of releasing 8700 pages 24 hours before the Official EPA Public Comment Meeting to thwart any meaningful community comments at the Official EPA Public Comment Meeting?

How many requests for another EPA public comment meeting have been received by the EPA?

Have the Congressional representatives of Glynn County requested the EPA provide a public comment meeting for the LCP Chemicals Superfund site marsh proposed plan?

Does EPA feel it is appropriate to limit participation in decision-making process to those with access to the internet, email, or innate ability to write comments to participate in the decision-making process?

1.3 Setting and Hydrodynamics of the Marsh

> "The intertidal vegetated marshes are a net depositional zone for suspended sediments due to the low current velocities and presence of vegetation within those areas. "Net depositional" means that particles are more likely to settle than to scour from the area."

What data is presented in support of this statement? How much sediment has accumulated or eroded from the LCP Site?

If the LCP marsh has a net deposition of particles, what is the annual deposition rate?

> "The Turtle River water surface elevation can vary in excess of nine ft during a tidal cycle."

Are these tides consistent with an area with "low current velocities"?"

What are the tidal ranges for the St. Simons sound estuary under storm conditions such as a northeast wind?

How does the wind effect currents in the estuary and on the tidal flats?

Figure 1, Figure 2

Why is the Salt Dock area not shown as part of the LCP Site?

How were the LCP Site boundaries shown in Figure 2 determined?

With the boundaries of the LCP Chemicals Superfund site determined by land ownership or by the extent of the contamination?

Are Superfund sites boundaries supposed to be determined by the extent of contamination or the surveyed ownership lines?

Past Actions

> "The approximately 13 acres of highly contaminated marsh sediments were excavated, backfilled with clean fill, and re-vegetated with native marsh grasses."

Why is marsh removal and re-vegetation with native marsh grasses not part of the Proposed Plan?

Were coffer dams used during past actions?

If coffer dams were used in the past, why was this technology not considered in the Feasibility Study?

What was the decision-making matrix that leads the exclusion of all technologies deployed from the uplands or utilizing dry excavation techniques?

> "As a result of these removal actions, the remaining contamination in OU1 is considered to be low-level threat waste to be addressed by this Superfund remedial action."

Is there only "highly contaminated…" and "low level threat…" wastes at the site?

Who made the determination that the remaining wastes are "…low-level threat waste"?

What is the definition of low-level threat waste?

What is the difference between waste and COCs?

How does the EPA quantify low-level threat waste and what is the threat level to humans and wildlife?

What are the numerical difference between low level, mid-level, and high level wastes for the Chemicals of Concern (COC) at the LCP Chemicals Superfund site?

Where can the low, mid, and high levels of waste threats definitions be found in EPA rules and regulations?

Mr. Franklin Hill of the Superfund branch at EPA Region 4 has publicly stated in an Atlantic Journal-Constitution Op-Ed that there is only residual contamination at the LCP Chemicals Superfund site.

How does the EPA defined residual contamination and how is that numerically quantified?

Would contamination that has resulted in documented sick Dolphins within this estuary qualify under the definition of residual contamination?

2.0 SITE CHARACTERISTICS

> "As a result of the RI studies and risk assessments, a limited number of contaminants were identified as **contaminants of concern** (COCs) (emphasis added) that warranted further evaluation and remedial action under CERCLA."

Were the COCs that have synergistic and similar modes of action considered, or were COSs like dioxin/furan excluded, even if they should be considered along with PCBs?

Were all PCBs included or were the others excluded and only Aroclor 1268 included?

If so, why?

If not, why is the data missing?

2.1 Distribution of COCs in Sediment

> "Figures 3 through 6 show the COC concentrations in surface sediment samples, defined as samples with a starting depth at the sediment surface and collected from the interval of 0-to-6 inches, or 0-to-1 ft below the sediment surface; the 0-to-1 ft interval was used when upper 6-inch intervals were unavailable."

Fiddler Crabs mix sediment up to 36 inches below ground.

Why was sampling limited to 6 or 12 inches?

Was the EPA or the PRPs unaware of the biosphere depth in the estuary that inhabits the marsh sediments?

Did the US Fish and Wildlife Service (USFWS) advise the EPA that sampling to only 12 inches was insufficient to delineate contamination in the LCP Marsh (USFWS, 1996)?

Did the USFWS advise the EPA to conduct whole body fish analysis?

Has the EPA assured whole body fish analysis has been conducted?

Did the USFWS note the Spartina root bed extends to 18 inches and COCs at this depth might have a higher propensity to be bioavailable (USFWS, 1996)?

How would the greater bioavailability of COCs at a depth of 18 inches affect a cap remedy?

Did the USFWS recommend in 1996 the EPA total "dioxin" levels reported for the nature and extent of the contamination within the marsh?

> "Two reference locations were used during the various ecological studies. One (Troup Creek) was located about 4.3 miles from the marsh, on the eastern side of the Brunswick

> Peninsula, and the other west of Sapelo Island, over 25 miles from the Brunswick area. The purpose of these reference locations is to collect data from areas presumed to have been uncontaminated with the LCP Chemicals Site, for the sake of comparison."

In light of the data collected since 2012, does the EPA agree the Reference Stations are likely, if not confirmed, to be within the radius of contamination deposition from the LCP Site (ATSDR, 2014b)?

If the EPA disagrees, what data does the EPA have to support continued use of the Reference Stations?

> "Methylmercury (MeHg) was measured at over 150 sediment sampling locations throughout OU1. The MeHg in sediment ranged from below detection limits to 0.05 mg/kg, with a mean concentration of 0.005 mg/kg. Only a small fraction of the mercury in sediment was present as MeHg. Because MeHg readily bioaccumulates, it is more prevalent and toxic in biota tissue and toxic than elemental mercury."

Does the EPA agree that there is only one sample of methylmercury for approximately every 4.5 acres of the LCP Site march? (640 acres/ 150 samples)

Is the reason a small fraction of the mercury was methylmercury because it readily bioaccumulates? If not, why not?

Figure 4 – Aroclor 1268 Concentrations in LCP Marsh Sediments

Why is there a high level of Aroclor 1268 reported at the Salt Dock in Figure 4?

Does this indicate dioxin/furan could have been transported to this area since the EPA and Honeywell argue the PCBs and dioxin/furan are co-located?

> "The distribution of COCs clearly points to the Eastern Creek, LCP Ditch and portions of Domain 3 Creek near the Site Uplands as major contaminant sources. In addition the Eastern Creek and LCP Ditch are more directly influenced by tidal action that can mobilize contaminants into Purvis Creek and beyond, much more so than contaminants in vegetated wetland marsh areas with very low tidal energy."

> "The high levels of MeHg and PCBs (primarily Aroclor 1268) detected in fish fillets resulted in a fish consumption advisory for the Turtle River/Brunswick Estuary (TRBE) issued by the Georgia Department of Natural Resources from 1995 to the present."

Why were fish not tested around the LCP Site and in Turtle River like they were at Lake Onondoga (whole, filet, juvenal and adult) and include dioxin and furans (USEPA, 2002)?

What Is Risk and How Is it Calculated?

> "A Superfund BRA is an analysis of the potential adverse effects caused by hazardous substances at a site under current and future conditions in the absence of any actions to control or mitigate these effects."

If the BRA is an analysis of current and future conditions, why does it use data 20 years old (DHHS, 1999)?

Did the ATSDR Public Health Assessment discredit the study used to establish the annual number of seafood meals used to determine risk (ATSDR, 2014a)?

Exposure Assessment

> "The high quantity fish consumer scenario evaluated exposures to individuals who consume more locally-caught fish, assumed to be 40 meals per year, than the typical recreational anglers."

If the BRA is an analysis of current and future conditions, why is it using data 20 years old (DHHS, 1999)?

Did the ATSDR Public health Assessment discredit the use of DHHS, 1999 with the following statement?

> "And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study.
> A study of fishers along the Savannah River showed that African-Americans
> • Eat more fish meals per month than whites (average, 5.4 vs. 2.9),
> • Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and
> • Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces).
> It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African Americans in the Brunswick area for those reasons." (ATSDR, 2014a)

Did the Sapelo Study of Chemicals in seafood consumer find an annual consumption rate closer to 156 meals per year (ARSDR, 2014b)?

> "Because risk assessments are designed to be conservative to ensure that risk management strategies will be protective of human health, as well as consistent with EPA requirements, two types of exposure scenarios were analyzed in the Baseline HHRA to assess the range of potential risk: the reasonable maximum exposure (RME), which

estimates the highest level of human exposure that could be reasonably expected to occur, and the central tendency exposure (CTE or "typical") scenario. Cancer and non-cancer health hazards were assessed under both these scenarios."

Does the EPA now realize the Baseline HHRA is seriously flawed?

<u>Toxicity Assessment</u>

"The Baseline HHRA provided detailed discussions on the toxicity of mercury and PCBs (Aroclor 1268) and their associated uncertainties."

Why is the additive effect from dioxin and furan not included in the discussion of associated uncertainties (EPA, 2000)?

Does EPA guidance instruct to include dioxin and furan in the analysis of the carcinogenic and non-carcinogenic effects of PCBs like Aroclor 1268 and the other PCBs found at the LCP Site (EPA, 2000)?

"Cancer risks: Cancer risks are only associated with Aroclor-1268."

Was the dioxin and furans known to be present in seafood and sediment evaluated in included in the Toxicity Assessment?

Does the EPA acknowledge the above statement is incorrect and there are cancer risks associated with dioxin and furans found in the LCP Site area and in Turtle River (EPA, 1996)?

"Non-cancer health hazards: The calculated RME non-cancer HIs ranged from 0.7 for consumption of shellfish to 8 for the child high quantity fish consumer. Adult recreational anglers would have a HI of 3 and the adult high-quantity fish consumer would have a HI of 5, both of which exceed EPA's acceptable level. Calculated CTE hazards exceeding the acceptable level are for child consumption of fish and shellfish and the high quantity fish consumer. The calculated RME non-cancer HIs ranged from 1 for the adolescent to 5 for the child."

Were this levels of risk based upon the discredited 40 meals per year (DHHS, 1999; ATSDR, 2014a)?

"There were no unacceptable health hazards or risks associated with lead or PAHs. The only two contaminants that contribute to unacceptable human health risks are mercury and Aroclor 1268."

Was dioxin furan data available to the EPA utilized in the Toxicity Assessment and factored into this statement?

Does the existing dioxin/furan data exceed the EPA allowable levels in seafood (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?

> "For example, Table 3 compares the current average edible tissue concentrations from the Baseline HHRA with the calculated protective tissue goals for the adult recreational fish/shellfish/clapper rail consumer at a HI of 1 and cancer risks at 1E-04 and 1E-06. These numbers and others from the Baseline HHRA and those calculated as part of the State of Georgia fish consumption advisory for the TRBE can be used for future monitoring to achieve edible tissue levels that will be protective of human health."

Is Table 3 based upon the discredited data (DHHS, 1999; ATSDR, 2014a)?

4.2 Ecological Risks

> "The COCs quantitatively evaluated in the BERA included mercury, Aroclor 1268, lead, and PAHs."

Was available dioxin and furans data included in the evaluation? If not, why not?

> "The results from tests on amphipods that burrow into the sediment indicated toxic effects in up to 85 percent of sediment samples from the LCP Chemicals marsh. However, toxicity was also observed in several reference samples from Troup Creek. Toxicity tests with grass shrimp (that generally float above the sediment) showed toxic effects in up to 69 percent of the samples, including those from reference stations. A detailed analysis of potential causes of the toxicity was presented in the BERA, along with the conclusion that, in addition to the COCs in sediment, various other non-measured factors likely influenced the tests, such as sulfide and organic carbon content, redox conditions, sediment pH, grain size, and potential pathogens in the test chambers."

In light of the toxicity sampling by the US National Park Service at Fort Puaski and Cumberland Island that did not find toxicity, does the sampling from the Reference Stations indicate they are toxic due to chemicals from the LCP Site, or failure of the lab to use appropriate protocols?

When questionable results are encountered, it is appropriate to repeat the test or do an analysis of the sediment to identify the toxic chemical or pathogen?

Did the EPA find any significance in the sediments being toxic to both burrowing and non-burrowing biota?

> "Table 4 summarizes the SEC concentrations based on the five statistical measures for the most sensitive toxicity tests (amphipod survival and grass shrimp embryo development). Although the data indicates a wide range of effect concentrations with low accuracies (**generally much less than a 50% chance of being correct** (emphasis added)), the SECs chosen were among the more reliable and accurate for these sensitive endpoints. Other test endpoints such as reproductive response and embryo hatching

resulted in higher SECs and even less accuracy. The SECs presented in Table 4 provide the basis for development of preliminary remedial goals."

Is it scientifically acceptable to the EPA to use data with a less than 50% chance of being correct to establish preliminary remedial goals?

Is the likelihood of the Proposed Plan working less than 50%?

If the data used has a likelihood of being less than 50% correct, how can a Proposed Plan based upon that data be any more correct or likelihood of success be anymore than "less than 50%"?

When questionable science is encountered, is the normal procedure to repeat the experiment to find the variables causing the low chance of being correct?

Is it correct to conclude the EPA saying the data being used has much less than a 50% chance of being correct?

"The LOAEL HQs suggest persistent low-level chronic effects."

What are the persistent low-level chronic effects expected to be present in the LCP Site marsh?

"None of the LOAEL HQs were exceeded for the redwing blackbird, marsh rabbit, raccoon and river otter, indicating minimal risks."

How many marsh rabbit, raccoon and river otter were sampled?

How many studies documented the population dynamics of marsh rabbit, raccoon and river at the LCP Site?

If none were conducted, why not?

Does the EPA have any empirical evidence or baseline monitoring to compare with the LOAEL HQs?

How does the EPA propose to evaluate the Remedial Action?

Has any data been collected to evaluate the upcoming Remedial Action or is all the data presented for the decision-making based upon models and assumptions?

If models and assumptions, when will baseline data (Baseline monitoring data) be collected for evaluating the remedy effectiveness?

Table 5. Summary of Risks to Wildlife Receptors

> "Diamondback terrapin None < 1 < 1 None"

Please explain how the EPA can conclude a HI or HQ less than 1 when empirical data reported reproductive failure (EPA, 1997)?

Uncertainties Related to the BERA

> **"** The evaluation of potential adverse effects to the benthic invertebrate community relied on hundreds of site-specific acute and chronic toxicity test measurements using both indigenous and laboratory-cultured organisms. The OU1 BERA notes that the development of PRGs for the protection of benthic invertebrates is "**highly uncertain with poor accuracies"** (emphasis added) and that "only conservative assumptions were used" for this purpose;"

Why is data that is "highly uncertain with poor accuracies" being used in the proposed Plan?

When science is unreliable, is the appropriate action to repeat the data collection, analysis, or experiment?

Uncertainties Related to the Dioxin and Furans

Why does this section ignore and not report the large volume of dioxin and furan data available for this area of Turtle River (GA DNR, 1989; GADNR, 1990; GADNR 1991; GADNR, 1992; GADNR, 1993; GADNR, 1994)?

> "During the remedial design, areas outside the remediation footprint chosen will be sampled for dioxins/furans to ensure that any unacceptable risk is addressed."

Why does the EPA feel it is so important to avoid dioxin and furan sampling until after the Proposed Plan, Record of Decision, and the Consent Decree is entered into and approved by the court?

How will the EPA know what the "Remedial Footprint" is without the dioxin and furan data?

Would the dioxin and furan data be additive to the PCB risk assessment data for humans and wildlife?

How could this dioxin and furan data significantly change the Proposed Plan?

Could the unexpected toxicity observed be due to the very toxic dioxin and furan?

Could dioxin and furan be the variable that is accounting for the "…generally much less than a 50% chance of being correct…" noted in Section 4.2 Ecological Risks?

If not, what is the factor causing the large disparity?

As noted in the section of the LCP Site Proposed Plan, "Relationship between Dioxin/Furans and Chlor-alkali Sites"**:**

> "At the Onondoga Lake Site, while dioxins/furans were determined to be both human health and ecological risk drivers as a result of fish consumption in Onondaga Lake,…"

Since this Onondaga Lake site is being used as a comparison site and as an argument to NOT test for dioxin and furan until after the Record of Decision and Consent Decree, why did the EPA NOT use the human health and ecological risk drivers found at Onondaga Lake in the LCP Site in Brunswick Risk Assessments?

Why did the EPA NOT do the same sampling at the LCP Site in Brunswick as at the Onondaga Lake Site?

Unlike Lake Onondaga, was dioxin and furan found widely distributed in the Turtle River and the St. Simons Sound estuarine system sediments (USEPA, 1995b)?

<u>Relationship between Dioxin/Furans and Chlor-alkali Sites</u>

The EPA's interjection of the Onondaga Lake LCP Site near Syracuse New York into the decision-making process for the LCP Site located in Brunswick Georgia presents an interesting situation. In order to compare and contrast the two sites the similarities and differences will need to be identified. In addition when similarities are found it will be interesting to note if the lessons learned have been applied to the LCP site in Brunswick Georgia.

> " The dioxins/furans and Aroclor 1268 sediment data collected to date show a strong relationship between dioxins/furans and Aroclor 1268 concentrations. A similar relationship was found at the Onondoga Lake and Ninemile Creek Superfund sites in upstate New York. **At the Onondoga Lake Site, while dioxins/furans were determined to be both human health and ecological risk drivers as a result of fish consumption in Onondaga Lake,** (emphasis added) they were not found to be widespread in lake sediments. The New York State Department of Environmental Conservation (NYSDEC) sediment screening criteria for protection of wildlife and humans from bioaccumulation were used as comparison values for the dioxins/furans. The areas where dioxins/furans are elevated are generally co-located with areas that exceeded the lake cleanup criteria for other contaminants, which are being addressed under the lake remedy.
>
> There was a similar situation with the Ninemile Creek Site and a similar approach was used. Dioxins/furans also contributed to Site risks but they exceeded the NYSDEC bioaccumulation screening criteria at only three of the 194 creek sample locations. These locations would be remediated based on concentrations of other detected contaminants (e.g., mercury).

Therefore, Site preliminary remediation goals for dioxins/furans in sediments were not developed."

At the Onondaga Lake site EPA found the dioxin and furans were a human health and ecological risk driver. But at the LCP site in Brunswick Georgia dioxin has not been considered as a risk driver in either the ecological or human health risk assessments.

Why has the EPA failed to apply the risk found at the LCP site in New York to the ecological and human health baseline risk assessments for the LCP site in Brunswick, Georgia?

Are the two Sites really similar and if so in what ways?

- **What are the similarities or differences in salinity ranges at the Lake Onondaga site when compared to the Brunswick Georgia site?**
- **What is the title range at the Lake Onondaga New York site compared to the Brunswick Georgia site?**
- **What is the rainfall at the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **One of the water temperature ranges at the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **What is the annual temperature ranges for the Lake Onondaga New York site when compared to the Brunswick Georgia site?**
- **Are the fish species found at Lake Onondaga New York site the same as those found at the Brunswick Georgia site?**
- **Does Lake Onondaga in New York have a Spartina marsh like at the LCP site in Brunswick Georgia?**
- **What is the water current speed in Ninemile Creek in New York and the current speed in Purvis Creek at the LCP site in Brunswick Georgia?**
- **Do people fish from Lake Onondaga in New York and from Turtle River near the LCP site in Brunswick Georgia?**

To my knowledge, the only similarity between the Lake Onondaga New York site in the Brunswick Georgia LCP site is that people consume fish from both the lake and Turtle River.

Does the EPA agree the only similarity between Lake Onondaga and Turtle River is people catch and eat fish from both locations?

Does the EPA agree the dioxin and furan is more widely distributed in the Turtle River area than at Lake Onondaga, and the EPA's data documents this dispersion (USEPA, 1995b)?

Will the EPA add the risks found from dioxin and furan in fish to the BERA and HHBRA for the LCP Site in Brunswick, Georgia? If not, why not?

As noted in the BERA:

> In addition, Aleiandro et al., (2006) states that some of the Clapper Rail effects observed may be attributable to "organochlorides other than PCBs (e.g. dioxins)." Kannan et al., (1998a,b) also associate dioxin-like compounds to the Site. These papers suggest dioxins/furans may be associated with the Aroclors at LCP. The magnitude of the TEC dioxin concentrations particularly in Eastern Creek suggests collocated contamination with Aroclor 1268. In the absence of TEC-dioxin data in sediment elsewhere in the estuary or in biota samples, the potential contribution of TEC dioxins to existing risk is unknown.

Does the noted uncertainty, "…the potential contribution of TEC dioxins to existing risk is unknown", still exist?

Since the EPA has proposed a plan to remediate the LCP site in Brunswick Georgia without any dioxin furan data or any dioxin furan risk calculations for wildlife or people who consume the seafood, will the risk data from the Lake Onondaga site be used at the Brunswick Georgia site to better estimate the additive risk of dioxin and furan to the existing PCB contamination?

5.0 REMEDIAL ACTION OBJECTIVES (RAOS) AND PRELIMINARY REMEDIAL GOALS (PRGS)

The most conservative potential sediment PRG would be one which protects humans at an upper bound excess cancer risk of 1E-06, based on consumption of fish with Aroclor 1268. However, this would require a sediment clean up goal of 0.037 mg/kg, which would result in destruction of almost 700 acres of **otherwise functioning marsh** (emphasis added) and was therefore rejected as a potential goal.

What data does the EPA have to support the statement that the LCP Site is "…otherwise functioning marsh…"?

> "Similarly, if a 1E-05 cancer risk were used as the basis for establishing a sediment goal, the Aroclor 1268 concentration would need to be 0.37 mg/kg, which would result in unwarranted harm to approximately 586 acres or 77% of the entire marsh."

How large is the entire marsh in the Turtle River (St. Simons Sound)?

Would remediating to 1E-05 result in removing the entire marsh, or just the contaminated areas adjoining the LCP Site?

> "Early in the feasibility study process, EPA and GAEPD concluded that achievement of a mercury SWAC PRG of 1 mg/kg for the entire marsh would not be appropriate."
> And,
> " EPA and GAEPD reached this conclusion after thoroughly evaluating whether the removal or treatment of sediment contaminants in 33 of the 81 acres would cause more long-term ecological harm than no active remedial action, since such a large remedial foot print would cause widespread physical damage to habitat and species."

How did the EPA and GAEPD come to the conclusion that achievement of a mercury SWAC PRG of 1 mg/kg for the entire marsh would not be appropriate and what were the decision-making metrics?

What timeframe did the EPA and GAEPD consider long-term ecological harm?

How long will the mercury remain in the marsh and continue the methylation process?

How long will it take to remove the mercury contaminated marsh and complete the restoration process?

When comparing leaving the mercury in place and the continued methylation process or removing the mercury contaminated sediments and restoring the marsh, which alternative results in the shortest impact to the marsh and estuarine system when considered over the long-term?

6.0 DESCRIPTION OF ALTERNATIVES

The proposed plan section concerning the description of alternatives is more notable for what's missing than what is discussed. In 2000, a preliminary restoration scoping analysis was conducted for the LCP Chemicals Superfund site marsh (NOAA, 2000). During this analysis many more remedial technologies were examined them were mentioned in the feasibility study or brought forward in the Proposed Plan. The technologies considered include, but are not limited to, the following:

- Controlled placement of multilayers with or without geosynthetic fabrics
- Solidification or stabilization biomechanically mixing the upper layers of the sediments with stabilizing or solidifying agents, which typically uses cement bentonite or polymer-based materials. The discussion of this technology include the use of containment structures such as coffer dams and caissons.
- Bioremediation by stimulating indigenous microbial activity with nutrients are introduction of design microorganisms. This technology was not found applicable for Mercury and PCBs. Also, consistent mixing and Spartina marsh would've been difficult.
- Mechanical including clamshell buckets, backhoes, bucket ladder, or similar technology. The drawbacks identified where the need for construction of berms, walls and silk curtains, and proper installation would require an effort similar to a dry excavation. But it was noted the typical drawbacks to dredging including site access and adequate space for sediment handling are not in issue for the LCP site.
- Dry excavation with a berm damn or dike marsh areas, followed by draining excavation is sediments and backfill, moving the berms and replanting was identified as a technology suitable for the site. Furthermore the technology was identified as being more efficient, reduced loss of sediments, and complete removal of the contamination when compared with dredging techniques.

The failure of the proposed plan to evaluate technologies utilizing coffer dams, sheet piling, berms, or dikes is an oversight that brings in the question the completeness of the Proposed Plan. Notable is the number of similar structures within the area of the LCP site. These include the aeration basin at the adjoining pulp and paper mill, the dikes at the Andrews island dredge spoil area, and even the existing road out to Purvis Creek at the LCP site. Furthermore, it is evident that the authors of the Feasibility Study failed to see the usefulness of the existing roadway (LCP Site causeway) as a significant containment structure within the area needing remediation. Placement of a coffer dam or sheet piling would be a very doable technology for the LCP site. The area can be accessed from the uplands, the spoils brought to the uplands, and a single point of entry and exit established for the purpose of decontamination.

What was the rationale of the EPA in excluding technologies that utilized coffer dams sheet piling or similar technologies to confine the area, reduce sediment dispersion, and facilitate dewatering of the sediments needing removal?

Did the EPA compare technologies utilizing dredging versus coffer dams or sheet piling?

If the EPA did compare the technologies, why were technologies that left contamination in place or that have a high probability of recent spending sediments selected?

Did the EPA consider accessing the marsh via an upland route instead of by barge?

Was a barge used previously for the EPA Emergency Response and Removal or was the marsh accessed via the uplands?

7.1 Overall Protection of Human Health and the Environment

> "These reductions are likely to be observed only after several years post remediation (i.e., after a few generations of fish lifespans)."

How many years is "…after a few generations of fish lifespans"?

Which fish species are being used to determine "fish lifespans"?

7.3 Long Term Effectiveness and Permanence

> "Sediment removal, sediment capping, and to a lesser degree thin-cover placement have been found reliable and effective at sites similar to the LCP Chemicals marsh."

What example of a similar marsh or estuary with *Spartina alterniflora* is being referenced as the example? Do the "…sites similar to the LCP Chemicals marsh" have tides in excess of 9 feet, Fiddler crabs, and other burrowing birds and animals?

> "Materials for sediment capping and thin-cover placement will be sized to ensure protection against erosion and scour. However, the thin cover is not an armored contaminant barrier. Based on several case studies, some burrowing and other types of

biological activities will occur in the thin-cover layer, but are not expected to adversely impact its effectiveness in reducing exposures to the benthic community. Monitoring and maintenance will be performed as necessary to ensure long-term remedy effectiveness."

How will the cap reducing exposures to the benthic community with the 200 Fiddler Crabs per square meter, documented in the BERA, burrowing to a depth of 36 inches?

Will the cap be compromised by approximately 8% per year?

If not by approximately 8% per year, how much sediment will be brought to the surface each year by the 200 Fiddler Crabs per square meter?

What are the other burrowing animals that will further compromise the cap materials?

"Monitoring and maintenance will be performed as necessary to ensure long-term remedy effectiveness."

How often is the monitoring schedule to take place at the site and what will this entail?

How often will maintenance be performed and how will the areas be accessed?

Will funding be in place to conduct the monitoring and maintenance or will it be contingent upon approval and appropriations by the PRPs or in the case of the EPA, Congress?

How much money will be set aside for the monitoring and maintenance program?

Does the EPA the description of the monitoring and maintenance program in detail is critical to the success of the remediation?

If so, please do describe in detail and include in Responsiveness Summary and the Record of Decision.

"Where alternatives include sediment capping and thin-cover placement, long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials."

How can the EPA claim "…long-term COC toxicity and mobility are reduced by creating a clean sediment surface through burial with clean materials", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?

7.4 Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment

"In Purvis Creek, In Purvis Creek, there is evidence that mercury fish and shellfish tissue concentrations have decreased over time.."

Does the EPA have whole fish sampling in support of the statement, "In Purvis Creek, there is evidence that mercury fish and shellfish tissue concentrations have decreased over time," or is this an opinion or based upon data that is not comparable or obtained by different sampling and analysis methods?

What is the source of the data of "evidence" the EPA is citing?

What are the two data sets being compared to conclude there is evidence of COC reduction in fish and shellfish to make this conclusion and where can they be found in the LCP Site documents?

Was the data collected used to conclude there is evidence of a reduction using EPA approved protocols?

Was both whole fish and filet sampling conducted?

> "The thin cover is not intended to function as an absolute contaminant barrier, but as a layer which will stimulate ongoing natural recovery processes. Therefore, some possible bioturbation beyond the cover depth is not expected to diminish the effectiveness of this remedy and would not preclude its beneficial use as a component of a protective remedy."

Where can the EPA's calculations for the bioturbation beyond the cover depth be found in the Feasibility Study?

Is the thin cover based upon data or what is expected?

Who is defining "what is expected" and what are their credentials to do so?

How much sediment is brought to the surface each year by 200 Fiddler Crabs per square meter?

What is the volume of sediment brought to the surface each year by the other burrowing animals in the marsh?

> "Capping and thin-cover placements, which leave contaminant material in place, isolate COCs and reduce bioavailability and mobility through burial with clean material."

How can the EPA claim "… isolate COCs and reduce bioavailability and mobility through burial with clean material.", when the marsh is occupied by 200 Fiddler Crabs per square meter burrowing to a depth of 36 inches?

What is the cap annual failure rate calculated by the EPA, and the associated reintroduction of COC to the biota?

"Residual risks posed by COCs left un-remediated are addressed through ICs (including permit requirements, which are already in place to limit use or future activities in the LCP Chemicals marsh and fish consumption advisories) and LTM."

A discussion of the EPA's history of implementing Institutional Controls is in the comments submitted on the HHBRA and incorporated herein by reference.

7.5 Short-term Effectiveness

> "These negative impacts primarily relate to extensive heavy equipment used for dredging and the transport of contaminated sediments through the community to an uplands disposal facility and clean material transport to the Site."

Was on-site treatment, the use of coffer dams of sheet pilling considered by the EPA or stakeholder agencies (USFWS, 1996)?

Were coffer dams used by the EPA during the removal action for the LCP Site dump during the Emergency Response and Removal Action?

Are coffer dams a proven technology at the LCP Site?

Did the EPA use coffer dams during the Emergency Response and Removal Action to keep sediments from entering the marsh and spreading further?

Did the EPA use coffer dams during the Emergency Response and Removal Action to control and contain tidal waters?

7.6 Implementability

8.0 PROPOSED CLEANUP LEVELS

> "The derivation of the ecologically-based CULs was also a complex process that involved consideration of the ecological relationship of the affected areas of remedy implementation to the surrounding habitat, the recovery potential of the affected ecological receptors, and the magnitude of current and predicted future effects of the COCs on local populations within the marsh."

Were ecological receptors such as dolphin, manatee, diamondback terrapin and mink considered in the derivation of the ecologically-based CULs? If not, why not?

Does the EPA realize the dolphin, manatee, and mink are either species very susceptible to the COCs from the LCP Site, protected species, or both susceptible and a protected species?

Was the EPA aware of the large amount of peer reviewed journal data concerning COCs in dolphins and people prior to the release of the Proposed Plan (ATSDR, 2014b)?

> "Further, it was clear that not all discontinuous or isolated sediment locations that exceed PRGs could be removed without causing more harm than benefit."

Where can the "Harm/Benefit" analysis be found?

What was the timeline utilized to evaluate harm verses benefit?

Was short-term harm and restoration evaluated against the alternative of no action and long term risk to the ecosystem and human health?

What were the specific decision-making metrics used for the harm/benefit analysis?

What technologies were explored for these isolated high levels of COCs areas or areas that exceed remedial action goals?

> "In accordance with the EPA's risk assessment guidance, the initial PRGs were based on the most conservative estimates, using the most sensitive sediment toxicity receptors and test endpoints. The range of mercury SECs was between 1.4 and 145 mg/kg. For Aroclor 1268, the SEC range was between 4 and 420 mg/kg. Similarly for PAHs and lead, the SEC concentrations ranged over an order of magnitude."

Did it occur to anyone in any of the stakeholder agencies that there is likely another COC causing the observed extreme range in toxicity?

> "After evaluating each alternative that was presented in the FS, it was determined that the proposed CULs would still provide substantial protection to the benthic community without undue harm to the existing marsh, especially in combination with a robust monitoring program."

What does a "robust monitoring program" entail?

How often would the "robust monitoring program" be conducted?

Where are the sampling locations for the "robust monitoring program"?

When would the sampling and analysis start, and how long would the "robust monitoring program" be continued under the Record of Decision and Consent Decree?

Will dolphins, mink, and manatees be part of the "robust monitoring program"?

Has the EPA or the PRPs done the needed baseline monitoring over the past 20 years needed for a "robust monitoring program"?

If not, why should anyone believe the EPA or PRPs will start to do so now?

What does the EPA or PRPs have to show for work over the past 10 years to indicate they are competent to perform a "robust monitoring program"?

Has the EPA or PRPs collected the baseline data for a monitoring program? If not, why not?

Does a monitoring baseline need several data points to track changes, which requires several sampling events over time to establish the baseline?

> "Each of the SWAC and benthic community proposed CULs are expected to result in the attainment of the RAOs. In addition, surface water criteria that are identified as chemical-specific ARARs are expected, over time, to be attained as a result of dredging and capping of contaminated sediments."

What is the time period for attainment of the RAOs?

When will the effectiveness of the remedy be evaluated?

> "Where CULs may not be achieved and residual risks in some areas may occur, CERCLA and the NCP requires monitoring no less than every five years after implementation of the final remedy. Given that COCs will be left in place, a robust monitoring program, with triggers for additional actions, will be implemented as part of the selected remedy for OU1 to monitor and ensure success of the selected remedy."

What is the time period, specific goals, the decision-making metric by which the goals will be determined, and follow-up that will be implemented if goals are not reached?

Why are the goals not specified in the Proposed Plan?

Why are the goal decision-making metric by which the goals will be determined and triggers for additional action implementation, or the actions to be taken, not specified in the Proposed Plan?

Why is there no baseline monitoring to use in establishing goals to be reached?

Why has there been no baseline monitoring over the past 20 years?

Will the time period to reach the goals be specified in the Record of Decision?

What specific actions will be taken if the goals are not reached?

Has an analysis been conducted to compare the cost of conducting a remediation that will have a higher likelihood of success verses the cost of a "…robust monitoring program…" and the highly likely need to remobilize and conduct another remedial action due to minimal removal and significant unknown toxicity found during toxicity tests?

Will multiple remedial action shave a greater impact on the marsh than one comprehensive removal action and restoration?

9.0 SUMMARY OF THE PREFERRED ALTERNATIVE

A summary of preferred alternative cannot be conducted due the data deficiencies identified in the comments on the Baseline Ecological Risk Assessment and the Human Health Baseline Risk Assessment, and failure to evaluate all the technologies previously identified for inclusion in the Feasibility Study.

10.0 COMMUNITY PARTICIPATION

Please see comments concerning the Public Participation section of comments on the Proposed Plan for identified deficiencies and recommendations.

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February 13, 2015

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Mr. Jackson and Ms. Johnston,

The following comments and attachments are submitted as part of the Public Comment period for the LCP Chemicals Superfund Site (LCP Site)Proposed Plan for the marsh, Operable Unit One (1), located in Brunswick, Glynn County, Georgia.

Attached, please find:

- Health Consultation, ORGANIC CHEMICAL RESIDUE IN SCHOOLYARD SOILS, GOODYEAR AND BURROUGHS-MOLLETTE ELEMENTARY SCHOOLS AND RISLEY MIDDLE SCHOOL AND EDO-MILLER PARK/LANIER FIELDCITY OF BRUNSWICK, GLYNN COUNTY, GEORGIA, MARCH 22, 2005 (ATSDR, 2005)
- Wind Rose for Glynn County (GLYNCO, Wind Rose)
- Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, September 3, 2014, by Lorraine C. Backer, PhD; David Mellard, PhD; Health Studies Branch, National Center for Environmental Health, Eastern Branch, Agency for Toxic Substances and Disease Registry (Backer, 2014)

The study cited in the ATSDR Health Consultation (March 22, 2005) is, "Determination of Toxaphene in Brunswick (GA) Public Access Area Soils by Immunoassay and Gas Chromatography, October 23, 2002" (Frohlick, Maruya, 2002), will be sent via postal mail for the LCP Site Administrative Record. The report cited by ATSDR also contains information about the specific species (congeners) of PCBs detected at the schools and playgrounds across the Brunswick Peninsula.

Comments and Questions

The quality of a Superfund Site cleanup or containment is contingent upon an understanding about how chemicals and other contaminates were released into the environment, and other environmental factors. The LCP Site air monitoring detected PCBs at the fence line. The sampling of soils at schools and playgrounds found a gradient of PCBs across the Brunswick Peninsula (ATSDR, 2005; (Frohlick, Maruya, 2002). PCB contaminated sediments with the congeners associated with the LCP Site were found in a wide radius in sediments and biota (Backer, 2014).

- **Did the EPA evaluate air transport and deposition of PCBs from the LCP Site as part of the LCP Marsh Remedial Investigation, Baseline Ecological Risk Assessment, or Human Health Baseline Risk Assessment?**
- **Does the EPA agree that the gradient of PCBs documented across the Brunswick Peninsula is a result of air releases from the LCP Site? If not, what is the mechanism for the formation of a PCB gradient of congeners associated with the LCP Site?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends into the marsh and likely the deposition is according to wind direction?**
- **Does the EPA agree that the gradient of PCBs found across the Brunswick Peninsula likely extends to Sapelo Island and is an explanation for how PCBs associated with the LCP Site crossed tidal nodes, rivers, and other natural hydrological boundaries? If not, what is the explanation for the PCBs crossing hydrological boundaries and barriers?**
- **Have PCBs been found past the Reference Stations at Troup Creek and Crescent River?**
- **Were dioxin and Furan Found at the Reference Stations? If so, could the source be the LCP Site?**
- **Could the source of observed toxicity at the Reference Stations be from the air transport of toxic compounds from the LCP Site? If not, why not? What additional efforts were made to identify the cause of toxicity at the Reference Stations?**
- **Did the EPA look at nearby toxicity sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski? If not, why not?**

- **Will the EPA consider using the sampling stations used by the United States National Park Service at Cumberland Island and Fort Pulaski as the Reference Stations for the LCP Site?**
- **Did the EPA ever consider the Reference Stations were within the area where chemicals and other compounds were released from the LCP Site? If not, why not?**
- **If the EPA did evaluate air transport and deposition, what was the estimated volume of PCBs distributed via air transport?**
- **Did the EPA evaluate the extensive record of air releases recorded by the Georgia Environmental Protection Division and documented in the LCP Site Removal Administrative Record?**
- **Does the Georgia Environmental Protection Division a documented air releases in the LCP Site Removal Administrative Record discuss the high temperature of the gasses released? What was the composition of the gasses released?**
- **Can heavier than air chemicals like PCBs and Dioxin/Furan be air transported in a release of heated gasses?**
- **What is the EPAs explanation for the gradient of PCB congeners associated with the LCP site that extend out from the Site?**

Thank you for your attention to this comments and we will look forward to your response.

Sincerely,

Daniel Parshley, Project Manager

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Determination of Toxaphene in Brunswick (GA) Public Access Area Soils by Immunoassay and Gas Chromatography

Final Report

by

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EXECUTIVE SUMMARY

Technical toxaphene, a broad spectrum organochlorine insecticide, was produced by Hercules Inc. in Brunswick (GA) for more than 30 years. Because several public access areas including schoolyards are in close proximity to the plant, concerns over human health risks from toxaphene contamination in soils have been raised. Previous studies have been inconclusive as to the levels and extent of toxaphene contamination in local schoolyard soils. The objective of this study was to determine if toxaphene contamination in soils from Goodyear and Burroughs-Molette Elementary Schools, Risley Middle School, and the Edo Miller/Lanier Field Recreational Area -- poses a potential human health risk.

A total of 94 surface soil samples were collected in Spring 2002 and analyzed for toxaphene using two analytical methods. A commercially available, enzyme-linked immunosorbent assay (ELISA) kit was used to semiquantitatively classify toxaphene concentrations. A sample subset (n=36) was analyzed by gas chromatography with electron capture and mass spectrometric detection (GC-ECD and GC-MS, respectively). In addition to toxaphene, concentrations of other organic chemicals of environmental concern (chlorinated pesticides, PCBs and PAHs) were determined by GC.

Based on ELISA, well over half the soil samples contained low amounts of toxaphene (<2 ppm). More than half of Goodyear Elementary School soils (56%) were classified as moderately to highly contaminated (>2 ppm) with a single sample classified as highly contaminated (>10 ppm). Roughly one quarter of Risley MS samples were in the moderate range (2<x<10 ppm). All soils from Burroughs Molette Elementary School and Edo Miller/Lanier Field Recreational Area were classified as low or undetectable (<2 ppm).

Less than a third (10 of 36; 28%) soil samples analyzed by GC had detectable levels of toxaphene. Total toxaphene (ΣTOX) in these samples ranged from 0.02 to 0.38 ppm. In contrast, nearly all samples contained detectable levels of PAH, PCB and chlordanes with maximum concentrations of 22, 0.064 and 0.79 ppm, respectively. Linear regression analyses indicated that Σchlordane was highly correlated with modeled ELISA concentrations (R^2=0.57), whereas ΣPAH and ΣPCB were not. Confirmational GC-MS analyses clearly indicated that chlordanes – and not toxaphene -- were the predominant class of organochlorine contaminants in these samples, including the single Goodyear ES sample classified by ELISA as highly contaminated (>10 ppm) with toxaphene.

Because cyclodiene pesticides including chlordane are similar in chemical structure to toxaphene, the ELISA test kit utilized in this study is subject to interference. The presence of chlordane residues at or above the test kit interference threshold coupled with low or undetectable levels of toxaphene by GC indicates that toxaphene is unreliably quantified (and overestimated) by ELISA in these samples. Furthermore, toxaphene levels as determined by GC are well below soil thresholds (~1 ppm) at which human health risks are deemed unacceptable.

1. INTRODUCTION

1.1 DEFINITIONS

Technical toxaphene (or "TTX"), a widely used pesticide, is a complex mixture of individual polychlorinated monoterpene (bornane, camphene and dihydrocamphene) compounds (or "congeners") with 6-10 chlorines per molecule and an average chlorine content of 68-70% [1]. Because of its persistence and potential for toxicity, toxaphene and its residues continue to pose a threat to ecological and human health. With several thousand compounds theoretically possible, it is thought that the technical mixture of toxaphene consists of several hundred congeners, making the analysis of toxaphene residues in environmental samples a challenging task [2]. Because components in TTX are selectively transformed in the environment, *toxaphene residues* (or simply "toxaphene") are defined as original TTX components and transformation products thereof.

1.2 TOXAPHENE PRODUCTION AND USAGE

Hercules Inc. in Brunswick, GA produced technical toxaphene from the late 1940s until 1980. During this period, it was used primarily as an agricultural pesticide, with applications on soybeans, wheat, cotton, and peanuts. This biocide was also used as a de-licer for livestock and to clear lakes of unwanted fish. During the late 20th century, toxaphene was one of the most heavily used chlorinated pesticides worldwide, with a global production since 1950 estimated at more than 1 megatons [3]. Although banned in the U.S in 1982, residues of toxaphene are transported via the atmosphere and as a result are detectable in polar as well as temperate ecosystems. Similar to other pollutants like DDT, polychlorinated biphenyls (PCBs) and other organochlorines, toxaphene was found in air, fish, marine biota, foods, human milk and even Arctic animals [4,5]. Nonetheless, toxaphene and similar products are still produced and used in some third world countries.

1.3 PHYSICAL AND CHEMICAL PROPERTIES

TTX was produced by isomerization of α-pinene to α-terpineol, bornylene, and camphene, followed by exhaustive chlorination using chlorine gas in the presence of ultraviolet radiation. Chlorinated monoterpenes (e.g. bornenes and camphenes) are formed during this process, but the majority of TTX components are based on the bornane skeleton (Fig. 1). TTX is a yellow, waxy solid at room temperature, with a mild terpene odor. It is readily soluble in most organic solvents, but it is more soluble in aromatic than in aliphatic hydrocarbon solvents. The average elemental composition of TTX is $C_{10}H_{10}Cl_8$ and its several hundred components are represented by the formulas $C_{10}H_{18-n}Cl_n$ or $C_{10}H_{16-n}Cl_n$, where n is 6 to 10 [1]. TTX is relatively stable but may be degraded by continued exposure to sunlight, alkali, or temperatures above 393K [6]. A specific gravity of 1.6 kg liter^{-1} has been reported for technical toxaphene [7]. Vapor

pressure and the log octanol-water partition coefficient (K_{ow}) value are comparable to that of hexachlorobenzene (HCB), $1.73x10^{-3}$ Pa at 298K [8], and a log K_{ow} of 5.5 [9].

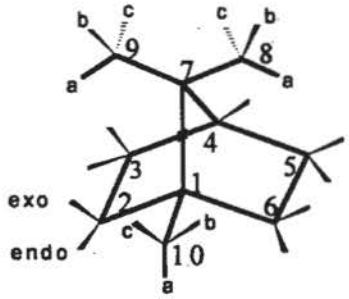


Figure 1. Bicyclic monoterpene (bornane) skeleton of toxaphene. Numbers represent IUPAC carbon numbering scheme; small case letters represent the conformational position of Cl or H atoms.

1.4 Fate and Effects

Wania and Mackay [10] reported that toxaphene is largely associated with aerosols in the atmosphere, and is thus removed by both wet and dry deposition. Moreover, toxaphene is transferred more rapidly from the atmosphere to soil and water at low temperature [2]. In warmer climates, evaporation from soils and surfaces will be a significant process. Toxaphene in soil can persist for long periods (1 to 14 yr) and is not expected to leach significantly into groundwater or be mobilized in runoff unless adsorbed to clay particles. In anaerobic soils and sediments, biotransformation of toxaphene results in the formation of lower chlorinated homologs [11]. Primary dechlorination products are 2-*exo*,3-*endo*,6-*exo*,8,9,10-hexachlorobornane (B6-923 or "Hx-Sed") and 2-*endo*,3-*exo*,5-*endo*,6-*exo*,8,9,10-heptachlorobornane (B7-1001 or "Hp-Sed"). Levels may be high in fish [12] and mammals [13] because toxaphene accumulates in fatty tissues. Several components resist environmental degradation, including those found in polar wildlife [4].

Toxaphene is classified by EPA as a persistent, bioaccumulative and toxic chemical of primary concern [14], and is listed as a probable carcinogen [15] based on experiments in mice and in rats [1]. For example, a dose-related increase in the incidence of hepatocellular carcinomas was observed in male and female mice exposed to toxaphene via oral administration. In addition, an increased incidence of thyroid tumors was observed in male and female rats. Toxaphene was also found to elicit mutagenic properties in the bacterium *Salmonella typhimurium*. It is acutely and chronically toxic to aquatic organisms and wildlife at parts per billion concentrations. Neurotoxic, behavioral and learning effects due to toxaphene exposure have been reported (Table 1). Histological changes in the brain of guinea pigs -- disorganization and enlargement changes in the neutron -- after exposure to toxaphene has been reported [16].

Table 1. Neurologic and development effects associated with toxaphene exposure.

In vivo Species	Route/ Duration	Dose, mg $kg^{-1}day^{-1}$	Type of effects	Effect
Rat	Oral/3days, 1x/day	25	Neurologic	Tremors, nervousness
Guinea pig	Oral/once	300	Neurologic	10% decreased brain weight
Dog	Oral/2days	10	Neurologic	Convulsions, salvation, vomiting
		5	Neurologic	No body weight gain
Rat	Ad lib/14days	10	Development	No body weight gain
Rat	Oral/gestation day 7-16, 1x/day	12.5	Development	Decreased fetal renal protein
Mouse	Oral/gestation day 7-16, 1x/day	35	Development	No body weight gain

data from [1]

Human exposure to toxaphene residues can occur via several pathways. For example, consumption of contaminated fish, exposure in the workplace, breathing of airborne toxaphene, or contact via contaminated soils are all possible exposure routes. There exist however little data on the risk to humans from toxaphene exposure [1]. Brown et al. [17] and Cantor et al. [18] reported an association between elevated risk of leukemia and non-Hodgkin's lymphoma (NHL) among farmers that were exposed to pesticides and other agricultural chemicals. The risk increased for farmers who worked with pesticides without protection. Some of the chemicals with risk of NHL were carbaryl, chlordane, DDT, diazinon, lindane, nicotine, and toxaphene. The International Agency for Research on Cancer (IARC) regards toxaphene as a carcinogenic risk to humans based on studies with mice and rats, despite the deficiency of adequate data for humans [15]. In contrast, de Boer and Wester found no correlation between the number of children borne and toxaphene levels in mother's milk [5].

1.5 Other Pesticides

1.5.1 Chlordane

Chlordane is the generic name of a technical biocide mixture consisting of several (10 major) components that are structurally related to toxaphene. Technical chlordane was used in the United States from 1948 to 1988. Two of the major components are α- and γ-isomers of chlordane, whose molecular formula is $C_{10}H_6Cl_8$. The IUPAC name for chlordane is 1,2,4,5,6,7,8,8-Octachlor-2,3,3a,4,7,7a-hexahydro-4,7-methanoinden (Fig. 2). Other major components are β-chlordane, heptachlor, and trans-nonachlor.

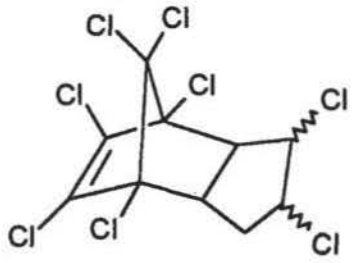
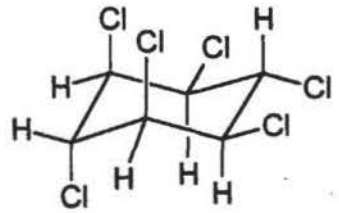


Figure 2. Chlordane, a mixture of chlorinated cyclodiene compounds.

Chlordane was used to control insects on agricultural crops, lawns, and gardens. It was also used as a fumigant and to control termites. Because of concerns over cancer risk, evidence of human exposure and accumulation in biological lipids, persistence in the environment, and potential toxicity to wildlife, the EPA canceled the use and manufacture of chlordane in 1988. Chlordane is stable in the environment for many years and is ubiquitous in food, air, water, and soil. Major transformation products of chlordane in the environment are oxychlordane and heptachlor epoxide. Chlordane residues are commonly found in all compartments of the environment, including humans.

1.5.2 HEXACHLOROCYCLOHEXANES (HCHS)

Hexachlorocyclohexanes (HCH) are a group of manufactured chemicals with eight possible isomers (Fig. 3). Technical grade HCH is composed of the four most common isomers: α–, β–, γ- (Lindane), and δ-HCH. Lindane, the most biologically active isomer, is a white solid substance that may evaporate into the air as a colorless vapor with a slightly musty odor. Lindane was used as an insecticide on vegetable crops and fruit and forest crops. It remains in use in ointments to treat scabies and head and body lice. Lindane has not been produced in the United States since 1977, however, it is still imported into the U.S.



γ-HCH

α-HCH aaeeee u. aeeeea 160°
β-HCH eeeeee 309°
γ-HCH aaaeee 114°
δ-HCH aeeeee 139°
ε-HCH aeeaee 219°
η-HCH aaeaee 90°
φ-HCH aeaeee 125°

Figure 3: HCH structure and isomers

1.5.3 POLYCYCLIC AROMATIC HYDROCARBONS (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are fused (2-6) ring structures formed during the incomplete burning of wood, coal, gas, oil, garbage, or other organic substances (Fig. 4). Some PAHs are thought to have biogenic origins. They can also be found in crude oil, coal, coal tar pitch, creosote, and roofing tar. They are ubiquitous contaminants in all major compartments of the environment. Although the health risks posed by individual PAHs may vary widely, several are considered as carcinogenic or as probable carcinogens (Table 2).

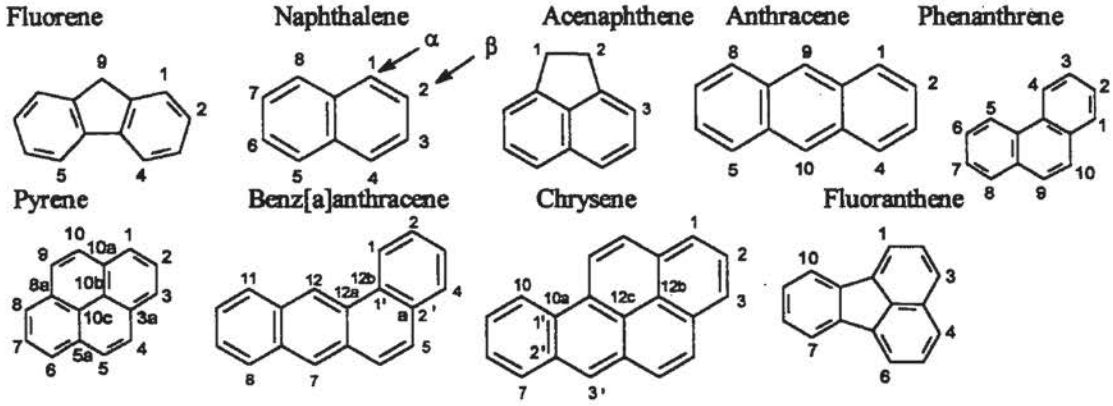


Figure 4. Structure of PAHs commonly found in the environment.

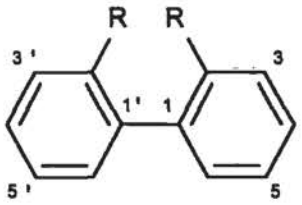
Table 2. PAHs of environmental concern.

Acenaphthene	Benzo[k]fluoranthene
acenaphthylene	Chrysene
anthracene	Dibenz[a,h]anthracene
benz[a]anthracene	Fluoranthene
benzo[a]pyrene	Fluorene
benzo[e]pyrene	indeno[1,2,3-c,d]pyrene
benzo[b]fluoranthene	Phenanthrene
benzo[g,h,i]perylene	Pyrene
benzo[j]fluoranthene	

PAHs enter the atmosphere via forest fires, volcanic emissions, residential wood burning, and combustion engine exhaust. The distribution of PAHs in the environment depends on individual physicochemical properties such as vapor pressure and water solubility. PAHs with > 4 rings are very hydrophobic and nonvolatile. As a result, they are associated with atmospheric particles (e.g. smoke) or soils and sediments with elevated organic matter content. PAHs accumulate in plants and animals, but are in general metabolized by higher organisms. PAHs are also subject to microbial degradation as well as sunlight (UV) induced transformation. Environmental half lives are generally proportional to the number of rings.

1.5.4 Polychlorinated Biphenyls (PCBs)

PCBs are a class of 209 individual chlorinated compounds with no known natural source. Commercial mixtures produced in the U.S. are known primarily by the trade name Aroclor. Percent chlorine by mass in Aroclor mixtures ranges from 16 to 68%.



R = H : Biphenyl
R = OH : 2,2'-Biphenyldiol
R = COOH : Diphenacid
R = Cl : PCB

Figure 5. Generic structure of PCBs.

PCBs were used as coolants and lubricants in transformers, hydraulic oils, capacitors, and other electrical equipment because of their dielectric properties, and chemical stability and inertness. PCB manufacture ceased in the U.S. in 1977 due to evidence of accumulation in the environment and concerns over environmental and human health effects. PCBs are stable in the environment and like other hydrophobic organic compounds, have low water solubility and vapor pressure. They accumulate in soils, sediments and biological compartments and exhibit biomagnification in terrestrial and aquatic food webs. The most commonly observed health effects in people exposed to elevated PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that are suggestive of liver damage. Animals exposed to highly contaminated food over relatively short periods of time exhibited liver damage and in some cases mortality. Animals surviving chronic exposure to PCBs developed various kinds of health effects, including anemia, acne-like skin conditions, and liver, stomach, and thyroid injuries. Other effects of PCBs include changes in the immune system, behavioral alterations, and impaired reproduction. Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Because rats exposed to high levels over two years developed liver cancer, PCBs are considered probable carcinogens.

1.6 Analytical Methods For Toxaphene

1.6.1 Immunoassays

Immunoassays were developed in the 1960s for the identification and localization of antigens in histological preparations. Immunoassays take advantage of specific interactions between antibodies and antigens to measure a variety of substances. Antibodies are proteins produced by lymphocytes (white blood cells) in response to infection caused by a foreign substance (antigen) in order to render it harmless. Production of antibodies can be induced by directly immunizing a vertebrate species (e.g.

rabbits or sheep). Antibodies produced *in vivo* are polyclonal, i.e. they reflect the entire immune response [19]. Monoclonal antibodies can also be produced artificially and subsequently isolated for various uses. For example, mouse lymphocytes producing the required antibody are fused with mouse cancer cells. The resulting hybrid cells produce the same type of antibody as their parent lymphocytes. Monoclonal antibodies prepared in this fashion are widely used to detect and quantify levels of antigens. Commonly used immunoassays are competitive or non-competitive.

1.6.1.1 COMPETITIVE IMMUNOASSAYS

Competitive assays use a single specific antibody type immobilized onto a solid surface. A corresponding analogue of the analyte, e.g. an antigen, is labeled with an enzyme such as alkaline phosphatase. When incubated together, the analyte or antigen in the sample "competes" with the labeled analogue for binding to the antibody. After separation of unbound analogue, the amount of label remaining is measured and the resulting signal is inversely proportional to the amount of antigen in the sample. Competitive assays are compatible with a wide range of analytes and are used for the majority of low molecular weight organic analytes (i.e. contaminants) of environmental and food safety concern.

1.6.1.2 NON-COMPETITIVE ("SANDWICH") IMMUNOASSAYS

Non-competitive assays utilize two specific antibodies to "sandwich" the analyte. One antibody is immobilized to a solid surface and the second antibody carries the label. In the assay, analyte is bound simultaneously by both the capture and label antibodies. After separation of unbound label antibody, the remaining label is measured and is directly proportional to analyte concentration in the sample. Sandwich assays are limited to those analytes of sufficient size to be able to bind two antibodies simultaneously, typically proteins and microorganisms [19].

1.6.1.3 DETECTION AND MEASUREMENT

Immunoassays most commonly utilize radioactivity, colorimetry, fluorescence, and chemiluminescence as detection methods. Early immunoassays used radioactive tracers. Non-radioactive detection in immunoassays began in the 1970's with the advent of colorimetry, normally by attachment of an enzyme to an antigen for the competitive methods, and attachment to a specific antibody for non-competitive assays. Entire enzyme systems like horseradish peroxidase (HRP) or alkaline phosphatase (AP) liberate a colored product after incubation with a suitable substrate. The amount of color generated is then measured at a specific wavelength. The optical density obtained is then related back to the concentration of the antigen in the sample. For better sensitivity and/or more rapid results, fluorometric or chemiluminescent detection can be substituted.

1.6.1.4 ENZYME LINKED IMMUNOSORBENT ASSAY (ELISA)

The enzyme linked immunosorbent assay (ELISA) has become a commonly used method to detect organic contaminants in environmental samples. The basic steps of ELISA are as follows:

- Immobilization
- Competition
- Separation
- Substrate reaction
- Stop reaction
- Detection

Test kits based on the use of antibodies that specifically or selectively bind the analyte (or analyte-enzyme conjugate) of concern are commercially available. Antibodies are immobilized on the walls of plastic test tubes. When an analyte is present in the sample, it competes with the enzyme-conjugate, which are analogues of the analyte, for a limited number of binding sites (i.e. immobilized antibodies). After binding reactions are complete, unbound molecules are removed, usually by washing. A colorless solution of chromogenic substrate is then added to the test tube. In the presence of bound analyte-enzyme-conjugate, the colorless substrate is converted to a colored solution. The reaction is then ceased and the color intensity determined with a pre-calibrated spectrophotometer.

1.6.1.5 INTERFERENCES

Immunoassays including ELISA kits are subject to interference from compounds that are structurally similar to the target analyte. Although antibody-antigen reactions may be highly specific, they do not necessarily distinguish between compounds of the same or similar chemical structures (e.g. chlordane and toxaphene). Thus, the detection level of the target analyte is dependent on the presence and concentrations of interfering compounds.

1.6.2 GAS CHROMATOGRAPHY (GC)

Gas chromatography (GC) is a technique of chemical separation of one or more individual compounds between two phases. One phase is fixed and called the stationary phase. The other is the mobile phase, which flows over the stationary phase. The components enter the stationary phase through the injector and move along the column at different rates. The lower the vapor pressure of the compound, the longer the compound will remain in the stationary phase. The time that each compound is retained on the fixed phase depends on the solubility of the compound in the stationary phase and the vapor pressure of the compound. Once eluted from the column, each compound is detected and its signal amplified and/or processed. The most important concept for the separation is that "likes dissolves likes". Thus, non-polar compounds are best separated using a non-polar stationary phase.

1.6.2.1 ELECTRON CAPTURE DETECTION (ECD)

Because toxaphene is highly chlorinated, the most widely used GC method is with electron capture detection (ECD). For example, EPA Method 8081 utilizes GC-ECD for a large number of chlorinated hydrocarbon analytes, including toxaphene [20]. Although ECD provides excellent sensitivity for these compounds, it is subject to interference from

a large number of halogenated and non-halogenated compounds alike. For example, the co-occurrence of toxaphene and PCBs in sediment and fish tissues from the Turtle/Brunswick estuary prevents accurate quantification of either contaminant by ECD without pre-separation [21,22].

1.6.2.1.1 TOXAPHENE TASK FORCE (TTF) METHOD

In an effort to standardize the approach and protocols for analyzing and reporting toxaphene levels in contaminated environmental media, a group known as the "Toxaphene Task Force" (TTF) developed a method based on GC-ECD [23]. This approach, known as the TTF method, requires the presence of four late eluting peaks in the ECD chromatogram in proportions similar to that found in unmodified (i.e. virgin) TTX. Environmental samples not meeting these criteria are assigned "not detected" (nd), regardless of the complexity and/or peak magnitude associated with the chromatogram.

1.6.2.2 ELECTRON CAPTURE NEGATIVE ION MASS SPECTROMETRY (ECNI-MS)

Mass spectrometry operating in the electron capture negative ion (ECNI-MS) mode offers excellent sensitivity and selectivity for chlorinated hydrocarbons such as toxaphene. When bombarded by a moderating ion, neutral toxaphene residue congeners capture an electron and thus become negatively charged, resulting in the formation of fragment ions (e.g. $[M\text{-}Cl]^-$). The simplicity of this fragmentation results in excellent sensitivity since only 1 or 2 ions can be monitored in the selected ion monitoring (SIM) mode. Pre-separation of PCBs prior to GC-ECNI-MS analysis minimizes the possibility of interferences or misidentification [24]. Whereas ECNI-MS readily confirms the identification of prominent target analytes, it is prone to response instability, and is thus less well suited than ECD or electron ionization MS for accurate quantification.

1.6.2.3 TWO DIMENSIONAL GC

Combining the best attributes of GC-ECD and ECNI-MS greatly reduces the uncertainty associated with non MS techniques in positively identifying toxaphene residues while retaining the response stability of ECD for quantification purposes. This approach, although costly and time consuming, has proven superior in determining the extent and congener distribution of toxaphene contamination in the Terry/Dupree Creek area of St. Simons Sound, GA [21,22,25]. This is particularly true for samples (i) where PCB interferences have largely been eliminated by pre-separation; and (ii) that have several fold higher levels of toxaphene relative to other organohalogen contaminants.

1.7 POTENTIAL RISKS ASSOCIATED WITH TOXAPHENE CONTAMINATED SOILS

Because toxaphene has been associated with neurotoxic and other deleterious effects on behavior and learning [2], the Glynn Environmental Coalition (GEC) has expressed concerns over the potential for human health risks at Glynn County schools. A review of historical records revealed that fugitive emissions of dust and dirt from the Hercules plant

in the city of Brunswick have been reported [26]. Soil within one half mile of the plant was expected to have 1 to 5 ppm toxaphene [27]. Moreover, Glynn County Schools were reported to have purchased toxaphene for use on parks, schools and recreational areas, including Edo Miller Recreational Area/Lanier Field [28].

Previous studies of schoolyard soils in the area used various methods to analyze for toxaphene and its environmental residues. The previously described TTF method has been used extensively in recent years [29]. Due to the omission of chemical compounds that elute in the toxaphene window or that are thought to be toxaphene related in GC chromatograms, however, this method is prone to underestimation of toxaphene residues in various environmental media [22,30-36]. Analysis of soils by EPA Method 8081 detected higher levels of toxaphene residues than the TTF method [31]. The TTF method failed to detect toxaphene residues at levels estimated up to 28 ppm in fish [22]. Analytical methods that estimated "total toxaphene" detected levels at Goodyear and Burroughs-Molette Elementary Schools that exceeded the 0.54 ppm screening level for carcinogenic risk, as well as the 10.88 ppm Georgia Environmental Protection Division reporting threshold [37]. Issues identified with the TTF method -- the data source for health consultations and human health risk assessments for citizens in the impacted area -- left community members questioning the validity and relevance of such assessments [22,37,38].

1.7.1 Previous Soil Investigations

In 1996 and 1997, Atlanta Testing and Engineering (AT&E) analyzed soil samples, conducted toxicity tests, and performed a risk assessment for 2 of the sites assessed in this study -- Goodyear and Buroughs-Molette Elementary Schools. Total toxaphene concentrations were estimated at 439 and 313 µg/kg (1 µg/kg = 1 part per billion or ppb) in single soil samples from Burroughs-Molette and Goodyear, respectively [39]. AT&E concluded that the schools had been impacted by toxaphene and recommended further investigation of the schoolyard surface soils [40]. Fourteen additional soil samples were then collected by AT&E and analyzed in accordance with EPA Method 8081 "total area" quantification protocols [41]. The range of toxaphene concentrations estimated in soil was 7180 to 64,600 µg/kg at Goodyear ES, and 614 to 13,000 µg/kg at Burroughs-Molette ES. Late in 1996, 40 additional samples were collected and analyzed for toxaphene, with six soil samples also tested for toxicity using the crustacean *Ceriodaphnia dubia* and the fathead minnow *Pimephales promelas* [41,42]. Toxaphene in soil ranged from 132 to 2145 µg/kg for Burroughs-Molette ES, and between 370-3870 µg/kg for Goodyear ES. Toxicity results revealed acute toxicity from 1 of the 6 soil samples taken at Goodyear ES [43]. As a result, it was suggested that cancer risk for students exceeded the baseline 1 in 1,000,000 based on a cumulative 180 days per year, 6 year exposure [39]. This risk assessment did not account for exposure to toxaphene via other pathways, (i.e. airborne, consumption of contaminated water or seafood) or during time spent outside of the school environment. Final corrective action recommendations by AT&E and the School Board's consultant were for the schoolyards to be covered with a layer of soil to prevent contact with contaminated soils by children [44-46].

2. METHODS

2.1 Reagents, Solvents, and Glassware

All chemical reagents and organic solvents used in this venture were of high purity (Optima or ACS reagent grade, Fisher Scientific Fair Lawn, NJ). Hydromatrix and Ottawa sand for the soil extraction were pre-extracted in a Soxhlet apparatus with ~400 ml of CH_2Cl_2. Florisil© (60-100 mesh) for extract fractionation was activated at 550°C in a muffle furnace for 24 h prior to deactivation with 1.0% hexane-washed water. All glassware was exhaustively detergent and water washed, kiln-fired at 650°C for > 8 h and rinsed with acetone and hexane prior to use.

2.2 Study Sites and Design

The following 4 public access areas in Brunswick, Georgia (USA) were chosen as sites for this study:

- Goodyear Elementary School (GYES)
- Burroughs-Molette Elementary School (BMES)
- Risley Middle School (RMS)
- Edo Miller/Lanier Field (EM/LF) Recreational Area

Prior to sampling, a grid network was superimposed on scaled plan views of each site. Individual sampling grids were 100 by 100 foot squares; in some cases, 200 to 100 foot grids were created. Each grid was given a numeric identifier (Figs. 6-9). Sampling grids with greater than 50% impervious surface coverage (e.g. school buildings, parking lots, sidewalks) were combined with an adjacent grid.

2.3 Soil Collection and Preservation

Prior to soil collection, sampling grid boundaries were marked off with rope and wooden stakes. In each grid, five surface soil grab samples to a depth of 3 inches were collected with a iron bulb planter (3" dia hollow iron cylinder). All grab samples were mixed thoroughly with a stainless steel spoon in an aluminum pan. Approximately 80g of homogenized soil from each grid was transferred into a pre-labeled 125ml clear glass I-Chem jar. Between samples, all sampling implements were wiped with a clean paper towel, rinsed with water followed by methanol and air-dried. Jars containing soil were kept cool and out of direct sunlight. Upon return to the lab, all sample jars were kept at 4°C in the dark for a maximum of 3 days prior to analysis.

2.3.1 Goodyear Elementary School

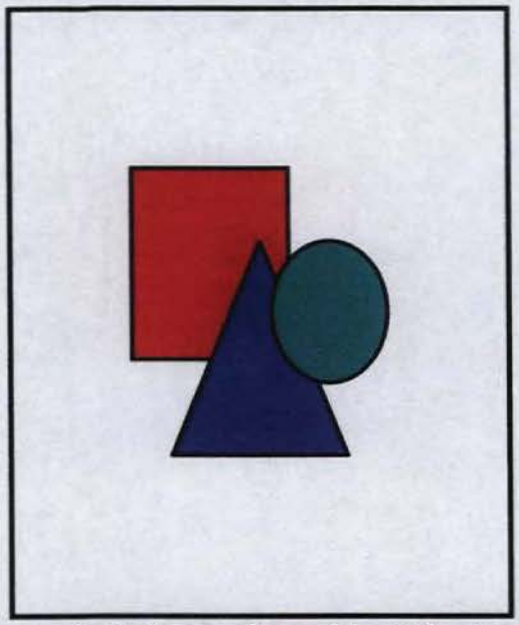


Figure 6. Soil sampling grids at Goodyear Elementary School.

2.3.2 Burroughs-Mollette Elementary School

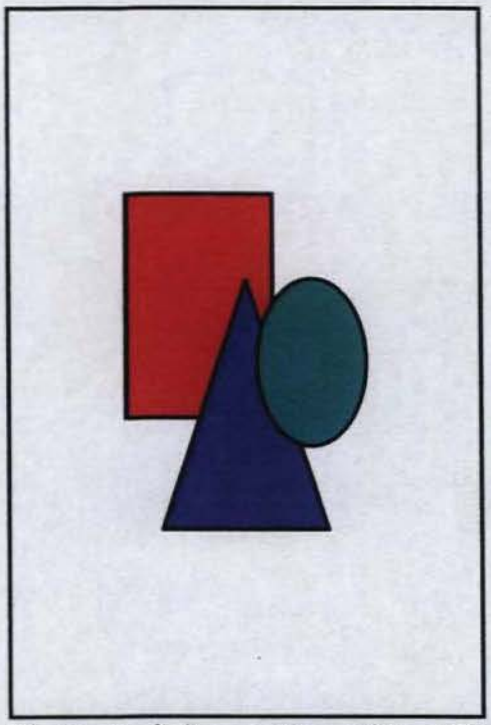


Figure 7. Soil sampling grids at Burroughs-Molette Elementary School.

2.3.3 Risley Middle School

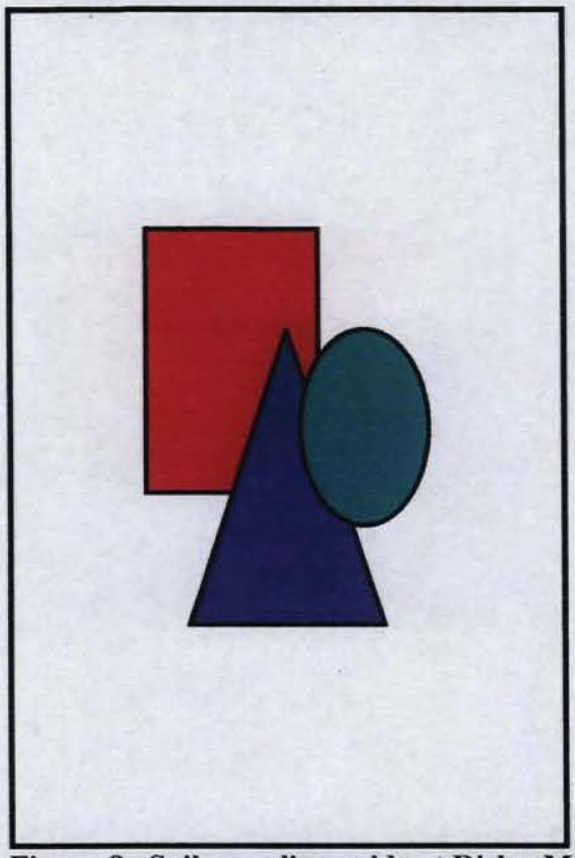


Figure 8. Soil sampling grids at Risley Middle School.

2.3.4 Edo Miller/Lanier Field, Recreational Area

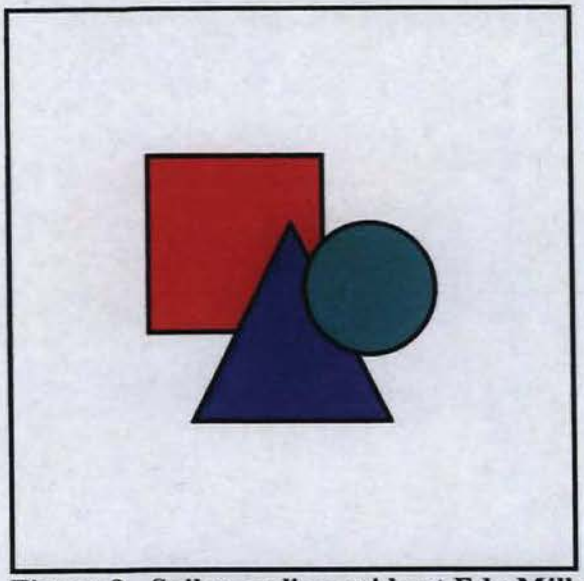


Figure 9. Soil sampling grids at Edo Miller/Lanier Field Recreational Area.

2.4 ELISA -- TOXAPHENE IN SOIL TEST KIT

EnviroGard™ Test Kits for Toxaphene in Soil and Extraction Test Kits were purchased from Strategic Diagnostics Inc. (Newark, DE, USA). Soil samples were extracted with a methanolic solution, filtered and assessed by ELISA using the SDI Toxaphene in Soil Test Kit in accordance with vendor instructions (Fig. 10).

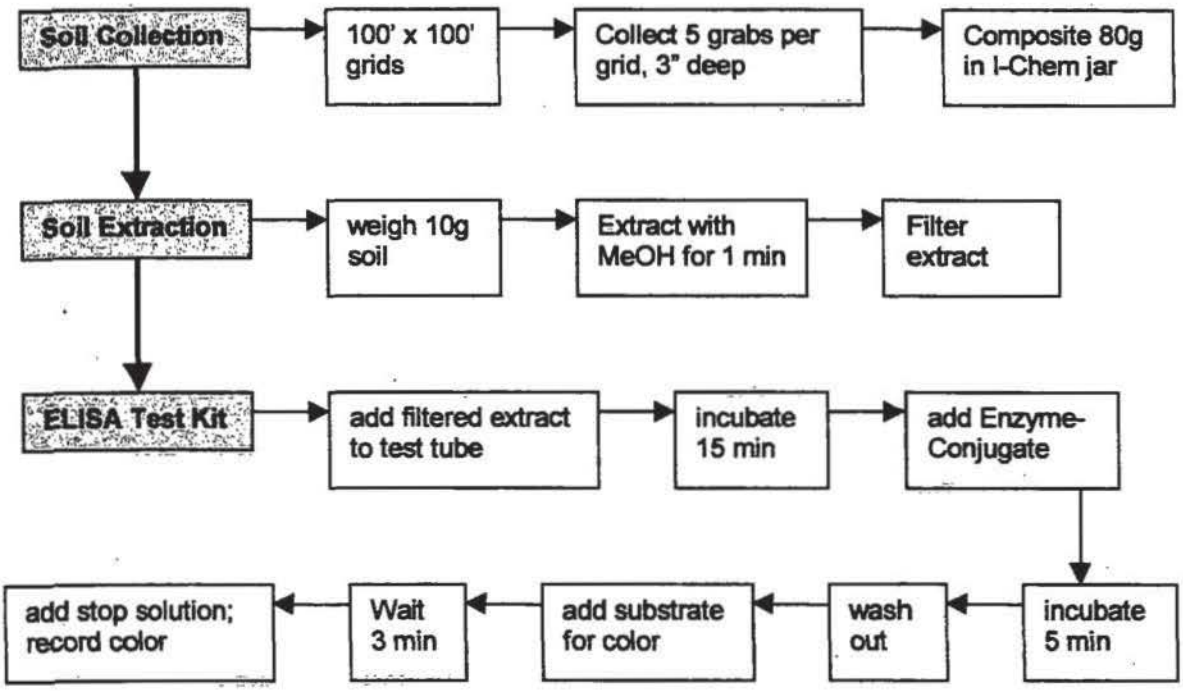


Figure 10. Schematic for analysis of toxaphene in soils using ELISA.

2.4.1 SAMPLE EXTRACTION

Fifteen (15) EnviroGard Toxaphene Soil Extraction Kits (SDI) were purchased from SDI (catalog no. 74200000EA). Ten gram aliquots of soil were extracted in accordance with the instructions provided by with the Sample Extraction Kits:

- weigh 10.0 g soil (using a wooden spatula)
- label extraction jar with sample information
- transfer 10.0 g aliquot of soil into jar
- pour contents of extraction solvent ampule (20 ml 90% methanol) into jar
- shake jar vigorously for 1.0 min
- allow methanolic extract to settle for 1 min (maximum 15 min)
- transfer ½ bulb capacity of liquid extract into the bottom of the filtration unit
- assemble the filtration unit and extrude sample through the filter

2.4.2 TEST KIT

Twelve (12) EnviroGard™ Toxaphene in Soil Test Kits (catalog no. 7420000) were purchased from SDI. The vendor advertised this kit as a semiquantitative enzyme immunoassay for the detection of toxaphene in soil, with screening levels at 0.5, 2.0 and 10.0 μg/g = parts per million (ppm). The vendor also reports that toxaphene in soils can be detected with 95% confidence of no false negative at the specified action level [47].

The EnviroGard™ Test Kits use coated polystyrene test tubes as the sorbing component of the ELISA. The sample is added along with the analyte labeled with an enzyme to a disposable test tube. Analyte present in the sample competes with the labeled analyte for binding sites on the antibodies. This immunological reaction occurs for 5 to 30 minutes. The tube is then washed and a color-developing reagent is added. After a short incubation, the color production is stopped and stabilized with acid. Color development is inversely proportional to the pesticide concentration (darker color = lower concentration).

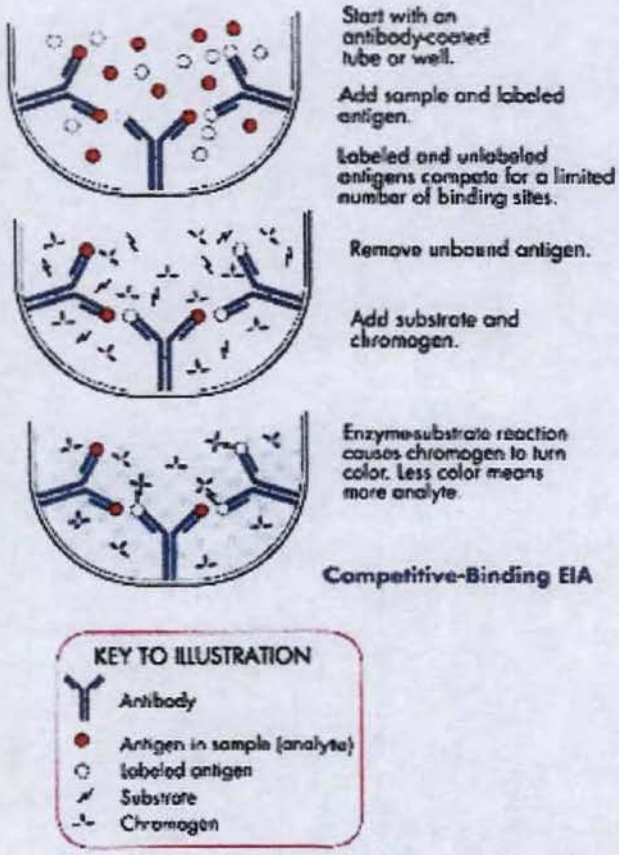


Figure 11. Toxaphene-enzyme specific interactions are measured colorimetrically using the Toxaphene in Soil ELISA Test Kit (SDI, Newark, DE).

2.4.2.1 PROCEDURES

- collect and extract soil sample (see section 2.4.1)
- add 250μL assay diluent to all test tubes
- using fresh pipette tips, add 50μL of each solvent to each test tube (including negative controls, pesticide calibrators)
- incubate tubes for 15 min
- add 200μL pesticide-enzyme conjugate
- gently shake test tube for 10-15 sec
- Leave tubes undisturbed for 5 min

- discard test tube liquid contents and wash out tube with cool tap/distilled water. Repeat three times. After final wash, remove as much water as possible
- add 500µL substrate to all test tubes
- briefly shake test tube rack and incubate for 3 min
- If the blue color does not develop in the negative control test tube within 3 min after addition of substrate, test is invalid
- add 500µL stop solution. Color will change from blue to yellow
- Record color intensity with a Varian Cary 3Bio dual beam UV-Visible spectrophotometer (λ=450nm) within 30 min

2.4.2.2 Method Detection Limit and Interferences

The reported method detection limit (MDL) for toxaphene based on 10g soil extracted is 0.5 ppm. Semiquantitative concentration ranges of <0.5; 0.5<x<2.0; 2.0<x<10; and x>10 ppm were established based on 3 calibrator solutions per kit. In addition, other organochlorine biocides can interfere with Test Kit response (Table 3). Also shown is the compound specific concentration required to inhibit one-half of the color developed by the negative control (IC50).

Table 3. Summary of ELISA kit method detection limits (MDLs) for toxaphene and interfering organochlorine compounds [47].

Compound	MDL	IC50
Toxaphene	0.5ppm	2.8ppm
Endrin	3.9ppb	22ppb
Endosulfan I	6.4ppb	36ppb
Endosulfan II	5.0ppb	28ppb
Dieldrin	7.5ppb	42ppb
Heptachlor	6.1ppb	34ppb
Aldrin	20.7ppb	116ppb
Chlordane	17.9ppb	100ppb
Gamma-BHC	0.8ppm	4.6ppm
Alpha-BHC	3.4ppm	19ppm
Delta-BHC	7.1ppm	40ppm

2.5 Gas Chromatography

A subset (n=36) of the 94 soil samples analyzed by ELISA were also analyzed by gas chromatography with electron capture and electron capture negative ion mass spectrometry (GC-ECD and GC-ECNI-MS, respectively). Samples were extracted with organic solvents, cleaned up and fractionated using Florisil column chromatography and reduced to ~1ml in hexane in preparation for GC analysis (Fig. 12). Comprehensive, performance based quality assurance/quality control measures were implemented to ensure data of the highest quality.

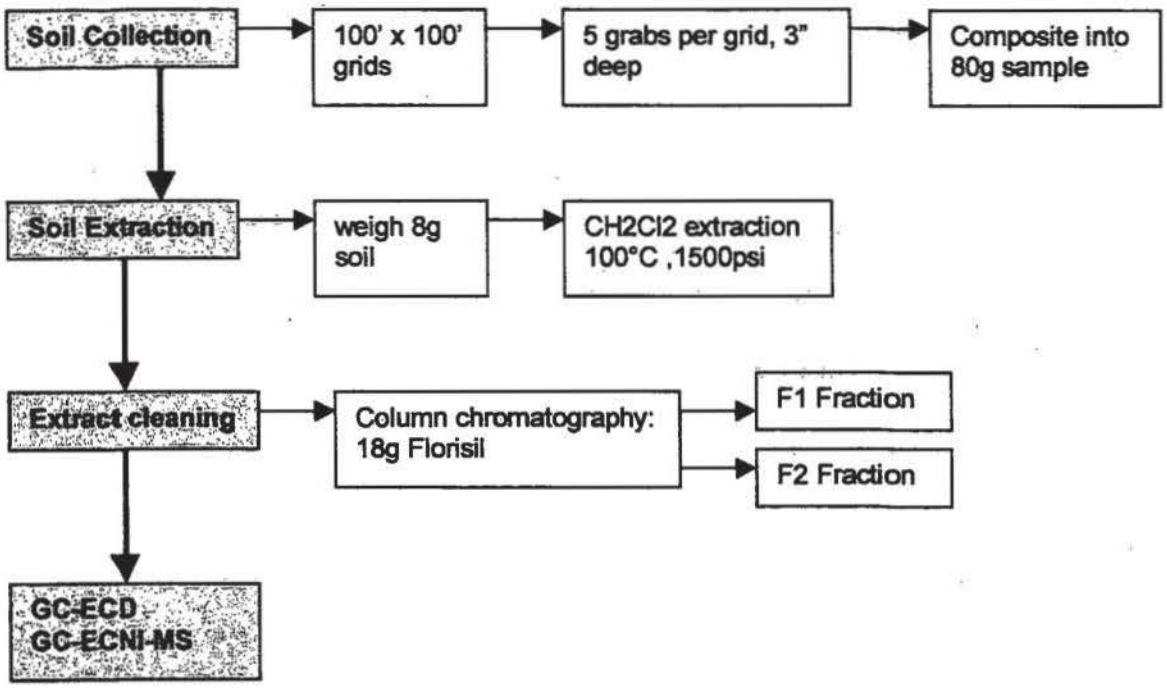


Figure 12. Sample processing schematic for GC analysis.

2.5.1 Soil Extraction

Eight grams of soil was homogenized with 4 g pre-extracted Hydromatrix and packed into stainless steel extraction cells. Pre-extracted Ottawa sand was added to completely fill the extraction cell. Dibromooctafluorobiphenyl (DBOFB) and α-HCH were then added to the top of each packed sample to track analyte recovery. Cells were then extracted using a Dionex Accelerated Solvent Extraction (ASE) 200 system with 90% CH_2Cl_2/10% methanol (v/v) heated to 100°C and pressurized to 1500 psi. ASE extracts were reduced to ~1ml and solvent exchanged to with hexane using a TurboVap II (Zymark Inc., Hopkington, MA). Hexane extracts were then applied to a glass column (500 mm L x 11 mm OD) dry packed with 18.0 g of 1.0% water deactivated Florisil. Two fractions were collected, the first fraction ("F1") was eluted with 90 ml hexane, and the second ("F2") was eluted with 150 ml of 20% CH_2Cl_2/80% hexane (v/v) to capture toxaphene residues. Both fractions were reduced and F2s exchanged to hexane using a TurboVap II. Water bath temperature and N_2 (>99.99%) pressure for the TurboVap II were maintained at 50°C and 8 psi, respectively. Final extracts in hexane were reduced to 1.0 ml and transferred to 2 ml glass vials sealed with Teflon-lined silicone rubber septa for GC analysis [21].

2.5.2 GC-ECD Analysis

F1 and F2 extracts (1 µl) were injected into a Varian 3400CX GC-ECD with an 8200 autosampler. Varian Star chromatography software (v4.01) was used to acquire and

analyze the chromatographic runs. A 30 m (L) x 0.25 mm (OD) fused silica capillary column coated with 0.25 μm DB-XLB was used to separate toxaphene components (Agilent/J&W Scientific, Folsom, CA). The GC oven was programmed as follows (hold times in parentheses): (i) 60°C (1 min); (ii) ramp to 120°C @ 10°C min^{-1}; (iii) ramp to 280°C @ 40°C /min (11 min). The total run time was 60 min. The injector and detector were maintained isothermal at 270°C and 330°C, respectively.

2.5.3 GC-ECNI-MS Analysis

To confirm the presence of individual toxaphene and other organochlorine analytes, extracts were analyzed on a Hewlett Packard 6890 Series II GC coupled to a 5973 mass selective detector operating in the electron capture negative ionization (ECNI) modes using an identical fused silica DB-XLB column as was used for GC-ECD analysis. The GC oven was programmed as follows (hold times in parentheses): (i) 60°C (1 min); (ii) ramp to 150°C @ 20°C min^{-1}; (iii) ramp to 280°C @ 4°C /min (2 min). The total run time was 40 min. The injector was programmed to track oven temperature. Helium at a constant flow rate of 1.0 ml/min was used as the carrier gas. Methane at a pressure of ~1 torr was used as the moderating gas. The quadrupole MS and ion source were maintained at 106 and 150°C, respectively. The MS was turned on after a 3.5 min solvent delay and was scanned between 200-500 daltons at 1.3 cycles s^{-1}. The electron multiplier was set to +400V bias for a total nominal voltage of ~1800V.

2.5.4 GC-EI-MS Analysis

To quantify the concentrations of PAH in our soil samples, extracts were analyzed on the HP6890II GC/5973 MSD operating in the electron ionization (EI) mode. The GC oven was programmed as follows (hold times in parentheses): (i) 60°C (1 min); (ii) ramp to 120°C @ 10°C min^{-1}; (iii) ramp to 300°C @ 4°C /min (8 min). The total run time was 60 min. The injector was programmed to track oven temperature. Helium at a constant flow rate of 1.0 ml/min was used as the carrier gas. The quadrupole MS and ion source were maintained at 150 and 230°C, respectively. The MS was turned on after a 5 min solvent delay ans was scanned between 50-550 daltons at ~1.5 cycles s^{-1}. The electron multiplier was set to +400V bias for a total nominal voltage of ~1650V.

2.5.5 Quantitation

Total toxaphene concentration (ΣTOX) was estimated by calibrating the GC-ECD with a technical toxaphene product standard ("TTX") provided by J. Hoffman of Hercules Inc and a toxaphene formulation purchased from Accustandard ("TTXA"). Serial dilutions of technical toxaphene were created in hexane at concentrations between 0.28 – 55 μg ml^{-1}. An average response factor for TTX was computed by summing the areas of all peaks of toxaphene, and dividing by the known standard mass. The TTX response was then applied to the summed area of peaks eluting within a specified retention time window (18-50 min) determined using the forced peak integration routine. For samples with detectable toxaphene residues in both F1 and F2 extracts using GC-ECNI-MS, ΣTOX was reported as the sum of both fractions. Areas for peaks corresponding to non-

toxaphene compounds eluting within this time window (e.g. Cl_4-Cl_7 PCBs in F1 extracts, and chlordanes and DDTs in F2 extracts) were subtracted from estimates of ΣTOX [21].

Total PCB and chlordane concentrations (ΣPCB and ΣChlordane, respectively) were estimated based on the sum of individual congeners in authentic standards. Seven congeners of chlordane were included in ΣChlordane estimates: heptachlor, oxychlordane, heptachlor epoxide, γ-chlordane, α-chlordane, trans- and cis-nonachlor. Fifteen penta- to decachlorinated PCB congeners (IUPAC nos 118, 188, 153, 105, 138, 187, 126, 128, 201, 180, 170, 195, 194, 206 and 209) in SRM2262 (NIST, Gaithersburg, MD) were summed to provide estimates of ΣPCB. Twenty four PAH congeners (SRM2260, NIST) ranging from naphthalene to benzo[ghi]perylene were summed for ΣPAH. Single point calibrations of the GC-ECNI-MS were used to estimate concentrations of chlordanes and PCBs. A 3 point calibration curve for PAHs was established using GC-EI-MS.

2.6 Quality Assurance/Quality Control

To ensure data of the highest quality, a comprehensive, performance based QA/QC plan was instituted and implemented for both ELISA and GC methods. These provisions included analysis of negative (blanks) and positive controls (matrix spikes), daily calibration of analytical instrumentation and the analysis of duplicate samples for precision. Unique project identifiers were assigned and sample jars/containers labeled with waterproof ink. When not in use, soil samples were kept cool ($\leq 4°C$) and in the dark.

2.6.1 ELISA

To verify the performance of each Toxaphene in Soil Test Kit, a positive and negative control were analyzed with each batch of 14 samples. The negative control consisted of methanol whereas the positive control consisted of methanol spiked with ~5 μg technical toxaphene dissolved in acetone. Preliminary attempts to analyze positive controls spiked with technical toxaphene in hexane resulted in unsatisfactory response. In addition, a reference soil sample from Skidaway Island (GA) and a spiked version of this soil were analyzed. Calibration of each test kit was performed using the 0.5, 2 and 10ppm calibrator standard solutions. Calibration curves were prepared for each test kit run. Exponential equations were fitted to the 3 calibration points using nonlinear regression. These equations were used to estimate ELISA-based toxaphene concentrations.

2.6.1.1 Positive Control

Positive controls consisting of Toxaphene in Soil Test Kit test tubes spiked with ~5 μg/ml TTX in methanol. All four positive controls prepared in this fashion exhibited concentrations in the correct (i.e. $2<x<10$ ppm) toxaphene concentration range (Table 4).

Table 4. ELISA results for positive control samples (TTX-spiked methanol).

Date	Absorption	conc. range [ppm]	conc. calc. [ppm]
4/17/2002, b	0.3344	2 < x < 10	7.04
4/18/2002, a	0.3386	2 < x < 10	6.49
4/18/2002, b	0.4807	2 < x < 10	6.44
5/14/2002, a	0.4667	2 < x < 10	3.21

2.6.1.2 Negative Control (Blank)

Negative controls consisting of pure methanol were required to confirm the correct use of the Test Kit. In practical terms, the presence of a dark yellow color corresponds to an absorption reading that is higher than the lowest calibrator solution (0.5 ppm). Consistently higher absorption for the 5 negative controls analyzed in this study indicates little or no interfering contamination was present (Table 5).

Table 5. Absorption for negative controls (NC) and 0.5 ppm calibrator solution.

Date	Absorption NC	Absorption 0.5ppm
4/13/02	1.3561	0.9835
4/15/02	1.5001	1.1053
4/17/02, a	1.1717	0.8415
4/17/02, b	1.4071	1.0156
5/14/02, a	1.1392	0.7876

2.6.1.3 Test Kit Calibration

Calibration of the spectrophotometer was performed in accordance with vendor instructions using 3 calibrator standard solutions -- 0.5, 2.0 and 10 ppm. As confirmed by vendor technical personnel, calibration curves were not linear (Fig. 13). Therefore, the test kit is only capable for semiquantitative concentration estimation. The absorption intensity may vary by kit but the nonlinear trend in each calibration curve is consistent. As a result, we performed nonlinear regression to generate exponential relationships between ELISA response and toxaphene concentration. These exponential equations were then used to estimate ELISA-based quantitative toxaphene concentrations.

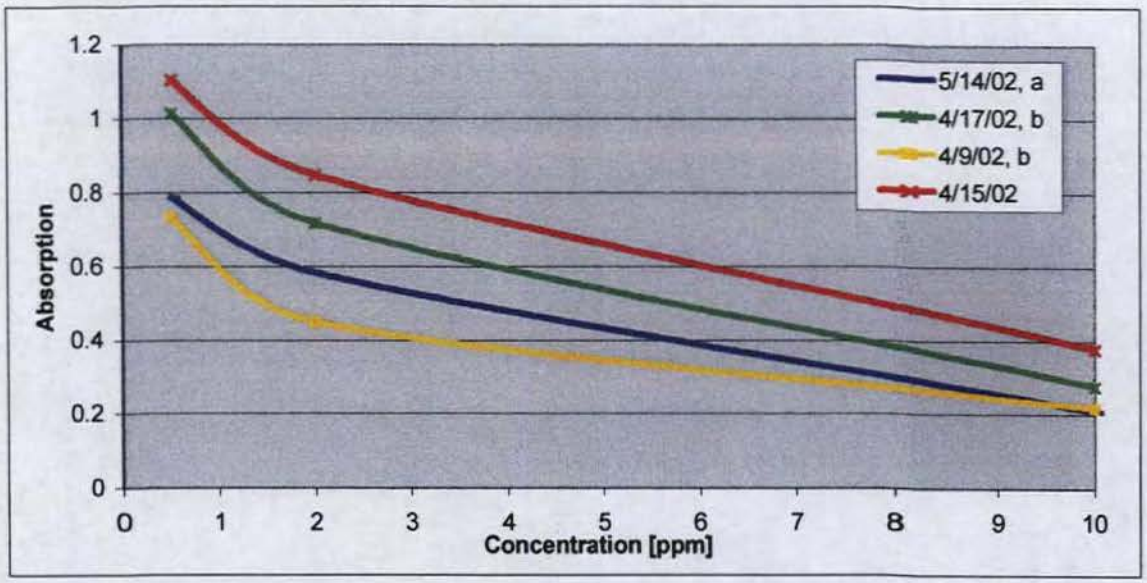


Figure 13. Nonlinear calibration curves for ELISA (Toxaphene in Soil Test Kit).

2.6.1.4 Spiked Reference Soil

Topsoil from a grass-covered field near SkIO on Skidaway Island (GA) was spiked with TTX dissolved in acetone or methanol. Nominal soil TTX concentrations after spiking were 0.1, 1 and 10 ppm. Spiked soils were allowed to age for 13h at room temperature prior to testing. Higher than expected ELISA responses and estimated concentrations were found (Table 6). In each case, the increasing trend in spiked toxaphene samples was detected by ELISA. The higher than expected concentrations could have been due to interfering contaminants present in Skidaway soil.

Table 6. ELISA results of spiked reference (Skidaway Island) soil.

Sample ID	Absorption	Spike [ppm]	conc. range [ppm]	conc. Calc. [ppm]
#1	0.7016	0.1	0.5 < x < 2	1.28
#2	0.5355	1.0	2 < x < 10	2.59
#3	0.2538	10.0	x > 10	10.22
#4	0.6582	0.1	0.5 < x < 2	1.57
#5	0.5015	1.0	2 < x < 10	2.95
#6	0.2312	10.0	x > 10	17.94

2.6.2 GAS CHROMATOGRAPHY

Calibration of the GC-ECD using solutions of TTX was highly linear ($R^2 > 0.99$), as was the calibration curve for PAH based on GC-EI-MS response. The recovery of technical toxaphene spiked into Skidaway reference soil was 95%. The mean recovery of recovery surrogates DBOFB and α-HCH was 66±22% (n=36).

2.6.2.1 BLANK

A procedural blank consisting of pre-extracted Hydromatrix and Ottawa sand was processed and analyzed for all target analytes with each batch of 15-20 soil samples. No target analyte was detected at greater than 10 ng/g (=ppb) in any blank.

2.6.2.2 GC CALIBRATION

The GC-ECD and GC-ECNI-MS were calibrated with serial dilutions of standards in hexane for the different compound classes: technical toxaphene (TTX) (Fig. 14); 22 component toxaphene congener mixture (TM2) (Fig. 15), 7 component chlordane mixture (SRM2261, PST A, B and C) (Fig. 16); 24 component PAH mixture (SRM2260) (Fig. 17), and a 28 component PCB mixture (SRM2262) that included the 15 congeners used to estimated ΣPCB. Because TTX contains several hundred individual components that are not resolved on a single GC column (Fig. 14), the GC-ECD calibration is based on the total mass of toxaphene as represented by the sum of peak areas in the ECD chromatogram (Fig. 18). The GC-ECD detection limit for technical toxaphene using this approach is ~0.01 μg/g.

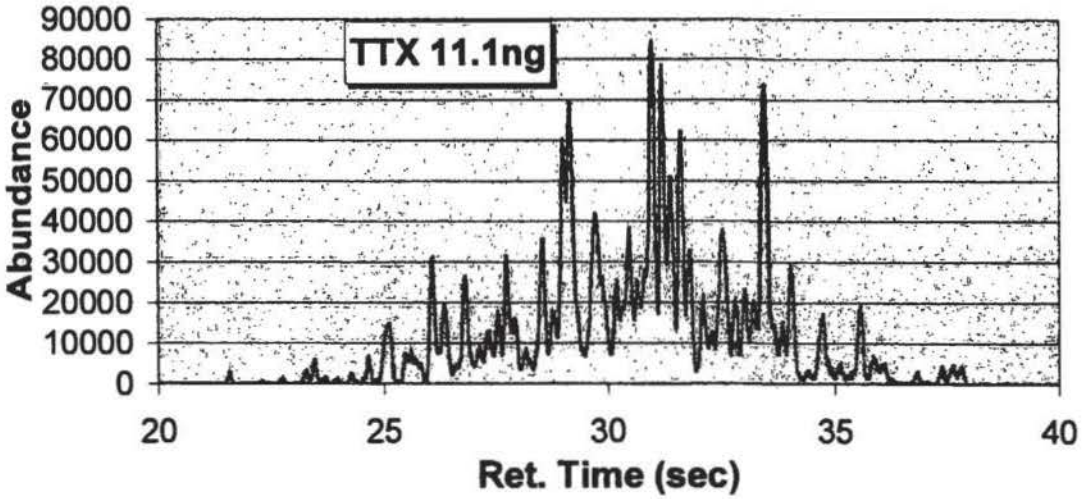


Figure 14. GC-ECNI-MS chromatogram of technical toxaphene.

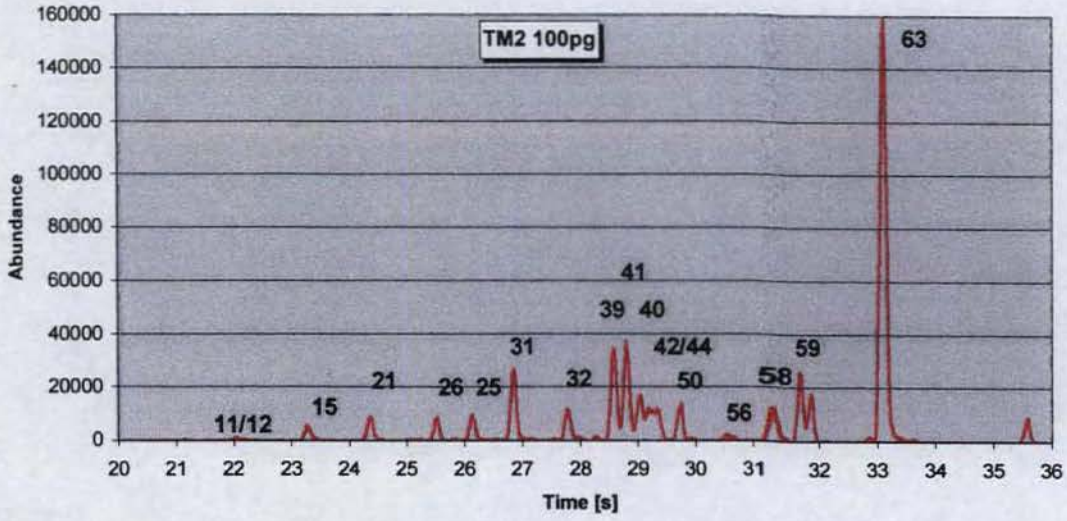


Figure 15. Twenty two component standard mixture of toxaphene congeners (100pg each congener, TM2, Dr. Ehrenstorfer, Augsburg, Germany). Peak numbers are defined by Dr. H. Parlar (TU Munich, Germany).

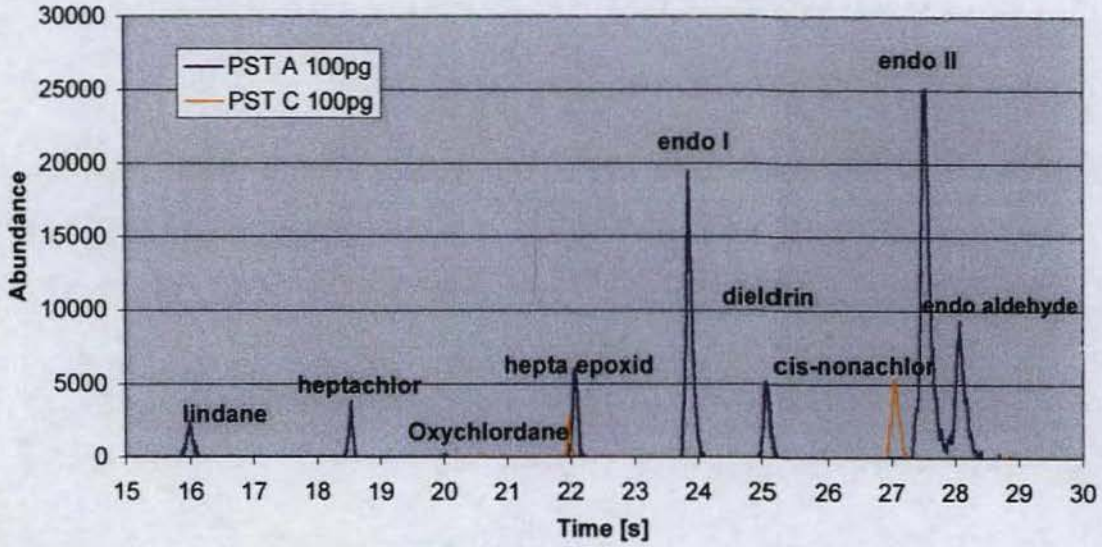


Figure 16. Custom organochlorine pesticide standard mixture containing 4 chlordane components (100pg each component; PST A and PST C).

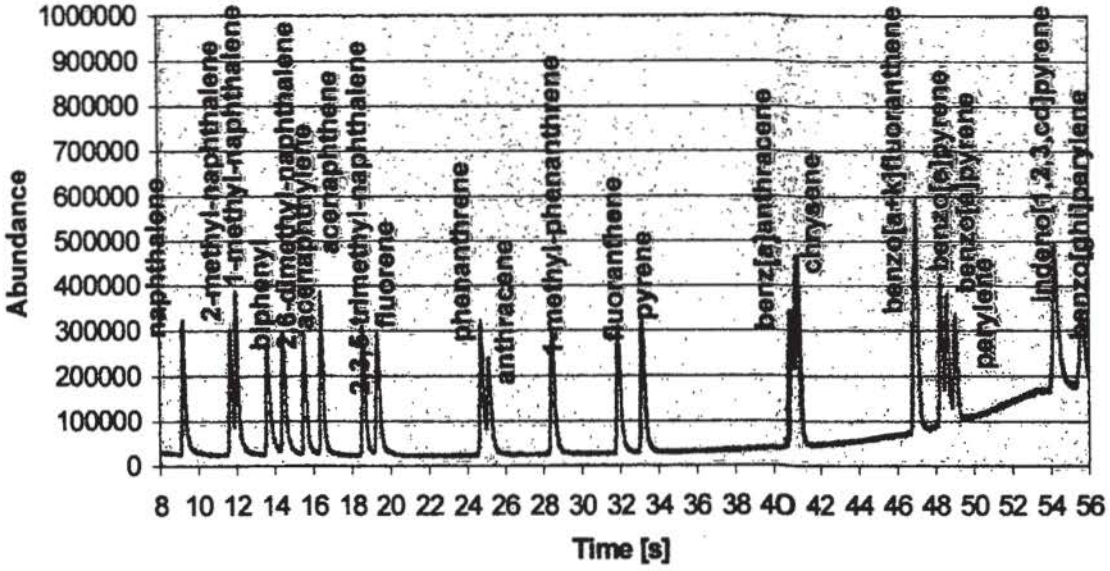


Figure 17. Twenty four component PAH standard mixture (1.9 ng each congener, SRM2260, NIST, Gaithersburg, MD).

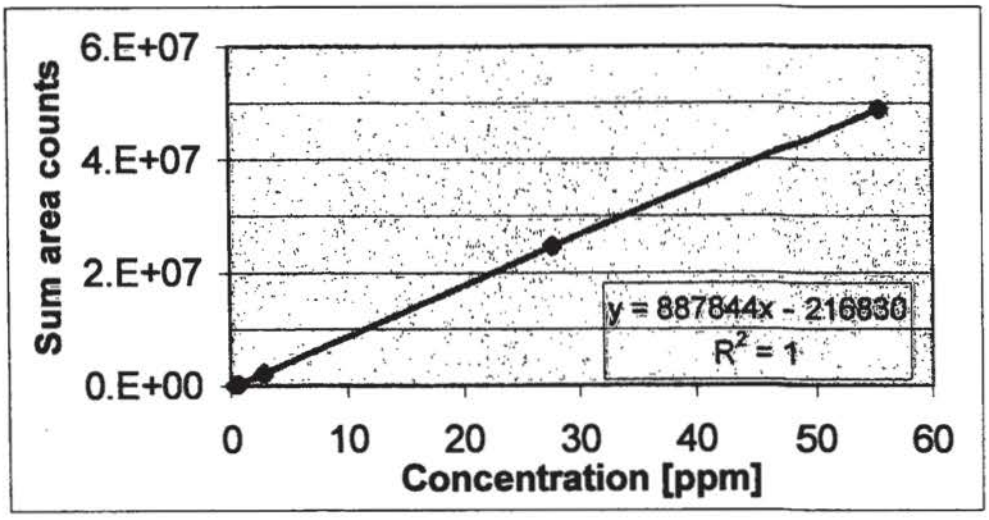


Figure 18. GC-ECD calibration curve based on technical toxaphene (TTX).

2.6.2.3 SPIKED REFERENCE SOIL

The recovery of TTX spiked into Skidaway Island reference soil at ~5 µg/g was 95%. This sample was allowed to equilibrate for 16h at room temperature before it was processed and analyzed using the same protocols as was used for Brunswick soil samples.

2.7 DATA AND STATISTICAL ANALYSES

All instrument calibration and sample concentration data were compiled and analyzed using Microsoft Excel 97 SR-1 spreadsheet software. Statistical evaluation of the data using analysis of variance (ANOVA) and t-tests were performed using the data analysis tool in Excel. GC and ELISA calibration curves were generated using the linear and nonlinear regression tools in Excel, respectively.

3. RESULTS

3.1 ELISA

3.1.1 GOODYEAR ELEMENTARY SCHOOL (GYES)

ELISA results by grid for GYES are summarized in Table 7 and shown in Fig. 6.

Table 7. ELISA results by sampling grid for Goodyear Elementary School soils.

Grid Number	Toxaphene Concentration Range (µg/g)
1	x < 0.5
2	x < 0.5
3	2 < x < 10
4	2 < x < 10
5	2 < x < 10
6	2 < x < 10
7	2 < x < 10
8 (rep. 1)	0.5 < x < 2
8 (rep. 2)	0.5 < x < 2
9	0.5 < x < 2
10	2 < x < 10
11-12 (rep. 1)	2 < x < 10
11-12 (rep. 2)	2 < x < 10
13	2 < x < 10
15	0.5 < x < 2
16 (rep. 1)	x > 10
16 (rep. 2)	x > 10
17	2 < x < 10
18-19	2 < x < 10
20-27	2 < x < 10
22 (rep. 1)	x < 0.5
22 (rep. 2)	0.5 < x < 2
23	2 < x < 10
23	0.5 < x < 2
24	2 < x < 10
25-26	2 < x < 10
29-30 (rep. 1)	x < 0.5
29-30 (rep. 2)	x < 0.5
35-28	2 < x < 10
36-37 (rep. 1)	x < 0.5
36-37 (rep. 2)	x < 0.5
38	0.5 < x < 2
39-40-41 (rep. 1)	x < 0.5
39-40-41 (rep. 2)	x < 0.5
42	2 < x < 10

3.1.2 RISLEY MIDDLE SCHOOL (RMS)

ELISA results by grid for RMS are summarized in Table 8 and shown in Fig. 8.

Table 8. ELISA results by sampling grid for Risley Middle soils.

Grid Number	Toxaphene Concentration Range (µg/g)
1	0.5 < x < 2
2	2 < x < 10
3-4	0.5 < x < 2
5	x < 0.5
6	2 < x < 10
7	x < 0.5
8	2 < x < 10
9	x < 0.5
10	2 < x < 10
11-21	0.5 < x < 2
15-25	0.5 < x < 2
16-26	x < 0.5
17 (rep. 1)	0.5 < x < 2
17 (rep. 2)	2 < x < 10
18	0.5 < x < 2
19	2 < x < 10
20	2 < x < 10
27 (rep. 1)	0.5 < x < 2
27 (rep. 2)	0.5 < x < 2
28	x < 0.5
28	0.5 < x < 2
29 (rep. 1)	x < 0.5
29 (rep. 2)	x < 0.5
30	0.5 < x < 2
31-32	0.5 < x < 2
33-34	0.5 < x < 2
35	2 < x < 10
36	0.5 < x < 2
37 (rep. 1)	0.5 < x < 2
37 (rep. 2)	0.5 < x < 2
38 (rep. 1)	0.5 < x < 2
38 (rep. 2)	0.5 < x < 2
39	0.5 < x < 2
40 (rep. 1)	0.5 < x < 2
40 (rep. 2)	0.5 < x < 2

3.1.3 BURROUGHS-MOLETTE ELEMENTARY SCHOOL (BMES)

ELISA results by grid for BMES are summarized in Table 9 and shown in Fig. 7.

Table 9. ELISA results by sampling grid for Burroughs-Molette Elementary School soils.

Grid Number	Toxaphene Concentration Range (µg/g)
1	x < 0.5
2	0.5 < x < 2
3	x < 0.5
4	x < 0.5
5	x < 0.5
6	x < 0.5
7	x < 0.5
8	x < 0.5
9	x < 0.5
10	x < 0.5
11 (rep. 1)	x < 0.5
11 (rep. 2)	0.5 < x < 2
12	x < 0.5
13	x < 0.5
14	x < 0.5
15 (rep. 1)	x < 0.5
15 (rep. 2)	x < 0.5
16	x < 0.5
17	x < 0.5
18	x < 0.5
19	x < 0.5
20	0.5 < x < 2
21	0.5 < x < 2
22	x < 0.5
23	x < 0.5
24	x < 0.5
25	0.5 < x < 2
26	x < 0.5
27	x < 0.5

3.1.4 EDO MILLER/LANIER FIELD, RECREATION AREA (EM/LF)

ELISA results by grid for EM/LF are summarized in Table 10 and shown in Fig. 9.

Table 10. ELISA results by sampling grid for Edo Miller/Lanier Field Recreational Area soils.

Grid Number	Toxaphene Concentration Range (µg/g)
1-1a-6a	0.5 < x < 2
2a-3a-4a	0.5 < x < 2
6-13-13a	0.5 < x < 2
7-14	0.5 < x < 2
11-18	x < 0.5
20-21	0.5 < x < 2
22-23	0.5 < x < 2
24-25	0.5 < x < 2
26-27	0.5 < x < 2
28-29	0.5 < x < 2
30-37-37a	0.5 < x < 2
35-36 (rep. 1)	x < 0.5
35-36 (rep. 2)	x < 0.5

3.1.5 SUMMARY

Based on ELISA results, soils from Goodyear ES contained the most toxaphene (Table 11, Fig. 19). More than 50% of samples from GYES were classified in the moderately contaminated (2.0<x<10 ppm) range. A single sample (GYES16) was classified in the highly contaminated (x>10 ppm) range. Soils from Risley MS ranked second, with 25% classified as moderately contaminated. In contrast, soils from Burroughs-Molette ES and Edo Miller/Lanier Field Recreational Area were similarly low in organochlorine contamination, with greater than 80% classified as having low concentrations (0.5>x >2.0 ppm) and the remainder having undetectable (x<0.5 ppm) levels. In cases where duplicate ELISA data indicated different toxaphene concentration ranges for the same soil sample, the sample was placed in the higher concentration range (Tables 7-10).

Table 11. Classification and sample percentages of toxaphene concentration ranges in study site soils.

Access areas	x < 0.5 [ppm]	0.5 < x < 2 [ppm]	2 < x < 10 [ppm]	x > 10 [ppm]
Burrough-Molette ES	14.8%	85.2%	0.0%	0.0%
Goodyear ES	22.2%	18.5%	55.6%	3.7%
Risley Middle School	21.4%	53.6%	25.0%	0.0%
Edo Miller/Lanier Field RA	16.7%	83.3%	0.0%	0.0%

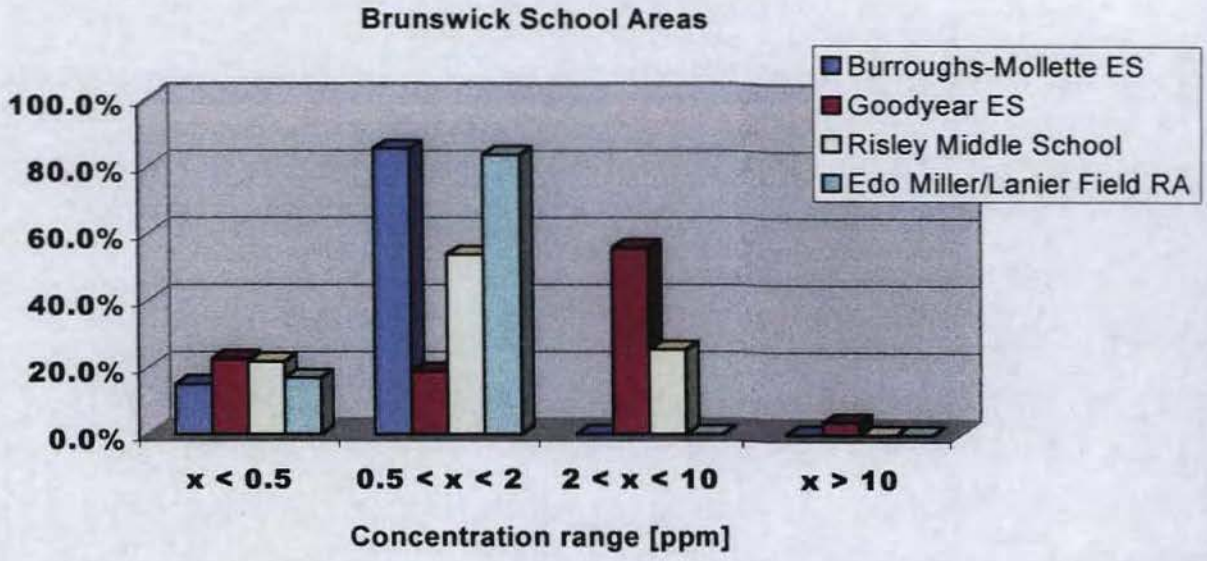


Figure 19. Percent distribution of ELISA toxaphene concentration ranges.

3.2 Gas Chromatography

3.2.1 Trace Organic Contaminant Concentrations

Total toxaphene (ΣTOX) concentrations in the 36 samples analyzed by GC ranged from <0.01 to 0.38 μg/g (Table 12). Ten of 36 (28%) samples had detectable levels of toxaphene, with a mean ΣTOX of 0.11±0.11 μg/g. In contrast, all 36 samples had detectable levels of PAH and chlordane, and 35 of 36 had detectable levels of PCBs. The mean Σchlordane (31.3±128 ng/g) was roughly 2-fold higher than the mean ΣPCB (14±13 ng/g). More importantly, mean Σchlordane exceeded the ELISA MDL (17.9 ng/g, Table 3). Soil from Goodyear ES grid no. 16 ("GY16") contained 795 ng/g chlordane, a level that was 10-fold higher than the next highest chlordane concentration (GY18-19). The maximum ΣPCB was 63.9 ng/g (EMF1-1a-6a). Mean ΣPAH was the highest of the 4 trace organic classes reported herein (1.19±3.79 μg/g) with a single sample (GY10) containing 3 times as much as the next highest sample. Interestingly, the mean toxaphene concentration as predicted by ELISA nonlinear concentration-response curves (1.4±1.4 μg/g) was more than 10-fold higher than that estimated by GC.

3.2.2 Toxaphene Concentrations and Congener Distributions

Detailed toxaphene congener analyses were not performed as part of this study. However, GC-ECNI-MS analysis of the soil sample with the highest ΣTOX (EMF7-14) revealed that Cl_8 bornanes in the 22-component TM2 standard mixture (Parlar nos. 41, 40, 42 and 44; Fig. 15) were prominent. Of the samples containing detectable levels of toxaphene, roughly 50% were from EM/LF and the remainder from BMES. Interestingly, none of the samples from GYES had detectable levels of toxaphene (Fig. 20).

Table 12. ELISA and GC-based concentrations of toxaphene and other trace organic contaminants. [1]

Sample	ELISA conc. range [µg/g]	ELISA conc. calc.[2] [µg/g]	Σ PAH [µg/g]	Σ PCB [ng/g]	ΣChlordane [ng/g]	ΣToxaphene [µg/g]
GY39-41	x < 0.5	-0.5	0.23	0.14	1.31	<0.01
BM17	x < 0.5	-0.3	0.01	3.04	0.19	0.02
BM24	x < 0.5	-0.2	0.01	23.20	1.80	0.03
BM26	x < 0.5	-0.2	<0.01	33.94	2.20	0.03
BM13	x < 0.5	-0.2	0.64	0.00	1.55	<0.01
EMF11-18	x < 0.5	-0.1	<0.01	12.96	3.85	<0.01
GY36-37	x < 0.5	0.0	0.84	26.65	2.15	<0.01
BM4	x < 0.5	0.1	0.07	6.37	0.16	<0.01
RIS7	x < 0.5	0.4	0.12	11.43	0.69	0.03
BM25	0.5 < x < 2	0.5	0.02	17.37	1.15	<0.01
BM21	0.5 < x < 2	0.6	0.01	11.47	0.94	<0.01
BM2	0.5 < x < 2	0.6	0.17	32.47	1.32	<0.01
RIS40	0.5 < x < 2	0.8	0.12	3.36	0.39	<0.01
EMF24-25 (Rep.1)	0.5 < x < 2	0.8	<0.01	2.80	5.66	<0.01
EMF1-1a-6a	0.5 < x < 2	0.8	0.21	63.91	14.47	0.19
EMF24-25 (Rep. 2)	0.5 < x < 2	0.8	<0.01	1.44	4.75	<0.01
EMF28-29	0.5 < x < 2	0.8	0.01	31.15	1.53	<0.01
EMF22-23	0.5 < x < 2	1.0	0.01	32.38	10.50	0.07
BM20 (Rep.1)	0.5 < x < 2	1.1	0.02	12.80	7.46	0.19
BM20 (Rep.2)	0.5 < x < 2	1.1	0.02	12.80	3.10	0.17
EMF30-37	0.5 < x < 2	1.4	0.08	20.50	9.64	0.04
GY23	0.5 < x < 2	1.4	0.24	2.38	10.38	<0.01
RIS31-32	0.5 < x < 2	1.4	2.49	16.21	4.60	<0.01
EMF2a-3a-4a	0.5 < x < 2	1.4	0.02	5.38	11.54	0.05
EMF7-14	0.5 < x < 2	1.9	0.01	19.93	54.88	0.38
RIS35	2 < x < 10	2.1	7.30	18.16	9.34	<0.01
GY3	2 < x < 10	2.1	0.15	0.82	10.17	<0.01
RIS6	2 < x < 10	2.2	0.72	12.74	2.54	<0.01
GY6	2 < x < 10	2.2	0.07	18.54	0.74	<0.01
RIS10	2 < x < 10	2.9	0.05	13.98	5.06	<0.01
GY24	2 < x < 10	3.0	0.59	1.32	22.72	<0.01
GY23	2 < x < 10	3.6	0.24	2.38	10.38	<0.01
GY18-19	2 < x < 10	3.9	1.20	1.03	78.72	<0.01
RIS2	2 < x < 10	4.0	0.61	18.10	1.99	<0.01
GY10	2 < x < 10	4.0	21.68	2.19	19.95	<0.01
GY20-27	2 < x < 10	4.9	1.80	2.78	45.75	<0.01
GY16 (Rep.1)	x > 10	10.0	0.25	0.37	794.66	<0.01
GY16 (Rep.2)	x > 10	10.0	0.34			<0.01

1 Ranked in ascending order of toxaphene concentration as determined by ELISA.

2 Calculated ELISA toxaphene concentration based on model equations of the form: $y=y_0+a*\exp(-b*x)$.

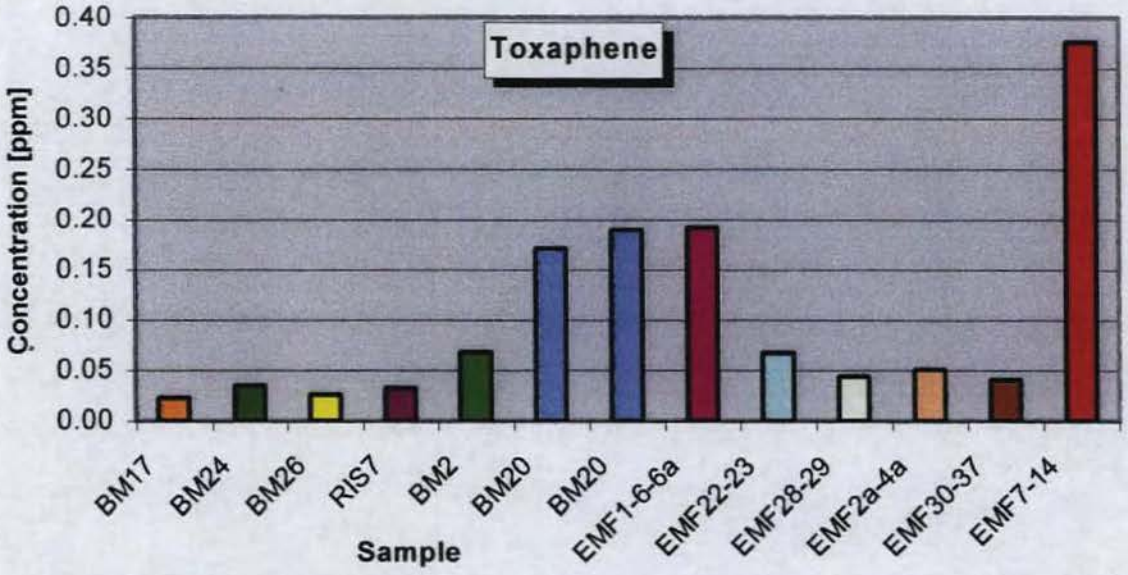


Figure 20. GC-based ΣTOX estimates (μg/g) in Brunswick public access area soils.

3.2.3 Chlordane Concentrations and Congener Distributions

Chlordane concentrations were highest in GYES soils, followed by soils from EM/LF. In fact, the 11 highest ranked samples in terms of Σchlordane were from these 2 areas (Fig. 21). Congener distributions were dominated by 3 compounds -- γ- and α-chlordane and *trans*-nonachlor (see also Appendix A). The dominance of γ- and α-chlordane is clear in GC-ECNI-MS confirmatory chromatograms (Fig. 22).

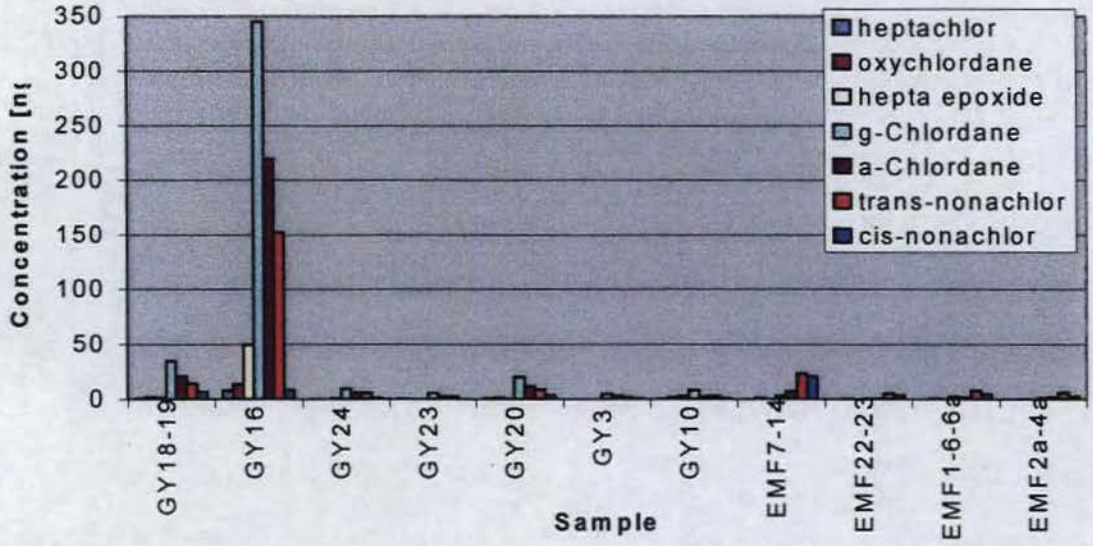


Figure 21. Chlordane concentration by component for the 11 soil samples with the highest Σchlordane (i.e. > 10 ng/g).

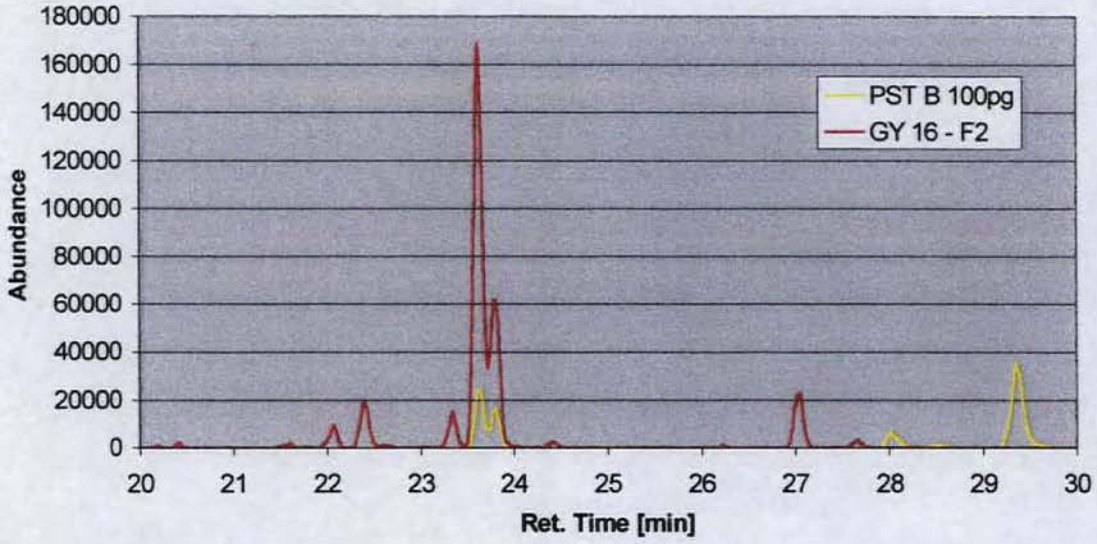


Figure 22. GC-ECNI-MS chromatogram of GY16 soil overlain by a pesticide standard mixture containing γ- and α-chlordane, eluting between 23 and 24 min.

3.2.4 PAH Concentrations and Congener Distributions

PAH concentrations were highest in GYES soils, followed by soils from Risley MS. The highest sample (GY10, 21.7 μg/g) was 3-fold higher than the next highest sample (RMS35, 7.30 μg/g). High molecular weight PAH, i.e. those with 4 or more fused rings, dominated the congener distribution in the majority of samples with the 4 ring isomers fluoranthene and pyrene having the greatest abundance (Fig. 23). The predominance of high MW PAH is consistent with PAH "soot", originating from sources such as combustion engine exhaust and/or highly weathered petroleum.

3.2.5 PCB Concentrations and Congener Distributions

PCB concentrations were highest in EM/LF and BMES soils. GC-ECNI-MS analysis of EMF1-6-6a confirms the presence of highly chlorinated congeners (e.g. IUPAC nos. 118, 153, 105, 138, 187, 180, 194, 206 and 209 (Fig. 24). The dominance of PCB-138, a hexachlorinated congener, suggests that a technical mixture with ~50% chlorine (e.g. Aroclor 1248 or 1254) is the primary source of soil-associated PCBs. Detection of PCB-206 and -209 also indicates the presence of Aroclor 1268 throughout the area (Fig. 25).

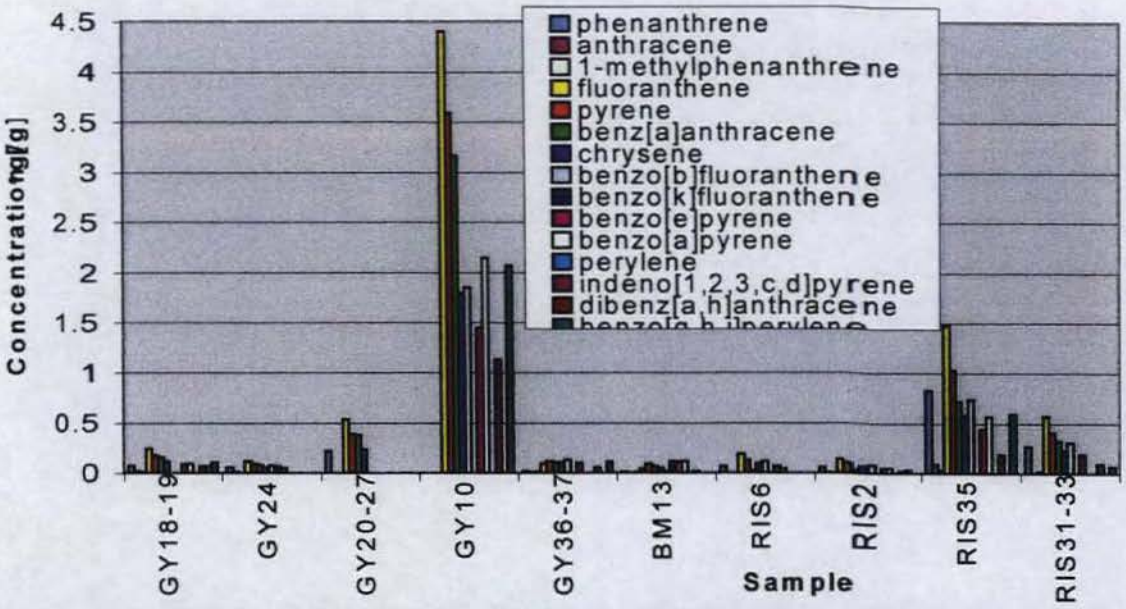


Figure 23. PAH congener concentrations and distributions for soil samples with ΣPAH > 0.5 μg/g.

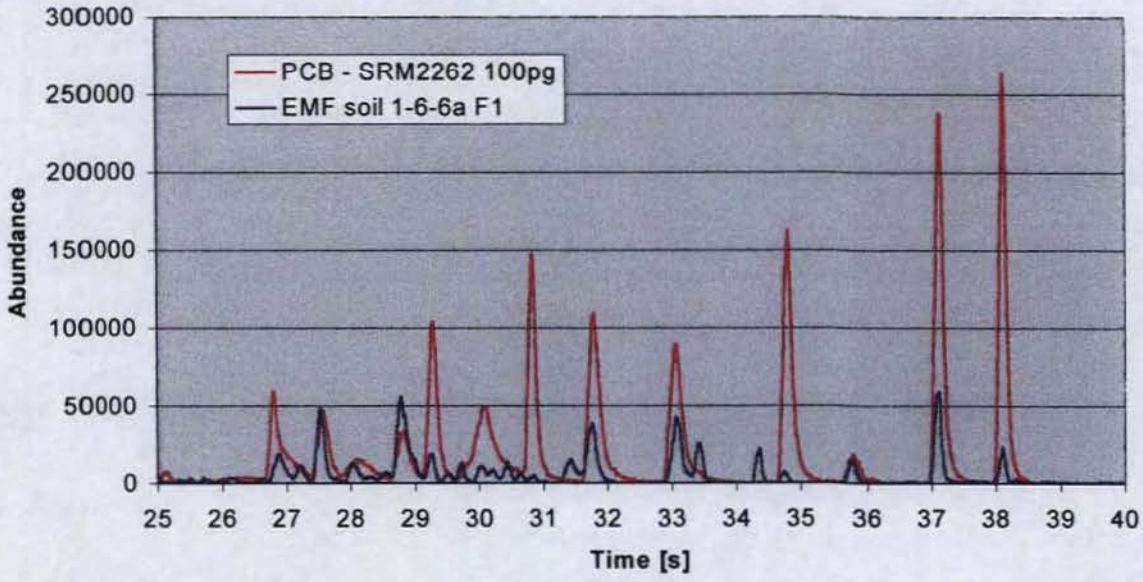


Figure 24. GC-ECNI-MS chromatogram of soil sample EMF1-6-6a overlain with that of a PCB congener standard mixture (SRM2262, NIST).

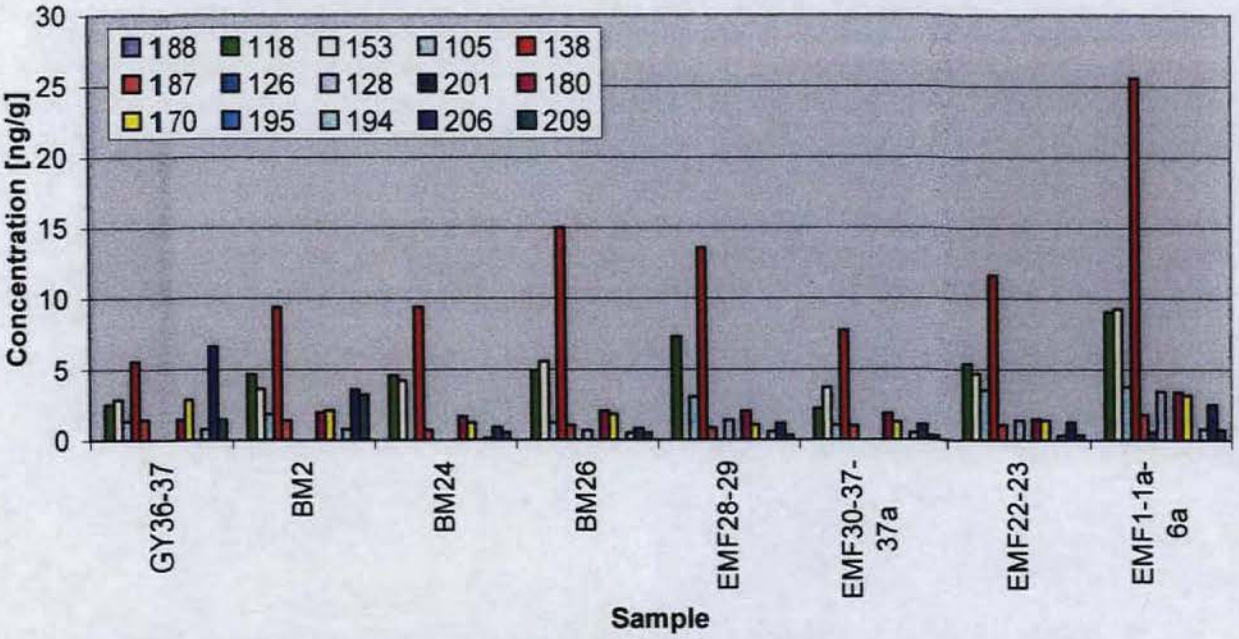


Figure 25. PCB congener concentrations and distributions for soil samples with ΣPCB > 20 ng/g.

3.3 Linear Regression – ELISA vs. GC Results

Linear regression analyses were performed to investigate relationships between soil toxaphene concentrations as predicted by ELISA ("ELISA-TOX") and the total concentrations of the 4 classes of organic contaminants as measured by GC. ΣChlordane was strongly correlated with ELISA-TOX, accounting for 57% of the total variation in this relationship (Table 13; R^2=0.57; p<<0.001). Based on a smaller sample size (n=10), the association between GC- and ELISA-based ΣTOX was also significant (R^2=0.47; p<0.5). Neither ΣPAH nor ΣPCB were significantly correlated with ELISA results.

Table 13. Strength of correlation between ELISA-TOX and GC-based estimates of ΣTOX, Σchlordane, ΣPAH and ΣPCB.

Relationship	N	R Square	P value
ELISA-TOX. vs. ΣChlordane	35	0.5742	8.7E-08
ELISA-TOX. vs. ΣToxaphene	10	0.4716	0.0196
ELISA-TOX. vs. ΣPCB	35	0.0903	0.0750
ELISA-TOX. vs. ΣPAH	36	0.0323	0.2870

4. SUMMARY AND CONCLUSIONS

Of the 94 surface soil samples collected and analyzed for toxaphene residues by ELISA, a single sample from Goodyear ES ("GY16") was classified as highly contaminated (> 10 ppm). Toxaphene residues were not detected in this sample using GC-ECD and GC-ECNI-MS, which did indicate that chlordanes were by far the predominant class of organochlorine contaminants. Furthermore, the estimated concentration of chlordane-related compounds in this sample (795 ng/g) far exceeded the interference threshold (17.9 ng/g) as published by the ELISA kit manufacturer. Of the 36 samples analyzed by GC, 75% (27 of 36) were classified by ELISA as containing detectable levels of toxaphene (> 0.5 ppm) and 33% (12 of 36) classified as containing greater than 2 ppm. However, GC analyses indicated only 27% (10 of 36) of these samples contained detectable levels of toxaphene residues (> 0.01 μg/g) and none contained greater than 0.5 ppm.

Other classes of organic contaminants were present, including PAHs and PCBs, with isolated samples containing relatively high levels (>1 ppm). Correlational analyses between ELISA-based ΣTOX and the GC-determined concentrations of toxaphene, PAH, PCB and chlordane indicated, however, that chlordane concentrations best explained the trend in ELISA results. Although ELISA and GC-based estimates of toxaphene residue concentrations were significantly correlated, the difference in the magnitude of ELISA-based toxaphene levels was 10-fold or higher. Thus, we conclude that chlordane, and possibly other unknown/uncharacterized substances in the soil interfered with the ELISA Test Kit, resulting in erroneously high predictions of toxaphene contamination.

The maximum GC-based ΣTOX of 0.38 ppm also suggests little or no risk due to toxaphene residues in surface (0-3 inches) soils from these public access areas. Human health risks associated with topsoils in areas with elevated trace organic contamination should be evaluated on a case-by-case basis. This may include areas represented by grids no. 16 (Σchlordane = 795 ppb) and 10 (ΣPAH = 22 ppm) at Goodyear ES.

Although not measured in this study, soil moisture, texture and composition (i.e. percent water, grain size and total organic carbon) is known to greatly influence the ability of a soil to retain (hydrophobic) organic contaminants such as toxaphene. Clearly, "soils" of large mean grain size and low TOC/water content, such as the hard-packed sands found at many locations during the study, have low potential for retaining environmentally relevant levels of the target analytes. In future studies, prioritization for testing soil contamination should be given to areas with fine-grained, high TOC soils.

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7. APPENDIX A

7.1 PAH Congener GC Concentrations (µg/g)

Sample ID Congener	GY18-19 Csamp [ppm]	GY16 Rep. 1 [ppm]	GY16 Rep. 2 [ppm]	GY24 Csamp [ppm]	GY23 Csamp [ppm]	GY20-27 Csamp [ppm]	GY3 Csamp [ppm]	GY39-41 Csamp [ppm]	GY6 Csamp [ppm]
naphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
2-methylnaphthalene	nd	nd	nd	nd	nd	0.010	nd	nd	nd
1-methylnaphthalene	nd	nd	nd	nd	nd	0.0049	nd	nd	nd
biphenyl	nd	nd	nd	0.0005	nd	nd	nd	nd	nd
2,6-dimethylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthene	nd	nd	nd	0.0024	nd	0.0071	nd	nd	nd
2,3,5-trimethylnaphthalene*	nd	nd	nd	nd	nd	nd	nd	nd	nd
fluorene	nd	nd	nd	0.0019	nd	0.0087	nd	nd	nd
phenanthrene	0.072	0.0078	0.040	0.056	0.020	0.22	0.0092	0.016	nd
anthracene	0.013	nd	0.0021	0.0089	0.0010	nd	nd	0.0025	nd
1-methylphenanthrene	0.0091	nd	0.024	nd	nd	nd	nd	0.0024	nd
fluoranthene	0.24	0.037	0.093	0.12	0.053	0.54	0.032	0.046	0.011
pyrene	0.172	0.023	0.059	0.089	0.037	0.39	0.024	0.043	0.011
benz[a]anthracene	0.16	0.052	0.048	0.078	0.035	0.38	0.022	0.039	0.0074
chrysene	0.12	0.040	0.039	0.052	0.027	0.24	nd	0.028	0.012
benzo[b]fluoranthene	nd	0.030	nd	0.075	0.016	nd	0.024	0.048	0.015
benzo[k]fluoranthene	nd	0.026	nd	0.065	0.021	nd	0.021	nd	nd
benzo[e]pyrene	0.086	0.017	0.031	0.046	0.026	nd	0.015	nd	0.010
benzo[a]pyrene	0.096	nd	nd	nd	nd	nd	nd	nd	nd
perylene	nd	nd	nd	nd	nd	nd	nd	nd	nd
indeno[1,2,3,c,d]pyrene	0.064	0.0090	nd	nd	nd	nd	nd	nd	0.0048
dibenz[a,h]anthracene	0.063	nd	nd	nd	nd	nd	nd	nd	nd
benzo[g,h,i]perylene	0.11	0.011	nd	nd	nd	nd	nd	nd	0.0026
Σ PAH	1.2	0.25	0.34	0.59	0.24	1.8	0.15	0.23	0.074

Sample ID Congener	GY10 Csamp [ppm]	GY36-37 Csamp [ppm]	BM20 Rep. 1 [ppm]	BM20 Rep. 2 [ppm]	BM2 Csamp [ppm]	BM4 Csamp [ppm]	BM13 Csamp [ppm]	BM17 Csamp [ppm]	BM21 Csamp [ppm]
naphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
2-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
1-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
biphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd
2,6-dimethylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthene	nd	nd	nd	nd	nd	nd	nd	nd	nd
2,3,5-trimethylnaphthalene*	nd	nd	nd	nd	nd	nd	nd	nd	nd
fluorene	0.075	nd	nd	nd	nd	nd	nd	nd	nd
anthracene	nd	0.002	nd	nd	nd	nd	nd	nd	nd
1-methylphenanthrene	nd	0.007	nd	nd	nd	nd	0.004	nd	nd
fluoranthene	4.4	0.094	0.003	0.001	0.031	0.019	0.044	0.002	0.004
pyrene	3.6	0.12	0.002	0.005	0.035	0.015	0.096	0.002	nd
benz[a]anthracene	3.2	0.10	nd	nd	nd	0.005	0.067	nd	nd
chrysene	1.8	0.10	0.001	0.002	0.016	0.009	0.047	0.001	0.001
benzo[b]fluoranthene	1.8	0.13	0.003	0.005	0.051	0.006	0.006	0.007	0.003
benzo[k]fluoranthene	nd	nd	0.003	nd	nd	0.007	0.12	nd	0.004
benzo[e]pyrene	1.4	0.099	0.003	0.003	0.033	0.012	0.11	nd	nd
benzo[a]pyrene	2.1	nd	nd	0.001	nd	nd	0.12	nd	nd
perylene	nd	nd	nd	nd	nd	nd	nd	nd	nd
indeno[1,2,3,c,d]pyrene	1.1	0.055	nd	nd	nd	nd	0.016	nd	nd
dibenz[a,h]anthracene	nd	nd	nd	nd	nd	nd	nd	nd	nd
benzo[g,h,i]perylene	2.1	0.11	0.002	nd	nd	nd	nd	nd	nd
Σ PAH	22	0.84	0.018	0.017	0.17	0.072	0.64	0.012	0.012

Sample ID Congener	BM24 Csamp [ppm]	BM26 Csamp [ppm]	BM25 Csamp [ppm]	RIS10 Csamp [ppm]	RIS6 Csamp [ppm]	RIS2 Csamp [ppm]	RIS7 Csamp [ppm]	RIS35 Csamp [ppm]	RIS40 Csamp [ppm]	RIS31-33 Csamp [ppm]
naphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
biphenyl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2,6-dimethylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2,3,5-trimethylnaphthalene*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
fluorene	nd	nd	nd	nd	0.001	nd	nd	nd	nd	nd
phenanthrene	nd	nd	nd	0.013	0.063	0.051	0.005	0.83	0.012	0.27
anthracene	nd	nd	nd	nd	nd	0.004	nd	0.093	nd	nd
1-methylphenanthrene	nd	nd	nd	nd	nd	0.001	0.004	0.032	0.002	0.018
fluoranthene	0.002	0.004	0.015	0.015	0.19	0.14	0.030	1.48	0.031	0.58
pyrene	0.003	nd	0.004	0.021	0.13	0.10	0.024	1.031	0.028	0.41
benz[a]anthracene	nd	nd	nd	nd	0.022	0.028	0.009	0.72	0.008	0.33
chrysene	nd	0.001	0.003	nd	0.092	0.069	0.019	0.58	0.013	0.23
benzo[b]fluoranthene	0.001	nd	0.003	nd	0.12	0.081	0.010	0.74	0.009	0.31
benzo[k]fluoranthene	nd	nd	nd	nd	nd	nd	0.008	nd	0.008	nd
benzo[e]pyrene	nd	nd	nd	nd	0.065	0.047	0.012	0.44	0.006	0.19
benzo[a]pyrene	nd	nd	nd	nd	0.045	0.045	nd	0.57	nd	nd
perylene	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
indeno[1,2,3,c,d]pyrene	nd	nd	nd	nd	nd	0.017	nd	0.19	nd	0.092
dibenz[a,h]anthracene	nd	nd	nd	nd	nd	0.030	nd	nd	nd	nd
benzo[g,h,i]perylene	nd	nd	nd	nd	nd	nd	nd	0.60	nd	0.067
Σ PAH	0.006	0.005	0.024	0.049	0.72	0.61	0.12	7.3	0.12	2.5

Sample ID Congener	EMF28-29 Csamp [ppm]	EMF30-37-37a Csamp [ppm]	EMF7-14 Csamp [ppm]	EMF11-18 Csamp [ppm]	EMF22-23 Csamp [ppm]	EMF1-1a-6a Csamp [ppm]	EMF2a-3a-4a Csamp [ppm]	EMF24-25 Csamp [ppm]
naphthalene	nd	nd	nd	nd	nd	nd	nd	nd
2-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd
1-methylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd
biphenyl	nd	nd	nd	nd	nd	nd	nd	nd
2,6-dimethylnaphthalene	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthylene	nd	nd	nd	nd	nd	nd	nd	nd
acenaphthene	nd	nd	nd	nd	nd	nd	nd	nd
2,3,5-trimethylnaphthalene*	nd	nd	nd	nd	nd	nd	nd	nd
fluorene	nd	nd	nd	nd	nd	nd	nd	nd
phenanthrene	nd	nd	nd	nd	nd	nd	nd	nd
anthracene	nd	nd	nd	0.001	nd	0.002	nd	nd
1-methylphenanthrene	0.002	nd	nd	nd	nd	0.001	nd	nd
fluoranthene	0.003	nd	0.006	nd	0.003	0.059	0.016	nd
pyrene	0.004	0.015	nd	nd	0.007	0.052	0.003	nd
benz[a]anthracene	nd	nd	nd	nd	nd	0.022	nd	nd
chrysene	nd	0.017	0.001	0.002	0.001	0.010	0.001	nd
benzo[b]fluoranthene	nd	0.051	nd	nd	nd	0.043	0.002	nd
benzo[k]fluoranthene	nd	nd	nd	nd	nd	nd	nd	nd
benzo[e]pyrene	nd	nd	nd	nd	nd	0.009	nd	nd
benzo[a]pyrene	nd	nd	nd	nd	nd	nd	0.001	nd
perylene	nd	nd	nd	nd	nd	nd	nd	nd
indeno[1,2,3,c,d]pyrene	nd	0.001	nd	nd	nd	0.007	nd	nd
dibenz[a,h]anthracene	nd	nd	nd	nd	nd	nd	nd	nd
benzo[g,h,i]perylene	nd	nd	nd	nd	nd	0.003	nd	nd
Σ PAH	0.009	0.084	0.007	0.003	0.011	0.21	0.024	<0.001

7.2 PCB Congener GC Concentrations (ng/g)

Sample ID Congener	GY18-19 Csamp [ppb]	GY16 Rep. 1 [ppb]	GY16 Rep. 2 [ppb]	GY24 Csamp [ppb]	GY23 Csamp [ppb]	GY20-27 Csamp [ppb]	GY3 Csamp [ppb]	GY39-41 Csamp [ppb]	GY6 Csamp [ppb]	GY10 Csamp [ppb]	GY36-37 Csamp [ppb]
188	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
118	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.5
153	nd	nd	nd	0.034	0.081	0.27	nd	nd	0.81	nd	2.8
105	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1.3
138	nd	nd	nd	0.035	nd	nd	nd	nd	1.1	nd	5.6
187	nd	nd	nd	nd	0.083	0.31	nd	nd	1.5	0.084	1.4
126	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
128	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
201	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.19	nd
180	nd	nd	nd	nd	nd	nd	nd	nd	1.1	nd	1.4
170	nd	0.045	nd	0.39	0.50	0.68	0.084	nd	3.1	0.42	2.9
195	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
194	nd	nd	nd	nd	nd	nd	nd	nd	0.85	nd	0.74
206	0.69	0.32	nd	0.51	1.4	0.86	0.65	0.14	7.8	1.2	6.6

Sample ID Congener	BM20 Rep. 1 [ppb]	BM20 Rep. 2 [ppb]	BM2 Csamp [ppb]	BM4 Csamp [ppb]	BM13 Csamp [ppb]	BM17 Csamp [ppb]	BM21 Csamp [ppb]	BM24 Csamp [ppb]	BM26 Csamp [ppb]	BM25 Csamp [ppb]	RIS10 Csamp [ppb]
188	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
118	nd	nd	4.7	0.30	nd	nd	1.8	4.6	4.9	1.3	nd
153	2.3	nd	3.6	0.90	nd	0.39	2.0	4.2	5.6	3.5	0.71
105	nd	nd	1.8	nd	nd	nd	nd	nd	1.2	nd	nd
138	6.0	nd	9.4	0.87	nd	0.88	4.9	9.4	15	8.4	0.82
187	0.59	nd	1.4	0.27	nd	0.11	0.30	0.71	1.0	0.57	1.0
126	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
128	nd	nd	nd	nd	nd	nd	0.31	nd	0.66	nd	nd
201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
180	1.1	nd	1.9	0.50	nd	0.14	0.74	1.7	2.0	1.5	0.74
170	nd	nd	2.1	0.38	nd	0.071	0.45	1.2	1.8	0.54	1.4
195	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
194	0.19	nd	0.76	nd	nd	0.097	nd	0.11	0.46	0.26	0.81
206	1.3	nd	3.6	1.5	nd	0.83	0.68	0.87	0.78	0.75	6.3
209	1.314	nd	3.2	1.7	nd	0.52	0.34	0.50	0.48	0.57	2.2
Σ PCB	13	<0.001	32	6.4	<0.001	3.0	11	23	34	17	14

Sample ID	RIS6	RIS2	RIS7	RIS35	RIS40	RIS31-33	EMF28-29	EMF30-37-37a	EMF7-14	EMF11-18
Congener	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]
188	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
118	0.91	3.3	nd	nd	nd	0.35	7.2	2.2	0.93	2.1
153	1.8	2.6	0.29	1.1	nd	1.3	nd	3.7	3.7	1.8
105	nd	nd	nd	nd	nd	nd	3.0	1.0	nd	0.58
138	3.4	7.0	0.55	0.87	nd	3.1	14	7.7	8.6	3.6
187	0.69	0.74	1.0	1.5	0.26	1.3	0.81	0.96	1.1	0.66
126	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
128	nd	nd	nd	nd	nd	nd	1.4	nd	0.63	nd
201	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
180	0.75	0.88	0.26	1.3	nd	1.1	2.1	1.9	1.6	1.0
170	1.4	1.4	1.4	3.0	0.31	2.4	1.0	1.2	1.7	0.92
195	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
194	0.38	nd	0.40	1.0	nd	1.0	0.58	0.50	0.34	0.26
206	2.7	1.8	5.6	7.2	2.3	5.2	1.1	1.1	1.3	1.6
209	0.67	0.38	1.8	2.2	0.45	0.44	0.28	0.28	0.21	0.41
Σ PCB	13	18	11	18.	3.4	16	31	20.	20	13

Sample ID	EMF22-23	EMF1-1a-6a	EMF2a-3a-4a	EMF24-25	EMF24-25
Congener	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Rep. 1 [ppb]	Rep. 2 [ppb]
188	nd	nd	nd	nd	nd
118	5.4	9.0	0.48	nd	nd
153	4.7	9.2	0.94	0.11	0.41
105	3.5	3.8	nd	nd	nd
138	12	26	1.5	0.37	1.3
187	1.0	1.8	0.34	nd	0.20
126	nd	0.50	nd	nd	nd
128	1.3	3.5	nd	nd	nd
201	nd	nd	nd	nd	nd
180	1.5	3.4	0.51	0.26	0.24
170	1.4	3.2	0.30	0.18	0.22
195	nd	nd	nd	nd	nd
194	0.28	0.77	nd	nd	nd
206	1.3	2.5	1.0	0.42	0.43
209	0.35	0.72	0.32	0.10	0.039
Σ PCB	32	64	5.4	1.4	2.8

7.3 Chlordane Congener GC Concentrations (ng/g)

Sample ID	GY18-19	GY16	GY24	GY23	GY20	GY3	GY39-41	GY6	GY10	GY36-37	BM20	BM20
Congener	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Rep. 1 [ppb]	Rep. 2 [ppb]
heptachlor	0.59	7.56	0.249	0.304	0.388	nd	nd	nd	0.177	nd	nd	nd
oxychlordane	1.48	13.6	nd	nd	0.998	nd	nd	nd	1.99	nd	0.414	nd
hepta epoxide	1.33	49.1	0.455	nd	0.264	nd	nd	nd	2.89	nd	nd	nd
g-Chlordane	34.1	345	9.16	5.34	20.0	4.51	0.841	0.308	8.34	1.08	0.524	0.360
a-Chlordane	20.6	219	5.62	2.52	11.7	2.97	0.343	nd	2.52	nd	0.450	0.295
trans-nonachlor	14.2	152	5.88	2.22	8.78	1.97	0.123	0.431	2.84	0.758	1.87	1.04
cis-nonachlor	6.38	8.06	1.36	nd	3.64	0.719	nd	nd	1.20	0.311	4.20	1.41
Σ chlordane	78.7	795	22.7	10.4	45.7	10.2	1.31	0.740	19.9	2.15	7.46	3.10

Sample ID	BM2	BM4	BM13	BM17	BM21	BM24	BM26	BM25	RIS10	RIS6	RIS2	RIS7	RIS35	RIS40
Congener	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	[ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]
heptachlor	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.306	nd
oxychlordane	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.746	nd
hepta epoxide	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.02	nd	nd	0.469	nd
g-Chlordane	0.160	0.163	0.565	nd	0.525	1.25	0.438	0.176	2.39	0.349	0.730	0.694	3.11	0.385
a-Chlordane	nd	nd	nd	nd	nd	0.174	0.220	nd	0.679	nd	0.295	nd	0.698	nd
trans-nonachlor	0.564	nd	0.631	0.194	0.420	nd	0.862	0.264	1.27	0.174	0.722	nd	2.42	nd
cis-nonachlor	0.598	nd	0.354	nd	nd	0.389	0.680	0.706	0.719	nd	0.242	nd	1.59	nd
Σ chlordane	1.32	0.16	1.55	0.194	0.94	1.81	2.20	1.15	5.06	2.54	1.99	0.69	9.34	0.38

Sample ID	EMF28-29	EMF30-37	EMF7-14	EMF11-18	EMF22-23	EMF1-6-6a	EMF2a-4a	EMF24-25	EMF24-25
Congener	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	[ppb]	Csamp [ppb]	Csamp [ppb]	Csamp [ppb]	Rep. 1 [ppb]	Rep. 2 [ppb]
heptachlor	nd	nd	nd	nd	nd	nd	nd	nd	nd
oxychlordane	nd	0.490	1.46	0.150	0.377	0.497	0.270	nd	nd
hepta epoxide	nd	nd	nd	nd	nd	nd	nd	nd	nd
g-Chlordane	0.306	0.692	3.19	0.728	0.549	nd	1.17	0.593	0.660
a-Chlordane	nd	0.704	6.94	2.11	0.649	1.84	1.50	0.462	0.550
trans-nonachlor	nd	7.37	22.7	nd	5.52	7.51	6.22	2.63	3.13
cis-nonachlor	1.22	0.387	20.6	0.868	3.40	4.63	2.39	1.07	1.32
Σ chlordane	1.53	9.64	54.9	3.85	10.5	14.5	11.5	4.75	5.66

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March 16, 2015

Via U.S. Mail and Electronic Mail

Mr. Galo Jackson
Remedial Project Manager
U.S. EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303

Re: Comments on LCP Chemicals Superfund Proposed Plan

Dear Mr. Jackson:

We submit these comments on behalf of One Hundred Miles, the Satilla Riverkeeper, and the Altamaha Riverkeeper, as well as the collective memberships of all of these organizations. How the LCP Chemical Site is remediated is of great concern to each of these partner groups. We feel there are serious shortcomings in the U.S. Environmental Protection Agencies' (EPA) Superfund Proposed Plan for operable unit 1 of the Site, as well as the underlying Remedial Investigation and Feasibility Study prepared by the potentially responsible parties.

In short, the Proposed Plan is flawed in the following ways: i) the scope of the cleanup does not encompass all the contamination from the Site, ii) portions of the Site have not been adequately sampled, iii) the exposure levels are not sufficiently protective, iv) some alternatives would allow for the capping and covering of contaminants in place despite the very volatile marsh environment; v) no alternative discusses marsh restoration; vi) none of the alternatives take into account sea level rise; vii) none of the alternatives set forth a monitoring plan; and in the event the contamination caps and covers were to fail, the Proposed Plan does not specify what action would be taken to remedy the situation.

As part of our comments we have attached expert reports from Dr. Philip B. Bedient, P.E., Ph.D. and Loren Raum, Ph.D. These reports detail many of the flaws outlined above.

Background

The marsh component of the LCP Chemicals Site is approximately 700 acres in size. It is located in the Turtle River estuary immediately outside of Brunswick, Georgia. The Site primarily consists of tidal marsh and is divided in half, north to south, by Purvis Creek. Over the past 70 years, a number of industrial facilities operated on the Site, such as Atlantic Refining Company, Georgia Power, and Honeywell International Inc., and each one significantly contributed to the contamination of the Site's soil, groundwater, and marsh sediment. This section will briefly discuss the Site's history and cleanup progression.

In 1919, the Atlantic Refining Company owned and operated an oil refinery on the Site, the first manufacturing facility on record. The Georgia Power Company purchased portions of the land from the Atlantic Refining Company in 1937, 1942, and 1950 for electric power generating. From 1941 to 1955, the Dixie Paints and Varnish Company manufactured paint and varnish on the property. The Allied Chemical and Dye Corporation subsequently purchased most of the property (including the portions owned by Georgia Power and Dixie Paints and Varnish), and operated a chlor-alkali chemical plant. The primary purpose of this facility was to produce sodium carbonate from salt, ammonia, and carbon dioxide. In 1979, Linden Chemicals and Plastics (LCP Chemicals-Georgia, Inc.) acquired the Site and continued operating it as a chlor-alkali facility. LCP Chemicals ceased production in 1994.

As a result of decades of contamination, the EPA (through its federal enforcement power) ordered the previous property owners to begin cleaning up the Site in 1994. These previous owners, or potentially responsible parties, included the Atlantic Richfield Company, Georgia Power, and Honeywell. The following year, the state of Georgia designated the Site as its highest priority release, and requested that EPA add it to the National Priorities List. The National Priorities List is "a list of the most serious sites identified for possible long-term cleanup," and is based on the site's potential release of hazardous substances or contaminates.[1] LCP Chemicals was officially added to the EPA National Priorities List in 1996. Subsequently, from 1998-1999, EPA conducted its own removal action, removing over 200,000 tons of hazardous material and removing and

[1] U.S. Environmental Protection Agency, "Superfund Cleanup Process," *available at* http://www.epa.gov/superfund/cleanup/index.htm, (last visited Mar. 5, 2015).

restoring approximately 13 acres of marsh from the Site. The EPA and the potentially responsible parties agreed to share the cost of this removal effort.

After the National Priorities List designation and the removal action, the potentially responsible parties conducted a series of investigations in order to draft a remedial investigation report and feasibility study for the LCP Chemicals marsh area. Upon review of these documents, EPA issued a Proposed Plan for cleaning up the marsh, which includes a number of alternatives based on the findings from the Feasibility Study. In the Proposed Plan, EPA selected the "preferred" cleanup alternative. The public is permitted to submit comments, like the ones in this document, relating to that preferred alternative. Once the public comment period closes and EPA revises the Proposed Plan based on the public's feedback, the agency will issue a Record of Decision, which will explain the cleanup alternative ultimately selected for the LCP Chemicals Site.

Comments

I. The potentially responsible parties have drawn the boundaries of the area that needs to be addressed by the LCP Chemical Site cleanup too narrowly.

Although the property boundaries of the marsh portion of the LCP Chemicals Site may only encompass 700 acres, the breadth of contamination is far greater. The potentially responsible parties have left a legacy of contaminants that stretches far beyond the Turtle River estuary. A recent study conducted by the Agency for Toxic Substances and Disease Registry concludes that the specific PCBs used at LCP Chemicals, Aroclor 1268, is widespread in sediments around Brunswick.[2] The study revealed, for instance, that residents from Sapelo Island have been exposed to Aroclor 1268 and have elevated levels of PCBs in their bloodstreams as a result.[3] The most likely way that the residents became exposed to the Aroclor 1268 was by eating fish and other sea food that had consumed Aroclor 1268 from the LCP Chemicals Site. Sapelo Island is over 30 miles

[2] Backer, Lorraine and David Mellard, Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations, (Powerpoint slides), Agency for Toxic Substances and Disease Registry, p. 8 (Sept. 3, 2014).
[3] *Id.* at 26.

from the LCP Chemicals Site, so it is likely residents throughout the coastal Brunswick area are impacted as well.[4]

Before this cleanup advances, the potentially responsible parties should be required to address their full contamination legacy. The fish and other seafood that is currently contaminated with LCP Chemical contaminants will continue to be caught and consumed by recreational and subsistence fishermen. Even if institutional controls are instituted on a wider scale, as the ATSDR study recommends,[5] funds should be established for cancer victims in the Brunswick area and funds should be established for local food banks to compensate subsistence fishermen that depend on seafood for their protein. In addition to these measures, the potentially responsible parties should fund the natural resource damage projects required by the Natural Resource Trustees. Unless the potentially responsible parties undertake measures such as these, they will not make the public whole for injuries that may have occurred as a result of contamination from the Site.[6]

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[4] It is well established that "the government need not trace or 'fingerprint' a defendant's wastes in order to recover under CERCLA." *United States v. Hercules, Inc.*, 247 F.3d 706, 716 (8th Cir. 2001), citing *United States v. Monsanto,* 858 F.2d 160, 169–70 (4th Cir. 1988).

[5] Backer at 26.

[6] Restoration Planning Scoping Notice, LCP Chemicals, Brunswick, Georgia (May 31, 2006).

II. The sampling on the Site is inadequate in areas such as Purvis Creek.

As Dr. Bedient commented in his expert report, the

> [s]ampling network used to delineate areas that need remediation is lacking in density and frequency. From figure 6-5 it is clear that approximately 50% of Purvis Creek has not been sampled for contaminants of concern. It is more likely than not that many of these non-sampled areas are contaminated with contaminants of concern.[7]

Without an adequate sampling network, the Site's contamination cannot be properly delineated. Before the Feasibility Study is finalized, the potentially responsible parties must complete an adequate sampling network and revise the Feasibility Study accordingly.

III. The exposure levels selected do not adequately protect human health and the environment.

In selecting remedial actions, the EPA is directed to establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following ... [f]or systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety.[8]

In performing this task for the LCP Chemical Site, the potentially responsible parties have failed to take into account site specific aspects of the Brunswick area and thus have based cleanup alternatives in the Proposed Plan on improper exposure levels.

For known or suspected carcinogens, acceptable exposure levels under the NCP are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response.[9] In other words, one additional person in 10,000 to one additional

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[7] Philip Bedient, Review of the LCP Chemicals Site, Brunswick, GA, Expert Report (Mar. 13, 2015) (Attachment A).
[8] 40 C.F.R. § 300.430(e)(2)(i).
[9] 40 C.F.R. § 300.430(e)(2)(i)(A)(2).

person in 1,000,000 will contract cancer as a result of exposure to the site. There is no requirement that a certain number of people be exposed. Rather, the NCP requirement is designed to protect an individual from an increased risk of contracting cancer as a result of exposure to hazardous substances.

A. The human health exposure levels are not protective enough.

1. The risk assessment underestimates the consumption of contaminated food.

The exposure level for human health was based in part on the number of seafood meals a subsistence fisherman would consume on a yearly basis. This number was "assumed" by the potentially responsible parties to be 40 meals per year.[10] This assumption was not based on any recent surveys of subsistence fishermen in the area.[11] Fortunately, there is a relevant study now. The ATSDR study mentioned above reveals that subsistence fishermen in the area consume up to 156 seafood meals a year—nearly four times the amount assumed by the potentially responsible parties.

Unless the potentially responsible parties take this differential into account and recalculate the exposure levels, they will be drastically underestimating the contaminants that will be consumed from the Site. In other words, subsistence fishermen have been and will continue to be exposed to more Aroclor 1268 and other contaminants from the Site than the Remedial Investigation report reveals.

The potentially responsible parties also erred in their treatment of adolescent subsidence fishermen. While it may be true that adolescent subsidence fishermen may fish less frequently than their parents, this has no bearing on how often they consume fish for supper. Most adolescents eat whatever ends up on the dinner table. Yet, the potentially responsible parties, for their risk modeling, contend that adolescent subsidence fishermen eat a full third less fish than their parents.[12] This does not square with reality and serves as another example of how the potentially responsible parties have underestimated the amount of exposure that subsidence fishermen would suffer even after the cleanup if it were done on the potentially responsible parties' terms. This is especially

[10] Proposed Plan at 16.

[11] Raun at 7.

[12] Human Health Risk Assessment for the Estuary, Operable Unit 1, Marsh Trespasser, Fish and Shellfish Consumer, Clapper Rail Consumer, Final, LCP Chemical Site, Brunswick, Georgia, Table 14a and Table 14b (Aug. 2011).

alarming considering that Site is very accessible to boats; as the Draft Feasibility Study states, boats up to 14 feet in length can access the Site using Purvis Creek.[13]

And the issue of subsistence fishing cannot be corrected by increasing fishing advisories. As other studies provide, subsistence fishermen do not pay attention to fishing advisories. "People are often aware of advisories, but continue to consume fish nonetheless (Reinert and other 1991, Burger and Gochfeld 1991, Burger and others 1992, 1993, Velicer and Knuth 1994, May and Burger 1996).[14] This is not surprising since fish "may be the main affordable source of protein."[15] And as Dr. Raun states in her expert report, "[f]ishing advisories will not keep hungry community members from eating contaminated seafood."[16]

2. The potentially responsible parties assumption that there has been a decrease in fish contamination is flawed.

The potentially responsible parties contend that the concentration of contaminants in fish has decreased, yet they offer no statistically significant evidence of this assumption. As Dr. Raun states in her expert report, the potentially responsible parties' contentions are largely overstated.[17] They are based on small sample sizes with limited statistical power, are unsophisticated, and tend toward bias.[18] Furthermore, the risk assessment does not acknowledge that a subsidence fisherman may eat more than one type of seafood, and the impact may be additive. As Dr. Raun points out in her report, "[t]his type of simplification is not protective with multiple contaminants impacting many different types of seafood."[19]

3. The potentially responsible parties did not take groundwater, surface water, and operable unit 3 into account.

The potentially responsible parties admit that contaminated groundwater is coming to the surface through seeps and mixing with surface water around the area that was

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[13] Draft Feasibility Study at 10.
[14] Burger, Joanna, et al., Science, Policy, Stakeholders, and Fish Consumption Advisories: Developing a Fish Fact Sheet for the Savannah River, 27 Environmental Management No. 4 p. 502 (2001).
[15] *Id.*
[16] Raun at 10.
[17] *Id.*
[18] *Id.* at 8-9.
[19] Raun at 8.

remediated in 1999. They contend, however, that the surface water dilutes the contamination to such an extent that it is not a factor. Dr. Raun disagrees. She views the increased levels of contamination in the formerly remediated area as evidence that whatever dilution that is taking place is not sufficient offset the groundwater contamination.[20] The potentially responsible parties must demonstrate that contaminated groundwater is not a problem at Site, or develop a plan for addressing it.

Additionally, the risk assessment does not take into account other pathways aside from fish consumption. As Dr. Raun states in her report,

> [r]isk assessment requires that all exposure pathways for a receptor be considered. . . . In other words, the risk for the high rate consumer should be added to the risk of receptors considered in the OU3 risk assessment, and RGOs developed based on the added risk. While it is acceptable to separate the contamination into operable units for management, it is not justifiable to consider the risk in an operable unit in a vacuum.[21]

For example, a subsidence fisherman could well be a trespasser on operable unit 3. The risk assessment must take into account both contaminant pathways. Similarly, the risk assessment does not take into account exposure to contaminated surface water and sediments from the Site. As Dr. Raun states in her report, "Any risk added from these other pathways would result in lower [remedial goals]."[22]

B. The ecological exposure levels are not protective enough.

In addition to using numbers that artificially reduce the exposure levels to humans, the potentially responsible parties have done the same for the environment. Starting in 2006, the Georgia Department of Natural Resources, NOAA Fisheries, and the National Ocean Service began to test bottlenose dolphin in the Brunswick area for PCB contamination. In particular they focused on Aroclor 1268.[23] As the study provides, "[b]ottlenose dolphins are ideal sentinels for coastal ecosystem health because they are top predators that are long-lived and tend to accumulate persistent environmental

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[20] Raun at 5.
[21] *Id.* at 3.
[22] *Id.*
[23] Georgia Department of Natural Resources, Bottlenose Dolphin Contaminants Project, http://www.georgiawildlife.org (last visited Feb. 26, 2015).

contaminants in their lipid-rich blubber."[24] The findings of the study reveal that the dolphins tested had concentrations of Aroclor 1268 ten times higher than any location previously documented.[25]

Even though the dolphin study was ongoing, was investigating the precise contaminant at issue at the LCP Chemical Site, and involved the "ideal sentinel for ecosystem health," the potentially responsible parties did not incorporate the data in their risk assessment. Nor did they test any dolphins themselves, even though they acknowledge that dolphins do visit the Site via Purvis Creek, the main tidal creek that connects the Site to Turtle River.[26] Instead of testing dolphins, the potentially responsible parties chose marsh rabbits, river otters, and raccoons for their ecological risk assessment.[27] The potentially responsible parties should be required to redo their ecological risk assessment so that it either incorporates existing data from the dolphin study or incorporates new data gathered by the potentially responsible parties.

The potentially responsible parties set as one of their remedial action objectives to "reduce piscivorous [fish eating] bird and mammal population exposure to [contaminants] from ingestion of prey exposed to contaminated sediment in the LCP Chemicals marsh to acceptable levels, considering spatial forage areas of the wildlife and movement of forage prey."[28] Yet the potentially responsible parties did not include the piscivorous mammal most prone to bioaccumulation in any of its analyses—the bottlenose dolphin.[29] This flaw must be corrected.

C. The exposure range selected is not acceptable.

Not only did the potentially responsible parties underestimate the amount of risk associated with exposure to the contaminants of concern, they then selected exposure levels based on the absolute lowest allowable risk factor—an additional cancer victim in every 10,000 people (1E-04).[30]

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[24] *Id.*
[25] *Id.*
[26] Draft Feasibility Study at 12.
[27] Proposed Plan at 21.
[28] Proposed Plan at 23.
[29] Draft Feasibility Study17 and 18.
[30] Proposed Plan at 24.

As the potentially responsible parties report in the draft feasibility study, "[o]nly the high-quantity fish consumer scenario has an ELCR estimate that exceeds USEPA's target risk range of 10^{-6} x to 10^{-4} and that estimate is 2 x 10^{-4}."[31] In other words the potentially responsible parties have proposed an exposure level for subsidence fishermen twice as high as EPA typically accepts. According to EPA guidance, to have a target risk of less than 1 x 10^{-4}, there must be site specific reasons that support such a departure.[32] The potentially responsible parties provide no site specific reasons that would justify such a change. Thus, not only have the potentially responsible parties underestimated the number of fish meals that subsidence fishermen eat per year, but they have compounded the problem still further by subjecting subsistence fishermen to higher exposure levels.

D. The potentially responsible parties want to leave contaminant hot spots in the marsh.

To compound the exposure level flaws still further, the potentially responsible parties also apply a concept called "surface weighted average concentration" which would, if the Proposed Plan were to go through, leave hot spots of contamination in the marsh.[33] Instead of cleaning the entire marsh up to a set level of contamination, the potentially responsible parties are proposing to leave areas of higher contamination in the marsh because they are more difficult to dredge. This is unacceptable. The potentially responsible parties should not be allowed to ignore contaminated areas because they are hard to reach.

IV. The thin layer cover approach used in Alternative 2 is inappropriate for this Site.

A. The Site is a volatile marsh environment unsuitable for a thin layer cap.

In the Superfund Proposed Plan, the U.S. Environmental Protection Agency and the Georgia Environmental Protection Division (the Agencies) provide, "[t]he Turtle River water surface elevation can vary in excess of nine ft during a tidal cycle."[34] In the Draft Feasibility Study, the potentially responsible parties acknowledge that "[t]idal

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[31] Draft Feasibility Study at 21.

[32] *Id.* at 20.

[33] Proposed Plan at 24.

[34] U.S. Environmental Protection Agency, Superfund Proposed Plan, LCP Chemicals Superfund Site, Operable Unit 1, Nov. 2014, at 3.

hydrodynamics have a significant effect on the transport of waterborne substances (e.g., suspended sediment, chemicals) within the Site." And that the 7-8 foot tide range "produces strong vertical mixing in the water column and a relatively long horizontal excursion of water."[35] The potentially responsible parties state further that "[c]urrent velocities are relatively high within the tidal creeks during flood tide."[36] Lastly, the potentially responsible parties admit that "[s]ediment erosion is likely to occur in some portions of the tidal creeks during spring tide conditions because peak current velocities are high enough . . . to exceed the critical shear stress of surface sediments . . . ."[37]

Despite the above descriptions of the Site that reveal it is a highly volatile environment, the potentially responsible parties contend that they can cover contaminants in place with a six-inch layer of sand and that it will all hold together through high tides, hurricanes, and storm surges.[38] As the EPA has stated in guidance, "[t]ypically, sand caps are used in low velocity waterways to protect them from scouring by strong (high energy)

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[35] Draft Feasibility Study at 8.

[36] *Id.* at 8.

[37] *Id.* at 9.

[38] Brunswick is no stranger to hurricanes and tropical storms as the following records document:

> 1874 Sept. 28th a hurricane from the SW stays just offshore with 80mph winds
> 1878 Sept. 12th just offshore moving north 90 mph
> 1885 Aug. 25th just offshore 105mph while moving north
> 1893 Aug. 28th a major hurricane with 115 mph winds just east kills over 2,000 in Georgia & Carolinas, reports had downtown Brunswick under 6 ft. of water for up to 12 hrs., offshore of St. Simons Island by 25-30 statute miles. . . .
> 1893 Oct. 13th just off shore while moving NNE 120 mph winds
> 1896 Sept. 29th a cat 2 110 mph passes over while moving N.E. Winds caused very heavy damage in the area.
> 1898 Oct. 2nd, 130 mph from the S.E. a hurricane leaves area under 4 ft. of water Oct. 2nd scores drowned. Winds east at 135 mph and data suggest that this Hurricane may have been the size of Hugo (1989 S Carolina). Calm reported at 11 am, Dunn and Miller reported 179 killed in coastal Georgia and 16 foot storm surge in downtown Brunswick. . . .
> 1928 Sept 18th from the south just inland with 90 mph winds
> 1968 tropical storm Abby 60 mph minor damage
> 1979 Sept 4th David to east by 30 miles with 85 mph winds minor damage.
> 1981 tropical storm Dennis to east with 50mph winds minor damage
> 1984 tropical storm Isadore passed over the area from the south west with 45mph minor damage.

Glynn County, Brunswick, Georgia's history with tropical systems, http://www.hurricanecity.com/city/brunswick.htm (last visited Feb. 27, 2015).

currents.[39] As mentioned above, the potentially responsible parties admit that there will be erosion along tidal creeks on the Site. As one study involving a Georgia marsh reported, roughly 10 to 25% of the marsh surface is occupied by creek banks and tall S. alterniflora zones.[40] With tidal creeks occupying so much surface area in Georgia marshes, there is plenty of opportunity for extensive scouring on the LCP Chemical Site.

Furthermore, as Dr. Bedient provides in this comments, the Site conditions simply are not suitable to a thin layer cap.[41] As he states,

> Placing a cap or thin sand cover on top to the contaminated sediment in the marsh would not prevent such erosion/scour given the volatile nature of the tidal regime and water level fluctuations during storm events (see Figure B3-15 from the Feasibility Report June 2014), especially since there is no tie-in into the existing marsh sediment so as to completely contain the contaminated sediment from being able to migrate.[42]

In short, the LCP marshes are no place for a thin layer cap.

Nonetheless, to support their choice of a thin layer placement approach, the potentially responsible parties include in the Draft Feasibility Study eight case studies of other remediations that have used this cover-in-place method; however, not one the projects combined 6 inch sand cover, a marsh environment, and a 9 foot tide. Furthermore, some of the projects were totally dissimilar and involved putting the thin cover on the floor of the rivers, inlets, or harbors.[43]

The remediation performed at one of the case studies, Bremerton Naval Complex, for example, involved thin-cover placement on the bottom of Sinclair Inlet offshore from a naval shipyard.[44] And the effectiveness of the project is still being evaluated.[45] Another

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[39] EPA, Contaminated Site Cleanup Information, http://clu-in.org/contaminantfocus/default.focus/sec/sediments/cat/Remediation/p/1 (last visited Feb. 22, 2015).
[40] Gribsholt, Britta, et al. Impact of fiddler crabs and plant roots on sediment biogeochemistry in a Georgia saltmarsh, 259 Mar. Ecol. Prog. Ser. 248 (Sept 12, 2003).
[41] Bedient at 4.
[42] *Id.*
[43] Draft Feasibility Study at 53.
[44] Merritt, K. et al., Enhanced Monitored Natural Recovery (EMNR) Case Studies Review, Technical Report 1983, p. 16, (May 2009).
[45] *See*, USGS, Sources of Mercury in Sinclair Inlet, http://wa.water.usgs.gov/projects/sinclair (last visited Feb. 24, 2015).

case study, Grasse River, involved the placement of a 12-inch cap on the bottom of a freshwater river.[46] A third involved another subaquaeous cap in Eagle Harbor in Pugent Sound.[47] A fourth involved a 9-12 inch thick cap placed at the bottom of the Lower Duwamish Waterway, in Washington. And a fifth involved the placement of a cap at a depth of 120 feet in Ward Cove in Alaska. This cap was placed over sediments that were already within human health and environment limits.[48]

The remaining case studies involved thin layer caps that were placed on tidal flats, but none involved the volatile marsh environment contemplated here. In short, the thin-cover placement technology is still in its infancy when it comes to the marsh environment. The eight case studies the potentially responsible parties have offered up are all too dissimilar from the LCP Chemicals Site to offer much comfort that a thin layer cap will perform adequately at the Site. As Dr. Bedient commented in his expert report, "[t]he experience that these concepts may have at other sites is not relevant to this site if the other sites do not have the kind of tidal regime and flood/hurricane conditions that exist at this site."[49]

If there are projects in which the thin layer cap approach has been used successfully in a marsh environment, the potentially responsible parties should be required to document these successes in the final feasibility study and discuss how those successes demonstrate that a thin layer cap could work in the volatile LCP Chemical environment. While the potentially responsible parties are correct when they say "[t]hin-cover placement is a readily implementable technology, *particularly in low-energy areas not subject to scour or erosion . . .*,"[50] with its 9 foot tide range, the Site cannot be considered "low energy."

B. The integrity of the thin layer cap will be compromised by bioturbation.

While the potentially responsible parties acknowledge that the thin cover cap will have holes poked in it by marsh organisms that will come to inhabit it, they do not consider that a problem. The potentially responsible parties contend that most of the organisms that would perform such work would be confined to the top 4 inches of the

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[46] Merritt at 26.
[47] *Id.* at 3.
[48] *Id.* at 7.
[49] Bedient at 5.
[50] Draft Feasibility Study at 54.

cover.[51] Yet, the potentially responsible parties state earlier in the Draft Feasibility Study that "fiddler crabs are ubiquitous in salt marshes."[52] One study reported that as many as 500 fiddler crabs can inhabit a square meter of marsh.[53]

Because of their numbers, "fiddler crabs are one of the principal agents of bioturbation in interlude salt marshes."[54] And fiddler crabs burrow far more deeply than 4 inches. The burrows typically range up to 10 inches in depth.[55] As the EPA has stated in guidance, "[t]he cap has to be at least as thick as the large populations of burrowing benthic organisms to keep them from becoming contaminated."[56] Thus, fiddler crabs on the LCP Chemical Site would regularly penetrate the 6 inch cap. As Dr. Bedient states in his report: "6 inches of sand is not sufficient to prevent sediment dwelling organisms from borrowing into and through the sand so as to expose the contaminated sediment to erosion."[57] In light of this bioturbation, the six-inch thin cap is unsuitable for this remediation.

C. The potentially responsible parties ignore sea level rise.

If the sea level rises at the rates estimated, 1-2 feet over the next 100 years,[58] the entire LCP Chemical marsh could be drowned out and replaced with mudflats. Although the potentially responsible parties contend that the Site is a "net depositional zone" because the marsh grass acts to slow the velocity of the tidal waters,[59] they need to evaluate if that were the case if the marsh grass were no longer present. Because the Draft Feasibility Study only explores the current conditions of the marsh and fails to include any discussion of how those conditions will likely change over time, it is inadequate and fails to discuss a long-term solution.

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[51] *Id.* at 52.
[52] *Id.* at 11.
[53] Gribsholt at 238.
[54] McCraith, Barbara J., et al., The effect of fiddler crab burrowing on sediment mixing and radionuclide profiles along a topographic gradient in a southeastern marsh, 61 Journal of Marine Research, 359, 359 (2003).
[55] Gribsholt at 238.
[56] EPA, Contaminated Site Cleanup Information, http://clu-in.org/contaminantfocus/default.focus/sec/sediments/cat/Remediation/p/1 (last visited Feb. 22, 2015).
[57] Bedient at 4.
[58] *Id.* at 4.
[59] Draft Feasibility Study at 8.

D. Summary of flaws with thin cap technology.

Dr. Bedient summed up his analysis of the thin layer cap application in the following:

The proposed cap will probably fail for [the] reasons listed below:

- Destruction of capping/cover material by scouring due to tidal action.
- Destruction of capping/cover material by hurricane type storms.
- Destruction of capping/cover material by changing hydraulic conditions due to sea-level rise.
- Destruction of capping/cover material by changing environmental conditions typically associated with meandering creeks within delta systems.
- Destruction of capping/cover material by sediment dwelling organisms.
- Lateral movement of contaminants within the subsurface sediment has not been addressed.[60]

In short, thin-cover placement is not an implementable technology for the LCP Chemicals Site and should not be used.

VI. The Draft Feasibility Study is incomplete because it does not include any alternatives that incorporate marsh restoration.

The potentially responsible parties admit that 700 acres of the marsh are contaminated to a level that would in certain circumstances trigger a cleanup of all 700 acres.[61] But then the potentially responsible parties explain that such a cleanup at this Site is not practical because it would cause "unwarranted harm" to the marsh.[62] Even the cleanup of 81 acres of the marsh was deemed so excessive that it was not even considered in the alternative cleanup approaches.[63] What is conspicuously lacking from this discussion is mention of any form of marsh restoration.

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[60] Bedient at 7.
[61] Proposed Plan at 24.
[62] *Id.*
[63] Proposed Plan at 25.

In their analysis, the potentially responsible parties simply assume that if they were to dredge areas of the marsh that they would have to be left in that state with perhaps some minimal backfilling. By failing to discuss what would be involved in restoring any dredged areas with adequate sediment replacement and replanting, the potentially responsible parties have failed to complete an adequate Draft Feasibility Study. This failure is particularly conspicuous considering that during the removal action on the Site, the EPA demonstrated that it could successfully dredge contaminated sediments from the marsh, backfill the dredged area, and replant the marsh. The EPA performed this restoration on the 13 most highly contaminated acres of the marsh.[64] The Draft Feasibility Study and the Proposed Plan are completely devoid of any explanation as to why the potentially responsible parties could not do what EPA has done, dredge, backfill, and restore the marsh.

From the description of the 13-acre marsh restoration that was conducted in 1998-99, the restoration was highly successful. As the Draft Feasibility Study reports, "[w]ithin two years after remediation, *Spartina* filled the remediated area of the Site . . . . After three to four years, the area was virtually indistinguishable from the surrounding marsh . . . ."[65] The Draft Feasibility Study goes on to state that "[t]hese site-specific restoration time frames are consistent with other observations noted for created salt marsh sites."[66]

As the potentially responsible parties acknowledge, the "removal of sediment by dredging or excavation has been demonstrated at numerous sites" and is a "mature" technology,[67] and the "industry and the region have substantial experience" with this form of remediation.[68] The industry is also developing experience in how to regrow marshes. In addition to the marsh that was regrown on Site, there are numerous successful marsh restoration projects across the country.[69] The potentially responsible parties should be required to explain in the Draft Feasibility Study why it did not incorporate marsh restoration into the alternatives it outlined.

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[64] *Id.* at 6.
[65] Draft Feasibility Study at 14; Raun at 10.
[66] *Id.* at 14.
[67] *Id.* at 63.
[68] *Id.* at 63.
[69] See, e.g., Florida Department of Environmental Protection, Project Greenshores, http://www.dep.state.fl.us/northwest/Ecosys/section/greenshores.htm (last visited Feb. 27, 2015).

Such analysis is particularly important considering that the potentially responsible parties rely so heavily on the concept that thin cover placement is better than dredging and backfilling the Site because a thin cover cap would have fewer short-term impacts on the marsh. But in reaching this conclusion, the potentially responsible parties are making an apples to oranges comparison. They should be comparing the thin layer cap to a dredged, backfilled, and *replanted* marsh. Because the Draft Feasibility Study does not include such a comparison, it is incomplete.

VIII. The Proposed Plan and the Draft Feasibility Study provide for inadequate information on monitoring.

As Dr. Bedient provides in his expert report, considering the nature of the thin layer cap and its vulnerability to hurricanes, tides, and storm surges, the Proposed Plan and Draft Feasibility Study should include more detailed information on monitoring.[70] For example, other thin layer cap sites have instituted monitoring plans that operate on a two-year interval.[71] Will the potentially responsible parties adopt such an interval or not? Furthermore, there is no discussion in the Draft Feasibility Study or the Proposed Plan that explains what course or courses of action will take place in the event one or more elements of the remediation were to fail. By failing to include such details, the EPA and the potentially responsible parties have denied the public its right to comment.

IX. The cap-in-place alternatives should be discarded because they do not provide a permanent solution.

The National Contingency Plan provides as follows:

> (E) Each remedial action shall utilize *permanent* solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.[72]

Because the LCP Chemicals Site is so volatile, is subject to sea level rise, and is subject to bioturbation, it is unlikely that the thin layer caps will survive long-term.[73] Thus, it should not be considered for the LCP Chemical Site.

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[70] Bedient at 5.
[71] *See e.g.,* Merritt at 6.
[72] 40 C.F.R. §300.430 (f)(1)(ii)(E) (emphasis added).
[73] Bedient at 6.

The EPA was faced with a very similar situation to the one here involving a contaminated river in Wisconsin. One alternative involved the removal of sediment from the bottom of the river. Another involved capping that sediment in place. Even though the sediment removal option was more expensive, the EPA opted for the more permanent solution. The Seventh Circuit Court of Appeals, which eventually heard an appeal on the case, reported on the district court decision as follows:

> The district court concluded that the agencies' decision to maintain a preference for dredging in the amended remedy was rationally related to the facts before them. In particular, the court noted that dredging represents a more permanent solution because it actually removes PCBs from the Site, while capping and sand covering merely contain PCB-contaminated sediment. Moreover, capping and sand covering require long-term monitoring to ensure their effectiveness, and they are susceptible to failure during catastrophic events like floods. Ultimately, the district court concluded that the agencies acted rationally by adopting "a mild preference for the benefits of dredging and viewed these as being worth their added expense." We agree.[74]

Thus, the EPA's decision to go with the more expensive permanent solution was upheld. Similarly, if EPA were to adopt a similar course in this case, that decision too would be upheld. As this same district court explained

> Specifically, it provides that "the court shall uphold the President's decision in selecting the response action unless the objecting party can demonstrate, on the administrative record, that the decision was arbitrary and capricious or otherwise not in accordance with law." This means that the government's selected response action is presumed valid unless the Defendants can meet their burden to demonstrate otherwise.[75]

The court went on to explain that "the Defendants [had] an uphill battle: no matter how one spins it, they were demanding that more poisonous chemicals be allowed to *stay* in the River."[76] Likewise, if any of the potentially responsible parties were to challenge an EPA decision to abandon the thin layer cap approach, they would have to argue for leaving contaminants in the marsh.

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[74] *United States v. P.H. Glatfelter Co.*, 768 F.3d 662, 670 (7th Cir. 2014), *reh'g denied* (Nov. 19, 2014).
[75] *United States v. NCR Corp.*, 911 F. Supp. 2d 767, 773 (E.D. Wis. 2012) *aff'd sub nom. United States v. P.H. Glatfelter Co.*, 768 F.3d 662 (7th Cir. 2014) (citations omitted).
[76] *Id.* at 786.

There is no requirement in the NCP that EPA select the lowest cost alternative that is consistent with the plan. As the district court for the Eastern District of Arkansas explained:

> Response costs that are not inconsistent with the NCP are conclusively presumed to be reasonable and therefore recoverable under CERCLA. See *United States v. Dico,* 266 F.3d 864, 879 (8th Cir.2001); *United States v. Findett Corp.,* 220 F.3d at 849; *United States v. Hardage,* 982 F.2d at 1441-1443; *United States v. Northeastern Pharm. and Chem. Co., Inc.,* 810 F.2d at 747-48 (8th Cir.1986); *United States v. Vertac Chem. Corp.,* 33 F.Supp.2d 769, 777 (E.D.Ark.1998); *United States v. Gurley,* 788 F.Supp. at 1481. The focus of the NCP is on procedures for the selection of response action rather than on "costs", per se:
>
> > The NCP regulates *choice of response action, not costs.* Costs, by themselves, cannot be inconsistent with the NCP. Only response actions-i.e., removal or remedial actions-can be inconsistent with the NCP, which can be demonstrated by a showing that the government's choice of response action was arbitrary and capricious. As long as the government's choice of response action is not inconsistent with the NCP, its costs are presumed to be reasonable and therefore recoverable. *Hardage,* 982 F.2d at 1443 (emphasis in the original).[77]

Thus, the EPA, in making its final selection of a remedy for the LCP Chemicals Site, can and should do what it did in the river site described above, choose permanency over price.

Conclusion

Before EPA is in a position to make any choice concerning a remedy, however, the potentially responsible parties must fix the multiple flaws in the remedial investigation and feasibility study documents. The scope of the cleanup must address the fact that PCBs and other contaminants from the Site have migrated out of the Turtle River. The exposure levels must be accurately calculated. The thin layer cap must be abandoned. Sea level rise must be taken into account. Marsh restoration scenarios must be factored in. And EPA must make a choice of remedy not based on price, but on the best remedy consistent with the National Contingency Plan.

---

[77] *United States v. Gurley*, 317 F. Supp. 2d 870, 878 (E.D. Ark. 2004) *aff'd,* 434 F.3d 1064 (8th Cir. 2006).

In responding to these comments, we ask that you also address any comments made in the attached expert reports.

Thank you for providing us with this opportunity to comment on this important project.

Sincerely,

William W. Sapp

William W. Sapp
Senior Attorney

cc: Megan Desrosiers, One Hundred Miles
Ashby Nix, Satilla Riverkeeper
Jen Hilburn, Altamaha Riverkeeper

ATTACHMENT A

Review of the LCP Chemicals Site, Brunswick, GA.

By Philip B. Bedient, P.E., Ph.D.

March 13, 2015

Philip B. Bedient

P. B. Bedient and Assoc., Inc

Review of the LCP Chemicals Site, Brunswick, GA.

I was retained on this project for the purpose of evaluating the potential contaminant transport from the LCP Chemicals Site into the Turtle River estuary system, here forth referred to as "the Site". My opinions are based on my professional experience in hydrogeology, environmental engineering, hydrology and hydraulics, and review of relevant data, maps, aerials, documentation to date, and are subject to change if and when additional information becomes available.

Section I. Qualifications

My educational background, research and professional experience and the review of documents provided are the basis of my opinions. I hold the Ph.D. degree from the University of Florida in Environmental Engineering Sciences, and I have attached a curriculum vita including a list of peer-reviewed publications. I am the professor of Civil and Environmental Engineering at Rice University, where I have been on faculty since 1975, and teach courses in hydrogeology, hydrology, floodplain analysis and hydrologic modeling. I have written two major textbooks, one on hydrogeology and one on hydrology. I have worked at over 30 hazardous waste sites and military bases nationwide since 1981 including over 12 Superfund Sites. I currently hold the following positions: Herman Brown Professor of Engineering, Fellow of ASCE, Diplomat of the American Academy of Water Resources Engineers, and the Director of the Severe Storm Prediction, Education, and Evacuation from Disasters (SSPEED) research center at Rice University. I am a registered professional engineer in Texas and a registered professional hydrologist.

Section II. Site History and Description

Use began in 1836 with construction of the Brunswick-Altamaha Canal along the uplands and the marsh boundary.

ARCO used Site as a refinery from 1919-1929.

Georgia Power operated an oil-fired power plant from 1937 through 1950.

Dixie Paint and Varnish Co. purchased part of the Site in 1941 and operated a manufacturing facility until 1955.

Allied Chemical purchased the Site in 1955 and constructed and operated a chlor-alkali facility, utilizing the mercury-cell process. Main products were chlorine gas, hydrogen gas, and sodium-hydroxide solution

LCP Chemicals purchased almost all of the Site in 1979 and continued to operate the chlor-alkali facility until 1994, when operations were discontinued. In May 1998, Allied Signal (Honeywell) purchased the LCP property from the estate in bankruptcy.

The LCP site occupies approximately 813 acres of tidal marshland and dry land northwest of Brunswick, Georgia, along the Turtle River estuary system.

Section III. Chemicals of Concern

- Mercury (including methylmercury)
- PCB (Aroclor 1268)
- Lead
- Polycyclic Aromatic Hydrocarbons (PAHs)

Section IV. Comments on Proposed Remedial Measures

1. **The cap/thin sand covering are subject to erosion/scour and/or failure given the volatile tidal regime in the area**

This site is located within a marsh of about 700 acres that is split by Purvis Creek, a tributary to Turtle River, and is subject to daily tides that can fluctuate from about 6 feet below mean sea level to as much as 4 feet above mean sea level (see Figure B2-18 from the Feasibility Report June 2014). Given that the marsh has a surface elevation of about 2-3 feet above mean sea level (see Figure B2-4), this means that the marsh is subjected to inundation and filling with high tide and to draining with low tide, twice a day. As such, the sediment in the marsh would be subjected to erosion/scouring and to being transported around, into and out of the marsh, both during tidal activity, as well as during rainfall/runoff conditions, especially during heavy rainfall events, floods and hurricanes. Placing a cap or thin sand cover on top of the contaminated sediment in the marsh would not prevent such erosion/scour given the volatile nature of the tidal regime and water level fluctuations during storm events (see Figure B3-15 from the Feasibility Report June 2014), especially since there is no tie-in into the existing marsh sediment so as to completely contain the contaminated sediment from being able to migrate.

2. **The cap/thin sand covering concepts are subject to disturbance by sediment dwelling organisms that inhabit the marsh area**

The thickness of the proposed cap concepts of about 6 inches of sand is not sufficient to prevent sediment dwelling organisms from borrowing into and through the sand so as to expose the contaminated sediment to erosion.

3. **The cap/thin sand covering concepts are subject to increased inundation due to sea level rise**

The proposed cap concepts do not recognize nor address the impact of sea level rise on the long-term effectiveness of these concepts to prohibit the escape of contaminants within the marsh. Estimates of sea level rise of from 1-2 feet over the next 100 years have been presented (e.g. from the USACE). Such change in the normal water levels in the area will inherently result in changes to the topography of the site and the nearby rivers,

streams, creeks, and gullies that have not been evaluated as to the long-term effectiveness of the proposed concepts.

4. **The cap/thin sand covering concepts will require long-term monitoring to ensure effectiveness**

These remedial concepts will require long-term monitoring to ensure that they are effective in containing and/or remediating the contaminated sediment at the site. There are no details as to what such monitoring will entail, as well as what actions would be taken if it is determined that these concepts are not working or fail.

5. **Movement of contaminants from under the thin sand layer is possible given the interaction of groundwater with the surface water in the marsh and the fluctuation of the tides in this area**

Given the evidence that there is groundwater interaction with the surface water and the marsh in this area, these concepts do not prevent such interaction from continuing, such that contaminants will continue to move out of the marsh and into the groundwater and surface water in the area.

6. **Previous experience at other sites not similar to this site given its volatile tidal regime in relation to the topography**

The experience that these concepts may have at other sites is not relevant to this site if the other sites do not have the kind of tidal regime and flood/hurricane conditions that exist at this site.

7. **The proposed cap areas along Purvis Creek seem to be selected based on limited sampling**

The location of dredge areas and proposed cap areas along Purvis Creek are based on the results of the selected samples taken along portions of the creek (see Figures 5-2 and 6-1C). However, there are numerous areas where no samples were taken, near to where there were samples showing high contaminant levels that will receive caps (see Figure 6-5). In addition, there were samples taken adjacent to one another that showed one to have

high levels of contamination and the other did not. This suggests that the extent of contamination is extremely variable along this creek, necessitating a much more dense sampling network than what was done, if the remedial plan is to simply cap only those areas where the samples taken showed high levels of contamination.

8. **Dredging is a more permanent solution than the cap/thin sand covering concepts**

These proposed remedial concepts do not permanently remove the contaminants from the area, and are subject to failure as discussed above. Dredging and removal of the contaminated sediments would be a permanent solution.

Section V. Opinions

The above review of information and findings support the following opinions:

- Chemicals of Concern have been and still are released in significant quantities into the Turtle River estuary system on a daily basis. The tidal action within the marsh area will ensure a constant exchange of sediment to and from the marsh area on a daily basis.
- The water quality in the Turtle River estuary system has continually deteriorated over the past several decades as a result of the contamination emanating from the Site. This will continue until the Site has been properly remediated.
- The location of the Site in direct proximity and connection to the Turtle River estuary system has created a major environmental impact on the immediate area as recognized by the EPA, ATSDR, GEPD, and other organizations.
- Sampling network used to delineate areas that need remediation is lacking in density and frequency. From figure 6-5 it is clear that approximately 50% of Purvis Creek has not been sampled for contaminants of concern. It is more likely than not that many of these non-sampled areas are contaminated with contaminants of concern.
- The proposed cap will probably fail for a number of reasons listed below:
    - Destruction of capping/cover material by scouring due to tidal action.

- Destruction of capping/cover material by hurricane type storms.
- Destruction of capping/cover material by changing hydraulic conditions due to sea-level rise.
- Destruction of capping/cover material by changing environmental conditions typically associated with meandering creeks within delta systems.
- Destruction of capping/cover material by sediment dwelling organisms.
- Lateral movement of contaminants within the subsurface sediment has not been addressed.

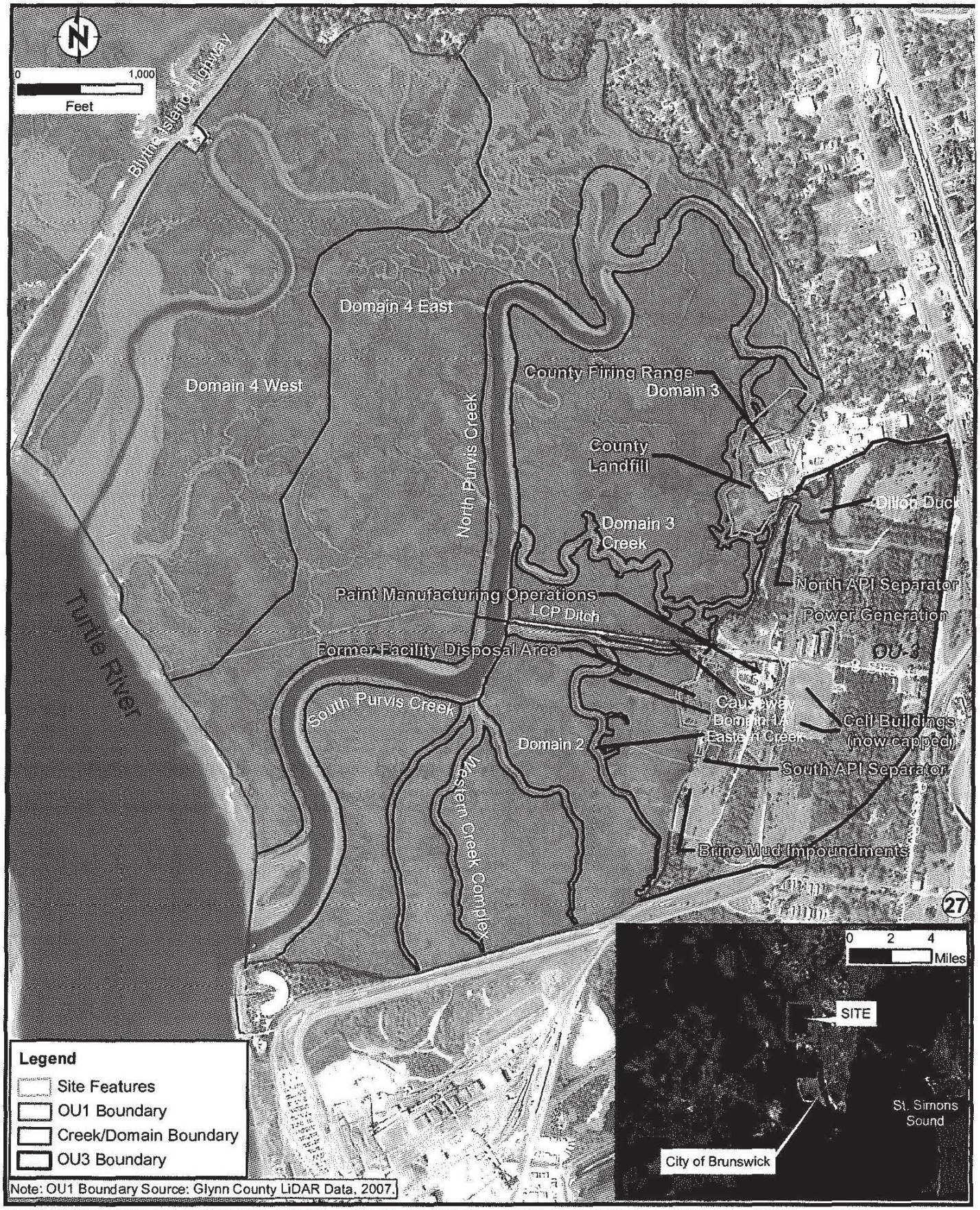
- Another major concern will be the long term monitoring that needs to take place after remediation has been implemented and action plans when remedial systems fail to protect the surrounding environment from the chemicals of concern. If the cap is constructed, it will have to be continually maintained and repaired, and this does not provide a permanent solution.

The comments, herein, are based on a preliminary review of available data to date and are subject to change. If additional information becomes available and is provided to me regarding this case, I will review it and provide supplementary opinions as appropriate.

Section VI. Documents Reviewed

1. *November 2014, U.S. Environmental Protection Agency Superfund Proposed Plan, LCP Chemicals Superfund Site, Operable Unit 1, City of Brunswick, Glynn County, Georgia*
2. *June 2, 2014 Draft Feasibility Study, Operable Unit No. 1 (Estuary), LCP Chemicals Superfund Site, Brunswick, Georgia (Draft)*
3. *June 20, 2013 Letter From Galo Jackson, USEPA to Prashant Guta, Honeywell, Subject: Comments on the Draft Feasibility Study Report for the Estuary, Operable Unit One*
4. *February 2013 Remedial Investigation Report Operable Unit 3 - Upland Soils, LCP Chemicals Site, Brunswick, Georgia (FINAL)*

5. *October 2012 Remedial Investigation Report Operable Unit One - Estuary LCP Chemicals Site, Brunswick, Georgia (FINAL)*



ENVIRON / ANCHOR QEA	Site Location Map	Figure 2-1
	LCP CHEMICAL SITE, BRUNSWICK, GEORGIA	

Legend

- Gibson Creek
- Approximate Turtle River Estuary
- Purvis Creek
- OU1 Boundary
- Estimated Fishable Area Outside OU1

The Estimated Fishable Area is approximately 5,700 acres

The LCP Estuary is 760 acres.

Turtle River Estuary is approximately 19,000 acres.

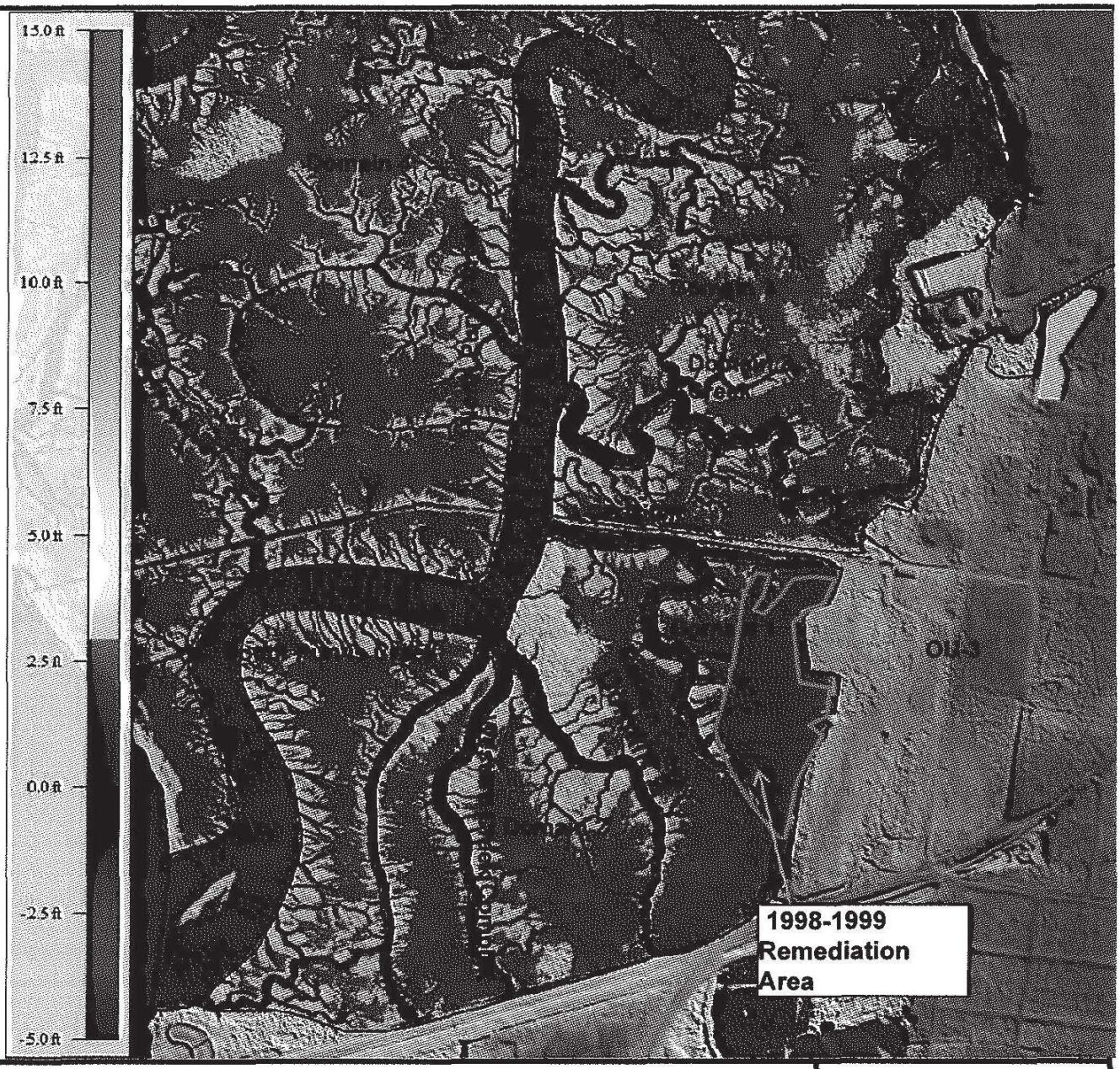
OU1 Boundary Source: Glynn County LiDAR Data, 2007.

N

Turtle River/Brunswick Estuary

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure 2-5

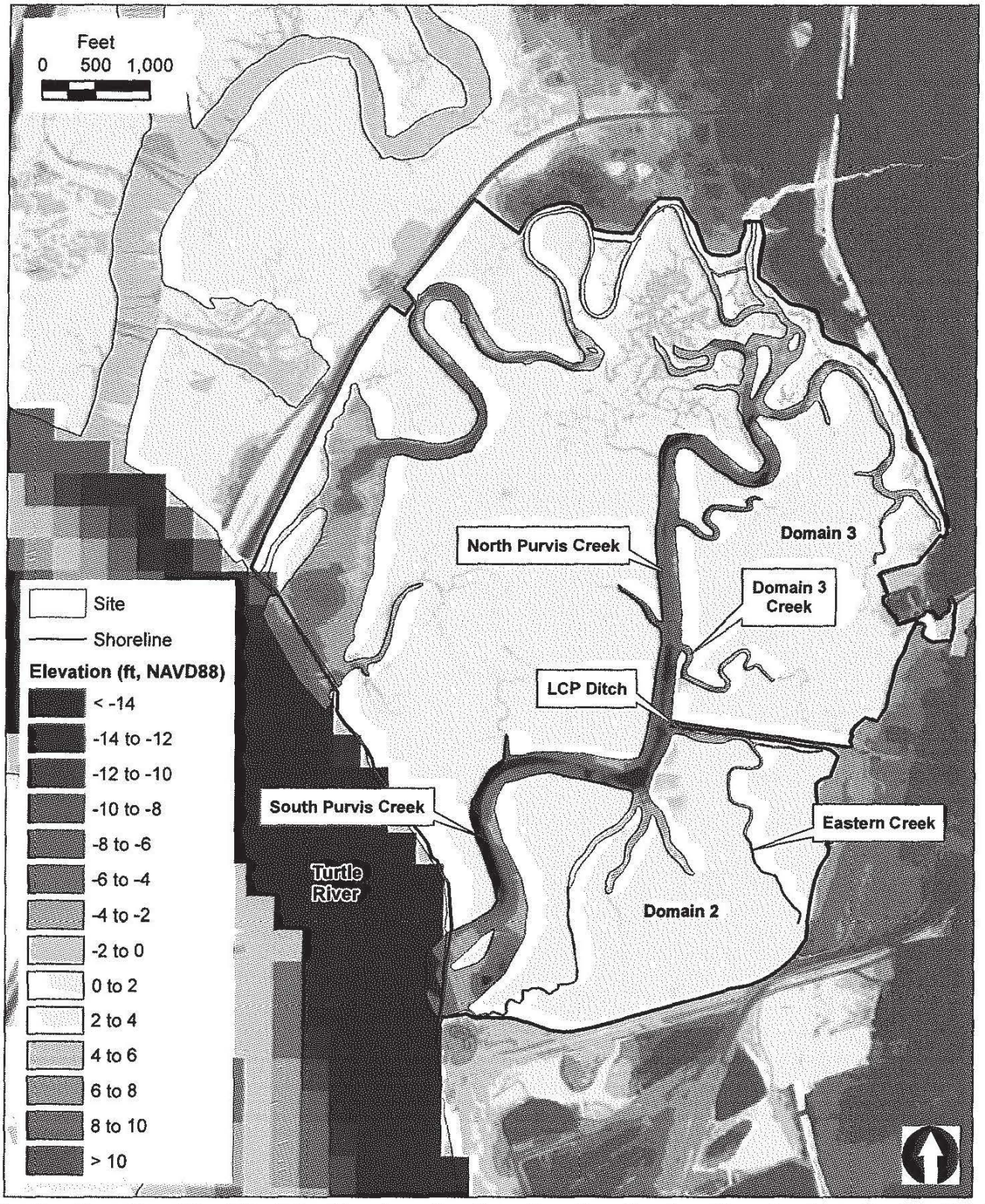


Marsh Inundation – Mean High High Water

Figure 2-7

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Marsh Inundation – Mean Low Low Water	Figure 2-8
LCP CHEMICAL SITE, BRUNSWICK, GEORGIA	



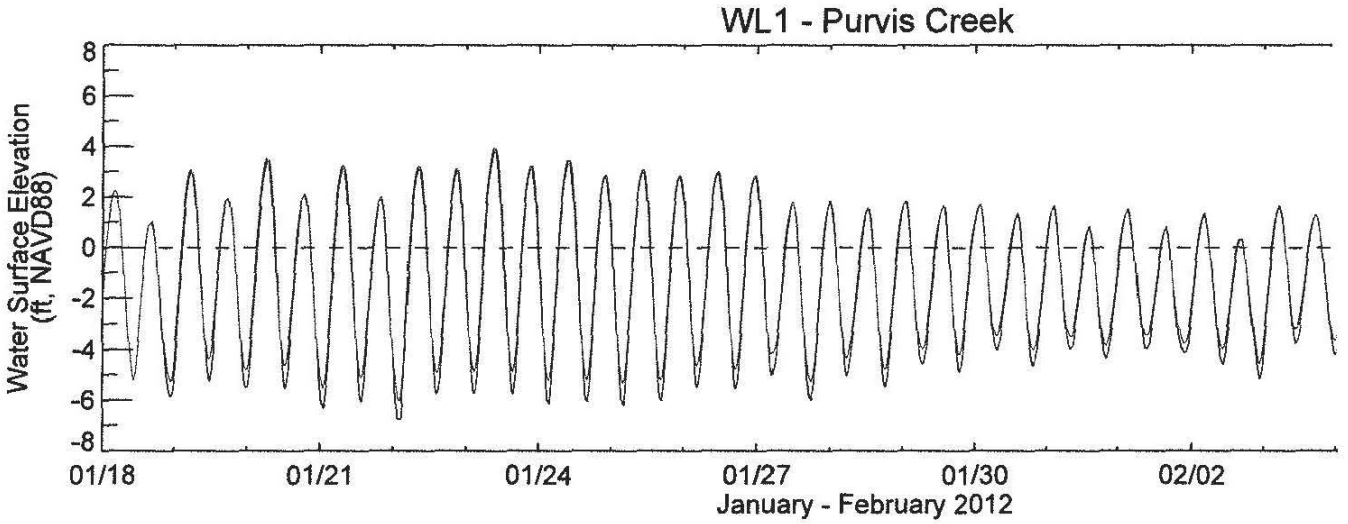
\\montvale\buljobs26a\Jobs\Brunswick\REPORT\HYDRO\120620\Decksbed_elevation.mxd vlist 9/27/2013 2:09:48 PM

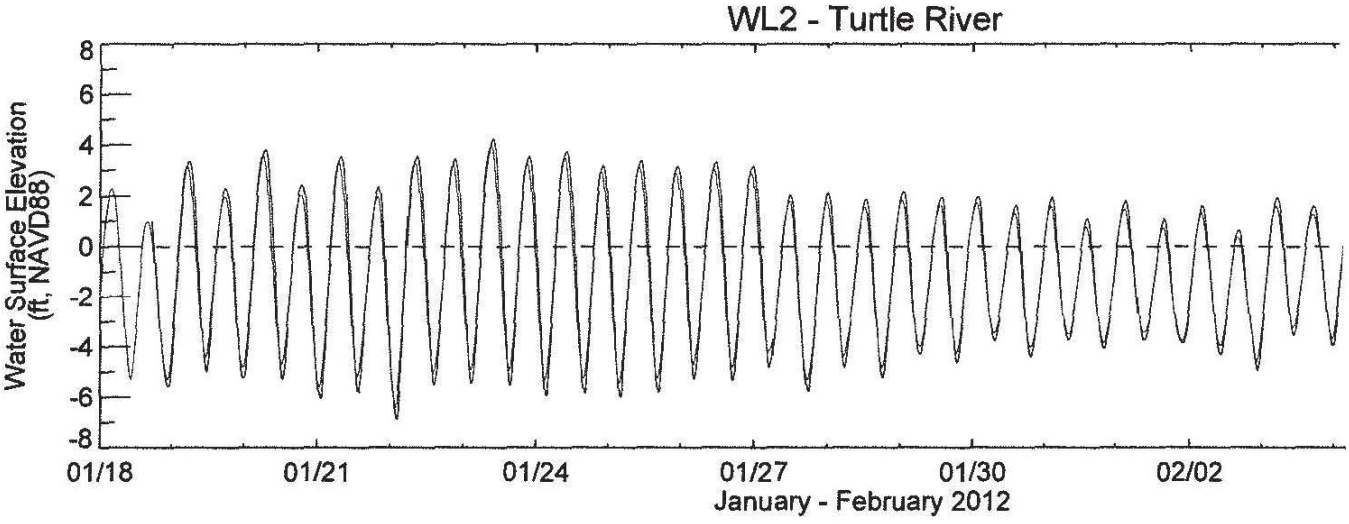
ENVIRON
ANCHOR QEA

Surface Elevation within the Site based on LiDAR Data in Marshes and Single-beam Bathymetry in Channels

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

Figure B2-4



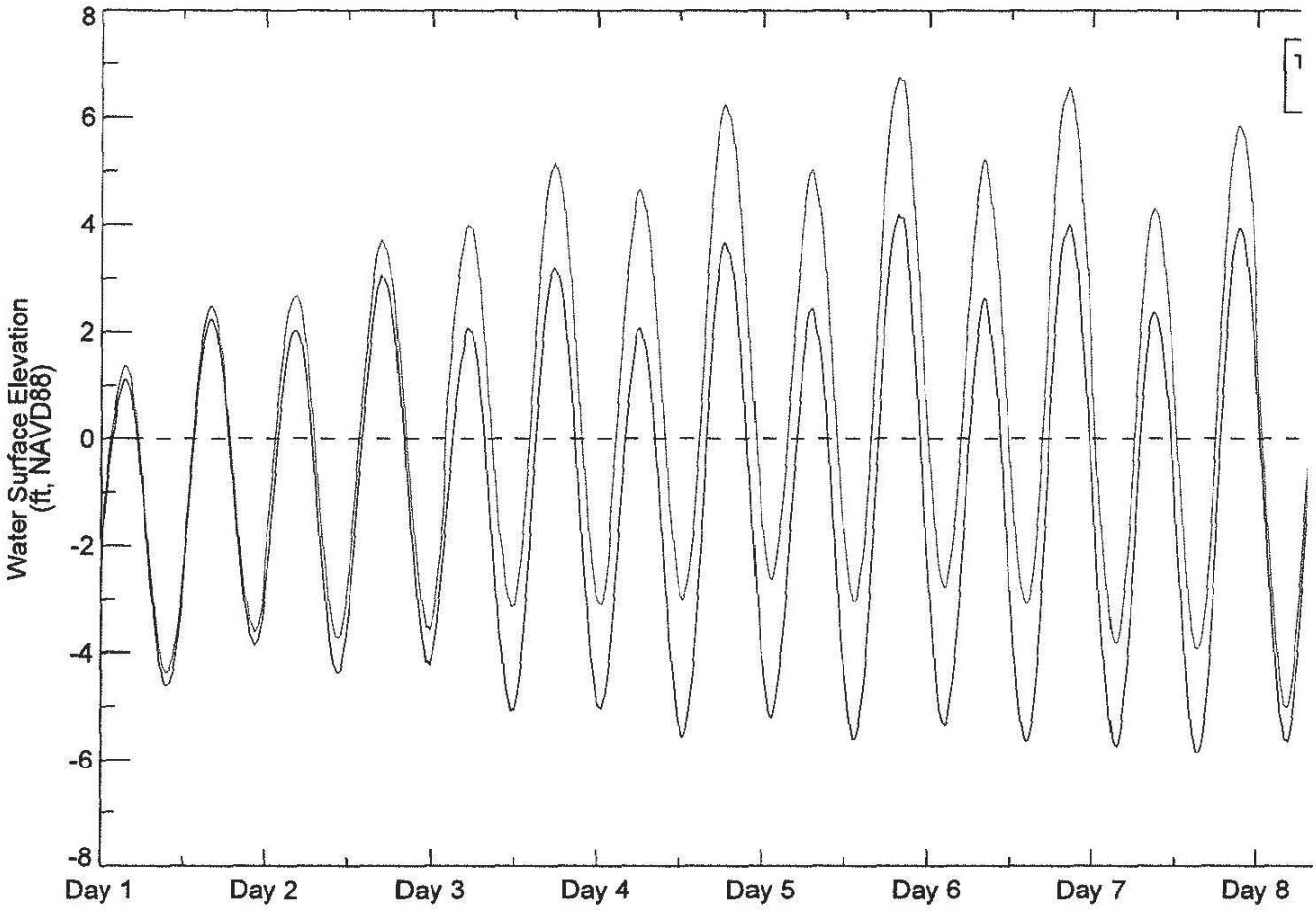


ENVIRON

ANCHOR QEA

Comparison of Predicted and Measured Water Surface Elevation at Stations WL1 and WL2

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA

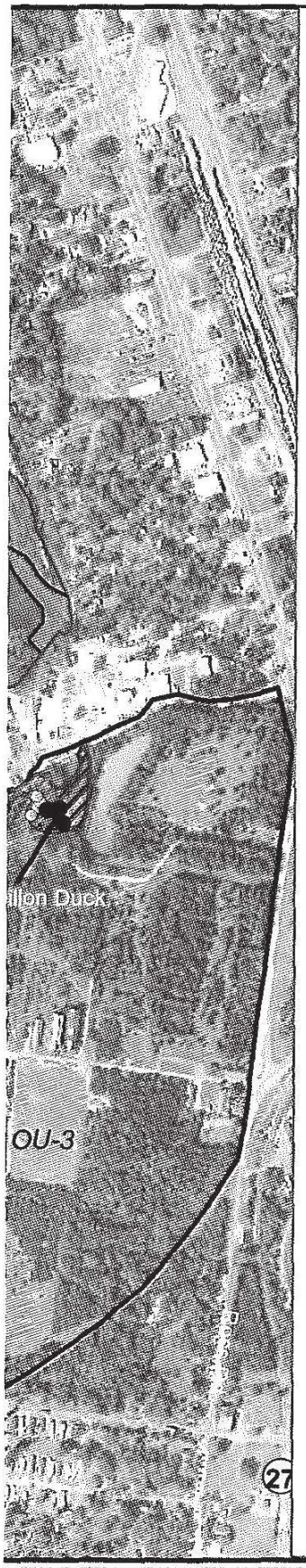


ENVIRON

ANCHOR QEA

Water Surface Elevation at Downstream Boundary during Hurricane Storm Surge Simulation

LCP CHEMICAL SITE, BRUNSWICK, GEORGIA



Legend

- Exceeds Benthic Community RGOs Shown Below
- No Exceedance of Benthic Community RGOs Shown Below
- Remediation Area (48 acres)
- Excluded Area (33 acres)
- OU1 Boundary
- Creek/Domain Boundary
- OU3 Boundary

Constituent	SWAC RGOs	Benthic Community RGOs
Hg	1	4
Ar1268	2	6
Pb	--	90
TPAHs	--	4

Notes:
- Units for all RGOs is mg/kg.

0 800 1,600
Feet

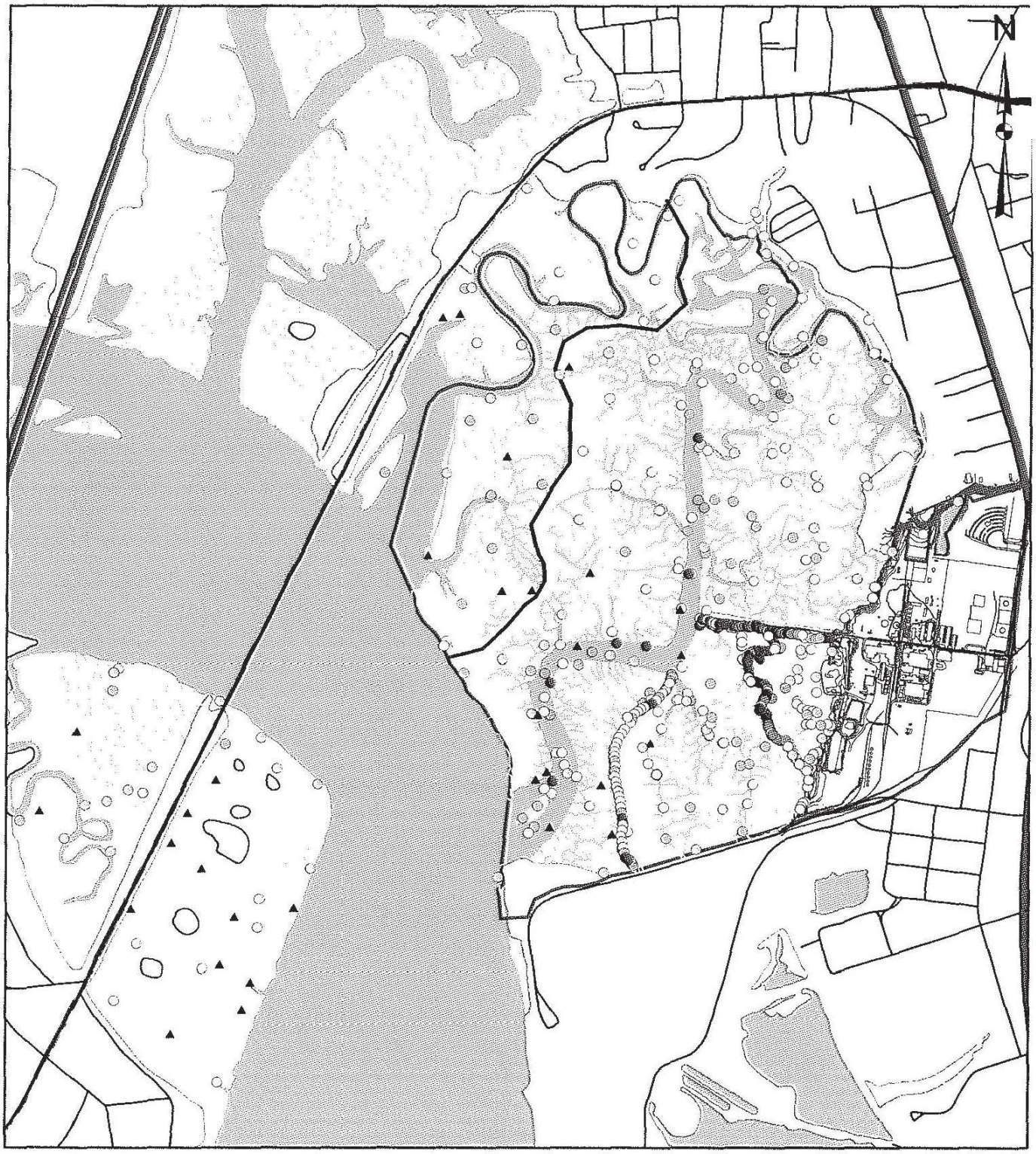
OU1 Boundary Source: Glynn County LiDAR Data, 2007.

ıent Management Area 1

IICAL SITE, BRUNSWICK, GEORGIA

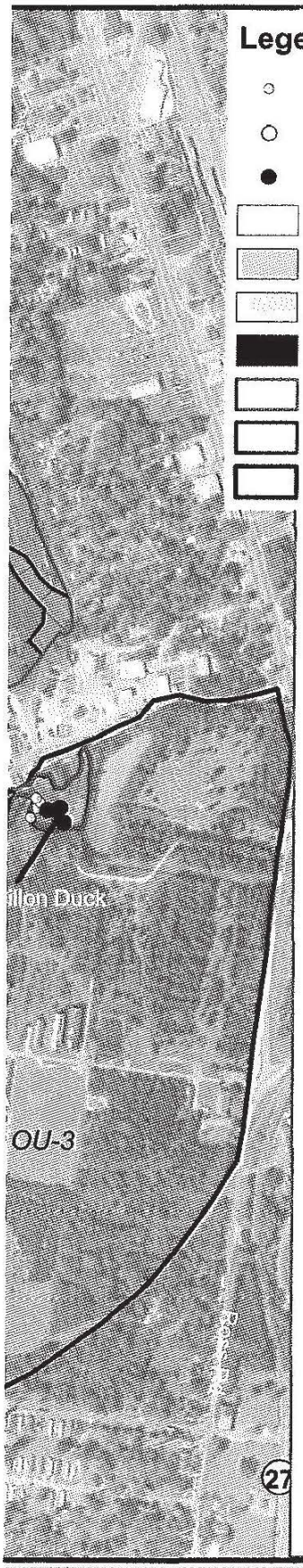
Figure 5-2

Spatial Distribution and Concentration of Aroclor-1268 in LCP Marsh Sediment



Environmental Planning Specialists, Inc.

Figure 6-1C

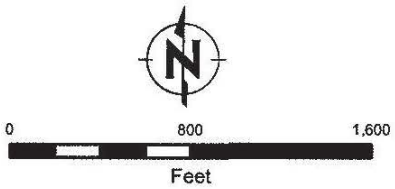


Legend

- ○ No Exceedance of Either Lower or Upper End Benthic RGOs
- ○ Within the Range of Benthic Community RGOs
- ● Exceeds Range of Benthic Community RGOs
- No Sample Location in 50-Meter Averaging Polygon
- Does not Exceed the Range of the Benthic Community RGOs Shown Below
- Within the Range of the Benthic Community RGOs Shown Below
- Exceeds the Range of the Benthic Community RGOs Shown Below
- OU1 Boundary
- Creek/Domain Boundary
- OU3 Boundary

Constituent	SWAC RGOs	Benthic Community RGOs
Hg	1-2	4-11
Ar1268	2-4	6-16
Pb	--	90-177
TPAHs	--	4

Notes:
-Colored boxes in Purvis Creek and Western Creek Complex reflect locations where averaging along approximately 50-meter polygons was conducted when more than one sample was collected within the approximate 50-meter interval.
-Units for all RGOs is mg/kg.



OU1 Boundary Source: Glynn County LiDAR Data, 2007.

deration for Alternative 1

JNSWICK, GEORGIA

Figure 6-5

February 2013

Philip B. Bedient, Ph.D., P.E.
Curriculum Vitae

ADDRESS:

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Department of Civil and Environmental Engineering
Rice University/MS - 317
6100 Main St. / Houston, Texas 77005
(713) 348-4953 or fax (713) 348-5239
Email – bedient@rice.edu

P.B. Bedient and Associates, Inc.
13910 Wilde Forest Court
Sugar Land, TX 77498
(281) 491-3911

EDUCATION:

B.S. Physics, University of Florida, Gainesville, Florida, 1969
M.S. Environmental Engineering, University of Florida, 1972
Ph.D. Environmental Engineering Sciences, University of Florida, 1975

PROFESSIONAL EXPERIENCE:

Herman Brown Professor of Engineering - Civil and Environmental Engineering- Rice University - July 2001 to present.
Professor - Environmental Engineering - Rice University - 1986 to 2001.
Professor and Chair - Department of Environmental Science and Engineering, Rice University, Houston, Texas, 1992 - 1999.
Associate Professor - Environmental Engineering – 1980 - 1986.
Assistant Professor - Environmental Engineering – 1975 - 1980.

SCIENTIFIC SOCIETIES:

American Society of Civil Engineers
American Institute of Hydrology
American Water Resources Association
Association of Environmental Engineering Professors
American Academy of Water Resources Engineers
American Geophysical Union

HONORS:

Diplomate - Water Resources Engineer, American Academy of Water Resources Engineers (2008)
C.V. Theis Award from the American Institute of Hydrology (April 2007)
Fellow – American Society of Civil Engineers (April, 2006)
Endowed Chair – Herman Brown Professor in Engineering (July, 2001)
Shell Distinguished Chair in Environmental Science (1988-93)
Phi Beta Kappa

PROFESSIONAL COMMITTEES:

SSPEED Center Committee 2007-2012
Expert Panel – "Impacts of Climate Change on Transportation Systems and Infrastructure in the Gulf Coast" USDOT and USGS, 2005 - 2006
TS Allison Recovery Project - Technical Advisory Committee - 2002-2003
Harris County Flood Control District - Brays Bayou Federal Project Com – 1998- 2002

National Academy of Engineers (National Research Council)
Committee on DoE Environmental Management Technologies (CEMT) - 1995-96
Committee on In-Situ Bioremediation - 1992-93

UNIVERSITY COMMITTEES:

Undergraduate Curriculum Committee, 2005-2012
Accreditation (ABET/SACS) Committee, 2005-2012
Events and Reception Committee (Chair) 2012
Mentorship Committee 2012
Space Planning Committee, 2005-2012
CEE Student-Group Advisors 2012
BSCE Advisor 2012
Center for Civic Engagement Committee, 2007-2012
Parking Committee, 1998-2012
Search Committee, Civil and Environmental Engineering, (2001-2002)
Chair, Dean of Engineering Search Committee, (1988)
Computer Committee, Athletics Committee, 1998-2000
Advisory Council, School of Engineering.

LICENSES:

Professional Engineer, State of Texas, Environmental Engineering (45626)
Professional Hydrologist, American Institute of Hydrology

RESEARCH INTERESTS:

Floodplain Management - Analysis of effects of land use changes and development patterns on flood hydrographs and floodplain boundaries; use of lumped and distributed hydrologic models; detailed modeling of alternative flood control strategies and dynamic floodplain models. Analysis of the severe storm impacts in urban watershed areas using radar rainfall data, combined with GIS techniques for digital terrain and hydraulic modeling in Houston and other coastal areas in Texas.

Flood Alert Systems with Radar - The development of a real-time flood ALERT system (FAS) for Brays Bayou and the Texas Medical Center in Houston, TX has been completed. The FAS currently uses NEXRAD radar for application to flood prediction and real-time flood alert systems. FAS2 is a second-generation system being implemented with funding from FEMA after TS Allison. TXDOT funded a new FAS for inundated bridge crossings (2008).

Groundwater Contaminant Transport - Monitoring and modeling of groundwater hydrology and contaminant movement from various waste sources, numerical and analytical methods for transport with biodegradation. Development and application of tracer studies and models for groundwater transport with biodegradation in a controlled release tank (ECRS), for studying degradation of PCE and TCE plumes and for ethanol in fuel spills. Analysis of plume dynamics at sites in California, Texas and Florida.

Hazardous Waste Site Evaluation - Monitoring and modeling of waste plumes associated with 35 hazardous waste sites nationally. Identification of extent of contamination, transport mechanisms, and control strategies. MODFLOW and RT3D modeling of transport and aquifer restoration using withdrawal-treatment and microbial degradation methods. Analysis of hazardous waste sites in California, Texas and Florida.

COURSES and STUDENTS:

- CEVE 412 - Hydrology and Watershed Analysis
- CEVE 512 - Hydrologic Design Laboratory

- CEVE 101 - Fundamentals of Civil and Environmental Engineering
- CEVE 415/515 - Water Resources Planning and Management (50%)

- 13 Ph.D. and 59 M.S. degrees since 1975

RESEARCH STATEMENT:

Dr. Philip B. Bedient is also Herman Brown Professor of Engineering in the Dept of Civil and Environmental Engineering at Rice University. He teaches and performs research in surface and ground water hydrology, disaster management, and flood prediction systems. He served as Chair of Environmental Engineering from 1992 to 1999. He has directed 60 research projects over the past 38 years, worth of $15 million in research, and has written over 180 articles in journals and conference proceedings. He is lead author on a text on "Hydrology and Floodplain Analysis" (Prentice Hall, 5th ed., 2012) used in over 75 universities across the U.S. He also has a second text on "Groundwater Contamination: Transport and Remediation" (Prentice Hall, 2nd ed., 1999). Dr. Bedient received the Herman Brown endowed Chair of Engineering in 2002 at Rice University. He was elected to Fellow ASCE in 2006 and received the prestigious C.V. Theis Award (groundwater) from the American Institute of Hydrology in 2007. He earlier received the Shell Distinguished Chair in Environmental Science (1988 to 1993) for his work on biodegradation modeling of fuel spills.

He has worked groundwater problems for over 38 years including over 30 major hazardous waste sites and four military bases in Texas, Florida, Utah, Michigan, California, and Louisiana. He has been actively involved in the area of hydrologic transport and groundwater remediation, and developed the original EPA Bioplume Model used for many years to evaluate BTEX plume behavior. He was PI on the Hill Air Force Base Advanced Remediation Study of DNAPL contamination from 1994 – 1999.

He is the current director of the Severe Storm Prediction Center (SSPEED) at Rice University (since 2007) consisting of a team of seven universities and 15 investigators from Gulf coast universities dedicated to improving storm prediction, education, and evacuation from disaster. The Center was approved by the Texas Legislature and is currently funded at over $4.5 million for 5 years from various sources including the Houston Endowment (Hurricane Ike Lessons Learned and Future Steps). A book has been developed and published by TAMU press titled "Lessons from Hurricane Ike" published in June 2012.

Dr. Bedient has over 37 years of experience working on flood and flood prediction problems in the U.S. He has evaluated flood issues in Texas, California, Florida, Louisiana, and Tennessee. He has worked on some of the largest and most devastating floods to hit the U.S. including the San Jacinto River flood of 1994, T.S. Frances in 1998, T.S. Allison in 2001, Hurricane Katrina in 2005, Hurricane Rita in 2005, Hurricane Ike in 2008, and the Nashville, TN flood of 2010. He routinely runs computer models such as HEC-HMS, HEC-RAS, SWMM, and VFLO for advanced hydrologic analysis. He developed one of the first radar based rainfall flood alert systems (FAS-3) in the U.S. for the Texas Medical Center.

The SSPEED Center has put on a number of conferences, meetings, and training courses since 2007. Prominent national speakers have been invited to these conferences, which include attendees from academia, industry, consulting, and emergency managers. These conferences provide a forum for public discussion and response for decision and policy makers, and stakeholders. As a result of this work, we have received a large number of Rice News stories over the past several years, in the form of both video interviews with the media as well as newspaper coverage.

Dr. Bedient has been involved in the technology transfer area for more than three decades through the teaching of short courses for government, university, and private sectors in both groundwater contamination and surface water modeling and prediction.

SURFACE WATER PROJECT

"SSPEED Center Proposal to the Houston Endowment Coastal Integrated Program", Houston Endowment, 2011-2014, $3,200,000.

"FAS3- Operational Support", Texas Medical Center, 2012, $69,000

"Urban Resilience: Flooding in the Houston-Galveston Area", Kinder. 2009-2012, $24,003

"White Oak Bayou BMP Demonstration Project – Cottage Grove Subdivision", City of Houston, 2009-2013, $165,000.

"Rice University FEMA: Food Analysis", Rice, 2011-2012, $70,000

"Amendment to Expand Development and Validation of the Online Storm Risk Calculator Tool for Public Usage", City of Houston, 2011, $388,030

"Hurricane Ike: Lessons Learned and Steps to the Future", Houston Endowment, 2009-2012, $1,250,000

"Libya AEL Training Grant", AECOM, 2008-2010, $1.7 million over 2 years.

"Texas OEM SSPEED Training" University of Texas, 2008, $90,000

"Watershed Information Sensing and Evaluation System", Houston Endowment (with UH), 2007-2010, $400,000.

"Advanced Flood Alert System for the TXDOT for Bridge Control at 288", HGAC, 2007-2011 $200,000.

"Civil and Environmental Engineering for the 21st Century", NSF Dept Reform Grant, 2005-2007, $100,000.

"CASA – Collaborative Adaptive Sensing of the Atmosphere – the Houston Testbed", NSF, 2003 – 2009, $110,000, ($90,000 for 2006-07).

"FAS2 - Operational Support", Texas Medical Center, 2003-2012, $69,000

"Flood Alert System (FAS2) for the Texas Medical Center and Brays Bayou", FEMA, 2002-2003, $300,000.

"Multi-Purpose Water Management Technology for the Texas Mexico Border", Advanced Technology Program, 2000-2001, $129,000.

"Analysis of Clear Creek Watershed," Galveston Bay Preservation Foundation, 1999-2000, $15,000.

"Flood Alert System - Maintenance and Support", Texas Medical Center, 1998-2002, $271,000.

"Flood Prediction System for the Texas Medical Center", Texas Medical Center, 1997-1998, $262,000.

"The Effects of Changing Water Quality and Market Inefficiencies on Water Resource Allocation in the Lower Rio Grande Valley", Energy and Environmental Systems Institute, Rice University, 1996-1997, $12,000.

"Characterization of Laguna Madre Contaminated Sediments", Environmental Protection Agency, 1995, $68,500.

"Role of Particles in Mobilizing Hazardous Chemicals in Urban Runoff", Environmental Protection Agency, 1992-95, $240,000. (P. B. Bedient, Co-P.I.).

"Galveston Bay Characterization Report", Galveston Bay National Estuary Program, 1991-1992, $35,000.

"Characterization of Non-Point Sources and Loadings to Galveston Bay", Galveston Bay National Estuary Program, 1990-1991, $125,000.

"Linkages between Sewage Treatment Plant Discharges, Lake Houston Water Quality, and Potable Water Supply during Storm Events", City of Houston, 1984-1985, $42,200.

"Plan of Study for Upper Watershed Drainage Improvements and Flood Control - San Jacinto River Basin", subcontract from R. Wayne Smith, Engineer, 1984-85, $120,260.

"Harris Gully Sub watershed Study", South Main Center Association, 1983-1984. $15,000.

"Sedimentation and Nonpoint Source Study of Lake Houston", Houston-Galveston Area Council, 1981-1982, $55,000.

"Environmental Study of the Lake Houston Watershed - Phase II", Houston-Galveston Area Council, 1980-1981, $30,000.

"Evaluation of Effects of Storm water Detention in Urban Areas", matching grant with City of Houston Health Department, Office of Water Research and Technology (OWRT), Washington, D.C., and City of Houston Public Health Engineering, 1980-81, $116,000.

"Environmental Management of the Lake Houston Watershed", Funded by City of Houston, Dept. of Public Health, 1978-80, $80,000.

"A Preliminary Feasibility Report for Bear Creek, Texas, Local Protection Project", Grant to Southwest Center for Urban Research, Funded by U.S. Army Corps of Engineers, 1977-78, $47,000.

"Environmental Study of New Iberia Navigation Port and Channel, Louisiana", Funded to Rice Center, 1979, $50,000.

"Strategies for Flood Control on Cypress Creek, Texas", Funded by U.S. Corps of Engineers, Galveston, Texas, 1977, $9,500.

"Water Quality Automatic Monitoring and Data Management Information System", Funded by City of Houston, Dept. of Public Health, 1977-1978, $62,414.

"Maximum Utilization of Water Resources in a Planned Community", The Woodlands Project, 1975-1976.

GROUNDWATER PROJECTS

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", (P.J.J. Alvarez – Co-P.I.) American Petroleum Institute, 2004-2007, $120,000.

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", Gulf Coast Hazardous Substances Research Center, 2004-2005, $45,000.

"A Large-Scale Experimental Investigation of the Impact of Ethanol on Groundwater Contamination", Gulf Coast Hazardous Substances Research Center, 2003-2004, $95,000.

"Chlorinated Solvent Impact and Remediation strategies in the Dry Cleaning Industry", Gulf Coast Hazardous Substances Research Center, 2000 – 2003, $149,400.

"Design Manual for the Extraction of Contaminants from Subsurface Environments", Environmental Protection Agency, 1994-2002, $4,500,000.

"Development of Data Evaluation/Decision Support System for Bioremediation of Subsurface Contamination", Environmental Protection Agency, 1993-1996, $450,000.

Shell Distinguished Chair in Environmental Science, Shell Oil Company Foundation, 1988-1993, $750,000.

"Evaluation of Nitrate-Based Bioremediation: Eglin Air Force Base", Environmental Protection Agency, 1992-1993, $120,000.

"Decision Support System for Evaluating Remediation Performance with Interactive Pump-and-Treat Simulator", Environmental Protection Agency, 1992-1994, $250,000.

"Characterization of Oil and Gas Waste Disposal Practices and Assessment of Treatment Costs", Department of Energy, 1992-94, $200,000.

"Subsurface Monitoring Data for Assessing In-Situ Biodegradation of Aromatic Hydrocarbons (BTEX) in Groundwater", American Petroleum Institute, 1991-93, $170,000.

"System 9 GIS System", Prime Computers, 1989-90, $50,000.

"Effects of Various Pumping and Injection Schemes and Variable Source Loading on Biorestoration", American Petroleum Institute, 1988-90, $186,000.

"Parameter Estimation System for Aquifer Restoration Model", U.S. Environmental Protection Agency, 1987-89, $400,000.

"Distribution of BIOPLUME II", National Center for Ground Water Research (EPA), 1987-88, $40,000.

"Development and Application of a Groundwater Modeling Data Base for Hazardous Waste Regulation", American Petroleum Institute, 1987-88, $40,000.

"Practical Procedures for Evaluating Attenuation of Ground Water Contaminants Due to Biotransformation Process", National Center for Ground Water Research (EPA), 1986-87, $150,000.

"Modeling and Field Testing of Contaminant Transport with Biodegradation and Enhanced In Situ Biochemical Reclamation", National Center for Ground Water Research (EPA), 1985-88, $249,000.

"Ground Water Modeling for the Houston Water Plant", City of Houston, subcontract from Law Engineering & Testing Co., 1985-86, $127,000.

"Environmental Fate and Attenuation of Gasoline Components in the Subsurface", American Petroleum Institute, 1984-86, $78,300.

"Simulation of Contaminant Transport Influenced by Oxygen Limited Biodegradation", National Center for Ground Water Research (EPA), 1984-85, $25,500.

"Ground Water Pollutant Transport along Flow Lines for Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1983-85, $167,000.

"Math Models for Transport and Transformation of Chemical Substances in the Subsurface", National Center for Ground Water Research (EPA), Subcontract from Oklahoma State University, 1982-83, $15,000.

"Characterization of Ground Water Contamination from Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1982-83, $113,000.

"Characterization of Ground Water Contamination from Hazardous Waste Sites", National Center for Ground Water Research (EPA), 1980-82, $45,000.

PUBLICATIONS AND PRESENTATIONS

A. Books or Related Chapters

1. Bedient, P. B. and W. C. Huber, 2012, "Hydrology and Floodplain Analysis", 5th Ed. Prentice-Hall Publishing Co., Upper Saddle River, NJ, February, 2012, 800 page textbook.

2. Bedient, P. B. and J. Blackburn, 2012 "Lessons learned from Hurricane Ike" Ed. Philip Bedient. College Station, TX: Texas A&M University Press, College Station, TX: 2012, 194 Pages

3. Rifai H.S., Borden R.C., Newell C.J. and Bedient P.B., " Modeling Remediation of Chlorinated solvent plumes" In Situ Remediation of Chlorinated solvent Plumes, Chapter 6, H.F. Stroo, C.H. Ward Editors, Springer, N.Y. 2010, 145 pp.

4. Bedient, P. B., Rifai H. S., and Newell C. J., "Ground Water Contamination: Transport and Remediation", 2nd Ed. PTR Publ., Upper Saddle River, NJ, 1999, 605 pages.

5. Thompson, J.F. and Bedient, P.B. "Urban Storm Water Design and Management," The Engineering Handbook, Chapter 94, CRC Press, 2004, 21 pp.

6. Fang, Z., Safiolea, E., Bedient, P.B. (2006) "Enhanced Flood Alert and Control Systems for Houston." In Chapter 16, Coastal Hydrology and Processes, Ed. By Vijay P. Singh and Y. Jun Xu, Water Resource Publications, LLC, pp. 199-210

7. Capiro, N.L. and Bedient P.B. "Transport of Reactive Solute in Soil and Groundwater" The Water Encyclopedia (2005): 524-531.

8. Horsak, R.D., Bedient, P.B., Thomas, F.B., and Hamilton, C. "Pesticides", Environmental Forensics (2005).

9. Charbeneau, R. J., Bedient, P. B. and Loehr R. C., "Groundwater Remediation", Technomic

Publishing Co., Inc., Lancaster, PA 1992, 188 pages.

B.Peer Reviewed Journal Publications

1. Teague, A., J. Christian, and P. Bedient. (2013) "Use of Radar Rainfall in an Application of Distributed Hydrologic Modeling for Cypress Creek Watershed, Texas". Journal of Hydrologic Engineering. DOI: 10.1061/(ASCE)HE.1943-5584.0000567 American Society of Civil Engineers.
2. Doubleday, G., Sebastian A., Luttenschlager, T., and Bedient, B. (2013) Modeling Hydrologic Benefits of Low Impact Development: A Distributed Hydrologic Model of The Woodlands, Texas, Journal of American Water Resources Association
3. Christian, J., A. Teague, L. Duenas-Osario, Z. Fang, and P. Bedient, (2012). "Uncertainty in Floodplain Delineation: Expression of Flood Hazard and Risk in a Gulf Coastal Watershed." Journal of Hydrological Processes, doi:10.1002/hyp.9360.
4. Ray, T., Stepinski, E., Sebastian, A., Bedient, P.B. (2011)"Dynamic Modeling of Storm Surge and Inland Flooding in Texas Coastal Floodplain" ", Journal of Hydrologic Engineering, ASCE, Vol. 137, No.10, October 2011, ISSN 0733-9429/2011/10-1103-1110
5. Fang, Z., Bedient, P. B., and Buzcu-Guven, B. (2011). "Long-Term Performance of a Flood Alert System and Upgrade to FAS3: A Houston Texas Case Study". Journal of Hydrologic Engineering, ASCE Vol. 16, No. 10, October 1, 2011, ISSN 1084-0699/2011/10-818-828.
6. Stepinski, E., J. Christian, and P. Bedient, (2011.) "Methods for Modeling Coastal Floodplains Under Hurricane Storm Surge Conditions." Journal of Hydrological Processes. (Accepted) July 2011
7. Teague, A., Bedient, P. and Guven, B. (2010). "Targeted Application of Seasonal Load Duration Curves using Multivariate Analysis in Two Watersheds Flowing into Lake Houston" (JAWRA-10-0003-P.R1). Journal of American Water Resources Association. Accepted.
8. Fang, Z, Zimmer, A., Bedient, P. B, Robinson, H., Christian, J., and Vieux, B. E. (2010). "Using a Distributed Hydrologic Model to Evaluate the Location of Urban Development and Flood Control Storage". Journal of Water Resources Planning and Management, ASCE, Vol. 136, No. 5, September 2010, ISSN 0733-9496/2010/5-597-601.
9. Fang, Z., Bedient, P. B., Benavides J.A, and Zimmer A. L. (2008). "Enhanced Radar-based Flood Alert System and Floodplain Map Library". Journal of Hydrologic Engineering, ASCE, Vol. 13, No. 10, October 1, 2008, ISSN 1084-0699/2008/10-926-938.
10. Gomez, D. E., De Blanc, P. C., Rixey, W., Bedient, P.B., Alvarez, P. J.J. (2008), "Evaluation of Benzene Plume Elongation Mechanisms Exerted by Ethanol Using RT3D with a General Substrate Interaction Module" Water Resource Research Journal, Vol. 44, May.
11. Rifai, H.S., Borden, R. C., Newell, C. J., and Bedient, P.B. "Modeling Dissolved Chlorinated Solvents in Groundwater and Their Remediation," in SERDP monograph on Remediation of Dissolved Phase Chlorinated Solvents in Groundwater, (accepted) 2007.
12. Bedient, P. B., Holder, A., and Thompson, J. F., and Fang, Z. (2007). "Modeling of Storm water Response under Large Tailwater Conditions – Case Study for the Texas Medical Center". Journal of Hydrologic Engineering, Vol. 12, No. 3, May 1, 2007.
13. Capiro, N.L., Stafford, B.P., Rixey, W.G., Alvarez, P.J.J. and Bedient, P.B. "Fuel-Grade Ethanol Transport at the Water Table Interface in a Pilot-Scale Experimental Tank" Water Research, 41(3), pp. 656-654, 2007.

14. Bedient, P.B., Rifai, H.S., Suarez, M.P., and Hovinga, R.M. "Houston Water Issues" Chapter in Water for Texas. Jim Norwine and J.R. Giardino, Eds. pp. 107-121, 2005.

15. Characklis, G.W., Griffin, R.C., and Bedient, P.B. "Measuring Long-term Benefits of Salinity Reduction" Journal of Agricultural and Resource Economics, 30 (1) (2005): 69-93.

16. Bedient, P.B., Horsak, R.D., Schlenk, D., Hovinga, R.M., and Pierson, J.D. "Environmental Impact on Fipronil to Louisiana Crawfish Industry" Environmental Forensics (2005): 289-299.

17. Characklis, G. W., Griffin, R.C., and Bedient, P.B. "Measuring the Long-term Benefits of Salinity Reduction" Journal of Agricultural and Resource Economics, 30(1), pp.69-93, 2005.

18. Vieux, B.E. and Bedient, P.B. "Assessing urban hydrologic prediction accuracy through event reconstruction" Journal of Hydrology, 299(3-4), pp. 217-236. Special Issue on Urban Hydrology, 2004.

19. Thompson, J.F. and Bedient, P.B. "Urban Storm Water Design and Management" The Engineering Handbook, Chapter 94, CRC Press, 2004, 21 pp.

20. Capiro, N.L. and Bedient P.B. "Transport of Reactive Solute in Soil and Groundwater" The Encyclopedia of Water, John Wiley and Sons, Inc., New York, NY, USA pp. 524-531, 2005.

21. Bedient, P.B., Holder, A., and Benavides, J. "Advanced Analysis of T.S. Allison's Impacts" submitted to Jn. of American Water Resources Assn., 2004.

22. Bedient, P. B., A. Holder, J. Benavides, and B. Vieux "Radar-Based Flood Warning System applied to TS Allison, ASCE Journal of Hydrologic Engineering, 8(6), pp 308-318, Nov, 2003.

23. Glenn, S., Bedient, P.B., and B. Vieux "Ground Water Recharge Analysis Using NEXRAD in a GIS Framework" submitted to Ground Water, October 2002.

24. Bedient, P.B., Vieux, B.E., Vieux, J.E., Koehler, E.R., and H.L. Rietz "Mitigating Flood Impacts of Tropical Storm Allison" accepted by Bulletin of American Meteorological Society, 2002.

25. El-Beshry, M., Gierke, J.S., and P.B. Bedient "Practical Modeling of SVE Performance at a Jet-Fuel Spill Site" ASCE Journal of Environmental Engineering pp. 630-638, (127) 7, July 2001.

26. El-Beshry, M.Z., Gierke, J.S., and P.B. Bedient "Modeling the Performance of an SVE Field Test" in Chapter 7, Vadose Zone Science and Technology Solutions, Brian B. Looney and Ronald W. Falta, editors, Vol. II, pp. 1157-1169, (2000).

27. Rifai, H.S., Brock, S.M. Ensor, K.B., and P.B. Bedient "Determination of Low-Flow Characteristics for Texas Streams" ASCE Journal of Water Resources Planning and Management, (126)5, pp.310-319, September-October 2000.

28. Bedient, P.B., Hoblit, B.C., Gladwell, D.C., and B.E. Vieux "NEXRAD Radar for Flood Prediction in Houston" ASCE Journal of Hydrologic Engineering, 5(3), pp. 269-277, July 2000.

29. Hamed, M.M., Nelson, P.D., and P.B. Bedient "A Distributed Site Model for Non-equilibrium Dissolution of Multicomponent Residually Trapped NAPL" Environmental Modeling and Software, (15), pp. 443-450, September 2000.

30. Holder, A.W., Bedient, P.B., and C.N. Dawson "FLOTRAN, a Three-dimensional Ground Water Model, with Comparisons to Analytical Solutions and Other Models" Advances in Water Resources, pp. 517-530, 2000.

31. Rifai, H.S., Bedient, P.B., and G.L. Shorr "Monitoring Hazardous Waste Sites: Characterization and Remediation Considerations" Journal of Environmental Monitoring, 2(3), pp. 199-212, June 2000.

32. Hoblit, B.C., Baxter, E.V., Holder, A.W., and P.B. Bedient "Predicting With Precision" ASCE Civil Engineering Magazine, 69(11), pp. 40-43, November 1999.

33. Bedient, P.B., Holder, A.W., Enfield, C.G., and A.L. Wood "Enhanced Remediation

Demonstrations at Hill Air Force Base: Introduction" Innovative Subsurface Remediation: Field Testing of Physical, Chemical, and Characterization Technologies, Mark L. Brusseau, et al., eds., pp. 36-48, American Chemical Society, Washington, DC, 1999.

34. Holder, A.W., Bedient, P.B., and J.B. Hughes "Modeling the Impact of Oxygen Reaeration on Natural Attenuation" Bioremediation Journal, 3(2): 137-149, June 1999.
35. Characklis, G.W., Griffin, R.C., and P.B. Bedient "Improving the Ability of a Water Market to Efficiently Manage Drought" Water Resources Research, (35)3, 823-831, March 1999.
36. Vieux, B.E. and P.B. Bedient "Estimation of Rainfall for Flood Prediction from WSR-88D Reflectivity: A Case Study, 17-18 October 1994" Weather and Forecasting, 1998 American Meteorological Society, 13:2, 407-415, June 1998.
37. Bedient, P.B. "Hydrology and Transport Processes" Subsurface Restoration, C.H. Ward, J.A. Cherry and M.R. Scalf, editors, Ann Arbor Press, Chelsea, MI, 59-73, 1997.
38. Hamed, M.M. and P.B. Bedient "On the Performance of Computational Methods for the Assessment of Risk from Ground-Water Contamination" Ground Water, 35(4), 638-646, July-August 1997.
39. Hamed, M.M. and P.B. Bedient "On the Effect of Probability Distributions of Input Variables in Public Health Risk Assessment" Risk Analysis, 17(1), 97-105, 1997.
40. Hamed, M.M., Bedient, P.B., and J.P. Conte "Numerical Stochastic Analysis of Groundwater Contaminant Transport and Plume Containment" Journal of Contaminant Hydrology, 1996, 24 pp.
41. Hamed, M.M., Bedient, P.B., and C.N. Dawson "Probabilistic Modeling of Aquifer Heterogeneity Using Reliability Methods" Advances in Water Resources, 19(5), 277-295, 1996.
42. Sweed, H., Bedient, P.B., and S.R. Hutchins "Surface Application System for In-Situ Bioremediation: Site Characterization and Modeling" Groundwater Journal, 34(2), 211-222, 1996.
43. Hamed, M.M., Conte, J.P., and P.B. Bedient "Uncertainty Analysis of Subsurface Transport of Reactive Solute Using Reliability Methods" Groundwater Models for Resources Analysis and Management, CRC Press, Inc., Chapter 8:123-135 1995.
44. Hamed, M.M., Conte, J.P., and P.B. Bedient "Probabilistic Screening Tool for Groundwater Contamination Assessment" ASCE Journal of Environmental Engineering, 121(11): 767-775, (1995).
45. Rifai, H.S. and P.B. Bedient "A Review of Biodegradation Models: Theory and Applications" Groundwater Models for Resources Analysis and Management, CRC Press, Inc., Chapter 16:295-312 (1995).
46. Rifai, H. S., Newell, C. J., Bedient, P.B., Shipley, F.S., and R.W. McFarlane, The State of the Bay, The Galveston Bay National Estuary Program, Webster, TX, 232 pp. (1994).
47. Rifai, H.S. and P.B. Bedient "Modeling Contaminant Transport and Biodegradation in Ground Water" Advances in Environmental Science Groundwater Contamination, Volume I: Methodology and Modeling, Springer-Verlag, New York, NY (1994).
48. Bedient, P.B. and H.S. Rifai "Modeling in Situ Bioremediation" In Situ Bioremediation, When Does It Work?" National Academy Press, pp. 153-159 (1993).
49. Rifai, H. S., Bedient, P.B., Hendricks, L.A., and K. Kilborn "A Geographical Information System (GIS) User Interface for Delineating Wellhead Protection" Ground Water, 31:3, pp. 480-488 (1993).
50. H. S. Rifai, Newell, C. J., and P.B. Bedient "Getting to the Nonpoint Source with GIS" Civil Engineering, June, pp. 44-46 (1993).

51. H. S. Rifai, Newell, C. J., and P.B. Bedient "GIS Enhances Water Quality Modeling" GIS World, August, pp. 52-55 (1993).

52. Bedient, P.B., Schwartz, F.W., and H.S. Rifai "Hydrologic Design for Groundwater Pollution Control" Handbook of Hydrology, McGraw Hill, pp. 29.1-29.47 (1993).

53. Wise, W.R., Robinson, G.C., and P.B. Bedient "Chromatographic Evidence for Nonlinear Partitioning of Aromatic Compounds Between Petroleum and Water" Ground Water, 30(6): 936-944. (Nov. - Dec. 1992).

54. Charbeneau, R.J., Bedient, P.B., and R.C. Loehr, Groundwater Remediation, Technomic Publishing Co., Inc., Lancaster, PA, 188 pages (1992).

55. Bedient, P.B. and H.S. Rifai "Ground Water Contaminant Modeling for Bioremediation: A Review" Journal of Hazardous Materials, 32:225-243 (1992).

56. Kilborn, K., Rifai, H.S., and P. B. Bedient "Connecting Groundwater Models and GIS" Geo Info Systems, pp. 26-31, (February 1992).

57. Rifai, H. S. and P. B. Bedient "Modeling Contaminant Transport and Biodegradation in Ground Water" To be published in Textbook: Advances in Environmental Science Groundwater Contamination, Volume I: Methodology and Modeling, Springer Verlag, (In Press) (September 1991).

58. Newell, C.J., Rifai, H.S., and P.B. Bedient "Characterization of Non-Point Sources and Loadings to Galveston Bay" Galveston Bay National Estuary Program, Houston, Texas, 150 pp (October 1991).

59. Rifai, H.S., Long, G.P., and P.B. Bedient "Modeling Bioremediation: Theory and Field Application" In Situ Bioreclamation Applications and Investigations for Hydrocarbon and Contaminated Site Remediation, Ed. by R. E. Hinchee and R. F. Olfenbuttel, Battelle Memorial Institute, Butterworth-Heinemann, Boston, (1991).

60. Kilborn, K., Rifai, H.S., and P.B. Bedient "The Integration of Ground Water Models with Geographic Information Systems (GIS)" 1991 ACSM/ASPRS 10 Annual Convention, Baltimore, Maryland, In Technical Papers, vol. 2, pp. 150-159, (March 1991).

61. Wise, W.R., Chang, C.C., Klopp, R.A., and P. B. Bedient "Impact of Recharge Through Residual Oil Upon Sampling of Underlying Ground Water" Ground Water Monitoring Review, pp. 93-100 (Spring 1991).

62. Rifai, H.S. and P.B. Bedient "Comparison of Biodegradation Kinetics with an Instantaneous Reaction Model for Ground Water" Water Resource. Res. 26:637-645 (1990).

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64. Newell, C.J., Haasbeek, J.F., and P.B. Bedient "OASIS: A Graphical Decision Support System for Ground Water Contaminant Modeling" Ground Water 28:224-234 (1990).

65. Chiang, C.Y., Wheeler, M.F., and P.B. Bedient "A Modified Method of Characteristics Technique and Mixed Finite Elements Method for Simulation of Ground Water Contaminant Transport" Water Resource. Res. 25:1541-1549 (1989).

66. Todd, D.A., Bedient, P.B., Haasbeek, J.F., and J. Noell "Impact of Land Use and NPS Loads on Lake Water Quality" ASCE J. Environmental Engr. Div. 115:633-649 (1989).

67. Borden, R.C., Lee, M.D., Thomas, J.M., Bedient, P.B., and C.H. Ward "In Situ Measurement and Numerical Simulation of Oxygen Limited Biotransformation" Ground Water Monit. Rev. 9:83-91 (1989).

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71. Freeberg, K.M., Bedient, P.B., and J.A. Connor "Modeling of TCE Contamination and Recovery in a Shallow Sand Aquifer" Ground Water 25:70-80 (1987).

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Conference Proceedings and Other Technical Publications

1. Juan, A., Fang, Z., and Bedient, P. B. (2012). "Flood Warning Indicator: Establish a Reliable Radar-Based Flood Warning System for Sugar Land, Texas", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.
2. Deitz, R., Christian, J. K., Wright, G., Fang, Z., and Bedient, P. B. (2012). "Linkage of Rainfall-Runoff and Hurricane Storm Surge in Galveston Bay", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.
3. Bedient, P. B., Doubleday, G., Sebastian, A., and Fang, Z. (2012). "Distributed Hydrologic Modeling of LID in the Woodlands, Texas", American Geophysical Union (AGU) 2012 Fall Meeting, San Francisco, CA, December 3-7.
4. Burcham, M. ,Bedient,P., McGuire, T., Adamson, D., . New Ch., (2012) Occurrence of Sustained Treatment Following Enhanced Anaerobic Bioremediation at Chlorinated Solvent Sites□, AGU Fall Meeting, San Francisco, California, December 3-7 2012
5. Fang, Z. and Bedient, P., Performance Evaluation of a NEXRAD-Based Flood Warning during Recent Events in 2012□, AGU Fall Meeting, San Francisco, California, December 3-7 2012
6. Juan, A., Fang, Z. and Bedient, P., Radar-based Flood Warning Indicator for the Upper Oyster Creek Watershed in Sugar Land, Texas□ *AGU* Fall Meeting, San Francisco, California, December 3-7 2012
7. Environmental and Water Res. Inst. (EWRI) 2012 Congress, Organized three sessions for SSPEED research results. Albuquerque, New Mexico, May 20-24 2012.
8. Fang, Z. and Bedient, P. B. (2012). "Creating Flood Alert Systems in Coastal Areas", SSPEED Conference – Gulf Coast Hurricanes: Mitigation and Response, Houston, Texas, April 10.
9. Fang, Z. and Bedient, P. B. (2012). "Advanced Radar-Based Flood Warning System for Urban Areas and its Performance Evaluation", SSPEED Conference – Gulf Coast Hurricanes: Mitigation and Response, Houston, Texas, April 11.
10. Teague, A, and Bedient, P. B. (2011). "Visualization of Hydrologic Simulations with Pollutant Load Estimation for Cypress Creek Watershed, Houston, Texas". 2011 World Environmental and Water Resources Congress. Palm Springs California 22-26 May 2011.
11. Christian, J. K., Fang, Z., and Bedient, P. B. (2011). "Probabilistic Floodplain Delineation", 2011 World Environmental and Water Resources Congress, Palm Springs, California. May 22-26
12. Fang, Z., Juan, A., Bedient, P. B., Kumar, S., and Steubing, C. (2011). "Flood Warning Indicator: Establishing a Reliable Radar-Based Flood Warning System for the Upper Oyster Creek Watershed", ASCE/TFMA, TFMA 2011 Annual Conference, Sugar Land, Texas, April 11- 14.
13. Bedient, P. B. and Fang, Z. (2010). "Advanced Radar-based Flood Warning System for Hurricane-prone Urban Areas and Performance during Recent Events", 2nd International Conference on Flood Recovery, Innovation and Response (FRIAR), Milano, Italy, May 26-28.
14. Fang, Z., Juan, A., Bedient, P. B., Kumar, S., and Steubing, C. (2010). "Flood Alert System for Upper Oyster Creek Watershed in Sugar Land, Texas using NEXRAD, HEC-HMS, HEC-RAS, and GIS", ASCE/TFMA, TFMA 2010 Annual Conference, Fort Worth, Texas, June 7- 10.

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17. Teague, A. and Bedient, P. 2010. "Distributed Modeling of Water Quality in Cypress Creek Watershed, Houston, Texas". 21st Century Watershed Technology: Improving Water Quality and the Environment, EARTH University, Costa Rica, February 21-24, 2010.

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19. Teague, A. and Bedient, P. 2010. "Distributed Water Quality Modeling for a Drinking Water Source Watershed for the City of Houston, Texas". Conference Proceedings. World Environmental and Water Resources Congress. May 16-20, 2010, Providence, RI.

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22. Fang, Z. and Bedient, P.B. (2009). "Flood Inundation Prediction and Performance during Hurricane Ike". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Kansas City, Missouri, May 17-21.

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24. Ray, T., Fang, Z., and Bedient, P.B. (2009). "Assessment of Flood Risk Due to Storm Surge in Coastal Bayous Using Dynamic Hydraulic Modeling". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Kansas City, Missouri, May 17-21.

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26. Fang, Z. and Bedient, P.B. (2009). "Flood Warning Systems for Urban Flooding". Grand Challenges in Coastal Resiliency I: Transforming Coastal Inundation Modeling to Public Security, January 20-21, Baton Rouge, LA.

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29. Fang, Z. and Bedient, P.B. (2008). "Flood Inundation Prediction and Performance during Hurricane Ike". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

30. Bedient, P.B. and Fang, Z. (2008). "Predicting and Managing Severe Storms in the Gulf Coast through University Research". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

31. Robinson, H., Fang, Z. and Bedient, P.B. (2008). "Distributed Hydrologic Model Development in the Topographically Challenging Yuna River Watershed, Dominican Republic". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

32. Ray, T., Fang, Z. and Bedient, P.B. (2008). "Assessment of Flood Risk Due to Storm Surge in Coastal Bayous Using Dynamic Hydraulic Modeling". Proceedings of Severe Storm Prediction and Global Climate Impact in the Gulf Coast Conference 2008, Houston, Texas, October 28-31.

33. Fang, Z. and Bedient, P.B. (2008). "Floodplain Map Library (FPML): Innovative Method for Flood Warning System for Urban Watershed in Houston, TX". Proceedings of World Environmental & Water Resources Congress 2008, Environmental and Water Resources Institute (EWRI), ASCE, Honolulu, Hawaii, May 13-16.

34. Bedient, P.B., "Foresight Panel on Environmental Effects" Houston-Galveston Area Council, Houston, Texas, February 5, 2008

35. Bedient, P.B., Fang, Z., Hovinga, R,M., "Flood Warning System (FAS_2) Rice University Training, Houston, Texas, January 15, 2008

36. Bedient, P.B., Fang, Z., Hovinga, R,M., SSPEED Meeting, Houston, Texas, November 16, 2007

37. Fang, Z. and Bedient, P.B. "Real-time Hydraulic Prediction Tool – FloodPlain Map Library (FPML)". American Water Resources Association 2007 Annual Conference, Albuquerque, New Mexico, November 12-15, 2007

38. Fang, Z. and Bedient, P.B. "Enhanced NEXRAD Radar-based Flood Warning System with Hydraulic Prediction Feature: Floodplain Map Library (FPML)". American Geophysical Union 2007 Fall Meeting, San Francisco, CA. December 10-14, 2007

39. Fang, Z. and Bedient, P.B. "The Future of Flood Prediction in Coastal Areas" Severe Storm Prediction, Evacuation, and Education from Disasters Conference, Rice University, Houston Texas, May 8-10, 2007

40. Bedient, P.B. and Fang, Z. "Radar-based Flood Warning System Using Dynamic Floodplain Map Library." Proceedings of World Environmental & Water Resources Congress 2007, Environmental and Water Resources Institute (EWRI), ASCE, Tampa, Florida, May 15-19, 2007

41. Bedient, P.B., and C. Penland "A Radar Based FAS for Houston's Texas Medical Center" IDRC Conference, Davos, Switzerland, Aug, 2006.

42. Safiolea, E. and P.B. Bedient "Comparative Analysis of the Hydrologic Impact of Land Use Change and Subsidence in an Urban Environment" Proceedings of AWRA GIS Conference, Houston, TX, May 8-10, 2006.

43. Bedient, P.B., Fang, Z., and R. Hovinga "Prediction for Severe Storm Flood Levels for Houston Using Hurricane Induced Storm Surge Models in GIS Frame" Proceedings of AWRA GIS Conference, Houston, TX, May 8-10, 2006.

44. Fang, Z., Safiolea, E., and P.B. Bedient "Enhanced Flood Alert and Control Systems for Houston" Proceedings of 25th American Institute of Hydrology Conference, Baton Rouge, LA, May 21-24, 2006.

45. Gordon, R. and P.B. Bedient "Rice University Engineers Without Borders: An Exercise in International Service Learning" Proceedings of the ASEEducation Conference, Chicago, June 18-21, 2006.

46. Gordon, R., Benavides, J.A., Hovinga, R., Whitko, A.N., and P.B. Bedient "Urban Floodplain Mapping and Flood Damage Reduction Using LIDAR, NEXRAD, and GIS" Proceedings of the 2006 AWRA Spring Specialty Conference: GIS and Water Resources IV, Houston, TX, May 8-10, 2006.

47. Fang, Z. and P.B. Bedient "IP2 Houston Flood Alert and Response-2006" CASA Meeting, Estes Park, Co, October 16-17, 2006.

48. Safiolea, E., Bedient, P.B., and B.E. Vieux "Assessment of the Relative Hydrologic Effects of Land Use Change and Subsidence Using Distributed Modeling" (July 2005).

49. Holder, A.W., Hoblit, B., Bedient, P.B., and B.E. Vieux "Urban Hydrologic Forecasting Application Using the NEXRAD Radar in Houston" Proceedings of the Texas Section American Society of Civil Engineers, Austin, TX, pp. 279-288, April 5-8, 2000.

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52. Hamed M.M. and P.B. Bedient "Uncertainty Analysis of Natural Attenuation in Groundwater Systems," Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:43-48.

53. Hamed, M.M., Holder, A.W., and P.B. Bedient "Evaluation of Reaeration Using a 3-D Groundwater Transport Model" Proceedings of the In Situ and On-Site Bioremediation Symposium, New Orleans, LA, 1997, 1:75-80.

54. Holder, A.W., Bedient, P.B., and J.B. Hughes "TCE and 1,2-DCE Biotransformation Inside a Biologically Active Zone" Proceedings of the First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 18-21, 1:219-224, 1998.

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59. Burgess, K. S., Rifai, H. S., and P. B. Bedient "Flow and Transport Modeling of a Heterogeneous Field Site Contaminated with Dense Chlorinated Solvent Waste" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, TX (Nov. 10-12, 1993).

60. Hamed, M., Conte, J., and P. B. Bedient "Reliability Approach to the Probabilistic Modeling of Ground Water Flow and Transport" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, TX (Nov. 10-12, 1993).

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63. Bedient, P.B., Long, G.P., and H.S. Rifai "Modeling Natural Biodegradation with BIOPLUME II" Proceedings of the 5th International Conference, Solving Ground Water Problems with Models, Dallas, Texas, pp 699-714. (February 11-13, 1992).

64. Robinson, G.C. and P.B. Bedient "Modeling a Time-Variant Source of Contamination" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, Texas, pp. 531-540. (November 20-22, 1991).

65. Chang, C. and P. B. Bedient "Multiphase Unsaturated Zone Flow and Transport Model for Ground Water Contamination by Hydrocarbon" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, Texas, pp. 515-529 (November 20-22, 1991).

66. Bedient, P.B., Vance, L.A., and H.S. Rifai "Implementation of Wellhead Protection Programs Utilizing Geographical Information Systems" Proceedings of the Eighth National Conference on Microcomputers in Civil Engineering, University of Central Florida and The American Society of Civil Engineers, Orlando, Florida, pp. 87-90 (October 1990).

67. Rifai, H.S., Bedient, P.B., and C.J. Newell "Review and Analysis of the Toxicity Characteristics Composite Landfill Model" Proceedings of the Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection and Restoration, The Association of Ground Water Scientists and Engineers (NWWA), Houston, Texas, pp.143-157 (October 1990).

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69. Chang, C.C., Wise, W.R., Klopp, R.A., and P.B. Bedient "In Situ Source Release Mechanism Study at an Aviation Gasoline Spill Site: Traverse City, Michigan" Proceedings of the Fourth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical Methods, Las Vegas, NV, pp. 459-473 (May 1990).

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72. Smythe, J.M., Bedient, P.B., and R.A. Klopp "Cone Penetrometr Technology for Hazardous Waste Site Investigations" Proceeding of the Second National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring and Geophysical methods, Association of Ground Water Scientists and Engineers, Las Vegas, NV, pp. 71-94 (1989).

73. Rifai, H.S. and P.B. Bedient "Biorestoration Modeling of a Pilot Scale Field Experiment" Proceedings of the National Water Well Association on Solving Ground Water Problems with Models, Indianapolis, IN, pp. 1187-1203 (1989).

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78. Chiang, C.Y. and P.B. Bedient "Simplified Model for a Surcharged Stormwater System" Proceedings of the Third Int'l Conf. on Urban Storm Drainage, Goteborg, Sweden, pp. 387-396 (1985).

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81. Todd, D.A. and P.B. Bedient "Use of Qual-II to Model Stream Protection Alternatives" Proceedings of the ASCE 1984 National Conference on Environmental Engineering, Los Angeles, CA, June 1984, pp. 60-65 (1984).

Invited Lectures (Recent)

1. The Resilience and Adaptation to Climate Risks Workshop: NASA Johnson Space Center and the Houston/Galveston Area, March 8, 2012, Houston, Texas

2. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Hurricane Ike, Revisited,*" September 14, 2009, Houston, Texas.

3. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Severe Storm Prediction and Global Climate Impact in the Gulf Coast,*" Sponsored by American Institute of Hydrology. October 29-31, 2008, Houston, Texas. (Attended by over 150 guests and speakers).

4. Bedient, P.B., SSPEED Conference. Chair and Organizer, "*Severe Storm Prediction and Global Climate Impact in the Gulf Coast,*" Sponsored by American Institute of Hydrology. October 29-31, 2008, Houston, Texas. (Attended by over 150 guests and speakers).

5. Bedient, P.B., Robinson, and H., Fang, Z. (2008). "Distributed Hydrologic Model Development in the Topographically Challenging Yuna River Watershed, Dominican Republic". Meeting in Dominican Republic before the President October 20, 2008.

6. Bedient, P.B. (June, 2008) Plan for the Dominican Republic Flood Study, before the Ministers of Education, Environment, and Economic Development.

7. Bedient, P.B. "Advanced Flood Alert Systems in Texas" International Disaster Response Conference, Daves, Switzerland, August 28, 2006.

8. Bedient, P.B. "IP2 Flood Alert System for Houston" CASA Meeting NSF Review, UMASS. April, 2006.

9. Bedient, P.B. "Severe Storm Impacts in the Gulf Coast" Severe Storm Impacts and Disaster Response in Gulf Coast, Houston, Rice University, March 15-16, 2006.

10. Bedient, P.B. "Living with Severe Storms in the Gulf Coast- Scientia Lecture" Rice University, Houston, TX. (September 2005).

11. Bedient, P.B., Fang, Z., Safiolea, E., and B.E. Vieux "Enhanced Flood Alert System for Houston" 2005 National Hydrologic Council Conference: Flood Warning Systems, Technologies and Preparedness, Sacramento, California. (May 16-20)

12. Fang, Z. and Bedient, P.B. "Enhanced Flood Alert and Control Systems for Houston" Proceedings of the 25th American Institute of Hydrology Conference: Challenges of Coastal Hydrology and Water Quality. Baton Rouge, Louisiana, May 21-24, 2006.

13. Fang, Z., Bedient, P.B., and R. Hovinga "Prediction of Severe Storm Flood Levels for Houston Using Hurricane Induced Storm Surge Models in a GIS Frame" Proceedings of AWRA 2006 Spring Specialty Conference: GIS and Water Resources IV. Houston, Texas, May 8-10, 2006.

14. Bedient, P.B. "Impacts of Climate Change on Transportation Systems and Infrastructure" Gulf Coast Study, Lafayette, LA. (May 2005)

15. Capiro, N.L., Da Silva, M.L.B., Stafford, B.P., Alvarez, P.J.J., and P.B. Bedient "Changes in Microbial Diversity Resulting from a Fuel-Grade Ethanol Spill" Eighth International Symposium on In Situ and On-Site Bioremediation, Baltimore, MD. (June 2005).

16. Safiolea, E. and P. B. Bedient "Assessment of the Relative Hydrologic Effect of Land Use Change and Subsidence Using Distributed Modeling" EWRI Watershed Management Conference, Williamsburg, VA. (July 9-22, 2005)

17. Capiro, N.L., Stafford, B., He, X., Rixey, W.G., and P.B. Bedient "A Large-Scale Experimental Investigation of Ethanol Impacts on Groundwater Contamination" Presentation at the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds; Monterey, CA; May 2004.

18. Capiro, N.L., Da Silva, M.L.B., Stafford, B.P., Alvarez, P.J.J., and P.B. Bedient "Changes in Microbial Diversity Resulting from a Fuel-Grade Ethanol Spill" Accepted for Presentation at The Eighth International Symposium on In Situ and On-Site Bioremediation; Baltimore, MD. June 2005.

19. Safiolea, E. and P.B. Bedient "Analysis of Altered Drainage Patterns and Subsidence Impact Using a Distributed Hydrologic Model" AWRA Annual Water Resources Conference in Orlando FL, November, 2004.

20. Safiolea, E. and Philip B. Bedient " Assessment of the Relative Hydrologic Effect of Land Use Change and Subsidence using Distributed Modeling" EWRI Watershed Management Conference in Williamsburg VA, Jul19-22, 2005.

21. Bedient, P.B. and J.A. Benavides "Use of QPE and QPF for Flood Alert (FAS2) in the Houston, TX Test Bed" CASA NSF ERC Conference, " Estes Park, CO, October, 2004.

22. Capiro, N.L., Adamson, D.T., McDade, J.M., Hughes, J.B., and P.B. Bedient "Spatial Variability of Dechlorination Activity Within a PCE DNAPL Source Zone" Presentation The 7th International Symposium In Situ and On-Site Bioremediation; Orlando, FL; June 2003

23. Benavides, J.A. and P.B. Bedient "Improving the Lead-Time and Accuracy of a Flood Alert System in an Urban Watershed" 2003 AWRA Annual Conference, San Diego, California, November 2003.

24. Whitko, A.N. Bedient, P.B., and S. Johnson "Sustainable Flood Control Strategies in the Woodlands – Thirty Years Later" 2003 AWRA Annual Conference, San Diego, California, November 2003.

25. Safiolea E., Hovinga, R., and P.B. Bedient " Impact of Development Patterns on Flooding in Northwest Houston using LIDAR Data" 2003 AWRA Annual Conference, San Diego, California, November 2003

26. Benavides, J.A. and P.B. Bedient "Improving the Performance of a Flood Alert System Designed for a Rapidly Responding Urban Watershed" 2003 Conference on Flood Warning Systems Technologies and Preparedness, Dallas, Texas. October 2003.

27. Bedient, P.B., Holder, A., and Baxter Vieux "A Radar-Based Flood Alert System (FAS) Designed for Houston, TX" *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

28. Holder, A., Stewart, E., and P.B. Bedient "Modeling an Urban Drainage System with Large Tailwater Effects under Extreme Rainfall Conditions" *International Conference on Urban Storm Drainage*, Portland, OR, September 2002.

29. Glenn, S., Bedient, P.B., and B. Vieux "Analysis of Recharge in Ground Water Using NEXRAD in a GIS Format" *AWRA Summer Specialty Conference*, Keystone, CO, July, 2002.

30. Bedient, P.B. "Flood ALERT System (FAS) for Brays Bayou and the TMC" T.S. Allison: A Brays Bayou Event, Rice University Conference Presentation, November 13, 2001.

31. Bedient, P.B. "Flood ALERT System for the Texas Medical Center" Hurricanes and Industry, Houston Conference Presentation, November 7, 2001.

32. Bedient, P.B. and J.A. Benavides "Analyzing Flood Control Alternatives for the Clear Creek Watershed in a Geographic Information Systems Framework" presented at ASCE's EWRI Spring 2001 World Water & Environmental Resources Congress Conference.

33. Hoblit, B.C., Bedient, P.B., B.E. Vieux, and A. Holder "Urban Hydrologic Forecasting: Application Issues Using WSR-88D Radar" *Proceedings American Society of Civil Engineers Water Research, Planning and Management 2000 Conference,* Minneapolis, MN, August 2000.

34. Spexet, A., Bedient, P.B., and M. Marcon "Biodegradation and DNAPL Issues Associated with Dry Cleaning Sites" *Proc. Natural Attenuation of Chlorinated Solvents, Petroleum and Hydrocarbons Conference,* Bruce Alleman and Andrea Leeson eds., 5(1), pp. 7-11, Battelle Press, Columbus, Ohio, 1999.

ATTACHMENT B

Review of the LCP Chemicals Site, Brunswick, GA.

By Loren H. Raun, Ph.D.

March 13, 2015

Loren H. Raun

P. B. Bedient and Assoc., Inc

Review of the LCP Chemicals Site, Brunswick, GA.

I was retained on this project for the purpose of evaluating the development of the remedial goals proposed for the estuary impacted by the LCP Chemicals Site. My opinions are based on my professional experience in human health risk assessment, environmental science, environmental statistics and hydrogeology and review of relevant data summaries, figures and documentation to date, and are subject to change if and when additional information becomes available.

Section I. Qualifications

My educational background, research and professional experience and the review of documents provided are the basis of my opinions. I hold a Ph.D. degree from Rice University in Houston in Environmental Science and Engineering and a B.S. in geophysics from the University of Texas in Austin, and I have attached a curriculum vita including a list of peer-reviewed publications. I am a research faculty fellow in the Department of Statistics at Rice University, where I have been on faculty since 2003, and teach courses in human health risk assessment and environmental statistics. My research focuses most heavily on tracking health effects from pollution exposure. I have extensive experience as a risk assessment reviewer for state and local governments and have served on EPA Science Advisory Board, Risk and Technology Review Methods Panel.

Section II. Comments on Development of Remedial Goals

The ultimate selection of remedial goals (RGOs) for the estuary and the method to achieve these goals is based on analysis of a complex interaction between the contamination in sediment, surface water, groundwater, soil and human and ecological receptors. Although much data have been collected and sophisticated models used, there is a large degree of uncertainty associated with the RGOs. In the thousands of pages of analysis there are times when conservative assumptions (i.e., which would result in more restrictive RGOs) were applied but there are equally multiple junctures where decisions were made which result in underestimation of risk and RGOs. The overarching concern is that RGOs be protective in spite of the uncertainties and that remediation attains these RGOs in this dynamic environment. In general some factors which could compound to underestimate the RGO or add to the uncertainty in this FS include:

Failing to add risk from OU3 when estimating the RGO for OU1- The contamination has been separated into three operable units (OU) for study and management. These units are the original site (OU3), the groundwater (OU2) and the estuary (OU1). The RGOs for the estuary were developed based on a baseline human health risk assessment and ecological risk assessment. As part of the risk assessment, receptors are identified. An important receptor in the OU1 risk assessment is the high rate consumer of seafood. Important receptors for the OU3 risk assessment are the onsite resident, worker or trespasser. Risk assessment requires that all exposure pathways for a receptor be considered. Clearly, the high rate seafood consumer could also be a resident, worker or trespasser. In other words, the risk for the high rate consumer should be added to the risk of receptors considered in the OU3 risk assessment, and RGOs developed based on the added risk. While it is acceptable to separate the contamination into operable units for management, it is not justifiable to consider the risk in an operable unit in a vacuum.

Failing to add the risk from exposure to surface water or sediment- Within the risk assessment conducted for OU1, risk from human exposure to surface water and sediment were not included in the development of RGOs. The only risk considered was consumption of seafood. Any risk added from these other pathways would result in lower RGOs.

Underestimating consumption of contaminated food by relying on default exposure factors especially given a large portion of the local community is below the poverty level (exposure frequency, ingestion rate), and likely a sensitive subpopulation- The risk assessment relies on default exposure factors to estimate the intake of the seafood for the high rate consumer. A better understanding of the local consumption pattern is extremely important to correctly calculate the risk from seafood ingestion. With a high percentage of individuals and families below the poverty level, the community may be relying heavily on seafood for meals. It is conceivable that more than one meal a day is seafood. The exposure frequency could easily be underestimated. The intake rate (the amount of seafood eaten per meal) used in the risk assessment may also be underestimated. The relationship between income and weight (and presumably intake) can vary by gender, race-ethnicity and age. Increase in intake or exposure frequency will add risk for the consumption of seafood and result in lower RGOs.

Misrepresenting concentration levels by not including statistical confidence- Samples are taken to estimate concentrations of the true population parameters (e.g., mean) in a media or seafood. While the true population parameter is not known, we can identify an interval within which we are statistically confident the parameter may fall. It is never appropriate to assume thc sample average is the true mean, instead the upper or lower limit of the confidence limit is used. The sample average is used repeatedly in the FS to represent the true mean and no confidence intervals are presented. This adds to the uncertainty in the RGOs, depending upon where it is applied it will raise or lower the RGOS.

Basing decisions on small sample sizes without enough statistical power. Samples are taken in a media and compared to a threshold (standard) or concentrations from a previous year. It is not appropriate to compare a sample average to limits or other distributions directly. The comparison must consider the variability of the data (see previous comment) and the statistical power. The statistical power is a measure of whether enough samples were collected to be able to detect a difference between the concentrations and the threshold if one existed. All other factors being equal, more samples are required for highly variable data than lower variable data. Power is never discussed in this FS.

Misrepresenting decreases in concentration which are not statistically significant. Environmental data vary in time for many reasons. The determination of if a concentration is decreasing in a media is conducted with a statistical trend test. It is not appropriate or sound science to present a graph or concentrations and state they are decreasing without discussing if the decrease is statistically significant.

Screening out COCs which did not exceed screening levels/standards or were present in the background. When chemicals of concern are screened out of the risk assessment because they were below a standard or were present in the background, an analysis of the impact on the RGOs if they had been included in the risk assessment is appropriate in an uncertainty analysis. The polycyclic aromatic hydrocarbons found at the site are also found in the background, however they do pose an involuntary risk to the community from the environment and therefore should be consider in some manner. The COCs below a surface water screening level or sediment screening level could contribute risk and impact the RGOs,

especially for example, if screening levels were developed assuming 1x10-5 risk as an acceptable limit.

In general some factors which would interfere with the attainment of the RGO include:

- Discharge from groundwater to the estuary; no explanation is provided for why the remediated area has increased in concentration
- Use of the sample arithmetic average to calculate the RGO when this value should be used to estimate the limits of the true mean and should be evaluated using a method consistent with the underlying distribution of the data
- Selection of 50 foot grid cell averages which dilute the cell average
- Comparison of average to limit without incorporating statistical confidence (as discussed previously)

Specific discussion of all of these general uncertainties is not feasible given the extent of the analysis. However, specific discussion with respect to some aspects of the uncertainties are included below.

Specific Comments

Groundwater- Groundwater was not included in the risk assessment or evaluation of the remedy although it is heavily contaminated and in contact with the surface water. The report indicates that seeps directly along the formerly remediated area and up gradient of Eastern Creek do discharge contaminated groundwater, however, modeling indicates surface water dilution would make the contribution negligible. There are several concerns associated with this conclusion.

It is apparent that sediment contamination exists around the area remediated in 1999. It is possible that this is empirical evidence that the seeps are recontaminating the formerly remediated area and therefore, groundwater is in fact acting as a continuous source. The report uses a simple mass flux calculation to estimate the mass that the groundwater could contribute. The analysis indicated that the concentrations from the groundwater could not account for the concentration now seen in the remediated area. However, there is no explanation given as to how the concentration increased since the remediation. In a situation where a model does not match the measured values, it would be helpful to pinpoint what model input would in fact create

such a concentration. Is it physically possible to re-contaminate from the groundwater to the level found? The model input was conservative but not necessarily correct. There are multiple areas of uncertainty including: the use of some filtered groundwater sample concentrations when unfiltered are more appropriate for the pcbs and mercury (only unfiltered should be use), the gradient from two events (no indication if events reflect high or low conditions), the assumption of homogeneity in the lithology, constant flow direction, variable height of surface water. If the recontamination concentration could not be achieved from the groundwater, is there another source that should be considered such as the OU3 surface soils which are also not included in the evaluation of the estuary. An increase after remediation indicates we do not know the full extent of the current contamination as it is increasing in some locations.

The report then indicates that the concentrations discharged to the surface water from contaminated groundwater would not pose any concern because they would be diluted by the surface water. There are concerns with this analysis also. First, the report has established that the COCs of mercury and PCBs are not found in filtered surface water but in the colloidal suspension or in the sediment. If the groundwater discharges contamination to surface water, the contamination will partition more heavily to the sediment. Dilution will have a limited impact. Dilution assumes something like complete mixing. The report indicates that the area around the upper reaches do not experience inundation and therefore, complete mixing is not expected. Clearly, the Eastern Creek has received the brunt of the contamination. This may be because the location acts as a sink. Complete mixing would not occur in a sink.

There is a discussion of dilution of the seep pore water samples down to insiginificant levels. Groundwater would seep when the hydraulic head in the groundwater is higher than the surface water. Groundwater could reasonably seep into a bank above the water level contaminating the soil and sediment.

The report presents the difference in mercury concentration in surface water when only examining dissolved phase and when examining total. The information presented about the seep sampling does not indicate if the samples were filtered. The results could be highly misleading if the concentrations presented are in fact from filtered samples. Likewise, we do not expect to see PCBs in the dissolved phase but in the colloids in the sample.

The report indicates that the seeps occur where the water bearing sand is exposed along the marsh edges. Does the remedy consider the seeps? Will the seeps be aggravated by the remedy? Should the groundwater be retained near these surfaces, especially in the vicinity of transect 1 where concentrations are highest?

Fish Tissue

Appendix F is first discussed in the FS in terms of decrease in concentration of fish concentration over time. It is referenced in Figure 6-4B. The figure graphically shows the concentration range for striped mullet over time. While the concentrations in 2011 appear lower, and may be lower in reality, there is no statistically significant difference between the 2011 and 2007 concentrations according to this data. There are not enough samples to detect a difference between the concentrations (i.e., not enough statistical power).

This appendix presents a comparison of the change in concentration in seafood over the years from the Turtle River and the associated safe concentration level. The safe concentration intake level (gm/day) related to meals per week, is based on the level associated with the carcinogenic risk (limit = 1x10-4) or non-cancer hazard (limit =1), whichever is more restrictive. The calculation assumes 30 year exposure, 70 kg adult, and 70 year lifetime. There are three main issues which result in bias in the presentation of this data:

<u>Comparison between concentrations in seafood between years does not consider statistical confidence.</u>

The main report indicates that the concentration in seafood has decreased. The text of the FS focuses on the fish advisories showing decreases across years. While the advisories have decreased, this implies that the concentrations in the fish have decreased near the site. The decrease is largely overstated according to the data shown in Figure F-3B. It is not appropriate to compare the sample means or individual levels to benchmarks (as shown in the Figure) without considering the statistical confidence, especially with so few samples (sample size of 1 to 3). Sample sizes this low have very limited statistical power. Limiting this critique to comparisons with at least 3 samples, Figure F-3B data appear to indicate that are there two seafood types with a statistically significant decrease in concentration. Estimating concentrations from the plot of those types of seafood, blue crab and white shrimp may have a

statistically significant decrease while striped mullet, black drum, southern kingfish and spotted seatrout do not. There is uncertainty because of the low sample size, and the lack of use of statistics to provide a quantitative conclusion introduces a sense that the report is not presenting straightforward results but a bias.

Comparison between concentrations in seafood to the advisory threshold does not consider statistical confidence.

In addition, although the same plot implies that the mean of the blue crab was greater than the 1 meal per month limit in 2002 while in 2011 it is below that limit, this implication is not statistically founded. When the concentration of blue crab are statistically compared to the benchmark (95^{th} upper confidence limit of the blue crab), the concentrations are not below the 1 meal per month limit. This analysis of eyeball comparison is unsophisticated and tends toward bias.

Additive Risk not considered

Unfortunately, the seafood advisories appear to consider only one contaminant at a time, when a fish could actually contain both mercury, lead and PCBs. Where the risk may be below a 1 meal per month limit for PCB and mercury individually, the summation may exceed the limit. In addition, a similar scenario of additive risk exceeding a limit could occur if the risk was below the 1 meal per month limit for blue crab and for shrimp but if a receptor ate both, they could be above the limit. The 1 meal per month limit is based on the risk of 1x10-4 per seafood type per chemical. This type of simplification is not protective with multiple contaminants impacting many different types of seafood.

Development of RGOs and Determination of Areas Exceeding RGOs

Appendix G: Letter from EPA to Mr Gupta Re: Human Health Risk Assessment for the Estuary, Operable Unit One (OU 1): LCP Chemicals Superfund Site, Brunswick, Glynn County, Georgia

In development of the RGOs the only pathway that the EPA considers is consumption of fish. The risk from a local resident or trespasser exposure to OU3 or sediments from OU1 should be

added to the ingestion of contaminated food (finfish, clapper rail and shell fish). If the trespasser or resident also ate contaminated food, the carcinogenic risk would increase by as much as 3.3E-6, and 5.2E-5, respectively. These additions would result in a lowering of the sediment RGOs.

Attachment A presents the method to calculate area weighted average. While spatial weighting between the areas is reasonable, use of the average to represent an area is not statistically appropriate. The sample average is only an estimate of the mean concentration and will vary depending upon the number of samples collected. The true mean must be estimated through a confidence interval. The human health risk assessment consistently used the 95^{th} upper confidence limit of the mean with reference to EPA guidance requiring this. However there is not parity in the use of statistics or the sophistication of the statistics used in the FS or in the ecological risk assessment. Statistical confidence should be considered in the calculation in Attachment A. There is not enough information provided to determine if the underlying distribution of the data are normal. The data are likely not normal and contain high concentration outliers therefore, more sophisticated statistical methods should be employed within each area.

In the case of calculating the RGO, the *lower confidence limit* should be used. The outliers would have biased the spatial weighted area arithmetic averages high. The assumption of the Attachment is that fish body burden is related to the sediment. The sediment remedial goal was calculated as the sediment concentration divided by the hazard index or risk. Therefore, if the value used to represent the concentration is higher than it should be (e.g., the skewed arithmetic average instead of the lower confidence limit of the mean), the RGOs will be higher than they should be.

For example, the RGO for the clapper rail is currently:

Target tissue at 1e-4 risk: 19.42/1.54e-4= x/1e-4, I x=12.95

Sed RGO: 19.42/3.408 mg/kg average=12.95/x, x=2.3

If the concentration was lower than 3.408 by 1 mg/kg (which it could easily be given the range of concentrations), then the RGO would be 1.6 mg/kg instead of 2.3 mg/kg. The BAF approach is also dependent on the sediment concentration and would be equally impacted.

Identification of areas exceeding RGOs was also based on arithmetic average without consideration for statistical confidence in some location.

Cost of Remediation/Selection of Remedy

The restrictions on fishing, the potential health consequences due to exposure and the stress of living in or near a contaminated area have inflicted a burden on the local community. According to the census, this community is largely African American and between a quarter to just under a third of the population live below the poverty level. The cost associated with this burden is not considered in the remedy evaluation. Fishing advisories will not keep hungry community members from eating contaminated seafood. The cost savings from avoiding adverse health should be considered. Choosing a remedy which will provide the fastest route to safe levels with limited uncertainty should be the main objective. The most reliable remedy is removal. Considering the uncertainty in this assessment, the more protective RGOs should be applied.

The report indicates that the dredging would be more damaging to the habitat than other remedial measures, however, the previously remediated area recovered much sooner than anticipated (two years). In addition, the contamination is on the surface of the sediment, not at depth. Therefore, the contaminants should be removed and the marsh replanted in the same manner as the previously remediated area.

Section III. Documents Reviewed

1. *April, 2011 Baseline Ecological Risk Assessment for the Estuary at the LCP Chemical Site in Brunswick, Georgia, Site Investigation/Analysis and Risk Characterization (Revision 4)*
2. *April, 2011 Human Health Baseline Risk Assessment for the Estuary, Operable Unit 1, Marsh Trespasser, Fish and Shellfish Consumer, Clapper Rail Consumer, Final, LCP Chemicals Superfund Site, Brunswick, Georgia*
3. *January 2012 Human Health Risk Assessment for Upland Soils (Operable Unit 3) LCP Chemicals Site, Brunswick, Georgia*
4. *June 2, 2014 Draft Feasibility Study, Operable Unit No. 1 (Estuary), LCP Chemicals Superfund Site, Brunswick, Georgia (Draft)*

Curriculum Vitae

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Faculty Research Fellow and Lecturer
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Education

1998 Ph.D., Environmental Science and Engineering
Rice University
Thesis research: Statistical Investigation of Air Pollution, Human Exposure Assessment; empirical modeling of ozone monitoring data using 3-D kriging, correlated to personal monitoring and exposure, asthma incidence and decrease in lung function in children and athletes

1989 M.S., Environmental Science and Engineering
Rice University
Thesis research: Groundwater Pollution, Stochastic Groundwater Fate and Transport Modeling; developed probabilistic input distributions for groundwater transport parameters for a range of hydrogeologic environments and lithologies and evaluated EPA Land ban model EPACML, (Monte Carlo)

1986 B.S., Geophysics
University of Texas, Austin, Texas

Academic Experience

2003-present Faculty, Rice University, Statistics Department, environmental statistics and human health risk assessment. These are graduate classes in a lecture/project format. The environmental statistics class focuses on using statistical tools to assess current environmental contaminant data. Topics include: sampling decision, distributional assessment,

hypothesis testing (parametric and nonparametric), trend analysis and comparison tests to evaluate human health thresholds. The human health risk assessment class focuses on all aspects of environmental contaminant risk assessment and includes exposure and contaminant transport modeling. Positions held: Faculty Fellow (2011 to present), Lecturer (2008-2010 and 1999-2001).

1999 — Lecturer, University of Houston, Civil and Environmental Engineer Department, graduate air pollution transport. This is a graduate air pollution transport and modeling class.

Other Research and Work Experience

2014 summer — Visiting Scientist, Centers for Disease Control and Prevention, Atlanta Georgia, Air Pollution and Respiratory Health Branch, Division of Environmental Hazards and Health Effects, National Center for Environmental Health

2010-present — Senior Environmental Analyst, Bureau of Pollution Control and Prevention, City of Houston. Review private landowner groundwater contaminant plume transport potential and human health risk for Municipal Setting Designation City ordinance. Conduct human health assessment of ambient air pollution data in the Houston Region.

2006-2010 — Senior Environmental Analyst, Mayor's Office City of Houston Office of Environmental Programming. Focused on statistical evaluation and human health assessment of ambient air toxics in the Houston Region. Major contributor to: City ordinance to control ambient air toxics concentrations; assessed and commented on EPA policy impacting the city (e.g., proposed rule on National Emission Standards for Hazardous Air Pollutants from Petroleum Refineries, air toxic regulation for refineries data collection analysis as impacting Houston, residual risk assessment).

2002 -2005 — Air Pollution Researcher, University of Houston, Civil and Environmental Engineering Department, Researcher. Director of air sampling program to support dioxin congener Total Maximum Daily Load (TMDL) project in Houston Region. Sampled ambient and wet and dry deposition flux, evaluated partitioning and developed multiple regression relationships between congeners and meteorological parameters.

2000	Risk Assessment Reviewer, Texas Railroad Commission, Risk Assessment reviewer and co-author of risk assessment guidance for pipeline/oilfield waste including development of default screening levels, dilution attenuation factors, and method for TPH surrogate.
1996 – 1999 (May)	Risk Assessment Regulatory Reviewer, Applied Earth Sciences Consulting, Texas Natural Resource Conservation Commission-LPST Division Risk Assessment Reviewer through a state privatization contract, reviewed more than 200 risk assessments of leaking underground storage tanks including groundwater, soil and air transport.
1999 - 2005	Instructor and Course Author, Applied Environmental Statistics Course (offered through Darcy Environmental),taught all aspects of environmental statistics for risk assessment (including parametric and nonparametric hypothesis testing, trend analysis, normality testing) to professionals in a two day continuing education course at various locations across southern United States several times a year (CEU for Texas Natural Resource Conservation Commission).
1995 - 2000	Risk Assessment Instructor, ASTM Risk-Based Corrective Action Trainer, taught all aspects of risk assessment including toxicology, data assessment, fate and transport to professionals in a three day continuing education course at various locations across the United States.
1989 - 1995	Risk Assessor Statistician and Modeler, (OHM Corporation in Austin, Tx, Jacobs Engineering in St. Louis, Mo and Houston, Tx, Woodward-Clyde Houston, Tx and Applied Earth Sciences, Houston, Tx), risk assessor, environmental modeler and statistician employing groundwater transport (e.g., Modflow, Bioplume/MOC, Domenico), soil vapor transport (Farmer's, Thibideaux-Hwang, Sesoil) and air transport (Box, Gaussian, ISCLT).

Awards and Honors

Eleanor and Mills Bennett Fellowship in Environmental Science, Rice University fellowship awarded to outstanding graduate students, 1996-1997, 1997-1998.

Blackburn Scholarship awarded to fund Environmental Research in Human Health Air Pollution Exposure and Risk Assessment, 1997.

Blackburn Award, Sixth Annual Rice Environmental Conference, for "An Improved Procedure to Estimate Human Exposure-Based Alternative Primary Ambient Ozone Standards," 1998.

National trainer for the ASTM Risk Based Corrective Action Standard, 1996-date.

Designed, Sponsored and Implemented Community Air Pollution Reduction/Awareness Programs:

- Mayor's Keep Houston Beautiful Award, No Mow No More Esplanade Naturalization Program, 2007.
- Governor's Award, Texas Environmental Excellence Award, Condit Elementary School, Condit Kids for Clean Air, 2002
- Mayor's Keep Houston Beautiful Award, Condit Elementary School, Condit Kids for Clean Air, 2002
- National Pollution Prevention Round Table, Most Valuable Pollution Prevention Program, 2002, Condit Elementary School, Condit Kids for Clean Air, 2002
- BP Environmental Excellence Award, Condit Elementary School, Condit Kids for Clean Air, 2002

Major Research Interests

Environmental statistics, human health risk assessment, air, soil and ground water pollution fate and transport.

Submitted Publications

Hoyt, Daniel and Loren H Raun, "Measured and Emission Factor Estimated Benzene and VOC Emissions at a Major US Refinery/Chemical Plant: Comparison and Prioritization," Atmospheric Environment, submitted March, 2015.

Publications

Raun Loren H, Kathy Ensor, Laura A. Campos, and David Persse. "Factors affecting ambulance utilization for asthma attack treatment: understanding where to target interventions," Public Health, March 2015.

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Ensor, Kathy, Loren Raun, and David Persse. "A case-crossover analysis of out-of-hospital cardiac arrest and air pollution." Circulation. Volume 127, pages 1192-1199, Feb 2013.

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Hopkins, Loren P., Katherine Ensor, Matthew P. Fraser, and Hanadi S. Rifai, "Evaluation of the Use of Empirical Ambient Ozone Pollutant Modeling and Subject Activity Logs as an Indirect Measurement of Exposure," Proceedings of the Air and Waste Management Association 91st Annual Meeting, San Diego, California, June, 1998. A&WMA, Paper # 98-MA12.01

Hopkins, Loren P., Katherine B. Ensor and Hanadi S. Rifai, "Empirical Evaluation of Ambient Ozone Interpolation Procedures to Support Exposure Models", Journal of the Air and Waste Management Association, V49, pp. 839-846. 1999

Hopkins, Loren P., Hanadi S. Rifai and Paul LaWare, "Using Compounding Risk as a Guide for Establishing Area-Specific RBCA Risk Limits," Proceedings of the NGWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, November, 1996.

Hopkins, Loren P. and David Bratberg, "Nationwide Survey of Risk Assessment and Risk-Based Corrective Action Procedures," Proceedings of the NGWA Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, November, 1995.

Bratberg, David and Loren P. Hopkins, "A Comparison of Risk Assessment and Risk-Based Corrective Action Procedures in the United States," Proceedings of the Hazardous Materials Control Resources Institute Superfund XV Conference, Washington, D.C., November 6-8, 1995.

Rifai, Hanadi and Loren P. Hopkins, "The Natural Attenuation Toolbox: A Decision Support System for Evaluating the Appropriateness of Natural Remediation as A Remedial Alternative," Proceedings of the Third Annual Symposium on Bioreclamation, San Diego, Ca., April 1995.

Raparthi, Viru and Loren P. Hopkins, "A Risk Based Evaluation of the Appropriateness of Natural Remediation as a Remedial Alternative in the Vadose Zone," Proceedings of the NGWA Outdoor Action Conference and Exposition on Aquifer Remediation, Ground Water Monitoring, Geophysical Methods, and Soil Treatment, May 2-4, 1995.

Hopkins, Loren P. and Viru Raparthi, "EPA and State Policies on Adjustment of Toxicity Factors for Dermal Absorption," for the Texas Natural Resource Conservation Commission, July, 1994.

Hopkins, Loren P. and Michael F. Marcon, "The Use of Kriging to Optimize Sampling for Risk Assessment and Remediation," Proceedings of the SPE/EPA Environmental Conference 1995.

Durham, Lisa A., Jeff Carman, and Loren P. Hopkins, "Delineation of Hydrostratigraphic Units in a Carbonate Aquifer," Proceedings of the Geological Society of America Meeting, October, 1992.

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LaGoy, Peter K., and Loren P. Hopkins, "Practical Considerations in Developing Site Specific Cleanup Levels," Remediation. January, 1991.

Newell, Charles J., Loren P. Hopkins, and Philip B. Bedient. "The HGDB: A New Hydrogeologic Database and Groundwater Modeling Tool," Journal of Ground Water, September-October 1990.

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Other Recent Scholarly Works

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"Houston Regional Benzene Air Pollution Reduction: A Voluntary Plan for Major Sources," City of Houston Mayor's Office of Environmental Programming, Department of Health and Human Services, Bureau of Air Quality Control, major author. 2006. Using results from the TRI, in conjunction with EPA's RSIE and NATA models, the major potential air toxic emitters posing the highest risk to Houstonians were identified. The ambient air toxic data from monitors up and downwind of these facilities were assessed. Statistically significant differences between air contaminant distributions were noted and established as baseline conditions. Facility and process specific emission reduction mechanism recommendations were made. Facilities entering the voluntary agreement would implement emission reduction mechanisms beyond those currently required by regulation. Subsequent reductions in air concentrations from the baseline condition would be tracked. http://www.greenhoustontx.gov/reports/benzenereductionplan.pdf

City of Houston Code of Ordinances, Draft Nuisance Ordinance; Drafted amendment to the nuisance ordinance to specifically address ambient air concentrations of certain hazardous air pollutants.

Current or Recent Board/Committee Participation

Houston Wilderness Board, 2014 to present.
EPA Science Advisory Board, Risk and Technology Review Methods Panel, 2009
Houston Region Air Quality Task Force, 2007
Houston Exposure to Air Toxics Study Advisory Committee, 2007 to 2009

Recent Multiple Reviews or Significant Edits

State of Health, Houston/Harris County, Texas, 2008, 2009, 2010, 2011. Houston Department of Health and Human Services.

Counting on Quality of Life: An Environment Indicator Report, December 2007, Center for Houston's Future.

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Raun, Loren, "What is actually emitted from Area Sources: Results of a Special Study of Metals Recyclers," EPA National Air Quality Conference - Ambient Monitoring 2012, Assessment and Special Studies, Denver, CO, May, 16,2012

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Memberships

Air and Waste Management Association
American Association for the Advancement of Science
American Heart Association
Houston Wilderness, Member of the Board
International Society of Environmental Epidemiology
Society of Public Health Educators

Current Funding

Houston Endowment- "Phase II- The impact of air pollution on the incidence of asthma attacks in Houston"
NIH- "Sustainable Solutions to Metal Air Pollution in Disadvantaged Neighborhoods"

March 16, 2015

Comments on:
LCP Chemicals Site Proposed Plan
prepared by
Environmental Stewardship Concepts, LLC
on behalf of
Glynn Environmental Coalition

Questions for EPA:
Based on comments and questions from the community and detailed review of the Proposed Plan, Human Health Risk Assessment and Baseline Ecological Risk Assessment, and in consultation with the Glynn Environmental Coalition, ESC, LLC has not been able to successfully determine the correct answer to a number of questions. Therefore, we submit the following questions to EPA:

1) What sampling will be undertaken to determine the full extent of contamination in the Turtle River estuary system as a result of the LCP facility activities? This question is based on the data showing Aroclor 1268 congener profiles on Sapelo Island sediments, human tissues and in dolphins from the Turtle River.

2) How will EPA incorporate new methods for cleaning up contaminated sediments that have not been considered in the FS?

3) What corrections will EPA make to the Human Health Risk Assessment to account for the errors and omissions in human exposures and toxicity of contaminants, considering that site use is greater than estimated, fish consumption is greater than the value used and that dioxin contribution has not been included in the toxicity of site contaminants?

4) How does the Proposed Plan address the contamination of dolphins and other marine life that are not now included in the BERA or in another aspect of the RI/FS?

5) What additional sampling or analysis will EPA conduct in order to account for the omission of fate and transport of PCBs and other contaminants by *Spartina* grasses?

6) Will EPA require ecological risk evaluation of dolphins, based on all mammalian data, such as mink and other marine mammals and evaluate the toxicity to mink and river otter on the effects (toxicity) of PCBs as congeners?

7) The toxicity evaluations of the sediment have not adequately captured the anticipated toxicity, thus, how will EPA re-evaluate the sediment toxicity to account for this information?

8) Will EPA require measurement and assessment of dioxin in the site contaminants, EPA having included reference to the cleanup at Lake Onandoga that has both PCBs and dioxins, and obviously admits the occurrence of dioxins in this type of site.

9) Will EPA require alteration of the assessment of damage to the marsh to account for the factual errors present in the statements of damage to the marsh based on out-dated methods that are not used in working in salt marshes?

10) What provisions in the Record of Decision will EPA make for the consequences of rising sea-level and climate change on the remedy and the site?

Table of Contents

Introduction

Environmental Stewardship Concepts, LLC is submitting comments on the LCP Chemicals Site Proposed Plan on behalf of Glynn Environmental Coalition. We cover specific comments on the Proposed Plan report, as well as several areas of concern including institutional controls, fish consumption, site boundaries, new technologies, and a literature review of PCB toxicity.

Specific LCP Chemical Site OU1 Proposed Plan Comments

Several items in the LCP OU1 Proposed Plan raise concerns that threaten the goal of a cleanup that will protect human and environmental health.

- There needs to be more sediment removal, compared to capping and thin-cover placement, because sediment removal is a more effective and permanent cleanup option.
- A re-planting program of *Spartina* post-remediation should be one of the first monitoring efforts to help speed up ecosystem recovery.
- The evaluation of the way the LCP site is used by community members is inaccurate, specifically seen in the fish consumption rates used in the risk assessment that set the basis for achieving specific cleanup goals.
- Atlantic bottlenose dolphins are an essential part of the local ecosystem and are not included in the ecological risk assessment for the site.

- Thin-cover placement, or enhanced natural recovery, is not a sustainable recovery method.
- The Human Health Risk Assessment does not accurately assess human health risks because fish consumption values are wrong, and because dioxins and furans are not included in the exposure toxicity assessment.
- *Spartina* accumulates PCBs, but this fact is not considered in the estimates of PCB contamination or fate and transport.

These specific issues are each discussed further below.

Sediment Removal vs. Capping

Capping and thin-cover placement have been proposed as cleanup methods for large sections of the site. However, both of these methods cover up, rather than clean up, the contaminants of concern. Sediment removal is a viable option for the LCP site and should be implemented on a larger scale.

While the Proposed Plan claims that thin-cover placement is a well-studied method for site cleanup, there are not enough documented success stories of using thin-layer caps at contaminated sites to say that this remediation method is well-studied. Many of the examples of thin-layer capping for sediment remediation found in the LCP Feasibility Study are not salt marshes but bays, harbors or other large waterways like rivers (USEPA 2014). These are all environments with greater water depths and different hydrology than a typical salt water marsh. Thus, the thin-layer capping sediment remediation examples in the Proposed Plan are not very relevant to the LCP site.

Furthermore, thin-cover placement is not a sustainable recovery method. By nature, the layer of sediment will be thin, six inches or less, and will not be adequate to contain any contaminants in the marsh bed. A thin-cover layer is easily disturbed. For example, a storm surge could easily move the sediment around, as could scour from a passing boat. In addition, animals living in the marsh like crabs and worms will burrow into sediment and disturb the layer, causing bioturbation of the cap.

As larger storms and hurricanes occur more often due to climate change, there will be an increased chance that the contaminated sediments at this site will be disturbed and that neither thin-cover placement nor capping will be protective. Armoring of a wetland cap is not affective as the tidal flow will simply redirect, carrying sediment with it.

Salt Marsh Grasses

The RI, FS and Proposed Plan make two substantial and fundamental omissions with regard to *Spartina* grasses in the estuary and on the LCP site. The first omission is failure to take into account the fact that *Spartina* does take up contaminants, and the site of accumulation may be any and all parts of the plant, including the rhizome, roots, stalk or stem, and leaf. The failure to account for these processes of uptake and accumulation means that contaminants contained in the living medium are not accounted in the estimate of total contamination on site. The second consequence is that the fate and transport of contaminants left on site under the Fs options and in the

Proposed Plan do not include the movement of contaminants via *Spartina* in the marsh. Both of these components of fate and transport of PCBs are potentially significant pathways and compartments for contaminants. The RI and FS really need to be redrafted to include *Spartina*.

The cleanup process for the marshes of the LCP site will involve the removal of native marsh vegetation, which is essential for the health of the ecosystem. The Proposed Plan relies heavily on the assumption that marsh plants will re-grow on their own within two years. However, the Plan must include a re-planting program in order to speed up recovery of the ecosystem post-remediation. Native *Spartina* will attract native wildlife, which will in turn help the ecosystem return to a pre-remediation state. Replanting Spartina has been conducted for many decades and there is substantial expertise on the practice, in both the private and public sectors (U.S. Fish and Wildlife, NOAA and US Army Corps of Engineers.

Estuary Use by People

The Proposed Plan states that the estuary is rarely used for recreation because it is too difficult to navigate with a small boat, and therefore the impacts of cleanup on that area do not need to be considered. However, there are no data outside the Purvis Creek area to show that the waterways of the estuary are used infrequently. Community surveys must be completed before the Plan can conclude that community members are not using this area for fishing or recreation. The lack of information is not data in support of the negative. Personal observation by ESC, by GEC and accounts from community members contradict the statement of lack of use, which must be considered anecdotal and of questionable value.

Dolphins

Atlantic bottlenose dolphins, which inhabit the Turtle/Brunswick estuary and coastal waters, are apex predators in the southeast. Because they are at the top of the food chain, dolphins bioaccumulate more toxins in their bodies than the animals lower in the food chain. Studies have shown that concentrations of PCBs in Brunswick dolphins are ten times higher than the PCB concentrations in dolphins found in the Savannah area, and the resident dolphins of Brunswick have the highest reported PCBs levels of any marine mammal in the world (Balmer et al. 2011). Dolphins across multiple generations have already been harmed by PCBs, suffering from anemia, reduced hormone levels, and increased susceptibility to disease (Schwacke et al. 2012). Dolphins play an important role in the Brunswick ecosystem and should be a central consideration in the Proposed Plan.

Human Health and Ecological Risk Assessments

The Human Health Risk Assessment in the Proposed Plan does not adequately account for the risks to human health posed by the contaminants at the estuary site. According to the risk assessment, the two chemicals causing the most harm are mercury and Aroclor 1268. There is no consideration of dioxin as a toxic chemical at the site, despite the fact that dioxin is a known contaminant of the industrial process at LCP (chlor-alkali). The reductions necessary to meet fish/shellfish goals to eventually end

consumption advisories “are likely to be observed only after several years post remediation,” delaying the health-protective measures of this remediation.

The Proposed Plan defines a high quantity fish consumer as an adult who eats 40 fish meals per year for 30 years, and a recreational fish consumer as someone who eats 26 fish meals per year for 30 years. The difference between the two consumer categories is small and the fish consumption numbers should be increased based on detailed surveys of local fishermen. The data on local fish consumption in the Brunswick area could have been obtained via surveys, but was not. In fact, ATSDR has a better data set from a nearby community and ATSDR recommended using that data, which would have substantially increased the consumption rates used in the HHRA. The result would have been a conclusion to reduce site risks by more contaminant removal or treatment.

In the Ecological Risk Assessment, one of the sites used to compare the levels of chemicals in the sediment at LCP is only four miles from the LCP site at Troup Creek, and has shown to be contaminated with the same chemicals. Another reference site with a history of cleaner sediments should be used instead. Very little constructive comparison can be made when using an equally contaminated reference site.

Additionally, not all of the individual stations, domains, and creeks meet the acceptable PRG risk ranges; they are only protective of the local ecosystem when creeks and/or domains are considered collectively. This averaging across spatial data dilutes the exposure possible at each area of contamination. Further, the proposed cleanup levels were determined to be adequate, despite areas “Where CULs may not be achieved and residual risks in some areas may occur” because they existed “in combination with a robust monitoring program”; a monitoring program should not be considered “robust” when monitoring only occurs every five years with an undefined set of “triggers” for additional actions.

Total Acreage of Cleanup

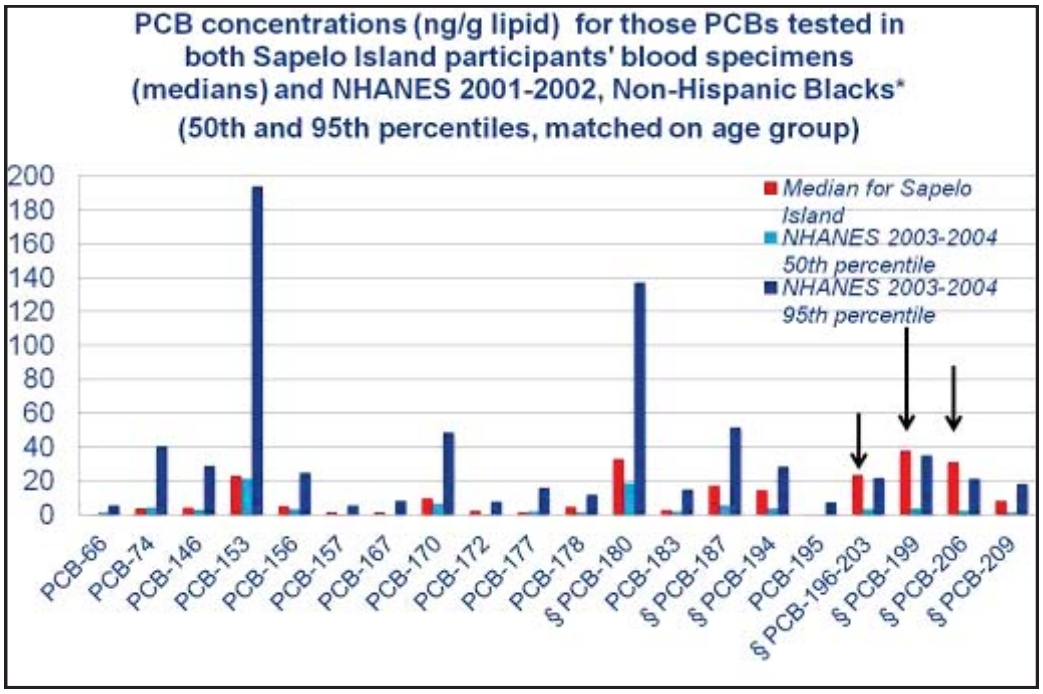
To clean up the marsh to a level protective of human and environmental health, 81 acres of marsh would need to be cleaned up. However, the chosen cleanup plan will only clean up 24 acres of marsh, leaving behind 57 acres with high levels of mercury and PCBs.

Sapelo Island

Sapelo Island is a state-protected barrier island north of Brunswick. The Agency for Toxic Substances and Disease Registry (ATSDR) recently conducted a study that showed that residents of Sapelo Island have dangerously high levels of PCBs in their bodies, based on their blood samples. Scientists conducting the study sampled nine residents, ages 21-74. All the residents stated that they ate two to three meals of locally-caught seafood per week, and had eaten locally-caught seafood for over five years.

When the results of the blood tests were compared to samples from non-Hispanic African Americans throughout the country, some of the PCB levels in blood of the

Sapelo Island residents were above the 95th percentile. In addition, when the Sapelo residents' samples were compared to the samples from local Atlantic bottlenose dolphins, scientists found that the human and dolphin samples contained similar environmental contaminants. This shows that contaminants from the LCP Chemicals Site have migrated into the waters and sediment surrounding Sapelo Island, into the local seafood, and finally, into the bodies of local residents who eat the local seafood.



The red bars are the median sample for the Sapelo Island residents. The three samples with the arrows above them point to Sapelo Island blood samples that were above the 95th percentile for PCB levels in blood (Backer and Mellard 2014).

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Institutional Controls at the Site

Institutional controls are a group of actions that seek to limit human activity to decrease exposure to a contaminated ecosystem. The EPA defines institutional controls as "…administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy" (USEPA 2014a). Common examples of institutional controls (ICs) include fish consumption advisories, land use designations, and zoning restrictions. The EPA's Proposed Plan for the LCP Chemicals Superfund Site relies heavily on ICs in the form of fish consumption advisories and permit requirements. Currently, fish consumption advisories are in effect for Purvis Creek and the Turtle River, and a commercial fishing ban was issued for Purvis Creek. Permits are required for any in-water construction activities for Operable Unit 1 of the site (USEPA 2014b).

To estimate risk at the LCP Chemicals Superfund site, the EPA used Baseline Risk Assessments (BRAs) found in the Remedial Investigation/Feasibility Study. A Baseline Human Health Risk Assessment (BHHRA) and a Baseline Ecological Risk Assessment (BERA) were conducted for the site. The BHHRA provided the cancer and non-cancer risks associated with consuming fish and shellfish from the site, and the BERA provided the estimated likelihood of adverse ecological effects at the site. While the EPA clearly outlined how risk reduction was estimated in the BRAs, any risk reductions that result directly from the use of ICs are not made clear. Thus, based on the information given in the Proposed Plan and Feasibility Study, it is not possible to determine the actual risk reduction resulting from the use of ICs.

Issues with Institutional Controls

While ICs are meant to protect human health, they are simply a means of removing an exposure pathway by restricting human activity. The Proposed Plan for the LCP Chemicals site states that ICs will address residual risks posed by any un-remediated contaminants, and that ICs "help ensure the remedy's long-term structural integrity and effectiveness in reducing COC concentrations in fish/shellfish…" (USEPA 2014c 40). Yet ICs do nothing to reduce contamination; they simply keep people away from contaminated media at a site. Studies and government reports have found significant flaws in the philosophy and implementation of institutional controls, specifically with fish consumption advisories.

In 2005, the U.S. Government Accountability Office published a report titled "Improved Effectiveness of Controls at Sites Could Better Protect the Public." The study analyzed the implementation and effectiveness of institutional controls at Superfund and RCRA sites throughout the U.S. The researchers found that while the use of ICs has increased over time, there are numerous problems with both the implementation and the organization of ICs. One of the most obvious issues is one of timing and accountability. The GAO found that often documentation did not adequately address when the ICs should be implemented, how long implementation should last, or who would be responsible for enforcement. This led to ICs not being implemented until after cleanup processes were finished, posing significant risks to local residents. The GAO also found

issues with the process for implementation of ICs. Language in the IC documentation was often vague, and the EPA sometimes failed to identify the specific mechanism for each IC. The GAO pointed out that in creating ICs, the EPA needs to identify the parties responsible for enforcing the ICs, such as state governments or site owners (2005). Because of the faulty implementation and enforcement of ICs, ICs come across as recommendations, and are thus taken much less seriously.

Results of a recent study of people living on Sapelo Island, a barrier island 25 miles northeast of Brunswick, showed that residents have dangerously high levels of PCBs in their bodies due to the consumption of locally-caught seafood (Backer and Mellard 2014). The study, which was conducted by the Agency for Toxic Substances and Disease Registry, examined blood levels from adults who had lived on Sapelo Island for at least five years, and who consumed at least two meals of locally-caught seafood each week. The researchers found that 44% of the sampled residents were unaware of Georgia's fish consumption advisories. Out of the five residents who were asked if they changed their fish consumption habits after learning of the advisories, only two responded that they had. If this small sample size is representative of the population in and around Brunswick, then the majority of residents who practice subsistence fishing are continuing to consume the contaminated fish that the consumption advisories warn against. Many scientific studies on fish consumption advisories, such as the two studies mentioned below, provide similar results to the Sapelo Island study: fish consumption advisories are often ignored or simply interpreted as recommendations.

In a study on the effectiveness of fish consumption advisories, researchers found that fish consumption advisories are unlikely to be effective in reducing the exposure of infants and children to persistent organic pollutants that have long elimination rates in the human metabolic system (Binnington et al. 2014). Persistent organic pollutants like PCBs have long elimination half-lives, meaning that the human metabolic system takes longer to break down persistent pollutants like PCBs than non-persistent pollutants. For this study, scientists used a mechanistic model to estimate and compare prenatal, postnatal, and childhood exposure to PCB-153 under different scenarios of maternal guideline adherence to fish consumption advisories. The scientists assumed realistic time periods for advisory compliance for mothers (from one year to five years before birth), and found that temporarily eliminating or reducing maternal fish consumption for fish contaminated with persistent organic pollutants did very little to reduce the exposure of infants and children to PCBs (Binnington et al. 2014). This study shows that it is not just the contaminated fish that prove problematic; it is the environmental persistence of the contaminants inside the human body, which can take years to be eliminated.

In a 2008 study concerning public knowledge about fish consumption advisories, Burger and Gochfeld found that many subjects questioned in a general university population could not give any specific answers to questions regarding the existence of fish consumption advisories. Of the respondents, 62% could not give any specific information as to why fish consumption warnings exist. Over half of the respondents did not know which fish are high or low in contaminants, and 16% of the subjects could not provide an answer as to why eating fish can be healthy. The authors point out that

government agencies are often concerned that the public will be confused by advisory details, and that information on the nature of risks and benefits of fish consumption can be too complicated to convey. The authors believe that operating based upon that assumption is a mistake. They state that the lack of such information is a major part of ineffective communication. The study concluded that public agencies must provide more directed messages regarding the basis for making risk decisions (Burger and Gochfeld 2008).

The results of the Burger and Gochfeld study on public knowledge of fish consumption advisories were echoed by the Sapelo Island study, where residents continue to consume locally caught seafood even after learning of the risks posed by eating contaminated fish. The problem with relying on fish consumption advisories and other ICs for the LCP Chemicals site is two-fold. Half of the problem is that ICs do nothing to reduce contamination; they are simply a means of controlling human activity. The other part of the problem is that fish consumption advisories are, and will continue to be, an ineffective way to protect human and ecological health. Many residents are unaware of the fish consumption advisories, and many of those that are aware of the advisories choose to ignore the regulations and continue eating contaminated seafood. The LCP Chemicals Proposed Plan needs to be amended to rely on a more comprehensive removal of contaminants, not on institutional controls that attempt to keep humans away from their local waterways.

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Fish Consumption Advisories at the Site

At the LCP Chemicals Superfund Site, fish consumption advisories are in effect for Purvis Creek and the Turtle River, and a commercial fishing ban was issued for Purvis Creek. Permits are required for any in-water construction activities for Operable Unit 1 of the site (USEPA 2014a). However, the fish consumption advisories described in the Proposed Plan are insufficient for the protection of human health. The Proposed Plan relies on fish consumption information that is outdated and fails to gather appropriate data on local African-American residents' fishing habits and fish consumption rates. The fish consumption information for the local community, as outlined in the health risk assessment and carried forward in the Proposed Plan, must be fully revised in order to protect human health.

The Problems

The issues with fish consumption advisories are not unique to this site; government reports and scientific studies have found numerous problems with implementation and community adherence to fish consumption advisories. For example, a 2011 survey by the EPA found that fish advisories are not legally enforced in all states. The survey reported that 49 U.S. states and Native American tribes do not legally enforce advisories or bans, and only seven do. This same survey documented 17 out of 18 states that include consumption information for sport and subsistence fishers in their commercial fishing ban information (USEPA 2011). Other inconsistencies at the state level include differences in the ways sampling is conducted and differences in the number of contaminated fish required to affect an advisory. For example, four states in the survey required only one individual fish sample exceeding human health criteria to issue an advisory while others, such as Virginia, required between 11 to 20 fish. Additionally, some states require multiple years of sampling before an advisory can be issued, even after contaminant levels in fish tissue have exceeded state criteria (USEPA 2011).

At the LCP site, the fish consumption advisories proposed by the EPA do not protect human health, nor do they accurately reflect the demographic makeup of the local population. The advisories are based upon a 1999 study conducted by the Glynn County Health Department (GCHD), comparing 211 residents who may have been exposed to mercury through wild game and seafood consumption from the Turtle River (target group participants) to 105 residents who reported they had not consumed seafood or wild game from that area (comparison group participants). Overall, 101 target group participants identified themselves as either recreational, commercial, or subsistence fishers; 96% of these individuals reported themselves as recreational fishers, 3% identified themselves as commercial fishers, and only 1% identified themselves as subsistence fishers (USDHHS/ATSDR 2014). However, the African-American community is severely underrepresented in the target study group. African-Americans made up only 4% of the people surveyed, yet according the 2010 U.S. census, African-Americans make up 26% of the Glynn County population, and nearly 40% of the population within four miles of the LCP site (USDHHS/ATSDR 2014). Thus,

the ATSDR confirms that the GCHD study is not an accurate representation of commercial or subsistence fishers living in the area (2014).

Other shortcomings of the GCHD study include the possibility that participants purposely restricted their intake of fish following the dietary recall survey, leading to inaccurate urine mercury results (USDHHS/ATSDR 2014). Furthermore, in a study of fishers living along the nearby Savannah River, Burger et al. found that, on average, African-Americans eat more fish meals per month than whites, eat slightly larger portions of fish than whites, and therefore eat higher amounts overall of fish per month than whites (1999). The ATSDR states that it is reasonable to assume that African-Americans living in Brunswick have similar eating habits to those living along the Savannah River, and so the report explicitly states, “The results of the Brunswick fish study should not be applied to African-Americans in the Brunswick area [. . .]” (2014, pp.8).

Lastly, sensitive groups including children, women of childbearing age, and the elderly reside within a one-mile radius of the site. The ATSDR reports that based on a 2010 U.S. census, approximately 4,202 people live within a one mile radius of the LCP site; among these, nearly 451 are children aged 6 or younger, 519 are adults who are at least 65 years of age, and 827 are women of childbearing age (2014). Although 37% of target group participants were 60 or older, only 6% of participants were under the age of 10 years old (GCHD 1999).

In light of the major problems with the fish consumption advisories at the LCP site and the data that the advisories are based upon, it is essential to enforce stricter and more accurate fish consumption advisories. It will be many years until local fish and shellfish are clean enough for human consumption, and as such all advisories should be maximally protective of human health. Below we describe the ways in which new fish consumption advisories should be implemented.

The Solution

The fish consumption advisories in the LCP Chemicals Proposed Plan need to be based on data from a more accurate source. The data collected from local residents should accurately represent the population. This means that the data should reflect that African-Americans make up 26% of the Glynn County population (USDHHS/ATSDR 2014). This type of data collection could be done through an environmental justice analysis. An environmental justice analysis recognizes that some populations experience higher levels of risk than others. According to Executive Order 12898, an environmental justice analysis “directs federal agencies to identify and address disproportionately high adverse human health or environmental effects on minority and low-income populations that may result from their programs, policies, or activities” (USEPA 2014b, pp.1). An environmental justice analysis would account for the higher levels of risk experienced by residents who practice subsistence fishing, and therefore help to create guidance for more protective fish consumption advisories.

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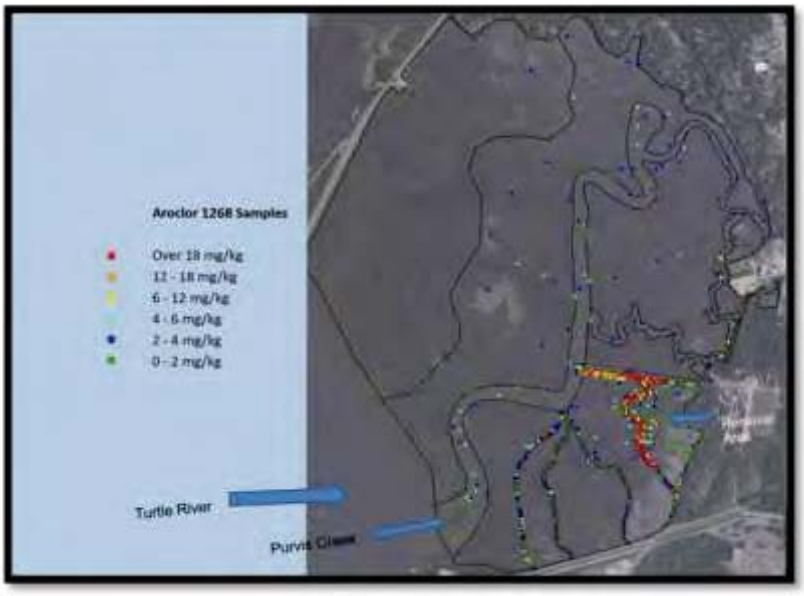
Site Boundaries at the Site

Site boundaries are established by the EPA as part of the Superfund process once the area of contamination has been determined. Boundaries delineate the area within which cleanup processes will occur and contamination will be contained. EPA further divides cleanup processes into operable units (OUs), which are "each of a number of separate activities undertaken as part of a Superfund site cleanup" (EPA 2013). The LCP Chemicals Superfund site is divided into three operable units (OUs) in order to address the differing types of contamination at the site. Following an EPA revision in 2005, Operable Unit 1 represents the marsh, Operable Unit 2 represents groundwater, and Operable Unit 3 represents dry-land soils (USDHHS/ATSDR 2014). The U.S. DHHS/ATSDR report (2014) states, "Other OUs may be examined when data are available for review" (pp.3). Sufficient data are available to question the currently designated site boundaries, conduct additional sampling, and add additional OUs.

The Problems

There are a number of problems with EPA's currently designated LCP Chemical's site boundaries. First, the boundaries are inaccurate. The EPA failed to include available data on the continued migration of Aroclor 1268 in its analysis of site boundaries. According to EPA's *Clarifying the Definition of 'Site' Under the National Priorities List*, "a 'site' is best defined as that portion of a facility that includes the location of a release (or releases) of hazardous substances and wherever hazardous substances *have come to be located* [emphasis added]." The document also advises that "the extent of contamination (site extent) may not be precisely determined at the time a site is listed on the NPL. In fact, the extent of the site may change significantly as the cleanup process progresses" (EPA 1996, pp.1). Recent scientific studies have discovered the presence of Aroclor 1268 outside of EPA-defined site boundaries, making the current delineation erroneous (Wirth et al. 2014; Balmer et al. 2011; Backer and Mellard 2014).



Source: EPA, LCP Chemicals Proposed Plan Public Meeting 2014

Secondly, sampling at the Brunswick LCP site is insufficient given the documented migration of contaminated media to Sapelo Island. Sediment and tissue sampling in the Turtle River must be conducted to determine the extent of contamination as well as the potential migration pathways to populations, such as residents of Sapelo Island, in order to accurately assess impacts of the contamination. As displayed

in the figure, previous sampling efforts for Aroclor 1268 and other contaminants have focused little on Turtle River as a potential migration pathway.

Additionally, Turtle River and Sapelo Island must be added as operable units. Backer and Mellard (2014) noted that there is evidence to suggest that Aroclor 1268 appears to be widespread around the Brunswick area and that residents of Sapelo Island have been exposed to the specific PCBs found at the LCP site; residents' median levels for highly chlorinated congeners of PCBs are equal to or greater than the 95th percentile NHANES study for Non-Hispanic Blacks. Another recent study documented similar PCB congener profiles for sediments and fish between the locations of Sapelo Island National Estuarine Research Reserve and Brunswick (Wirth et al. 2014). These congener profiles were also consistent with the Aroclor 1268 signature noted in residents of Sapelo Island in the former study.

Lastly, there are boundary discrepancies among various documents pertaining to the LCP site. Tables 1 and 2 include differing acreage estimates for the area of contamination. Table 1 refers to Operable Unit 1 acreage estimates only, while Table 2 refers to site-wide estimates. Once site boundaries have been updated to include additional areas of contamination, one consistent estimate is warranted.

Table 1: OU1 acreage estimates

Source	Acreage Marsh (OU1)	Acreage Land (OU1)	Acreage Tidal Creeks (OU1)	Link
EPA Brunswick LCP OU1 PP	670+			http://www.epa.gov/region04/foiapgs/readingroom/lcp_chemicals_site/superfund-proposed-plan-nov-2014.pdf
EPA Brunswick LCP OU1 Draft FS	≈662		98	http://www.epa.gov/region04/foiapgs/readingroom/lcp_chemicals_site/draft-feasibility-study-report-june-2-2014.pdf

Table 2: Site-wide acreage estimates

Source	Acreage Marsh (site-wide)	Acreage Land (site-wide)	Acreage Tidal Creeks (site-wide)	Link
Honeywell Fact Sheet	681	120		http://www.lcpbrunswickcleanup.com/documents/fact%20sheet.pdf
EPA LCP Chemicals Georgia webpage	"550-acre site"			http://www.epa.gov/region4/superfund/sites/npl/georgia/lcpchemga.html#location

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Modern Construction Methods for Salt Marsh Remediation

In the Proposed Plan, EPA states that the type of construction required for removal or treatment of contaminated sediments in the LCP salt marsh would cause "widespread physical damage to habitat and species" (USEPA 2014a, pp. 25). The EPA goes on to state that construction would also impact hydrology, "possibly in ways which are not readily anticipated or predictable" (USEPA 2014a, pp. 25). This line of thought leads the EPA to conclude that 48 acres is the largest possible removal action that would be sufficiently protective of the environment. These statements about salt marsh construction are not accurate. Construction in salt marshes is widely practiced and not nearly as environmentally detrimental as stated in the Proposed Plan. There are modern, accepted methods for construction in salt marshes that pose minimal disturbance risks to the surrounding ecosystems.

It is only later in the document (Section 7.6 Implementability) that EPA, by its own admission, states: "There are technologies and techniques available to meet the challenges associated with working in soft sediments in tidally influenced marsh areas. These include employing low-ground-pressure earthmoving equipment, telescoping conveyor belts for cap placement, shallow draft barges for water-based sediment removal and sediment capping, and hydraulic equipment to place thin-cover material." It is obvious there are technologies to attain effective remediation without irreparable damage to the marsh. There are also new technologies that should be considered before moving into the remedial design.

Use of Alternative Technologies

The Proposed Plan relies on sediment removal, capping, and thin-cover placement for contaminant remediation at the site. Modern remediation methods exist that would work best to remediate a salt marsh without stressing the marsh beyond its ability to recover. EPA needs to consider using new remediation technologies that are more efficient and more environmentally sound than the ones recommended in the LCP Proposed Plan. Below we outline several alternative technologies that could be applied at the LCP site.

In Situ Technologies

PCB remediation is an expensive process and removal of the contaminated soil or sediment, whether by excavation or dredging, contributes a large part of that cost. These processes also risk disturbing and dispersing PCBs. In situ remediation technologies are designed to clean up PCBs without removal from the environment. Most in situ technologies remain difficult to implement on a large scale and are typically suited to low concentrations of contamination; however, several emerging technologies may be viable alternatives to traditional practices.

Bioremediation

Bioremediation is a process through which microbial degradation of PCBs is facilitated through creating a favorable environment for the process; this can be done through controlling the physical, chemical, and microbial aspects of the environment (EPA,

2012). This process generally begins with instigating anaerobic dechlorination, or the removing of chlorine atoms by anaerobic bacteria; this results in lightly chlorinated PCBs that are both less toxic and degrade more readily into inert molecules through the secondary process of aerobic biodegradation (Gomes, Dias-Ferreira, and Ribeiro 2013). Bioremediation may be of particular use in combination with active containment technologies such as reactive capping or phytoremediation.

There are many examples of bioremediation used in the remediation industry. One such example of note is the South Carolina company BioTech Restorations[1]. BioTech specializes in the bioremediation of chlorinated contaminants including PCBs through application of a proprietary protein "factor" which stimulates the indigenous microbial population and enhances its ability to degrade PCBs. While previously demonstrated in soils, dredged sediment could also be treated in this manner. Some of BioTech's successful remediation projects include the cleanup of the former New England Log Homes factory site in Great Barrington, Massachusetts and the Hercules Chemical Plant in Brunswick, Georgia.

Phytoremediation

Phytoremediation is an increasingly popular technology that employs specific plants to sequester, extract, and degrade contaminants in situ. Phytoremediation of PCBs works through three main pathways: i) uptake by the roots (sequestration), ii) degradation through plant enzymes, and iii) improving natural bioremediation through root activity in the soils (Gomes et al., 2013). While PCBs are partially retained in plant biomass, phytoremediation provides a noninvasive means of removing/degrading the contaminants. PCB contaminated plant matter may also be converted into biofuels during which the remaining concentrations would be destroyed. Phytoremediation can be implemented using a variety of plants; canarygrass and switchgrass were found to be particularly effective on soil (Chekol et al., 2004), while eelgrass was effective in aquatic sediment (Huesemann et al. 2009). Phytoremedation is also a good candidate for use in conjunction with bioremediation due to the root and rhizomatic boosts to biological activity.

There are several exampes of phytoremediation in the field. In 2015, the Iowa Superfund Research Program will finish a full scale study of employing phytoremediation to remove PCBs from soil and groundwater at a confined disposal facility in East Chicago. A similar test is being conducted on a PCB contamined wastewater pond in Altavista, Virginia. Several engineering and remediation firms use phytoremediationto remove PCBs including Edenspace, TRC Companies, and EADHA enterprises.

In Situ Sediment Ozonator

[1] Disclaimer: Environmental Stewardship Concepts, LLC worked with BioTech Restorations on the first draft of the QAPP for the Housatonic River cleanup. ESC completed the project in May 2014 and is no longer under contract to BioTech Restorations.

In situ Sediment Ozonation (ISO) is a new technology developed by the University of Utah in cooperation with the National Oceanic and Atmospheric Administration (NOAA). ISO uses a floating rig equipped with ozone reactors and conveyors to remediate without dredging. Ozone has been shown to react with PCBs by forming more biodegradeable products, as well as boosting biological activity in sediment or soil (Gomes, Dias-Ferreira, and Ribeiro 2013). ISO enhances this process using pressure-assisted ozonation which injects sediment with ozone and rapidly cycled pressure changes to increase the efficacy of the ozone (Hong 2008). The final report on the technology suggests that the materials to build ISO rigs are readily available in current dredging technology, and that contaminated sediment could be treated for as little as fifty dollars a cubic yard. This technology also naturally enhances biological activity and would be a logical choice to increase remediation efficiency of more passive technologies, such as bioremediation or phytoremediation.

Ex Situ Technologies

In many cases, the most practical means to treat a contaminated area is to remove the target media with dredging or excavation. The materials can then be transported and treated ex situ, or off-site. Treating contaminations ex situ allows for the use of more intensive treatment technologies that would be unsafe or impractical in situ. While incineration remains the most common ex situ technology, several emerging technologies are showing promise.

BioGenesis℠

BioGenesis Enterprises' proprietary BioGenesis℠ Soil/Sediment Washing Technology is one of the most well documented alternatives to incineration. BioGenesis℠ is a sequence of eight processing steps that treat contaminated sediment sufficiently to allow the post-treatment media to be used as high-end topsoil or construction grade products (BioGenesis 2009). BioGenesis℠ is designed to accommodate large volumes of contaminated sediment through the construction of a facility in a location where sediment can be directly delivered by barge or hydraulic pipe.

BioGenesis℠ has conducted several bench-scale studys and a recently completed full-scale demonstration of the technology in the New York/New Jersey Harbor which handled materials from the Raritan, Passaic, and Arthur Kill. According to the final report, the full-scale test facility was capable of remediating 250,000 cubic yards of sediment per year at a cost of $51-59 per cubic yard (2009). While initial costs of construction of these facilities is higher than other technologies, repeated demonstrations have provided enough data to conclude that BioGenesis℠ is an environmentally and economically sound alternative.

Mobile UV Decontamination

Researchers at the University of Calgary have developed a mobile PCB remediation unit that builds upon a study showing ultraviolet light's capability of effectively degrading PCBs in transformer oil, as well as soils and sediment (Kong, Achari, and Langford 2013). The project, backed by SAIT Polytechnic and IPAC Services Corp., is a 15 meter long mobile unit that combines UV and visible light technologies to degrade PCBs

as much as 94%, at a fraction of the cost of inicineration while remaining on site (Unviersity of Calgary 2013). This technology is well suited for operation in areas where soil or sediment could be removed and processed nearby. The unit is currently designed to handle smaller contaminations but the project group plans to expand the technology to address the needs of larger remediation projects.

nZVI Dechlorination

Zero-valent iron nanoparticles (nZVI) is primarily an ex situ treatment based on zero-valent iron (ZVI), a technology which has been used to clean up aquifers contaminated with a variety of chemicals. Where PCBs are concerned, ZVI works through dechlorination into less toxic and more biodegradeable constituents (Gomes, Dias-Ferreira, and Ribeiro 2013). ZVI has been tested in the sediment of both the Housatonic River and New Bedford Harbor in Massachusetts; however mixed results have prevented ZVI from mainstream implementation. nZVI improves upon ZVI through a reformulation using nanoparticles which exhibits superior reactivity and more consistent removal of PCBs in groundwater and soil (Mikszewski 2004). While nZVI can be used in situ, due to limited research on the effects of nanoparticles on the environment, most commercial and academic uses are conducted off-site. However, NASA currently licenses an associated technology, emulsified zero-valent iron (eZVI), and has demonstrated successfully removing a variety of contaminants both in situ and ex situ (Parrish 2013).

Removal Technologies

When in situ treatment is not possible, removal of the contamination, whether it be industrial waste, soils, or sediment is required before ex situ remediation is possible. Where PCBs are concerned, the most common, and often most concentrated contaminations are found in river sediment in and around industrial areas. Heavy dredging equipment is often required to remove and transport the sediment, the use of which can be expensive economically and environmentally. However, advances in removal technologies can reduce these costs through more precise and focused application.

Environmental Dredging

Environmental dredges are designed with the understanding that dredging can re-suspend and disperse contaminants beyond the original site. Most environmental dredging uses hydraulic cutter dredges, which break up and then pump sediment and water through pipes to a desired location. The Bean technical Excavation Corporation's (Bean TEC) *Bonacavor* builds upon that standard using a hybrid model: mechanical excavation and hydraulic transport. This hybrid model allows more precise control of dredging which reduces unnecessary dredge area or depth and sediment disturbance. The *Bonacavor* also features an advanced onboard GPS and Crane Monitoring System (CMS) that provides precise control of the crane while dredging, as well as a Slurry Processing Unit (SLU) that increases solid concentration during dredging resulting in less water intake (Lally and Ikalainen). Smaller hydraulic cutter dredges have also been developed by companies such as Ellicott and Great Lakes Dredging (Randall, Drake,

and Ii 2010). These dredges have smaller footprints and are able to facilitate removal at less cost and disturbance to the environment.

Activated Metal Treatment and Green PCB Removal

Technologies that allow PCBs to be removed without removing the contaminated media may offer alternatives to dredging in the future. NASA has also licensed two technologies that are designed to absorb PCBs from the environment for removal. The Activated Metal Treatment System (AMTS) is a solvent solution that can be applied to surfaces to remove PCBs from paints, caulk, or sealants (Parrish 2013). AMTS has been extremely successful during in situ remediation of industrial facilities where PCBs were used widely as paints and sealants on storage tanks, buildings, and other structures. The product allows extraction of PCBs without removal of the structures, whereupon the contaminants can be treated safely ex situ. While AMTS is primarily used for structure remediation, Bio Blend ® Technologies, a company currently licensing AMTS, is testing the technology in a variety of applications including in situ extraction of PCBs from soils and sediment (Parrish 2013).

Specific to sediment and soil contamination, NASA is also developing GPRSS, or Green PCB Removal From Sediment Systems, which is a system that uses a redeployable polymer blanket with “resevoir spikes.” The spikes are treated with AMTS, which removes PCBs from sediment (Parrish 2013). The blanket is inserted into the target area, wherein the AMTS breaks down and absorbs PCBs; the blanket system can then be removed and decontaminated before reuse. While still in preliminary testing, GPRSS appears to be a promising technology for removal of PCBs without dredging.

Containment Technologies

Monitored natural recovery (MNR), a process by which PCBs are monitored and left to degrade naturally in the environment, is a remediation method employed in areas where removal of a contaminant is impractical or impossible. As natural degradation of PCBs is a slow process, the contaminant is often contained or capped to keep it from dispersing in the wider environment (Gomes, Dias-Ferreira, and Ribeiro 2013). This method has highly variable success, in large part due to the slow rate of natural PCB biodegradation. Advances in containment technology are increasingly implementing in situ treatments, such as bioremediation, to increase the outcome of the treatment.

Reactive Capping

While traditional capping passively contains a pollutant, reactive capping is an emerging technology that caps the designated area with additives that can absorb and immobilize, increase degradation, or reduce the bioavailability of PCBs; additives used in this process include Activated carbon, biochar, and metals such as zero-valent iron coated palladium (Gomes, Dias-Ferreira, and Ribeiro 2013). CETCO®, a minerals technologies company, markets the *Reactive Core Mat (RCM)*, a cap which can be tailored to meet the specific needs of a remediation project by augmenting the additives included in the product.

Aquablok® and Aquagate® are two complimentary reactive containment technologies from Aquablok Ltd that can be used to form a “funnel and gate” system in sediment. Aquablock® acts as a low permeability barrier to contain wastes while Aquagate® allows specific treatment materials for bioremediation or phytoremediation to interact with contaminated sediment, thus improving the remediation outcome.

Conclusions

Advances in PCB remediation and removal technologies provide viable alternatives to sediment removal, capping, and thin-cover placement. General conclusions include:

- Many viable technologies exist for in situ and ex situ treatment.
- Dredging and removal technology has improved as well and can be more economically and envrionmentally sustainable.
- As circumstances differ dramatically from one project site to another, each option should be assessed independently when determing appropriate remediation technologies.

The EPA needs to institute an evaluation of possible alternative technologies. This could mean re-opening the Feasibility Study.

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PCB Literature Review

Introduction

In reviewing PCBs in the scientific literature, the current review, now more than ever before, indicates the high level of toxicity and irreversible effects of PCBs on human health and the environment.

Polychlorinated biphenyls (PCBs) are industrial chemicals that were manufactured under the trade name Aroclor for use in transformers, electrical equipment, motor oils, plastics, paint, and numerous other applications. Although banned thirty-five years ago, these contaminants are still widely detected in humans and the environment.

PCBs primarily accumulate in soils and sediment as a result of spills, leaking toxic landfills, or contamination from products containing the chemicals. While PCBs do pollute the air via volatization and dispersion, the contaminants are most problematic in soils and sediments where they adhere to organics and are very slow to degrade. The primary route of exposure for humans and wildlife is through the ingestion of contaminated dietary items. PCBs are highly lipophilic and dissolve in fatty tissues and bioaccumulate over an organism's lifespan. This property is important to both human and ecological toxicology because bioaccumulation leads to biomagnification, the process by which persistent toxins increase in concentration upward through the food chain (Faroon et al., 2003). As a result, the highest concentrations of PCBs are often observed in top predators with long life-spans and high fat deposits such as dolphins, whales, and humans.

In the United States, PCBs are regulated by several different agencies and regulatory frameworks. The Environmental Protection Agency (EPA) requires drinking water to have a maximum contaminant level (MCL) of 0.5 parts per billion (EPA, 1996); fish consumption advisory numbers are also maintained in contaminated waters. States are increasingly being urged by EPA to develop PCB total maximum daily loads (TMDLs)-goals for reducing PCB concentrations in affected waterways. Disposal and remediation of PCBs is regulated under the Toxic Substances Control Act (TSCA) (EPA 2005). Finally, the Federal Drug and Food Administration (FDA) publishes tolerances for PCB concentrations and residues in foods such as milk, eggs, and poultry and enforces bans on the use of the compound in product packaging.

Brief Review of Human and Ecological Toxicology

PCBs are a broad category of compounds consisting of 209 individual congeners differentiated by the position and number of chlorine atoms that make up the molecule (Lauby-Secretan et al. 2013). Part of the complexity of studying PCB toxicity is recognizing that the chemical, physiological, and ecological effects of these distinct congeners can vary. PCBs are classified as endocrine disrupters because of their ability to mimic hormones and activate, deactivate, and even damage receptors that modulate

and control cellular and body systems (Lauby-Secretan et al. 2013). The specific receptors affected varies based on the congener or mixture of congeners involved and these multiple mechanisms of action result in a wide range of possible human and environmental effects. The following section provides an overview of toxicological effects of PCBs with the understanding that these general conclusions do not apply to all congeners.

Carcinogenic Effects
Increasingly the consensus points towards a strong link between cancer in humans and wildlife exposed to PCBs. In 2013 the International Agency for Research on Cancer (IARC) upgraded PCBs from “probable carcinogen to humans” to “carcinogenic to humans”. This decision was made based on 70 epidemiological studies which showed elevated risks of melanoma in both individuals with occupational exposure and the general public; increased risks of breast cancer and non-Hodgkin’s lymphoma were also noted (Lauby-Secretan et al. 2013). This report aligns and strengthens the position of EPA's 1996 report which concluded that PCBs are likely carcinogenic with evidence of increased risk of thyroid, liver, and gastrointestinal cancer from PCB exposure(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA 1996)(EPA, 1996)(EPA, 1996).

Non-Carcinogenic Effects
PCBS have been shown to affect most of the major body systems including the respiratory, cardiovascular, gastrointestinal, renal, endocrine, and musculoskeletal (Faroon & Olson, 2000). PCBs can also affect the reproductive system; studies on rats have documented decreased litter sizes and body weight, as well as reduced sperm count and conception rates (Faroon et al. 2003). In both humans and rats, neurological and developmental deficits have been observed in children with high *in-utero* exposure (EPA, 1996). Children exposed to PCBs at an early age have been reported to exhibit weaker reflexes, reduced memory, and a higher likelihood of attention deficit issues (Faroon et al, 2003). PCBs have also been linked to immunological effects that range from a weakening of the immune system to increases in inflammatory disorders such as tonsillitis and bronchitis (Faroon et al, 2003).

The toxicology of PCBs continues to be an area of extensive international research and each year brings numerous new studies on the contaminant.

2013-2015 Literature Search

The current literature search is an update of one conducted in August-September 2014 (Appendix B) that covered PCBs in the literature from 2013-2014 and one conducted in August-September 2013 (Appendix C) that covered PCBs in the literature from 2002 to 2013. The most recent review of the literature published in 2014 and 2015 on PCB toxicology returned over 100 relevant publications. These publications are listed in

Appendix A for the reader's convenience. While it is not within the scope of this memo to address them all, a few key studies are discussed in brief below.

Carcinogenic Effects

As stated above, IARC's 2013 classification of PCBs as carcinogenic is significant and several recent studies support this classification. Dong et al. (2014) found some PCBs are both cytotoxic and genotoxic in liver cells and increased DNA and chromosome breaks were observed in cells exposed to this congener. Ruder, Hein, Hopf, & Waters (2014) examined a cohort of 24,865 workers exposed to PCBs at manufacturing plants in the U.S. and found elevated overall mortality and an increased risk of melanoma and stomach, prostate, and nervous system cancers. Similar studies conducted by Li et al., (2013) and Onozuka, Hirata, and Furue (2014) examined workplace exposure cohorts and found decreased net survival rates primarily caused by increased cancer rates. PCB exposure was also linked to chemoresistance of liver cancer, resulting in a poorer prognosis in patients with the disease (An et al., 2014).

Non-carcinogenic Effects

Several new studies have addressed the link between PCBs and neurological effects. Gaum et al. (2014) studied individuals with work-related exposure to PCBs and found a significant relationship between PCB burden and increased depression and psychosomatic symptoms. Wigestrand, Stenberg, Walaas, Fonnum, & Andersson (2013) found PCBs can inhibit uptake of dopamine in the same manner as cocaine; the researchers suggest this mechanism is a likely factor in PCB neurotoxicity and behavioral effects such as depression.

The effects of PCBs on human development have been well-documented but several new studies provide an international scope to the literature. A 2014 study of toddlers in Japan found a relationship between prenatal exposure of PCB congeners in cord blood and decreased IQ (Tatsuta et al., 2014). This is significant because prenatal exposure continues to be a significant exposure pathway in the U.S.; Nanes et al. (2014) surveyed 43 human placentas from several U.S. locations and found PCBs in all specimens. Dallaire et al. (2014) studied a cohort of Inuit children and found a correlation between concentrations of PCB 153 in blood and lower weight, shorter height, and smaller head circumference across a range of ages and suggest PCBs are disrupting thyroid function. Decreased motor coordination was also positively correlated with PCB exposure; a study of 97 Dutch infant-mother pairs found high PCB 107 and 187 blood concentrations were associated with decreased motor coordination (Berghuis, Soechitram, Hitzert, Sauer, & Bos, 2013).

Finally, a 2014 paper corroborates previous epidemiological studies that suggested a link between exposure to PCBs and auditory impairment in children and adults; data surveyed from 1999-2004 indicated a positive relationship between serum PCB levels and hearing impairment in U.S. adults (Min, Kim, & Min, 2014).

Environmental and Ecological Effects

PCBs are potent contaminants in the environment as well; many of the same effects seen in humans have been documented in wildlife. However, international bans and cleanup efforts have resulted in a reduction of PCB levels in soils and sediments in some cases. Everaert et al. (2014) report two to threefold reduction in PCB concentrations between 1991 and 2010 in an open water ecosystem near Belgium; no significant decrease was observed in an industrial estuary receiving no remediation. As Bruckman et al. (2013) indicate in their survey of PCB soil depositions in Germany, PCB congeners have long half-lives and can be retained in sediment for decades unless the PCBs are cleaned up.

Remediation of PCB contamination has been shown to be effective in many cases. A 2013 study by Ficko, Luttmer, Zeeb & Reimer compared PCB concentrations in vegetation and field mice on an abandoned Air Force station before and after PCB remediation work was conducted; the study found vegetation concentrations were four times lower while concentrations in deer mice were three times lower.

Several new studies add to the well-established ecotoxicological profile of PCBs. A 2013 study of six arctic birds found that migration and opportunistic feeding increased PCB burden equivalent to one full increase in trophic level (Baert, Janssen, Borgå, & De Laender, 2013). Evidence of these effects on migratory birds reinforces the international scope of PCB contamination. Persson & Magnusson (2014) surveyed 101 wild mink and found that PCBs alter the size and shape of mink reproductive organs, likely leading to reproductive effects. Similarly, Carpenter et al. (2014) found high PCB concentrations in Illinois river otters and concluded the species is at risk of PCB toxicity.

Marine mammals such as whales and dolphins have been shown to retain high PCB concentrations decades after the PCB ban. Dorneles et al. (2013) found high accumulation of PCBs in false killer whales and rough-toothed dolphins off the coast of Brazil. Similarly, a survey of beluga whales found moderate levels of PCB exposure and confirmed the contaminant can disrupt vitamin profiles in the large mammals (Deforges et al., 2013). As Kubo et al. (2014) report in their study of Steller sea lions, marine mammals are also at risk of PCB exposure through maternal-to-fetal transfer.

Summary

As investigations into all aspects of PCBs continue around the globe, new information continues to reveal several trends:

- PCBs are toxic at lower levels than previously believed
- PCBs cause a wider range of toxic effects on wildlife and humans, including cancer
- Remediating PCB contamination is effective in reducing the PCB burdens

PCB contamination is a local, regional and global problem- the PCBs in one locality will contaminate the living and non-living environment, contribute to the regional PCB burden, and add to the global PCB burden for generations to come.

Appendix A
Literature Search and References –2014-2015 Publications on Toxicology of Polychlorinated Biphenyls

The following is a reference list of materials resulting from a literature search conducted in January 2015 on the toxicology of Polychlorinated Biphenyls (PCBs), individual PCB congeners, and frequently associated compounds. This reference list is an update and addition to prior literature searches conducted on the toxicology of PCBs, which are listed below in Appendices B and C. Included in the search are references pertaining to the effects of PCBs on both human health and the environment, including persistence, fate and transport, and specific effects on ecological systems and organisms.

A number of studies focused specifically on early exposure to PCBs and effects on development in both humans and animals. In human health, Casas et al. (2015) studied prenatal exposure to PCB-153 and *p,p'*-DDE in order to evaluate the relationships between organochlorine compounds and birth outcomes. These authors observed an inverse linear exposure-response relationship between prenatal exposure to PCB-153 and birthweight, even at low levels of exposure. The association was modified by maternal smoking and ethnicity; the most susceptible subgroup was girls with mothers who smoked while pregnant. Elnar et al. (2015) conducted a study on juvenile male mice and found that lactational exposure to low levels of the six indicator non-dioxin-like (NDL) PCBs led to over expression of genes involved in the repair and response to DNA damage as well as repression of neuronal activity. The level used in the study was lower than the guidance level for human consumption of contaminated fish. Lastly, Poon et al. (2015) investigated the effects of a PCB mixture composed of Aroclors 1242, 1248, 1254, and 1260 on developmentally-exposed rats and observed that they were more susceptible to audiogenic seizures when exposed to loud noise as adults; female rats were also more susceptible than males.

The literature search was conducted through the Virginia Commonwealth University Library System using the VCU multi-database search tool as well as the specific database Science Direct. All of the following materials are peer-reviewed journal articles.

ESC, LLC makes no claims about the research in these citations in terms of validity and does not necessarily agree with the conclusions within. We note that readers need to confirm that authors of scientific papers are free of conflicts of interest, financial or

otherwise. We advise readers to determine if the authors receive funding from the industries or companies that may be affected by the results of their research.

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Appendix B
Literature Search and References –2013-2014 Publications on Toxicology of Polychlorinated Biphenyls

The following is a reference list of materials resulting from a literature search conducted in late August 2014 on the toxicology of Polychlorinated Biphenyls (PCBs), its congeners, and frequently associated compounds. The reference list includes primarily publications from 2013-2014 but a few key reports from agencies such as EPA and WHO have been included for background information. Toxicology is loosely defined as those materials documenting the effects of PCBs on both ecological systems as well as human health. While toxicological reports were the primary focus of this search, some related materials describing environmental prevalence, fate, and transport are also included.

This literature search was conducted via the Virginia Commonwealth University Library system using the VCU multi-database search tool, as well as specific databases such as BIOSIS and Science Direct. The majority of these materials are peer reviewed journal articles; however, government/NPO reports and white papers are included where appropriate and relevant.

ESC, LLC makes no claims about the research in these citations in terms of validity and does not necessarily agree with the conclusions within. We note that readers need to confirm that authors of scientific papers are free of conflicts of interest, financial or otherwise. We advise readers to determine if the authors receive funding from the industries or companies that may be affected by the results of their research.

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Appendix C
Literature Review on Toxicology of Polychlorinated Biphenyls (PCBs), 2002-2013

The following is a bibliographic listing of articles resulting from an extensive literature search, conducted during the period August-September 2013, on recent research regarding Polychlorinated Biphenyls (PCBs) during the period 2002 to present (2013). Research was narrowly defined as professional (peer-reviewed) journal articles relating to the toxicological effects on living organisms, which included human health effects, other aquatic and land animals, plants, microorganisms, etc. This literature search was conducted via the Virginia Commonwealth University Library system, specifically utilizing the BIOSIS reference database which includes abstracts of literature in biological and biomedical areas of specialty. The literature search also includes documents available in Environmental Stewardship Concepts, LLC's in-house resource files.

ESC, LLC makes no claims about the research in these citations and does not make any blanket claims as to their veracity, nor necessarily agree with the conclusions. We note that readers need to confirm that authors of scientific papers are free of conflicts of interest, financial or otherwise. We advise readers to determine if the authors receive funding from the industries or companies that may be affected by the results of their research.

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Relationship between persistent organic pollutants (POPs) and ranging patterns in common bottlenose dolphins (*Tursiops truncatus*) from coastal Georgia, USA

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ABSTRACT

Bottlenose dolphins (*Tursiops truncatus*) are apex predators in coastal southeastern U.S. waters; as such they are indicators of persistent organic pollutants (POPs) in coastal ecosystems. POP concentrations measured in a dolphin's blubber are influenced by a number of factors, including the animal's sex and ranging pattern in relation to POP point sources. This study examined POP concentrations measured in bottlenose dolphin blubber samples (n = 102) from the Georgia, USA coast in relation to individual ranging patterns and specifically, distance of sightings from a polychlorinated biphenyl (PCB) point source near Brunswick, Georgia. Dolphin ranging patterns were determined based upon 5 years of photo-identification data from two field sites approximately 40 km apart: (1) the Brunswick field site, which included the Turtle/Brunswick River Estuary (TBRE), and (2) the Sapelo field site, which included the Sapelo Island National Estuarine Research Reserve (SINERR). Dolphins were categorized into one of three ranging patterns from photo-identification data. Individuals with sighting histories exclusively within one of the defined field sites were considered to have either Brunswick or Sapelo ranging patterns. Individuals sighted in both field sites were classified as having a Mixed ranging pattern. Brunswick males had the highest concentrations of PCBs reported for any marine mammal. The pattern of PCB congeners was consistent with Aroclor 1268, a highly chlorinated PCB mixture associated with a Superfund site in Brunswick. PCB levels in Sapelo males were lower than in Brunswick males, but comparable to the highest levels measured in other dolphin populations along the southeastern U.S. Female dolphins had higher Aroclor 1268 proportions than males, suggesting that the highly chlorinated congeners associated with Aroclor 1268 may not be offloaded through parturition and lactation, as easily as less halogenated POPs. Individuals sighted farther from the Superfund point source had lower Aroclor 1268 proportions.

1. Introduction

Bottlenose dolphins (*Tursiops truncatus*) are top-level predators and long-lived residents of bays, estuaries, and tidal marshes along the southeastern United States (reviewed in Shane et al., 1986; Wells and Scott, 1999). Lipophilic persistent organic pollutants (POPs), which are biomagnified in organisms at higher trophic levels, are stored in their lipid-rich blubber, making the bottlenose dolphin a sensitive indicator for POPs in coastal ecosystems (Kucklick et al., in review).

Contamination of the Turtle/Brunswick River Estuary (TBRE) in southern coastal Georgia (Fig. 1) by the highly chlorinated (>5 chlorines) polychlorinated biphenyls (PCBs) mixture Aroclor 1268 has been well documented (Kannan et al., 1997, 1998; Maruya and Lee, 1998; Maruya et al., 2001). The primary PCB congeners found in the TBRE are those that comprise Aroclor 1268, a highly chlorinated (>5 chlorines) mixture of PCBs. This mixture was used extensively at a chlor-alkali plant that operated in the TBRE from 1955 to 1994. The site, referred to as LCP Chemicals, was designated a National Priority List (i.e. Superfund) site in 1996 due to extensive environmental

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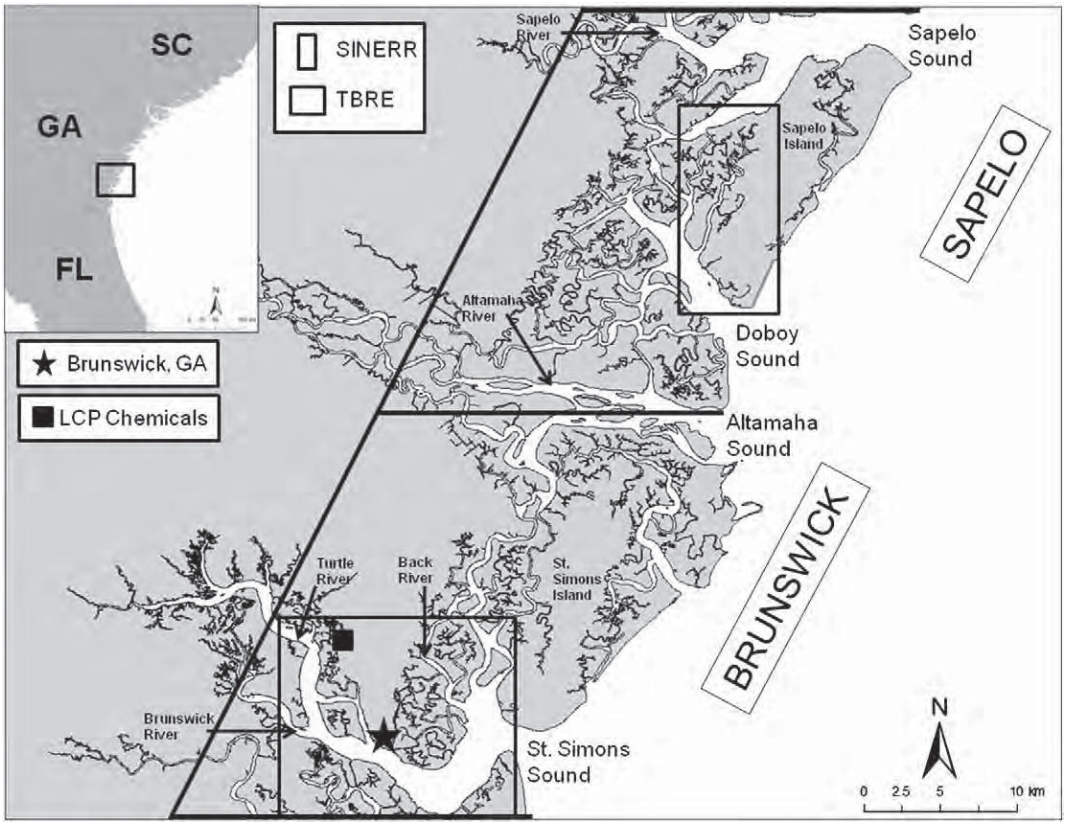

Fig. 1. Brunswick and Sapelo field sites located in the southern Georgia study area (SGA). The Sapelo Island National Estuarine Research Reserve (SINERR) is the area within the rectangular box located within the Sapelo field site. The Turtle/Brunswick River Estuary (TBRE), is the area within the square box located in the Brunswick field site. The brackets define the SGA boundaries including the division between the Brunswick and Sapelo field sites and 15 km upriver of the major tributaries.

contamination from mercury, lead, PCBs, dioxin, and other organic compounds (EPA, 2007; Kannan et al., 1997). Understanding the long-term impacts of these contaminants requires knowledge of the extent to which they contaminate the adjacent environment and food web.

Kannan et al. (1997) measured PCB levels in sediments within the TBRE and determined that sediments sampled from the LCP Chemicals site had PCB concentrations 50 times higher than those measured 500 m from the site. Fish species, including spotted sea trout (*Cynoscion nebulosus)* and striped mullet (*Mugil cephalus)*, sampled in the TBRE had PCB concentrations that were three times higher than PCB levels measured in fish from the Skidaway River, approximately 100 km north of the TBRE (Maruya and Lee, 1998). High concentrations of PCBs, specifically those with the Aroclor 1268 congener pattern, were also reported from a pilot study which sampled bottlenose dolphins in the TBRE (Pulster et al., 2009). Pulster et al. (2009) compared PCB levels from blubber of live dolphins sampled via remote biopsy in St. Simons Sound and the adjacent Back River in the TBRE with blubber samples from stranded dolphins collected approximately 90 km to the north, near Savannah, Georgia. Even with a small sample size of only four male TBRE dolphins, the study was able to discern a congener pattern indicative of an Aroclor 1268 source and similar to the congener profile documented in prey fish from the area (Pulster et al., 2009, 2005). In addition, Rosel (unpublished NOAA data) reported that mitochondrial DNA control region sequences and microsatellite markers from dolphins remotely biopsied in the TBRE were significantly different from those of dolphins sampled in Savannah, Georgia, and Charleston, South Carolina. Thus, it has been hypothesized that the dolphins in the TBRE and surrounding waters may be long-term residents to this region (Pulster et al., 2009). However, to date, this hypothesis has not been tested and no previous data have been published on ranging patterns of dolphins along this region of the Georgia coast.

This study builds on the previous research of Pulster et al. (2009) by expanding the sampling of dolphins within and outside of the TBRE to examine the relationship between measured POP concentrations and individual dolphin ranging patterns. Biopsy sampling was extended 40 km northeast of the TBRE to the waters in and around the Sapelo Island National Estuarine Research Reserve (SINERR) (Fig. 1). The SINERR is a federal- and state-managed protected area and is the focus of long-term ecological research projects such as water quality monitoring, primary productivity assessment, and fisheries sampling (e.g. Dresser and Kneib, 2007; Hanson and Synder, 1979; Owen and White, 2005). The area surrounding Sapelo Island, including the SINERR, is relatively undeveloped and was chosen with the intent that dolphins in this area could potentially act as a reference group for comparison with dolphins inhabiting the more contaminated TBRE. However, nothing was known about the ranging patterns of bottlenose dolphins within and between the TBRE and SINERR regions. Thus, if dolphins in the SINERR region were found to have elevated POP levels, it would be unclear whether such findings were due to contaminant transport or movement of dolphins between the two regions.

Photo-identification of dorsal fins has proven to be a very effective method of identifying individual dolphins and determining their ranging patterns (e.g. Irvine et al., 1981; Scott et al., 1990; Wells and Scott, 1990). Photo-identification surveys were initiated within the TBRE and SINERR regions to document the presence of individual dolphins and their potential movement between the sites. The goals of this study were to characterize the POP, and specifically PCB, exposure of dolphins in the TBRE and SINERR regions and examine patterns of

PCB congeners in relation to individual dolphin ranging patterns based upon photo-identification sighting histories.

2. Materials and methods

2.1. Study area

The southern Georgia photo-identification survey area (SGA) included the estuarine waters from Sapelo Sound south to St. Simons Sound, representing approximately 60 km of north–south estuarine shoreline (Fig. 1). The survey area's eastern boundaries were defined as the mouths of Sapelo, Doboy, Altamaha, and St. Simons Sounds. The western boundaries were defined as 15 km upriver of the Sapelo, Altamaha, and Turtle rivers. The SGA was divided into two field sites based upon the location of major sounds within each site. The Brunswick field site included the TBRE and all estuarine waters from St. Simons Sound north to and including Altamaha Sound. The Sapelo field site excluded Altamaha Sound and covered all estuarine waters north to, and including Sapelo Sound.

2.2. Biopsy sample collection

Biopsy samples from individual bottlenose dolphins were collected during both remote biopsy sampling surveys and a capture-release health assessment. Remote biopsy sampling was conducted in the Brunswick field site in August 2006 and March 2007 and in the Sapelo field site during August 2007, March 2008, and August 2008 utilizing standard techniques demonstrated to be safe and effective in numerous studies of small cetaceans (Kiszka et al., 2010; Sellas et al., 2005; Wells and Scott, 1990). The remote biopsy samples were obtained using a 0.3 m long carbon fiber dart with a 25 mm stainless steel cutterhead, which was propelled by a 0.22 blank charge from a modified 0.22 caliber rifle. The rifle was equipped with a holosight (Bushnell Corporation, Overland Park, KS) to improve sampling accuracy and a digital video camera and/or digital still camera to identify the dorsal fin of the sampled individual and to document the animal's reactions post-sampling. Dolphins were sampled within a range of 2–6 m from the vessel. Sampling location was typically along the animal's flank, approximately 10 cm below and 10 cm behind the caudal insertion of the dorsal fin. The sample collected from the biopsy cutterhead included a superficial layer of epidermis in addition to a full thickness section of blubber approximately 10 mm in diameter and 0.5–1.0 g in weight. Once a sample was obtained, the epidermis was removed from the blubber using latex gloves and sterile instruments. The blubber samples were placed in Teflon jars and frozen in a liquid N_2 dry shipper to be analyzed for persistent organic pollutant (POP) concentrations. Only full thickness blubber samples were utilized to determine POP concentrations in this study. The epidermis, which was stored in 20% DMSO/saturated NaCl, was used to identify the sex of the sampled individual using molecular methods (Rosel, 2003).

In addition to the remote biopsy samples, surgical biopsy wedges were collected during a health assessment of bottlenose dolphins in August 2009 (Schwacke et al., in review). Dolphins were captured through encirclement with a seine net and brought aboard a specially designed veterinary examination and sampling vessel. Biopsy wedge samples were collected by a veterinarian at a site 10 cm below and 10 cm behind the caudal insertion of the dorsal fin. A chlorohexiderm and ethanol scrub was used to sterilize the sampling region and lidocaine hydrochloride with epinephrine was administered as a local anesthetic. Sterilized instruments that were hexane and acetone washed as well as autoclaved were used to surgically remove the biopsy wedge sample. For POP analysis, a 0.7–1.0 g, full-depth, subsection of the biopsy wedge sample was placed into a 15 ml Teflon jar and frozen in a liquid N_2 dry shipper on the sample processing vessel. Following sampling, the dolphins were radio-tagged and released at the capture site. At the lab, the sample was stored frozen at −80 °C until analysis. Epidermal samples were also collected and utilized to identify sex as described above.

2.3. Biopsy sample analysis

Blubber samples were analyzed for POPs as described previously (Litz et al., 2007). Briefly, approximately 1 g of blubber was minced, dried with sodium sulfate and extracted by pressurized fluid extraction using dichloromethane. Samples were cleaned up by size exclusion chromatography and aluminum solid phase extraction prior to analysis by gas chromatography mass spectrometry. Lipid content was calculated gravimetrically from a weighed portion of the PFE extract. POP concentrations were determined using a gas chromatograph-mass spectrometer (GC/MS; Agilent 6890/5973, Palo Alto, CA).

A five to seven point calibration curve of compounds was determined from National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) solutions and utilized to quantify all analytes and calibrants. Samples were extracted, cleaned, and analyzed by GC/MS in lots of 30–40 with a minimum of one blank and 1–3 aliquots of NIST SRM 1945 Organics in Whale Blubber (Kucklick et al., 2010). POP concentrations identified within each aliquot of SRM 1945 were within 7.5% ± 3.5% (mean ± standard deviation) of the certified values. The limit of detection (LOD) for each analyte was defined as the greater of (a) the mass of the analyte in the lowest detectable calibration solution divided by the sample mass, or (b) the average mass of the analyte detected in blanks plus three times the standard deviation. The limits of detection ranged from 0.089 ng/g wet mass to 16.9 ng/g wet mass for all measured analytes.

2.4. Photo-identification

The photographic records for this study were from three efforts of varying duration and scope, totaling 238 surveys from 2004 to 2009 (Table 1). All efforts were included in this analysis to establish the broadest record possible for each individual dolphin's sighting history.

Dorsal fin images were obtained from remote biopsy sampling surveys conducted in 1–2 week sessions in the TBRE during December 2004, August 2006, and March 2007 and in and around the SINERR during August 2007, March 2008 and August 2008 (Table 1). Contaminant results of biopsy samples from the December 2004 TBRE surveys were previously reported (Pulster et al., 2009) and are not included in this analysis. However, photographic images obtained during the 2004 surveys were included for analysis of individual sighting histories.

Abundance surveys utilizing photo-identification of individuals' dorsal fins were conducted during every season for 2008 and 2009 in both the Brunswick and Sapelo field sites. During this effort, a 6–7 m, center console vessel with three observers surveyed both field sites to obtain photographs of every individual dolphin's dorsal fin. Mark-recapture analyses were then performed to determine seasonal abundance (methods reviewed in Balmer et al., 2008) in both the Brunswick and Sapelo field sites.

Radio-tracking was used to identify ranging patterns during summer/fall 2009, following the capture–release health assessment. The two goals of the health assessment were to (1) perform detailed health examinations of bottlenose dolphins from the Brunswick and Sapelo field sites including collection of a surgical wedge biopsy sample for contaminant analysis and (2) attach radio transmitters on bottlenose dolphins to determine short-term ranging patterns. Balmer et al. (2008) have previously described the methodology for radio transmitter attachment and follow-up tracking. Briefly, bottlenose dolphins in both the Brunswick and Sapelo field sites were temporarily captured and restrained utilizing practices similar to those implemented by the Chicago Zoological Society's Sarasota Dolphin Research

Table 1
Photographic records and biopsy sampled obtained from 2004 to 2009 for all survey effort in the southern Georgia study area (SGA).

Date	Field site	Survey type	# of individuals sighted	# of remote biopsy samples obtained	# of surgical biopsy samples obtained
14–17 Dec. 2004	Brunswick	Remote biopsy	11		
21–30 Aug. 2006	Brunswick	Remote biopsy	130	13	
12–23 Mar. 2007	Brunswick	Remote biopsy	114	19	
20–31 Aug. 2007	Sapelo	Remote biopsy	169	20	
04–16 Feb. 2008	Brunswick and Sapelo	Abundance	146		
17–27 Mar. 2008	Sapelo	Remote biopsy	77	10	
01–11 Apr. 2008	Brunswick and Sapelo	Abundance	146		
29 Jul.–9 Aug. 2008	Brunswick and Sapelo	Abundance	222		
18–28 Aug. 2008	Sapelo	Remote biopsy	106	14	
06–16 Oct. 2008	Brunswick and Sapelo	Abundance	100		
29 Jan.–9 Feb. 2009	Brunswick and Sapelo	Abundance	131		
31 Mar.–11 Apr. 2009	Brunswick and Sapelo	Abundance	159		
06–16 Jul. 2009	Brunswick and Sapelo	Abundance	196		
03–14 Aug. 2009	Brunswick and Sapelo	Health assessment	26		26
15 Aug.–9 Oct. 2009	Brunswick and Sapelo	Radio tracking	224		
13–24 Oct. 2009	Brunswick and Sapelo	Abundance	179		
25 Oct.–20 Nov. 2009	Brunswick and Sapelo	Radio tracking	69		

Program (Wells et al., 2004). Radio transmitters were deployed on 28 dolphins (14 male, 14 female) and subsequently tracked by vessel for over 100 days with GPS positions recorded for the visual locations of all tagged individuals.

For all three survey efforts, dorsal fin images were graded on both distinctiveness of the dorsal fin, and photographic quality, following the methods of Urian et al. (1999). A catalog of all fins was created with each individual receiving a unique number based on its distinctive markings. Currently, the SGA photo-identification catalog consists of 646 individual bottlenose dolphins. The photo-identification records from the remote biopsy, abundance, and radio-tracking surveys were used to analyze individuals' sighting histories and classify each biopsy sampled individual into one of three ranging patterns. In this study, a ranging pattern is defined as the photo-identification sighting history for an individual dolphin within the SGA region. If all photo-identification sightings of a biopsy sampled individual were in either the defined Brunswick or Sapelo field site, they were identified as having a "Brunswick" or "Sapelo" ranging pattern, respectively. Biopsy sampled individuals that were sighted in both field sites were identified as having a "Mixed" ranging pattern.

2.5. Data analysis

Blubber samples in this study were analyzed for PCB congeners (IUPAC PCB numbers 18, 28 + 31, 44, 49, 52, 56, 66, 70, 74, 87, 92, 95, 99, 101, 105, 110, 118, 119, 128, 130, 137, 138, 146, 149, 153 + 132, 151, 154, 156, 157, 158, 163, 170, 172, 174, 176, 177, 178, 180, 183, 185, 187, 189, 194, 195, 197, 199, 200, 201, 202, 203 + 196, 206, 207, 208, and 209), polybrominated diphenyl ether (PBDE) congeners (47, 99, 100, 153, and 154), dichlorodiphenyl-dichloroethanes (DDTs) (2,4′-DDD DDE, and DDT; and 4,4′-DDD, DDE, and DDT), chlordanes (CHLs) (*cis*- and *trans*-chlordane and nonachlor, oxychlordane and heptachlor epoxide), hexachlorobenzene (HCB), dieldrin, and mirex. Σ PCBs was defined as the sum of the 54 PCB congeners. Σ Aroclor 1268 was defined as the sum of the following congeners identified by Maruya and Lee (1998) as indicative of Aroclor 1268 (174, 180, 183, 187, 194, 196, 199, 200, 201, 202, 206, 207, 208, and 209). Aroclor 1268 proportion was calculated as Σ Aroclor 1268/Σ PCBs. To control for lipid content variability between individuals and sampling seasons, POP concentrations for all samples were calculated on a lipid-weight basis and log transformed to meet the assumptions of normality.

Because mothers transfer much of their accumulated lipophilic contaminant loads to their offspring during each pregnancy and associated lactation period (Aguilar et al., 1999; Wells et al., 2005; Yordy et al., 2010), all biopsied individuals were separated based upon sex. Each sampled individual was classified into its respective ranging pattern (Brunswick, Sapelo, or Mixed) based upon its photo-identification sighting history from all survey efforts. If a sampled individual had a non-distinctive fin or had not been sighted pre- or post-biopsy sampling (i.e. its ranging pattern could not be identified), it was excluded from these analyses. The proportion of Aroclor 1268 congeners was arcsine transformed to meet the assumption of normality. A two-way analysis of variance (ANOVA) including sex (male, female) and ranging pattern (Brunswick, Sapelo, Mixed) as factors was performed. When the F-statistic was significant for ranging pattern, pairwise comparisons were made using Tukey's Honestly Significant Difference (HSD) test.

The location of the LCP Chemicals site (31.189440 N, 81.508330 W) (EPA, 2002), the likely point source for Aroclor 1268 contamination, was used as a reference point and photo-identification sighting histories for each biopsy sampled individual were utilized to calculate the distance of each sighting from this point. Distance for each photo-identification sighting was calculated as the closest on-water distance between the sighting and the reference point using the "Measure" tool in ArcMap 9.2 (ESRI, Redlands, CA). For each individual dolphin, the mean distance to point source was determined from that dolphin's entire sighting history. Linear regression analysis was performed to examine any relationships between the proportions of Aroclor 1268 congeners, and mean sighting distance from point source. A test for homogeneity of slopes was used to determine interactions between sex and distance from point source.

3. Results

A total of 105 blubber samples were collected via remote biopsy from dolphins in the Brunswick and Sapelo field sites. Of these, 29 remote biopsy samples were excluded because individuals had non-distinctive fins or were not sighted pre- or post-sampling. In addition, 26 samples were collected via surgical biopsy during the capture–release health assessment bringing the total number of samples utilized in this study to 102. Sampled individuals, which were sighted a mean number of 14 ± 12 (± standard deviation) times, were separated by sex and grouped into one of three ranging patterns; Brunswick (♀ = 10, ♂ = 24), Mixed (♀ = 4, ♂ = 18), and Sapelo (♀ = 14, ♂ = 32).

Male dolphins had significantly higher mean concentrations for all POP classes than did females (Table 2). Mean percent lipid was significantly higher in female dolphins than male dolphins ($P = 0.0022$). Σ PCB and Σ Aroclor 1268 differed significantly across all ranging patterns. There were no significant differences in mean

Table 2
Geometric mean persistent organic pollutant (POP) contaminant values and 95% confidence intervals in (μg/g) lipid weight mass from Brunswick, Mixed, and Sapelo bottlenose dolphins sampled in the SGA. Significant P-values are indicated in bold. *Note*: For each POP class, statistical differences were determined utilizing a two-way ANOVA with sex and ranging pattern as factors. When the F-statistic was significant for ranging pattern, pairwise comparisons for ranging patterns within each sex were made using Tukey's Honestly Significant Difference (HSD) test. Homogeneous groups are indicated by capital (male) or lower case (female) letter subscripts.

	POP class	Lipid (%)	Σ PCB	Σ Aroclor 1268	Aroclor 1268 proportion	Σ PBDE	Σ DDT	Σ CHL	HCB	Dieldrin	Mirex
Males	*Brunswick*	25.12	509.56^{A}	407.78^{A}	0.77^{A}	3.85	36.77	6.30	0.04	0.16	2.65
	(n = 24)	(13.17–37.07)	(369.04–703.59)	(290.30–572.78)	(0.74–0.80)	(2.79–5.32)	(21.93–61.65)	(4.31–9.22)	(0.03–0.06)	(0.06–0.39)	(1.86–3.78)
	Mixed	27.90	253.57^{B}	170.71^{B}	0.68^{B}	5.12	28.55	5.75	0.05	0.32	2.17
	(n = 18)	(17.02–38.77)	(177.89–361.45)	(119.14–244.61)	(0.65–0.71)	(3.78–6.95)	(16.87–48.32)	(3.68–9.01)	(0.04–0.07)	(0.19–0.55)	(1.53–3.08)
	Sapelo	23.57	115.73^{C}	69.10^{C}	0.60^{C}	2.48	20.49	3.83	0.04	0.15	1.69
	(n = 32)	(14.39–32.74)	(91.66–146.13)	(54.97–86.86)	(0.58–0.62)	(1.95–3.17)	(14.03–29.93)	(2.76–5.34)	(0.03–0.04)	(0.11–0.21)	(1.30–2.20)
Females	*Brunswick*	32.80	116.47^{a}	94.87^{a}	0.85^{a}	0.63	15.68	0.63	0.02	0.16	0.45
	(n = 10)	(12.71–52.90)	(78.14–173.60)	(64.41–139.72)	(0.79–0.84)	(0.22–1.82)	(2.79–88.10)	(0.24–1.63)	(0.01–0.04)	(0.03–0.72)	(0.27–0.76)
	Mixed	28.61	45.94^{a}	35.15^{a}	0.78^{a}	0.38	1.59	0.49	0.01	0.22	0.46
	(n = 4)	(17.18–40.03)	(20.75–101.72)	(19.43–63.60)	(0.55–1.00)	(0.05–2.57)	(0.23–10.99)	(0.08–3.05)	(0.00–0.03)	(0.04–1.30)	(0.12–1.74)
	Sapelo	36.44	48.27^{a}	30.60^{a}	0.63^{b}	1.27	10.03	1.31	0.03	0.09	0.77
	(n = 14)	(19.04–53.84)	(27.25–85.50)	(17.72–52.86)	(0.59–0.67)	(0.63–2.55)	(3.98–25.32)	(0.37–4.74)	(0.02–0.04)	(0.03–0.26)	(0.42–1.41)
P-value (ranging pattern):		P = 0.8960	**P < 0.0001**	**P < 0.0001**	**P < 0.0001**	P = 0.7237	P = 0.0674	P = 0.7384	P = 0.3640	P = 0.8094	P = 0.8948
P-value (sex):		P = 0.0022	P < 0.0001	P < 0.0001	P < 0.0001	P < 0.0001	P = 0.0006	P < 0.0001	P < 0.0001	P = 0.0132	P < 0.0001

percent lipid and all other POP classes, across male ranging patterns. The highest Σ PCB concentrations in male dolphins were 2870 μg/g (Brunswick), 756 μg/g (Mixed), and 333 μg/g (Sapelo). Brunswick males had significantly higher mean Σ PCB and Σ Aroclor 1268 concentrations than did Sapelo males (P < 0.0001 and P < 0.0001, respectively). Mean Σ PCB and Σ Aroclor 1268 concentrations for Mixed males were significantly lower than Brunswick males (P = 0.0036 and P = 0.0024, respectively) and significantly higher than Sapelo males (P = 0.0028 and P = 0.0090, respectively). The highest Σ PCB concentrations measured in female dolphins were 339 μg/g (Brunswick), 154 μg/g (Mixed), and 279 μg/g (Sapelo). There were no significant differences in mean percent lipid, Σ PCB, Σ Aroclor 1268, and all other POP classes between females across ranging patterns. However, the low sample size (n = 4) for Mixed females limits interpretation of contaminant data associated with this ranging pattern in comparison to the other female ranging patterns.

Aroclor 1268 proportion in male dolphins differed significantly between all three ranging patterns (P < 0.0001 for all pairwise comparisons), with Brunswick males having the highest proportion followed by Mixed, and Sapelo males (Table 2). Brunswick and Mixed females had a significantly higher proportion of Aroclor 1268 (P < 0.0001 and P = 0.0009, respectively) than did Sapelo females. Aroclor 1268 proportion did not differ significantly between Brunswick and Mixed females (P = 0.9288).

Linear regression analysis was performed to identify relationships between Aroclor 1268 proportion and mean sighting distance from the point source for each biopsy sampled individual (Fig. 2). For both male and female dolphins, there was a negative relationship between the proportion of Aroclor 1268 congeners and mean sighting distance from the point source (males: $R^2 = 0.6842$, P < 0.0001; females: $R^2 = 0.7137$, P < 0.0001). The slopes of the regression lines did not differ between males and females (P = 0.4020).

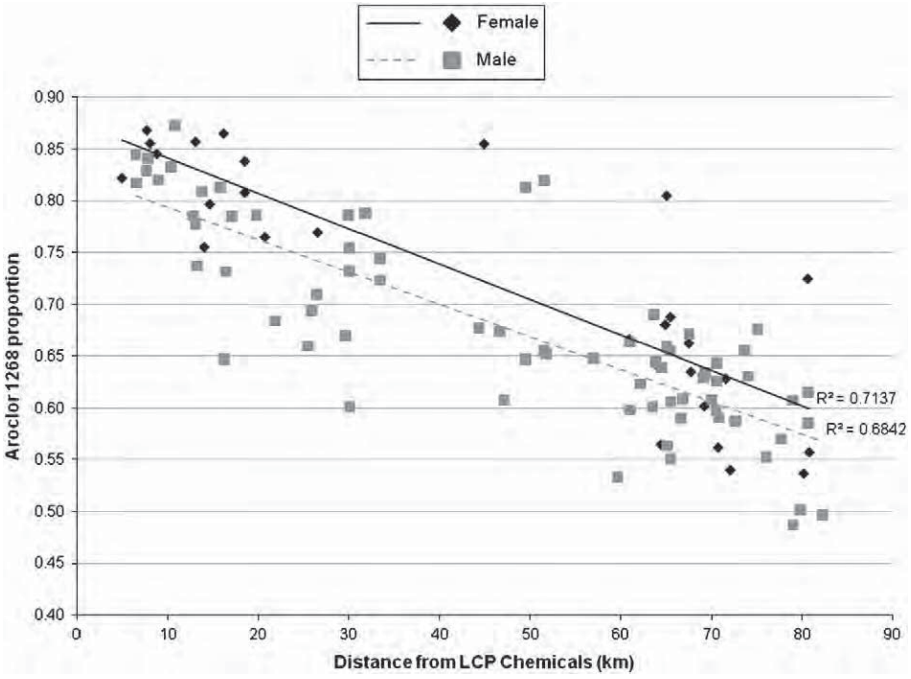

Fig. 2. Relationship between the proportions of Aroclor 1268 congeners found in the blubber of each biopsy sampled individual and its calculated mean sighting distance from LCP Chemicals.

4. Discussion

This study confirms that dolphins utilizing the TBRE are exposed to extraordinarily high levels of PCBs. The maximum PCB concentration measured in a Brunswick male was over 1.5 times greater than the maximum PCB level measured in transient, male Pacific killer whales (*Orcincus orca*), which were previously reported to have the highest PCB levels of any cetacean (Krahn et al., 2007; Ross et al., 2000). Biomagnification of contaminant concentrations has been extensively documented in marine mammal species (reviewed in Houde et al., 2005). Transient killer whales, at the top of the northeastern Pacific marine food web, primarily feed on other marine mammal species (Ford et al., 1998), therefore high contaminant levels would be expected in these individuals through biomagnification. Bottlenose dolphins along the southeastern U.S. are also considered top-level, marine predators (reviewed in Wells et al., 2005). However, bottlenose dolphin prey is primarily based on lower trophic levels such as pinfish (*Lagodon rhomboides*), mullet (*Mugil* spp.), and a variety of soniferous fish species (Barros and Odell, 1990; Barros and Wells, 1998; Berens McCabe et al., 2010; Gannon and Waples, 2004). Thus, based solely on trophic level differences, it would be expected that bottlenose dolphin contaminant concentrations should typically be lower than those of transient killer whales. The higher levels of PCBs measured in Brunswick male dolphins compared to male transient killer whales is related to the proximity of this population to a major PCB point source and the exposure to these contaminants within their localized environment due to their ranging patterns.

Σ PCB concentrations measured in male dolphins that were only sighted in the Sapelo field site were lower than in Brunswick males, but were comparable to those measured for male bottlenose dolphins in northern Biscayne Bay, Florida (Litz et al., 2007). These males were previously reported to have the highest PCB concentrations for bottlenose dolphins in the southeastern U.S. The Sapelo Island National Estuarine Research Reserve (SINERR) has been identified in numerous studies as a "pristine" reference site based upon the minimal amount of urbanization in the region (e.g. Alberts et al., 1990; Chalmers et al., 1985; Plumley et al., 1980). The elevated levels of PCBs and high Aroclor 1268 proportion in Sapelo male dolphins suggest otherwise. Although there are limited industrial influences surrounding the SINERR, dolphins that have been sighted exclusively in this region have elevated PCB levels associated with a point source located 40 km southwest of their observed ranging pattern. Future research is necessary to identify the pathways leading to Aroclor 1268 contamination in Sapelo dolphins, such as determining contaminant levels and movement patterns of key bottlenose dolphin prey fish species. Contaminated prey or sediments are the most likely routes leading to dolphin exposure as the Aroclor 1268 mixture is extremely hydrophobic (mean log $K_{ow} = 7.9$ L/kg) (Maruya and Lee, 1998) and water transport is unlikely.

For each ranging pattern within the southern Georgia survey area (SGA), female dolphins had significantly lower mean Σ PCB and Σ Aroclor 1268 concentrations, but significantly higher proportions of Aroclor 1268 than males. Female cetaceans, upon reaching sexually maturity, offload the majority of their contaminants to their first born offspring, primarily through lactation (reviewed in Aguilar et al., 1999). For example, PCB concentrations measured in adult female bottlenose dolphins from Sarasota are much lower than those of juvenile females from the same community (Wells et al., 2005; Yordy et al., 2010). Yordy et al. (2010) identified significant changes in POP profiles of female bottlenose dolphins at sexual maturity, where the smallest, least lipophilic contaminants were offloaded through lactation to their first offspring. The predominant Aroclor 1268 congeners are highly chlorinated and therefore may not partition to the milk during lactation, making them resistant to offloading (Kannan et al., 1997, 1998; Yordy et al., 2010). Thus, the proportion of Aroclor 1268 in female dolphins would be expected to be higher than in males, as females offload the less lipophilic contaminants and retain the most lipophilic contaminants. The results of this study suggest that SGA female bottlenose dolphins either continue to be exposed to PCBs, or are not offloading contaminants at the same rate as dolphins in other regions, or some combination of these two processes.

Schwacke et al. (2002) suggested that risk of reproductive failure, such as neonate mortality, would be highest for primiparous female bottlenose dolphins, but that following a successful birth and lactation, the risk of reproductive failure would be reduced with a lower contaminant load. The high PCB levels in SGA females, maintained over the course of a reproductive lifetime, may also maintain the high risk for reproductive failure, even for subsequent reproductive events. Photo-identification data from the 2008 survey effort identified six neonates within the SGA, only one of which survived until the following year (B. Balmer, unpublished data), yielding an annual neonate survival rate of 0.167. For comparison, Speakman et al. (2010) calculated an annual neonatal survival rate of 0.754 (95% CI = 0.647–0.878) for bottlenose dolphins in the Charleston Estuarine Stock. In Sarasota Bay, Florida, the average annual overall neonatal survival is approximately 80%, with about 50% of first-born calves surviving the first year (Wells and Scott, 1990; Wells et al., 2005). Although our SGA estimate is only for a single year, and survival rates often vary greatly across years, these results suggest that dolphin reproductive potential in the SGA may be limited in comparison to other estuarine areas. Knowledge of life history parameters from stranding data is necessary to improve the accuracy of neonatal survivorship estimates. However, collection of high quality stranded carcasses in the SGA has been hampered by geographic remoteness, high tidal flux, and other logistical constraints in the region. Enhanced stranding response, stranding reporting and continuation of photo-identification surveys in the SGA are all needed in order for survival estimates to be calculated and compared with other dolphin populations.

The PCB congeners that comprise Aroclor 1268 have been identified as a point source pollutant from the LCP Chemicals Superfund site (Kannan et al., 1997; Kucklick et al., in review; Maruya and Lee, 1998; Pulster and Maruya, 2008). There was a significant negative relationship between the proportion of Aroclor 1268 congeners and mean sighting distance from the LCP Superfund site, indicating that the exposure of a SGA dolphin is directly associated to its proximity to this site. Although PCBs are ubiquitous contaminants and there is potentially some background exposure resultant from long-range environmental transport, the high levels and proportion of Aroclor 1268 congeners indicate that PCB exposure of the sampled dolphins was predominantly from this single point source. Other studies along the southeastern U.S. have reported elevated levels of highly chlorinated PCB congeners in bottlenose dolphins (Hansen et al., 2004; Houde et al., 2006; Kucklick et al., in review; Watanabe et al., 2000). Watanabe et al. (2000) determined that over 60% of the PCB profile measured in liver samples from stranded bottlenose dolphins consisted of six (hexa) and seven (hepta) chlorobiphenyls. Similarly, in blood plasma samples from bottlenose dolphins obtained during capture-release health assessments, the predominant PCB homolog groups measured were those that contained between five (penta) and seven (hepta) chlorines (Yordy et al., 2010). However, the specific PCB profile of the highly chlorinated congeners associated with Aroclor 1268 have only been identified along the southern coast of Georgia (Kucklick et al., in review). Although our study has identified SGA dolphins with localized ranging patterns exclusively within the Brunswick and Sapelo field sites, future research is necessary to determine if other groups of dolphins are entering the SGA as well as prey species' movements into and out of the region.

Kucklick et al. (in review) utilized POP concentrations measured in bottlenose dolphins at 14 locations along the southeastern U.S. and Gulf of Mexico coasts, to identify geographic differences in POPs. The

contaminant levels measured in the Brunswick and Sapelo field sites for this study were two of the locations included in this analysis. Kucklick et al. (in review) confirmed the results of this study, which identified that Brunswick dolphins had the highest Σ PCB concentrations measured along the southeastern U.S. and Gulf of Mexico coasts. Σ PBDE concentrations in SGA dolphins were comparable to dolphins sampled in Charleston, SC, and Mississippi Sound, and higher than dolphins sampled in all other sampling locations. Mirex concentrations in SGA dolphins were comparable to dolphins sampled in Sarasota Bay, FL, Tampa Bay, FL, and Mississippi Sound, and higher than all other sampling locations. Σ DDT, Σ CHL, HCB, and dieldrin concentrations were intermediate in SGA dolphins, in comparison to all other sampling locations. The geographic differences in POP concentrations provide an additional tool to identify bottlenose dolphin stock delineations.

NOAA has defined five coastal and nine estuarine North Western Atlantic (NWA) bottlenose dolphin stocks, based upon photo-identification, telemetry, and genetic studies at multiple locations along the southeastern U.S. coast (reviewed in Waring et al., 2009). Numerous NWA bottlenose dolphin stocks overlap with each other and the precise delineations of these stocks, and movements of individuals between these stocks, are currently not well understood. On a broad-scale, Hansen et al. (2004) identified differences in POP concentrations between individual dolphins biopsy sampled in multiple states along the southeastern U.S. Similarly, Litz et al. (2007) identified significant differences in PCB exposure of different bottlenose dolphin communities in the localized estuary of Biscayne Bay, Florida. The results of this study suggest that the elevated POP levels and patterns may provide insight into Georgia bottlenose dolphin population structure. The two NOAA defined stocks in this region are the South Carolina/Georgia Coastal Stock (SCGCS) and the Southern Georgia Estuarine Stock (SGES) (Waring et al., 2009). The SCGCS includes all of the coastal waters of South Carolina and Georgia out to 25 m in depth. The SGES includes all of the estuarine waters from Altamaha Sound south to the Cumberland Sound (Georgia/Florida border). The spatial extent, ranging patterns, and overlap between these two stocks are not well understood. Dolphins that live in the estuarine waters to the north of the SGES, including Sapelo Island and the SINERR, are not classified into any stock at this time. The results from the photo-identification data and measured contaminant concentrations from this study suggest that Brunswick and Sapelo bottlenose dolphins may be part of separate estuarine stocks; SGES and a previously undefined stock beginning at the Altamaha Sound and extending northward, respectively. Recent studies determining seasonal abundance estimates, as well as ranging and movement patterns of bottlenose dolphins within the Brunswick and Sapelo field sites will augment this study and enhance these proposed changes in current SGA stock delineations.

The results of this study suggest that POP, and specifically Aroclor 1268, contamination extends farther outside of the TBRE than previously documented. Elevated levels of POPs, such as PCBs, have been identified as potential stressors to marine mammals (reviewed in Houde et al., 2005). Numerous studies have linked high tissue levels of PCBs to deleterious effects on reproduction and immune function (Aguilar and Borrell, 1998; DeLong et al., 1973; Helle et al., 1976; Martineau et al., 1987). However, identifying POPs as a causative factor of reproductive failure and immune suppression has proven difficult due to the logistical, political, and ethical constraints involved with marine mammals (reviewed in Schwacke et al., 2002). SGA bottlenose dolphins have extremely high levels of PCBs, specifically the highly chlorinated congeners associated with Aroclor 1268, which have been suggested to be resistant to offloading. Individual dolphins within the SGA have relatively localized distribution patterns facilitating routine follow up monitoring. Thus, the bottlenose dolphins within the SGA provide a unique opportunity to identify possible deleterious effects associated with chronic PCB exposure.

Disclaimer

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Polychlorinated Biphenyls (PCBs) in Georgia Coastal Environments and Populations September 3, 2014

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Health Studies Branch, National Center for Environmental Health
Eastern Branch, Agency for Toxic Substances and Disease Registry

Outline

- **PCBs in Coastal Georgia Environments**
  - LCP Chemicals
  - Fish advisory areas
  - Seafood
- **PCBs in Coastal Populations**
  - Sapelo Island
    - Study description
    - Study findings
- **Next Steps**

PCBs in Coastal Georgia

- **Soil at the LCP Chemicals Superfund Site in Brunswick, GA**
- **Fishing advisory areas**
  - Brunswick
  - Near Sapelo Island
- **Distribution**
  - Total PCBs
  - PCB congener 206
- **Seafood samples from coastal Georgia**
  - Brunswick
  - Sapelo Island

PCBs at LCP Chemicals Superfund Site

- **Aroclors detected in soils at LCP**
  - 1016
  - 1221
  - 1248
  - 1254
  - 1260
  - 1268
- **Target EPA Action Level for total PCBs at LCP**
  - 25 ppm

Frequency of Aroclors Detected in Soils at LCP

Frequency of detection for various Aroclors in soil.			
Substance	# Detections	# Samples	Frequency
Aroclor 1016	2	891	0.2
Aroclor 1221	1	902	0.1
Aroclor 1232	0	902	0.0
Aroclor 1242	0	902	0.0
Aroclor 1248	2	902	0.2
Aroclor 1254	81	902	9.0
Aroclor 1260	37	902	4.1
Aroclor 1268	171	852	20.1

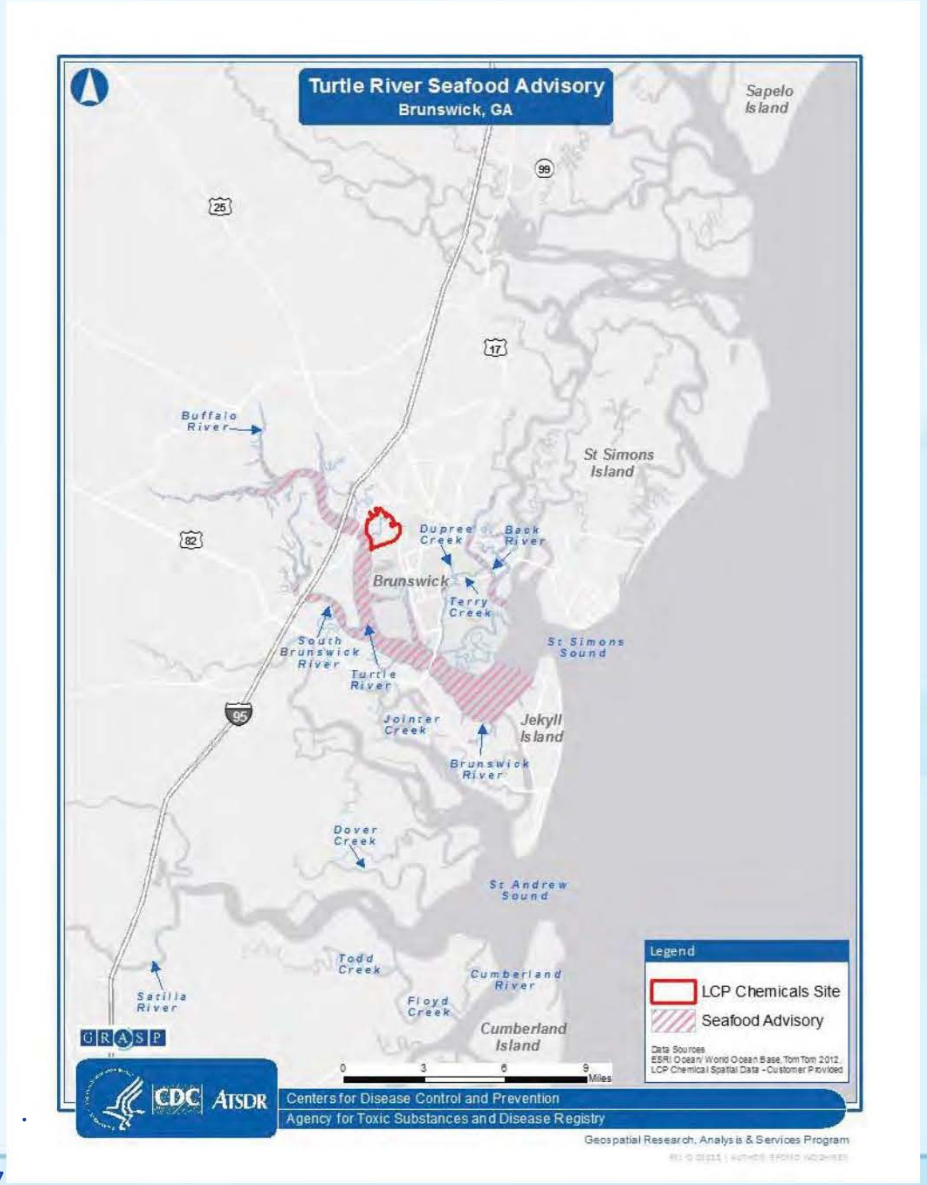
Aroclor 1268 concentration generally much higher than 1254 and 1260 concentrations

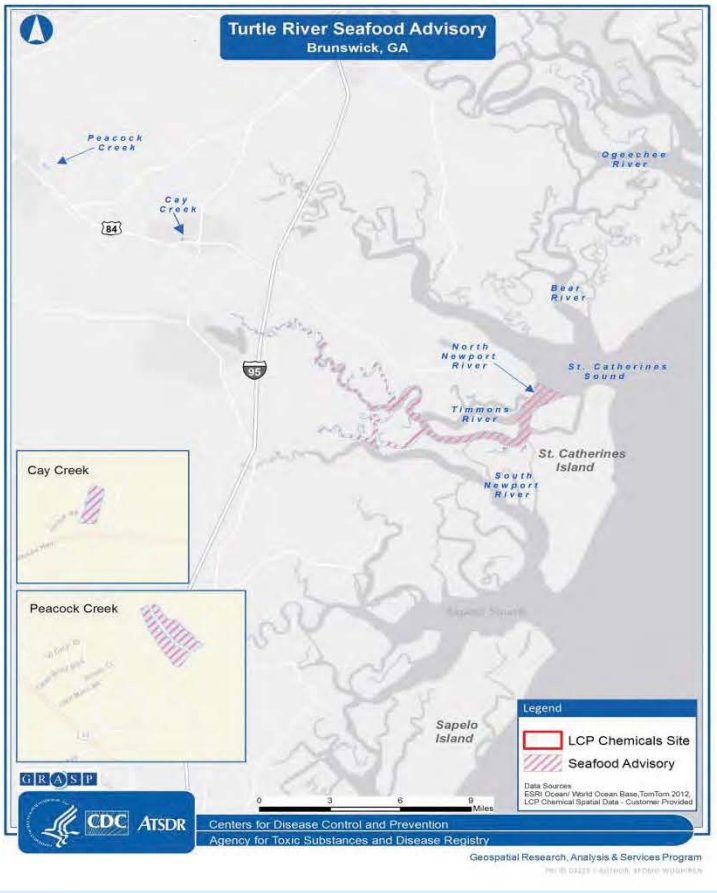
Source: ATSDR Public Health Assessment for the LCP Chemicals Superfund Site, 2014

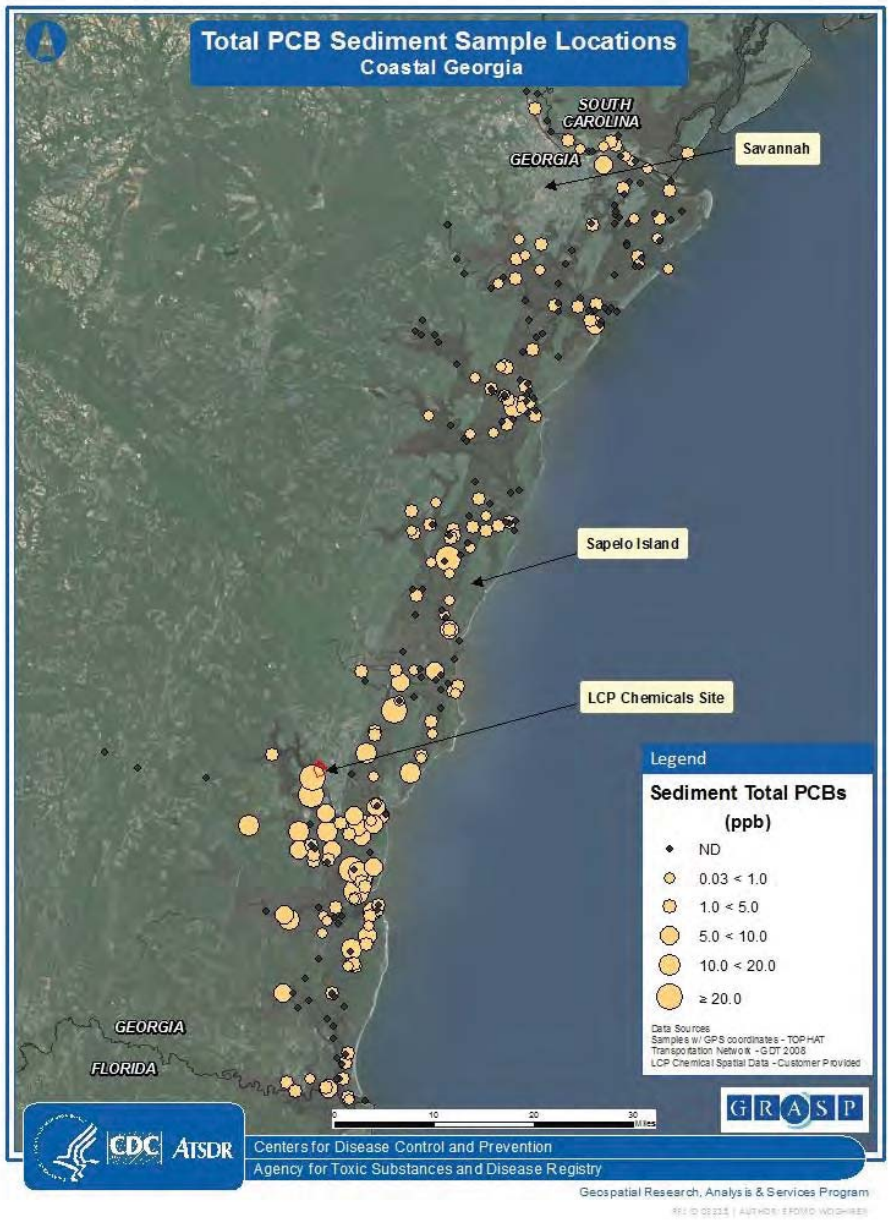
Aroclors 1268, 1260, and 1254 Congeners

Aroclor 1268	Aroclor 1260	Aroclor 1254
206 (>50%)	180	101
209	153	138
208	138	119
199	149	52
196	170	153
202	101	149
187	194	106
194		44
180+193		
201		

Coastal Georgia Fishing Advisory Areas

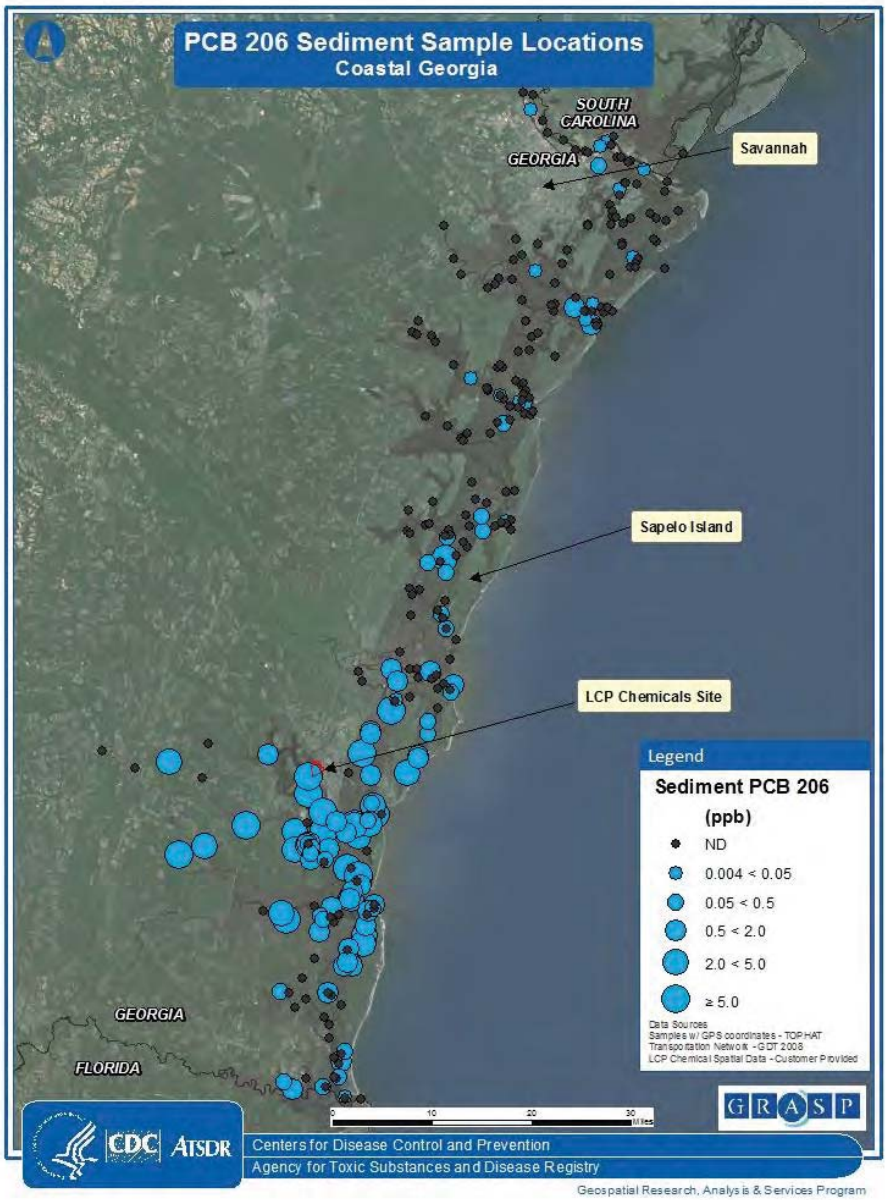




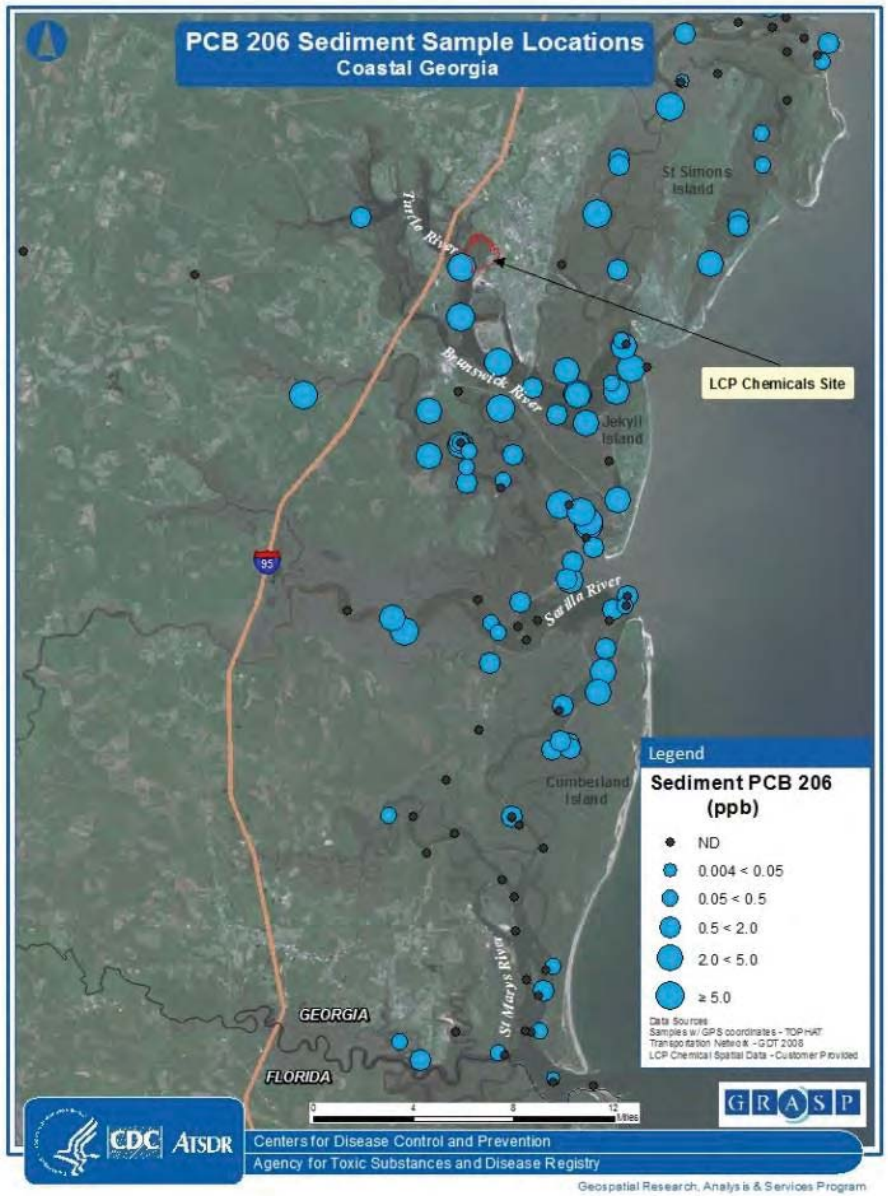


Source for all PCB sediment maps.
EPA's National Coastal Database

http://www.epa.gov/emap2/nca/html/data/index.html



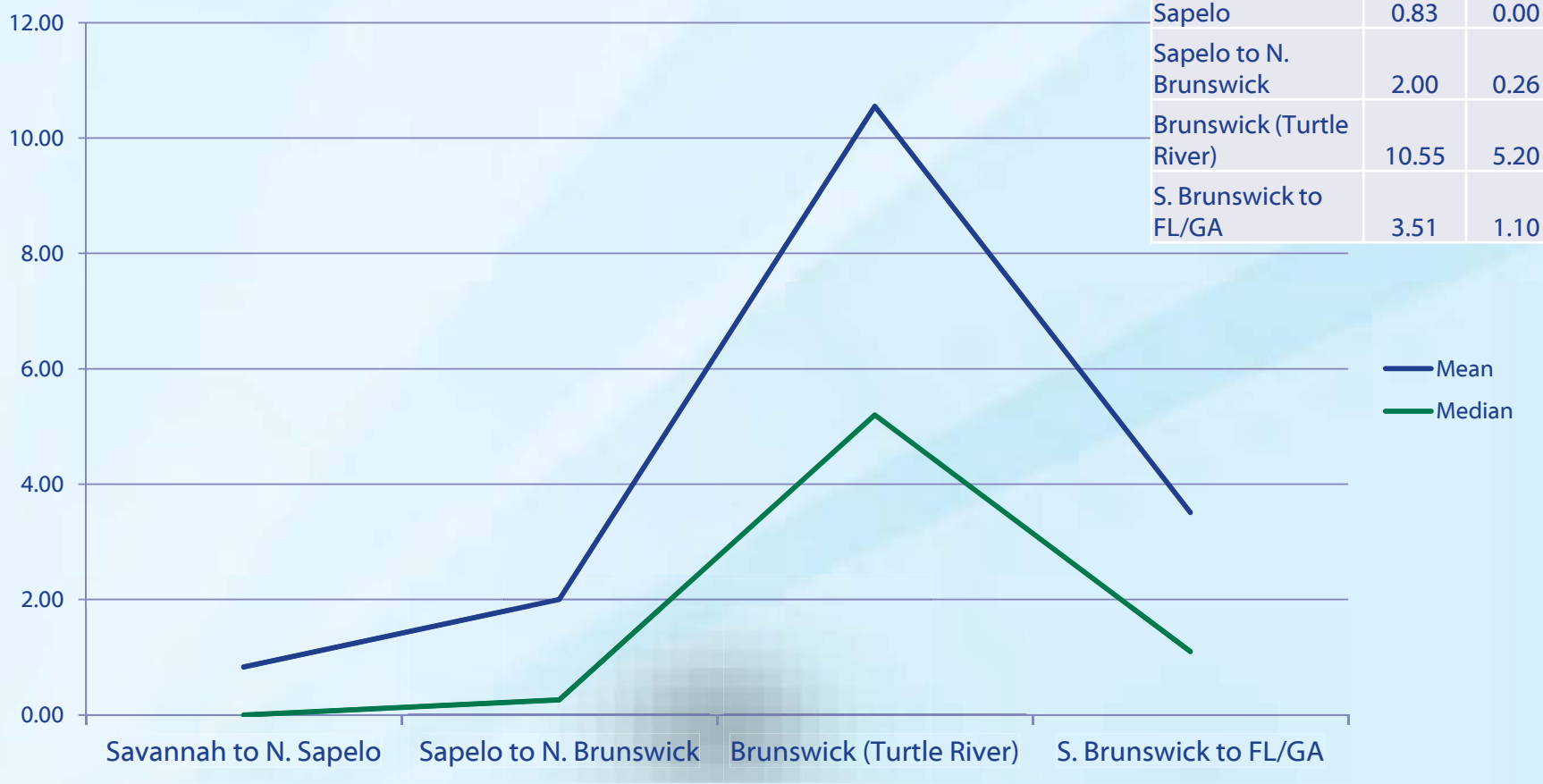
PCB 206
most abundant
congener in
Aroclor 1268


PCB 206 Sediment Sample Locations
Coastal Georgia
St Simons Island
Turtle River
Brunswick River
LCP Chemicals Site
Jekyll Island
95
Satilla River
Cumberland Island
St Marys River
GEORGIA
FLORIDA
Legend
Sediment PCB 206 (ppb)
ND
0.004 < 0.05
0.05 < 0.5
0.5 < 2.0
2.0 < 5.0
≥ 5.0
Data Sources
Samples w/ GPS coordinates - TOPHAT
Transportation Network - GDT 2008
LCP Chemical Spatial Data - Customer Provided
0 4 8 12 Miles
GRASP
CDC ATSDR
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Geospatial Research, Analysis & Services Program

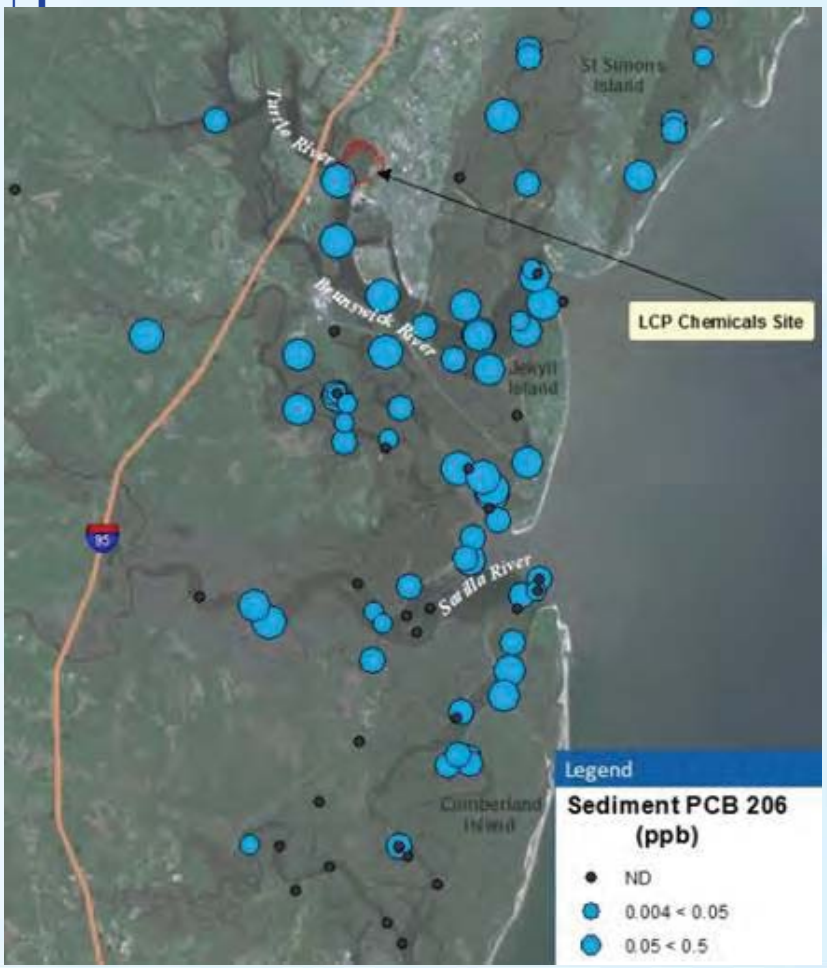
.

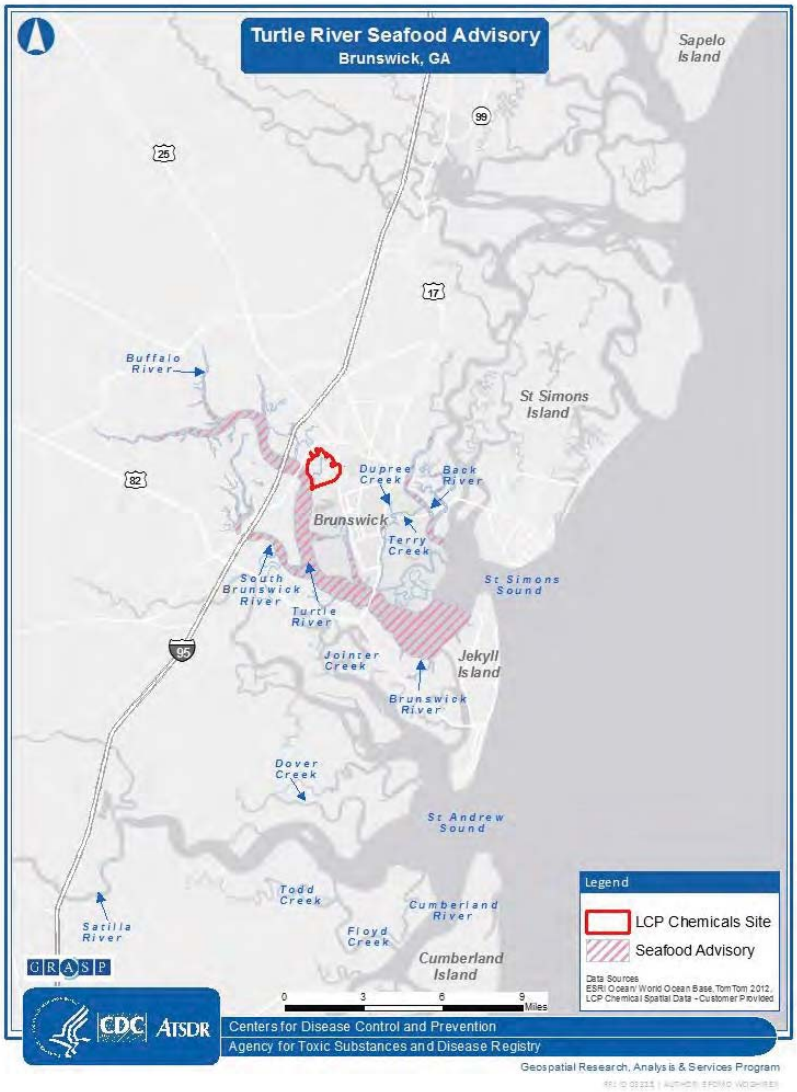
Total PCB Sediment Levels in ppb

Location	Mean	Median
Savannah to N. Sapelo	0.83	0.00
Sapelo to N. Brunswick	2.00	0.26
Brunswick (Turtle River)	10.55	5.20
S. Brunswick to FL/GA	3.51	1.10



Turtle River Fish Advisory





Burnett Creek and Altamaha Canal

Recent Seafood Samples from the Turtle River system

Location and Date	Aroclor 1268 concentrations in mg/kg-wet weight (ppm-ww)				
	Red Drum	Mullet	Sea Trout	Blue Crab	Shrimp
Altamaha Canal* 2011	0.02	0.25	0.08	0.015	0.015
Burnett Creek 2012** Blackdrum 0.113 S. Kingfish 0.2 (Whiting)	0.035	NA	0.39	NA	NA

* Skin-on fillets; Source: ATSDR PHA for the LCP Chemicals Superfund Site, 2014

** Composite samples, skin-on fillets, except red drum (single sample): Source: ATSDR/GA DPH Health Consultation, Burnett Creek Fish Tissue, Brunswick Wood Preserving, Brunswick, GA

PCBs in Fish from the Turtle River System, 2002-2012

Location and Date	PCB concentrations in mg/kg-wet weight (ppm-ww)				
	Red Drum	Mullet	Sea Trout	Blue Crab	Shrimp
Altamaha Canal, 2011 (Aroclor 1268 only)	0.02	0.25	0.08	0.015	0.015
Burnett Creek, 2012 (Aroclor 1268 only)	0.035	NA	0.39	NA	NA
Lower Turtle River south of the site, 2002	0.11	0.36	NA	0.1	0.1
Upper Turtle River (north of LCP), 2002	0.25	1.4	NA	0.16	0.1
Middle Turtle River (adjacent to LCP), 2002	0.14	2.6	NA	0.02	0.23

Source: ATSDR Public Health Assessment for the LCP Chemicals Superfund Site, 2014

Comparison of Brunswick and Sapelo Island Seafood

Date and Location	Total PCB concentrations mg/kg-wet weight (ppm-ww)					
	Red Drum	Diff	Mullet	Diff	Sea Trout	Diff
2010 Sapelo Island*	0.007		0.004		0.0095	
2011 Altamaha Canal (Brunswick)	0.02	3	0.25	63	0.08	8
2012 Burnett Creek (Brunswick)	0.035	5	NA	NA	0.39	41
2002 Turtle River (Brunswick)	0.16	23	2.5	625	NA	NA

* Sapelo Island fish data collected by NCEH as part of their investigation at Sapelo Island

Environmental Contaminants in Coastal Populations

- **Purposes**
  - Conduct pilot studies
  - Compare results in people with what is known about dolphins
- **Method**
  - Targeted 3 coastal communities with offshore resident dolphins
    - Sapelo Island, Georgia; Biscayne Bay, Florida; Charleston Harbor, South Carolina
  - Inclusion criteria:
    - Have resided in the community for at least 5 years
    - Consume at least two meals of locally-caught seafood each week
  - Recruited 9 study participants in each community to:
    - Complete questionnaire unique to each community
    - Provide blood samples and seafood for analysis
      - PCBs, PFOAs, PBDEs, heavy metals, and chlorinated pesticides

Sapelo Island Study Results

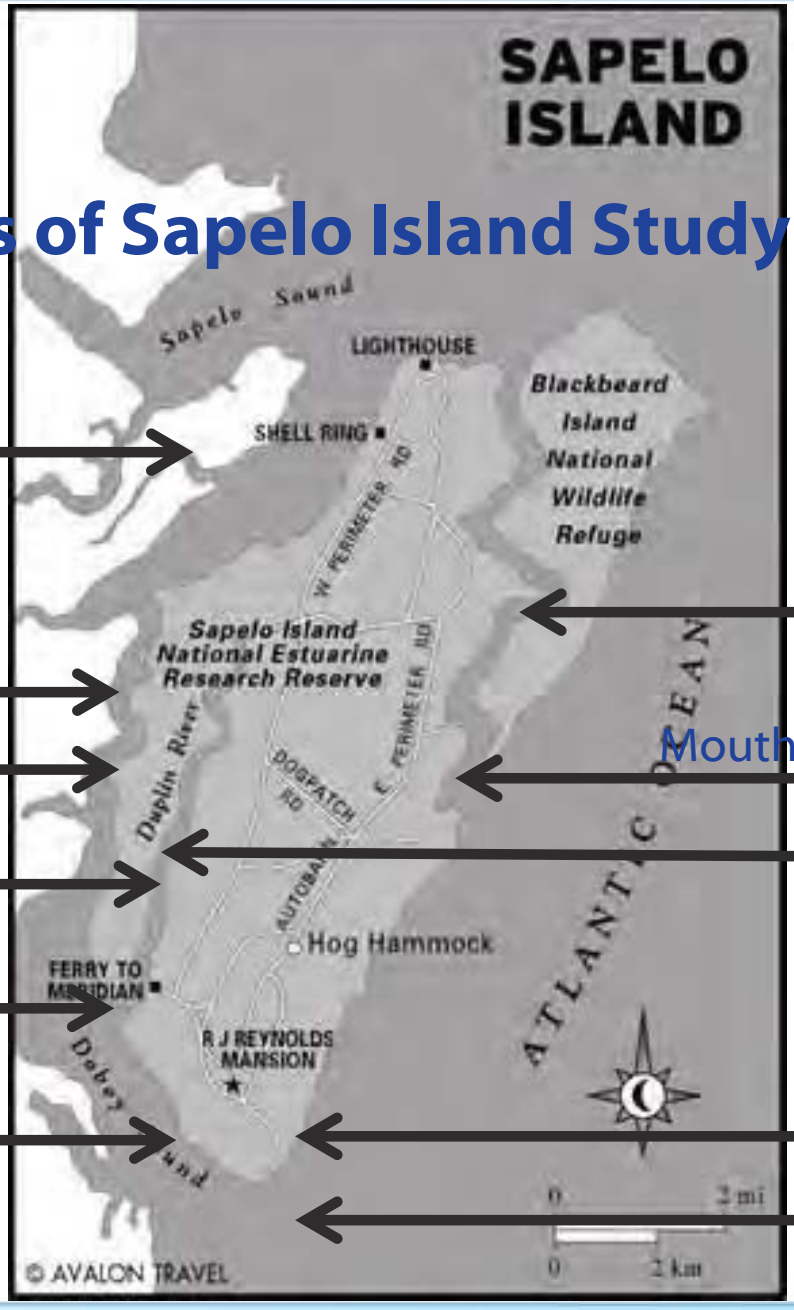
- **The discussion will be limited to our findings regarding PCBs**

Demographics of Sapelo Island Study Participants

Characteristic	Median (range)
Age (years)	51 (21-74)

Characteristic	Number (percent)
Race	
Black	6 (67 %)
White	3 (33 %)
Sex	
Female	1(11%)
Male	8 (89 %)
Residence	
On Sapelo Island	8 (89 %)
On mainland across estuary	1 (11%)

Fishing Areas of Sapelo Island Study Participants



Mud River (2)

Little Moses Hammock (1)

Lumber Landing (3)

Community Landing (3)

Marsh Landing (4)

Lighthouse (3)

Raccoon Bluff (2)

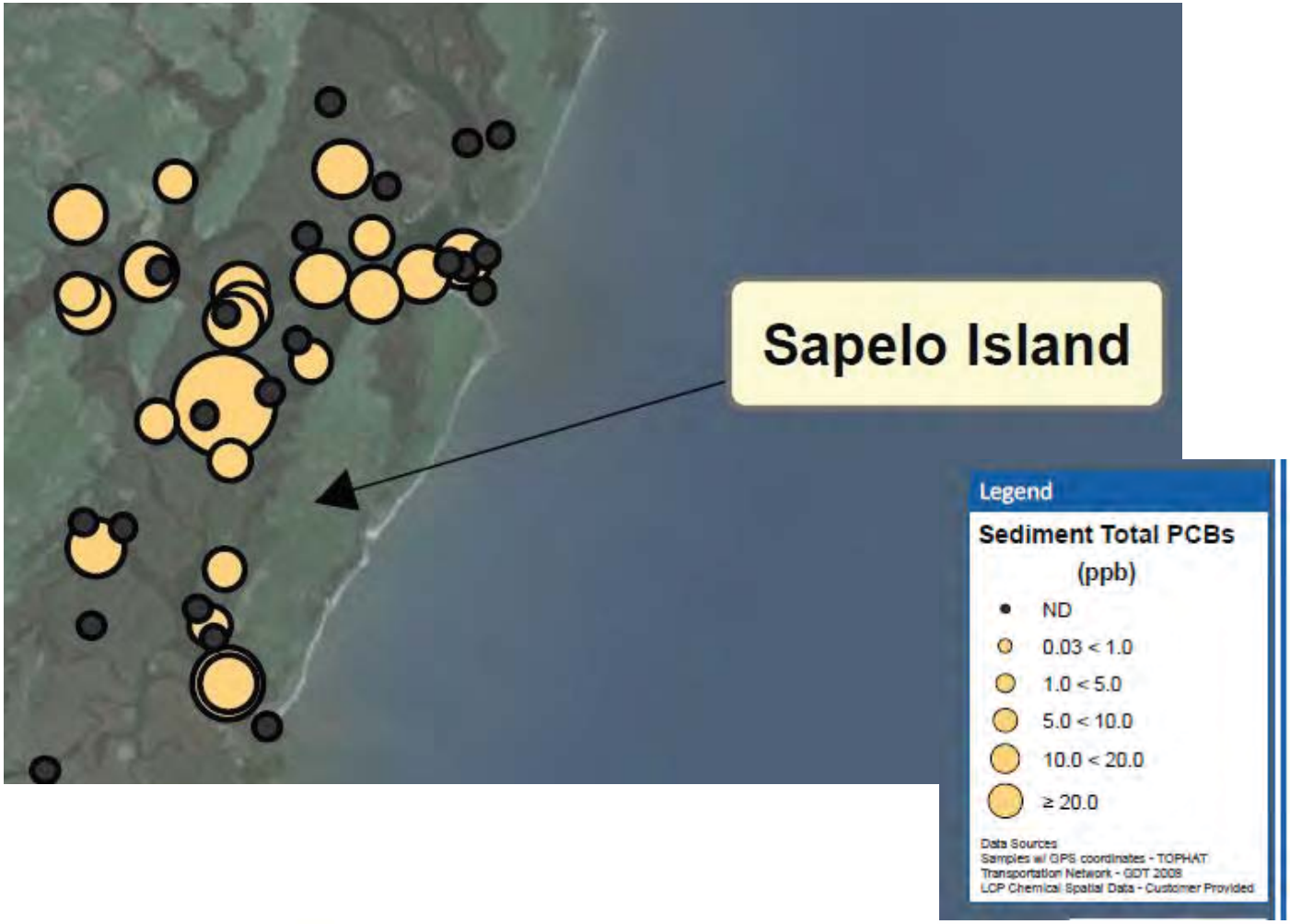
Mouth of Blackbeard Creek (1)

Duplin River (2)

Nanny Goat Beach (2)

Southeastern Coast (2)

Sapelo Island
Total PCBs in Sediment



Local Seafood Consumption by Sapelo Island Study Participants

Characteristic	Number
Eats 2-3 meals of locally-caught seafood/week	9 (100 %)
Has eaten locally-caught seafood for > 5 years	9 (100 %)
Eats seafood meals of: 6 oz 9 oz	 5 (56 %) 4 (44 %)
Eats seafood meals of*: Filet with skin removed Filet with skin on Whole fish (gutted) Whole fish (not gutted) Fish eggs * Responses not mutually exclusive	 1 (11 %) 3 (33 %) 5 (56 %) 1 (11 %) 4 (44 %)

Species of Fish Eaten by Sapelo Island Study Participants

Species	Number of People
Red drum	1 (11 %)
Catfish	1 (11 %)
Shark	1 (11 %)
Brim/spot	2 (22 %)
Flounder	2 (22 %)
Sheepshead	3 (33 %)
Croaker	6 (67%)
Mullet	6 (67 %)
Spotted sea trout	7 (78 %)
Spot-tailed bass/red fish	9 (100 %)
Whiting	9 (100 %)

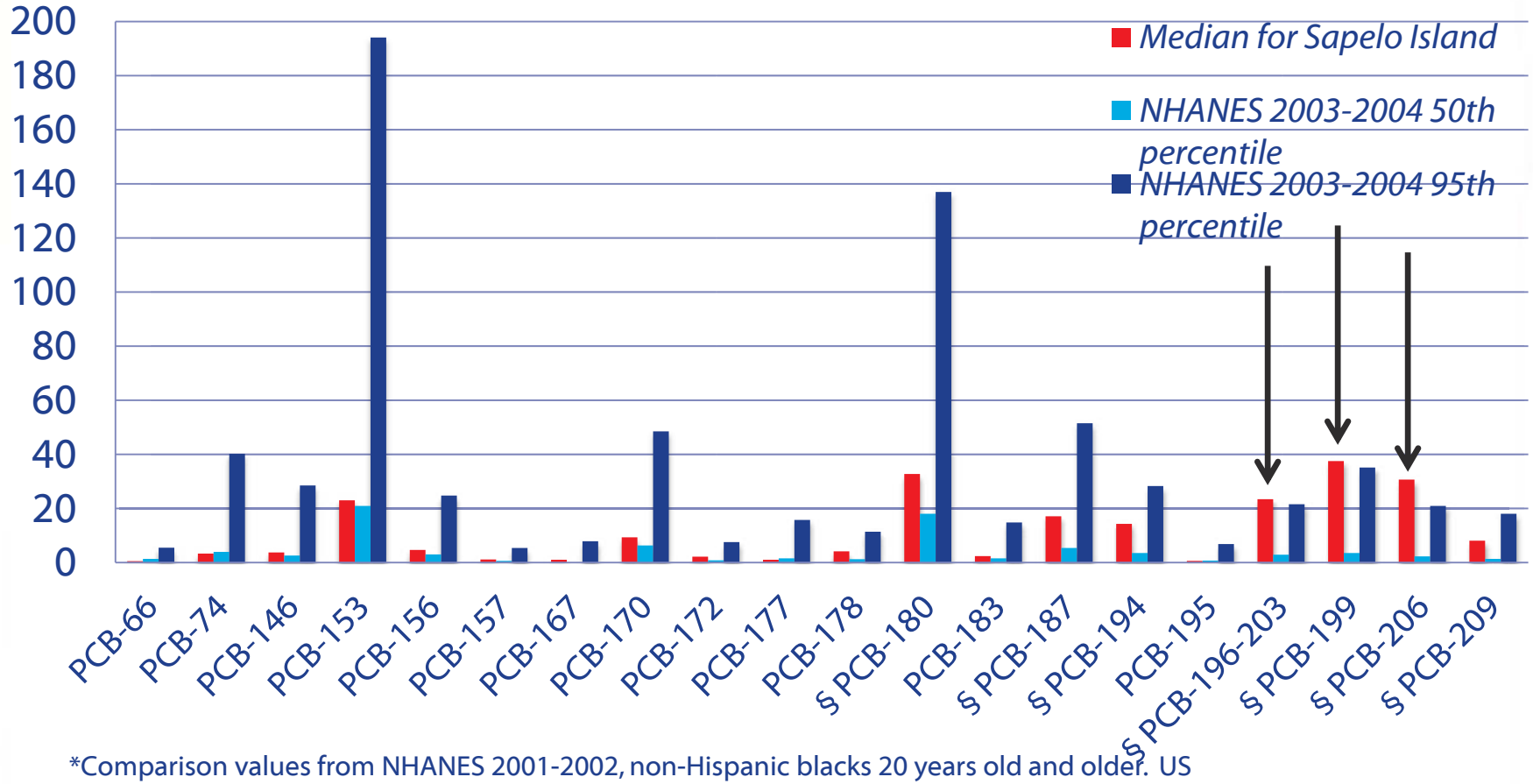
Local Meat Consumption by Sapelo Island Study Participants

Animal	Number
Venison	1 (11 %)
Duck	1 (11 %)
Raccoon	2 (22 %)

Knowledge of Fish Advisories in Sapelo Island Study Participants

Characteristic	Number of People
Aware of Georgia fish advisories?	
Yes	5 (56%)
No	4 (44 %)
Since you became aware of the advisories, did you change your habits of catching or eating seafood? (N = 5)	
Yes	2 (40 %)
No	3 (60 %)

PCB concentrations (ng/g lipid) for those PCBs tested in both Sapelo Island participants' blood specimens (medians) and NHANES 2001-2002, Non-Hispanic Blacks* (50th and 95th percentiles, matched on age group)



*Comparison values from NHANES 2001-2002, non-Hispanic blacks 20 years old and older. US Department of Health and Human Services. 2005. Third National Report on Human Exposure to Environmental Chemicals. July.

Study Limitations

- **The pilot study sample size was small (n =9).**
- **We analyzed legacy chemicals**
  - They accumulate in tissues over time
  - Cannot determine when exposure occurred
- **However, we did find that human and dolphin specimens contain qualitatively similar environmental contaminants (dolphin data not shown).**

Conclusions

- Aroclor 1268 appears to be widespread around Brunswick, GA.
- Based on sediment and fish samples, contamination from LCP Chemicals Superfund Sites may have migrated along the Georgia coast.
- The current fishing advisory for the Turtle River system may not adequately cover other contaminated rivers and creeks around Brunswick, GA.
- Residents of Sapelo Island have been exposed to specific PCB also found at the LCP site.

Now that we know more about the extent of PCB contamination along the Georgia coast, what should we do next?

- More fish sampling?
- More sediment sampling?
- Extend the fish advisory area?

This information is distributed by ATSDR under applicable information quality guidelines. It does not represent and should not be construed to represent final agency conclusions and recommendations

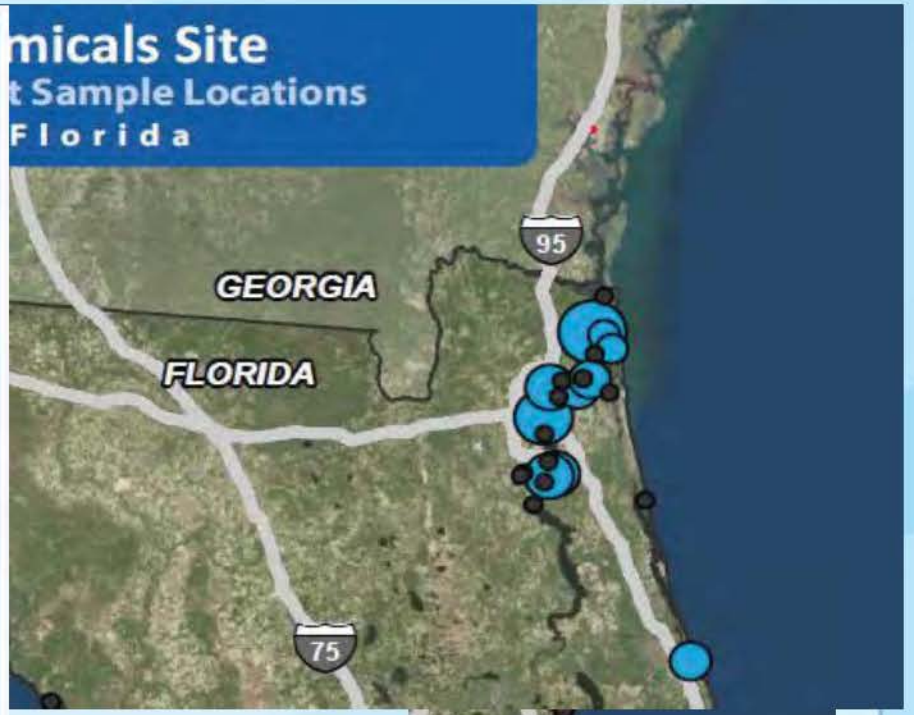
Extra Slides

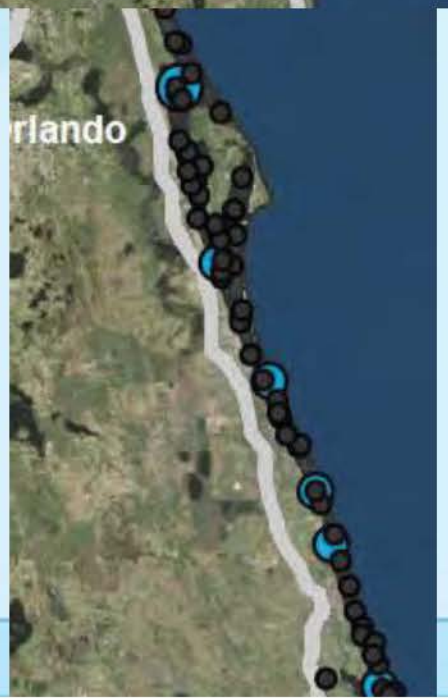
(to be used to answer questions)

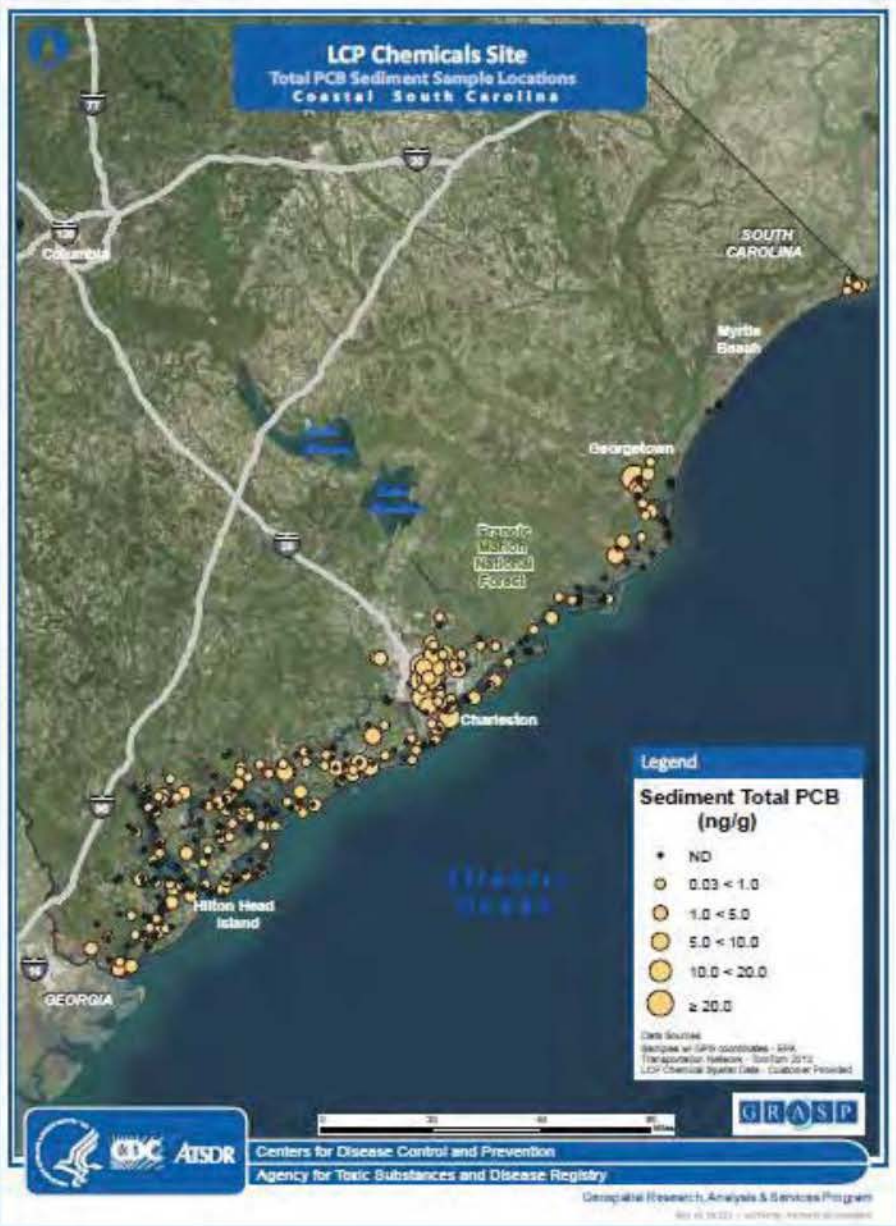
- PCBs along Florida and South Carolina Coast


LCP Chemicals Site
Total PCB Sediment Sample Locations
Coastal Florida
GEORGIA
FLORIDA
Tallahassee
Orlando
Tampa
Legend
Sediment Total PCB (ng/g)
ND
0.03 < 1.0
1.0 < 5.0
5.0 < 10.0
10.0 < 20.0
≥ 20.0
GRASP
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Geospatial Research, Analysis & Services Program


LCP Chemicals Site
PCB 206 Sediment Sample Locations
Coastal Florida
GEORGIA
FLORIDA
Tallahassee
Orlando
Tampa
Legend
Sediment PCB 206
(ng/g)
ND
0.004 < 0.05
0.05 < 0.5
0.5 < 2.0
2.0 < 5.0
≥ 5.0
CDC ATSDR
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
GRASP
Geospatial Research, Analysis & Services Program

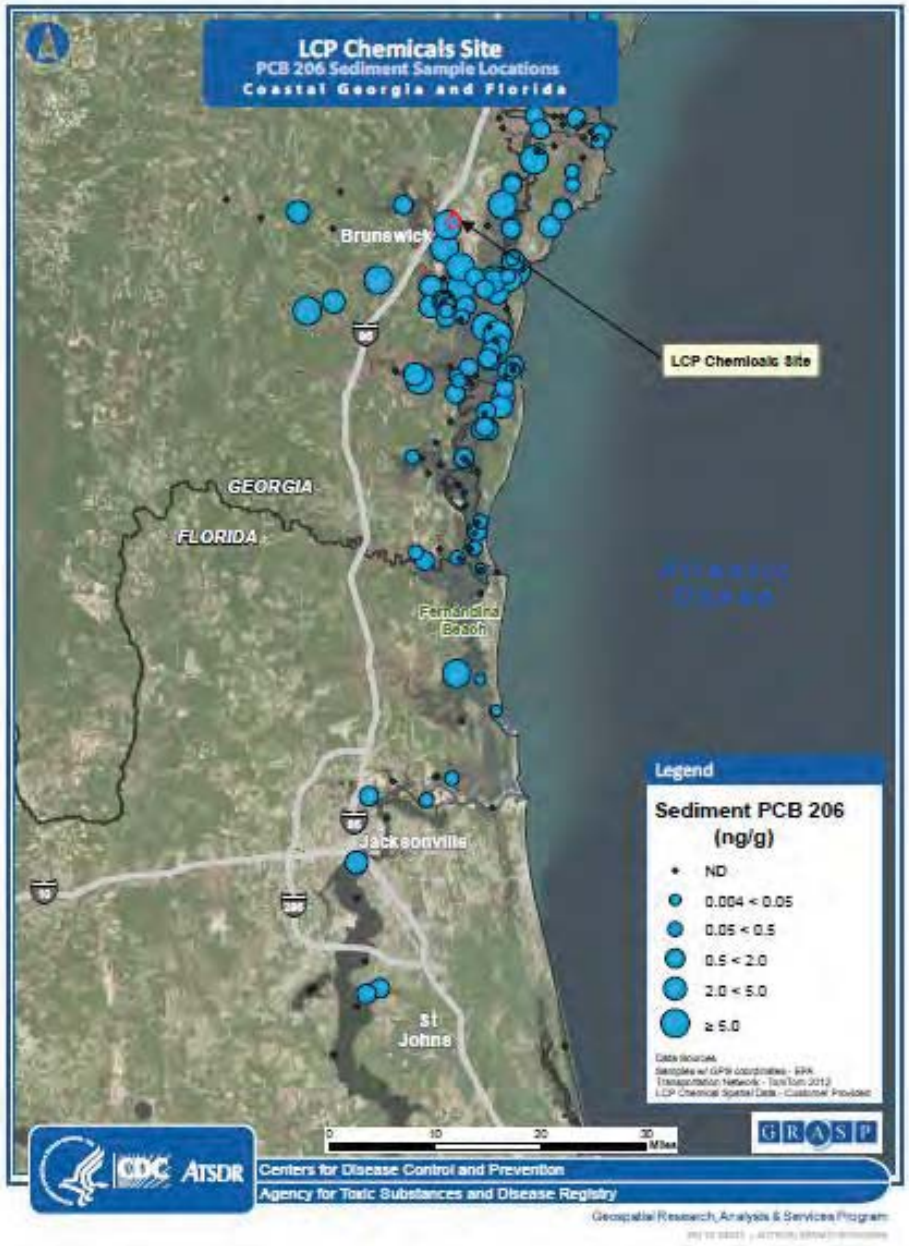

micals Site
t Sample Locations
Florida
GEORGIA
FLORIDA
95
75


rlando


LCP Chemicals Site
Total PCB Sediment Sample Locations
Coastal South Carolina
Columbia
SOUTH CAROLINA
Myrtle Beach
Georgetown
Francis Marion National Forest
Charleston
Hilton Head Island
GEORGIA
Legend
Sediment Total PCB (ng/g)
ND
0.03 < 1.0
1.0 < 5.0
5.0 < 10.0
10.0 < 20.0
≥ 20.0
GRASP
CDC ATSDR
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Geospatial Research, Analysis & Services Program

.


LCP Chemicals Site
PCB 206 Sediment Sample Locations
Coastal South Carolina
SOUTH CAROLINA
Myrtle Beach
Georgetown
Francis Marion National Forest
Charleston
Hilton Head Island
GEORGIA
Atlantic Ocean
Lake Moultrie
26
95
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Legend
Sediment PCB 206 (ng/g)
ND
0.004 < 0.05
0.05 < 0.5
0.5 < 2.0
2.0 < 5.0
≥ 5.0


LCP Chemicals Site
PCB 206 Sediment Sample Locations
Coastal Georgia and Florida
Brunswick
LCP Chemicals Site
GEORGIA
FLORIDA
Fernandina Beach
Jacksonville
St Johns
Legend
Sediment PCB 206 (ng/g)
ND
0.004 < 0.05
0.05 < 0.5
0.5 < 2.0
2.0 < 5.0
≥ 5.0
0 10 20 30 Miles
GRASP
CDC ATSDR
Centers for Disease Control and Prevention
Agency for Toxic Substances and Disease Registry
Geospatial Research, Analysis & Services Program

Aroclor 1268
PCB Congener Non-Cancer Toxicity

PCB-180[a]	BMI	Highest BMI with intermediate exposures (quartile 2)
PCB-187[a]	HDL cholesterol levels	Lowest levels with intermediate exposures (quartile 2)
PCB 196–203	Diabetes incidence	Highest risk in groups with intermediate exposures (quartile 2)
PCB-196	Endometriosis	Decreased risk in groups with intermediate exposures (quartile 3)

Source: Vandenberg LN, Colborn L, Hayes TB et al. 2012. Hormones and endocrine-disrupting chemicals: Low-dose effects and nonmonotonic dose responses. Endocrine Reviews 33(3);378-455.

United States Government Accountability Office

GAO

Report to Congressional Requesters

January 2005

HAZARDOUS WASTE SITES

Improved Effectiveness of Controls at Sites Could Better Protect the Public

GAO-05-163

January 2005

HAZARDOUS WASTE SITES

Improved Effectiveness of Controls at Sites Could Better Protect the Public

GAO Accountability • Integrity • Reliability

Highlights

Highlights of GAO-05-163, a report to congressional requesters

Why GAO Did This Study

The Environmental Protection Agency's (EPA) Superfund and Resource Conservation and Recovery Act (RCRA) programs were established to clean up hazardous waste sites. Because some sites cannot be cleaned up to allow unrestricted use, institutional controls—legal or administrative restrictions on land or resource use to protect against exposure to the residual contamination—are placed on them. GAO was asked to review the extent to which (1) institutional controls are used at Superfund and RCRA sites and (2) EPA ensures that these controls are implemented, monitored, and enforced. GAO also reviewed EPA's challenges in implementing control tracking systems. To address these issues, GAO examined the use, implementation, monitoring, and enforcement of controls at a sample of 268 sites.

What GAO Recommends

To ensure the long-term effectiveness of institutional controls, GAO recommends that EPA (1) clarify its guidance on when controls should be used; (2) demonstrate that, in selecting controls, sufficient consideration was given to all key factors; (3) ensure that the frequency and scope of monitoring efforts are sufficient to maintain the effectiveness of controls; and (4) ensure that the information on controls reported in new tracking systems accurately reflects actual conditions. EPA generally agreed with GAO's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-05-163.

To view the full product, including the scope and methodology, click on the link above. For more information, contact John Stephenson at (202) 512-3841 or stephensonj@gao.gov.

What GAO Found

Institutional controls were applied at most of the Superfund and RCRA sites GAO examined where waste was left in place after cleanup, but documentation of remedy decisions often did not discuss key factors called for in EPA's guidance. For example, while documents usually discussed the controls' objectives, in many cases, they did not adequately address when the controls should be implemented, how long they would be needed, or who would be responsible for monitoring or enforcing them. According to EPA, the documents' incomplete discussion of the key factors suggests that site managers may not have given them adequate consideration. Relying on institutional controls as a major component of a site's remedy without carefully considering all of the key factors—particularly whether they can be implemented in a reliable and enforceable manner—could jeopardize the effectiveness of the remedy.

EPA faces challenges in ensuring that institutional controls are adequately implemented, monitored, and enforced. Institutional controls at the Superfund sites GAO reviewed, for example, were often not implemented before the cleanup was completed, as EPA requires. EPA officials indicated that this may have occurred because, over time, site managers may have inadvertently overlooked the need to implement the controls. EPA's monitoring of Superfund sites where cleanup has been completed but residual contamination remains often does not include verification that institutional controls are in place. Moreover, the RCRA corrective action program does not include a requirement to monitor sites after cleanups have been completed. In addition, EPA may have difficulties ensuring that the terms of institutional controls can be enforced at some Superfund and RCRA sites: that is, some controls are informational in nature and do not legally limit or restrict use of the property, and, in some cases, state laws may limit the options available to enforce institutional controls.

To improve its ability to ensure the long-term effectiveness of institutional controls, EPA has recently begun implementing institutional control tracking systems for its Superfund and RCRA corrective action programs. The agency, however, faces significant obstacles in implementing such systems. The institutional control tracking systems being implemented track only minimal information on the institutional controls. Moreover, as currently configured, the systems do not include information on long-term monitoring or enforcement of the controls. In addition, the tracking systems include data essentially derived from file reviews, which may or may not reflect institutional controls as actually implemented. While EPA has plans to improve the data quality for the Superfund tracking system—ensuring that the data accurately reflects institutional controls as implemented and adding information on monitoring and enforcement—the first step, data verification, could take 5 years to complete. Regarding the RCRA tracking system, the agency has no current plans to verify the accuracy of the data or expand on the data being tracked.

Contents

Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
EPA	Environmental Protection Agency
GPRA	Government Performance and Results Act of 1993
ICTS	Institutional Controls Tracking System
NPL	National Priorities List
RCRA	Resource Conservation and Recovery Act
ROD	record of decision

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, D.C. 20548

January 28, 2005

The Honorable James M. Jeffords
Ranking Minority Member
Committee on Environment and Public Works
United States Senate

The Honorable Barbara Boxer
Ranking Minority Member
Subcommittee on Superfund, Toxics, Risk and Waste Management
Committee on Environment and Public Works
United States Senate

The Honorable Lincoln D. Chafee
United States Senate

The Environmental Protection Agency (EPA) estimates that one in four Americans lives within 4 miles of a hazardous waste site. To protect the public's health, the Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, which established the Superfund program to clean up the most seriously contaminated of these sites. In addition, in 1984, the Congress amended the Resource Conservation and Recovery Act (RCRA) to add a corrective action program to clean up contamination at facilities that treat, store, and dispose of hazardous waste.[1] Since the inception of these two programs, EPA has overseen the cleanup of over 5,000 hazardous waste sites across the country. At many of these sites, however, EPA has selected cleanup remedies that leave at least some waste in place because the agency believes it is impossible, impractical, or too costly to clean up the contaminated property so that it can be used without restriction. Cleanups at such sites often rely on institutional controls—legal or administrative restrictions on the use of land or water at the site—to limit the public's exposure to residual contamination. As of December 2004, about 1,600 hazardous waste sites were being cleaned up by the Superfund program and another 3,800 facilities were being cleaned up by the RCRA corrective action program.

[1]The Congress enacted RCRA in 1976 to establish a framework for managing hazardous waste from its generation to final disposal.

States play a significant role in the cleanup of hazardous waste sites under both the Superfund and RCRA programs. Within the Superfund program, states may enter into agreements with EPA to perform certain program actions, such as initial site assessments, and EPA also consults with states throughout the cleanup process. Under the RCRA program, EPA has authorized 40 states and Guam to implement and enforce their own hazardous waste regulations in lieu of federal regulations and to carry out corrective action activities. However, regardless of whether a particular state is authorized, either the state or EPA may assume the lead on working with a facility to implement corrective action. In addition, at certain Superfund and RCRA sites, state and local government entities may be responsible for monitoring the status of institutional controls and enforcing their terms.

The cleanup process for the Superfund and RCRA programs is similar in many ways. For both programs, the process begins with a preliminary investigation to determine the extent of the contamination at a site. In this initial phase, under Superfund, EPA places the most seriously contaminated sites on its National Priorities List (NPL).[2] In both programs, cleanup officials typically analyze a range of alternatives before selecting a remedy to address a site's contamination. In the Superfund program, the remedy is described in a record of decision (ROD); in the RCRA program, it is usually described in a "statement of basis." Once the remedy is selected, remedy implementation under both programs typically involves a number of phases, including remedy design, construction, operation and maintenance, and completion. Under Superfund, when EPA, in consultation with the relevant state, determines that no further remedial activities at a site are appropriate, EPA deletes the site from the NPL. When remedial measures are completed for a RCRA facility, the corrective action process for that facility is terminated.

[2]In this report, we use the term "Superfund program" to refer to long-term remedial actions carried out at sites on the NPL. EPA also carries out removal actions under Superfund, which are generally shorter term cleanups designed to address more immediate threats to health and the environment.

Institutional controls can be a critical component of the cleanup process and may be used to ensure short-term protection of human health and the environment during the cleanup process itself as well as long-term protection once the site is deleted from the NPL or corrective action is terminated. EPA defines institutional controls as "non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land or resource use." In September 2000 and December 2002, EPA issued guidance setting out, among other things, the key factors to be considered when evaluating and selecting institutional controls at Superfund and RCRA sites and responsibilities for implementing, monitoring, and enforcing institutional controls at these sites.[3] Under this guidance, EPA generally—although not always—requires that institutional controls be put in place at Superfund and RCRA sites where total cleanup is not practical or feasible. If deemed necessary, these controls may be combined with engineering controls—such as capping or fencing—to limit exposure to residual site contamination. For example, the remedy selected for a hazardous waste landfill may include engineering controls, such as placing a protective layer, or "cap" made of clay or synthetic materials, over the contamination. At such sites, EPA may also add institutional controls to prohibit any digging that might breach this protective layer and expose site contaminants.

Concerned that institutional controls may not be effectively protecting human health and the environment, you asked us to review (1) the extent to which institutional controls are used at sites addressed by EPA's Superfund and RCRA corrective action programs; (2) the extent to which EPA ensures that institutional controls at these sites are implemented, monitored, and enforced; and (3) EPA's challenges in implementing systems to track these controls. To address these issues, we examined EPA's use, implementation, monitoring, and enforcement of institutional controls at a nonprobability sample of nonfederal sites where (1) the cleanup process was completed in earlier periods, for historical perspective; (2) the cleanup process had ended more recently; and (3) the remedy had only recently been selected, for insight into the likely future use of these controls. (Results from nonprobability samples cannot be used to make inferences about a population, because in a nonprobability sample

[3]The December 2002 guidance was issued in draft form for public comment. It had not been finalized as of September 2004 because, according to an EPA official, the agency received and must respond to a large number of comments on the draft document.

some elements of the population being studied have no chance or an unknown chance of being selected as part of the sample.) Our review focused on institutional controls that remain in place after site deletion or termination to determine whether these controls are effective in the long run. Although both the Superfund and RCRA programs address federal and nonfederal sites, our review did not address federal sites because federal agencies are generally responsible for cleaning up their own sites and EPA involvement is limited. We also focused our reviews of RCRA facilities on those whose cleanup was led by EPA.

To gain a broader view of past use of institutional controls, we reviewed files for all 20 Superfund sites deleted from the NPL during fiscal years 1991 through 1993; in addition, in the two EPA regions[4] with the most corrective actions, we reviewed files for all 40 RCRA facilities at which, according to EPA's database, a preliminary investigation was conducted and corrective action was terminated before fiscal year 2001. Regarding sites where the cleanup was recently completed, we examined documentation related to institutional controls at all 53 Superfund sites deleted from the NPL during fiscal years 2001 through 2003 and at all 31 RCRA facilities where corrective action was terminated during the same period. For those sites whose documentation indicated the use, or potential use, of institutional controls, we conducted follow-up interviews with EPA or state officials knowledgeable about the site to obtain detailed information and additional documentation and to determine what institutional controls were actually in place.

To gain a sense of the projected use of institutional controls in the future, we examined all 112 Superfund RODs finalized during fiscal years 2001 through 2003, and statements of basis for all 23 RCRA corrective action facilities that reached the remedy decision stage during that period. For our review, we examined only the principal remedy decision documents for the sites in our universe, rather than all remedy decision documents. We also interviewed RCRA program managers from a sample of 6 states to understand the extent to which those states implement, monitor, and enforce institutional controls. In addition, we visited 5 Superfund sites with residual contamination and institutional controls remaining in place after the site was deleted from the NPL. To identify the challenges of implementing a system to track institutional controls, we interviewed EPA and state officials. A more detailed description of our scope and

[4]Region III in Philadelphia and Region V in Chicago.

methodology is presented in appendix I. We conducted our work from October 2003 to January 2005 in accordance with generally accepted government auditing standards, including an assessment of data reliability and internal controls.

Results in Brief

Institutional controls were used at most of the Superfund and RCRA sites we examined where cleanup was completed and waste was left in place. In reviewing selected Superfund and RCRA sites in three different time periods or stages of cleanup for comparison, we found an increase in the use of institutional controls over time. We found that one-half of the Superfund sites we reviewed where cleanup was completed during fiscal years 1991 through 1993 and three-quarters of the RCRA facilities we reviewed where cleanup was completed before fiscal year 2001 with residual waste remaining did not have institutional controls in place. In contrast, we found that institutional controls were in place at almost all (28 of 32) of the Superfund sites and all 4 RCRA sites we reviewed that were cleaned up during fiscal years 2001 through 2003 and had waste remaining. EPA's guidance states that it generally requires that institutional controls be placed on sites that cannot accommodate unrestricted use and unlimited exposure; however, because the agency's guidance does not specify when controls are necessary, it is unclear whether any of the sites we reviewed that had residual waste but no institutional controls were inconsistent with this guidance. When considering remedy decisions issued during fiscal years 2001 through 2003 for sites that have not yet been cleaned up, we found that 93 of the 112 Superfund and 15 of the 23 RCRA remedy decision documents we reviewed called for some type of institutional control. However, while EPA's guidance advises that four key factors be taken into account in selecting controls for a site, 69 of the 108 remedy decision documents we examined did not demonstrate that all of these factors were sufficiently considered to ensure that planned controls will be adequately implemented, monitored, and enforced. In this regard, the documents generally discussed two of these factors—the objective and mechanisms of the institutional controls—but the language was often vague. In many cases, the documents did not adequately address the two remaining factors—the timing or duration of implementation and the party responsible for monitoring and enforcing the controls. According to EPA, discussion in the ROD may be intentionally vague because key decisions on issues such as who may implement the remedy and institutional controls have not yet been made. Relying on institutional controls as a major component of a selected remedy without carefully considering all of the applicable factors—including whether they can be implemented in a

reliable and enforceable manner—could jeopardize the effectiveness of the site remedy.

EPA faces challenges in ensuring that institutional controls are adequately implemented, monitored, and enforced. Although EPA has taken a number of steps to improve the management of institutional controls in recent years, we found that controls at the Superfund sites we reviewed were often not implemented before site deletion, as EPA requires. In some cases, institutional controls were implemented after site deletion while, in other cases, controls were not implemented at all. An EPA program official believed that these deviations from EPA's guidance may have occurred because, during the sometimes lengthy period between the completion of the cleanup and site deletion, site managers may have inadvertently overlooked the need to implement the institutional controls. Moreover, in terms of monitoring, while EPA reviews Superfund sites where contamination was left in place every 5 years to ensure that the remedy is still protective, EPA officials acknowledged that such site reviews may be too infrequent to ensure the continued effectiveness of the institutional controls. For example, at 1 Superfund site we examined, an institutional control prohibiting any use of groundwater without prior written approval from EPA had been violated for at least a year before it was discovered during an EPA 5-year review. In addition, while parties other than EPA, such as state or local governments or site owners, are sometimes required to monitor a Superfund site more frequently than every 5 years, this monitoring does not always include a review of the site's compliance with institutional controls or verifying that the controls are still in place—and sometimes is not performed at all. In contrast to the Superfund program, the RCRA corrective action program does not include any general requirement to monitor institutional controls at terminated corrective action sites. Some states monitor institutional controls at RCRA sites independent of any EPA requirement; however, because not all states are required to or, in fact, do monitor institutional controls at RCRA sites, EPA has no assurance that such controls remain protective. Finally, EPA acknowledges that it may have difficulties ensuring that the terms of institutional controls can be enforced at some Superfund and RCRA sites for two reasons. First, some institutional control mechanisms selected for sites—such as deed notices and advisories to the public—are informational in nature and do not legally limit or restrict use of the property. Second, local and state laws may limit the options available to enforce institutional controls. For example, some states' laws do not allow enforceable institutional controls, such as covenants, to be placed on a property.

EPA faces significant obstacles in implementing institutional control tracking systems for its Superfund and RCRA corrective action programs. The agency recently began implementing such systems to improve its ability to ensure the long-term effectiveness of institutional controls. Such controls are often key components of selected cleanup remedies that need to be implemented, monitored, enforced, and kept in place as long as the danger of exposure to residual contamination remains. Because residual contamination can remain at a site long after EPA involvement is completed and an entity other than EPA assumes responsibility for long-term monitoring and enforcement of the controls, effective oversight requires that EPA be able to readily identify which sites have institutional controls in place and whether the controls are being monitored and enforced. However, historically, EPA has had no system in place to allow the agency to make these determinations. Although EPA recently has begun implementing such systems, they currently track only minimal information on the institutional controls—as currently configured, they do not include information on long-term monitoring or enforcement of the controls. In addition, initial reports of tracking system data show that there may be potential problems with the systems' implementation. For example, because RCRA program officials asked EPA regions and states to identify and report on only those facilities with institutional controls, the program has no way of determining the extent to which the data are complete. In addition, the tracking systems include data essentially derived from remedy decision documents, which reflect plans for the use of institutional controls, rather than the actual presence of these controls.

To help EPA site managers and other decision makers better understand when institutional controls are or are not necessary at sites where contamination remains in place after cleanup, we are recommending that EPA clarify its institutional controls guidance. Furthermore, to better ensure the long-term protectiveness of institutional controls, we recommend that EPA ensure that adequate consideration is given to the controls' objectives; the types of controls to be used; the timing of their implementation and their duration; and the party who will be responsible for implementing, monitoring, and enforcing them. We also are recommending that EPA take steps to ensure that the frequency and scope of monitoring at deleted Superfund sites and closed RCRA facilities where contamination has been left in place are sufficient to maintain the protectiveness of any institutional controls at these sites. In addition, we recommend that EPA ensure that the information on institutional controls reported in the Superfund and RCRA corrective action tracking systems

accurately reflects whether controls have actually been implemented at the site, rather than what is called for in site remedy decision documents.

Background

Land use and institutional controls are usually linked, and should be considered together during the investigation phase of cleanup, according to EPA guidance. As a site moves through the early stages of the cleanup process, site managers should develop assumptions about reasonably anticipated future land uses and consider whether institutional controls will be needed to maintain these uses over time. EPA guidance states that, if remediation leaves waste in place that would not permit "unrestricted use" of the site and "unlimited exposure" to residual contamination, use of institutional controls should be considered to ensure protection against unacceptable exposure to the contamination left in place. Even sites that are appropriate for residential use after the cleanup process is complete may require institutional controls if they do not allow for unlimited use and unrestricted exposure. For example, residential properties may be located over a contaminated groundwater plume where the properties are not the source of contamination. In such a situation, well drilling restrictions put in place to limit the use of groundwater may serve as appropriate institutional controls.

EPA recognizes four types of institutional controls—governmental controls, proprietary controls, enforcement and permit tools with institutional control components, and informational devices:

- Governmental controls use the regulatory authority of a government entity to impose restrictions. Generally, EPA must depend on state or local governments to establish these controls. Examples of governmental controls include zoning restrictions, local ordinances, and groundwater use restrictions.

- Proprietary controls involve legal instruments placed in the chain of title of the site or property, such as easements and covenants.

- Enforcement and permit tools with institutional control components are issued or negotiated to compel the site owner to limit certain site activities. These controls, which can be enforced by EPA under Superfund and RCRA legislation, include administrative orders and consent decrees.

- Informational devices warn the public of risks associated with using contaminated property. Examples of informational devices are deed notices, state registries of hazardous waste sites, and health advisories.

Approximately 3,800 RCRA facilities have corrective action under way or will require corrective action. EPA refers to these facilities as its "corrective action workload." Under the Government Performance and Results Act of 1993 (GPRA), which requires agencies to assess progress toward achieving the results expected from their major functions, EPA developed short-term goals for 1,714 of these facilities, referred to as the "GPRA baseline." According to EPA's GPRA goals, by 2005, EPA and the states will verify and document that 95 percent of the baseline facilities have "current human exposures under control" and 70 percent have "migration of contaminated groundwater under control."

According to EPA, over the last 10 years, the agency has focused increased attention on understanding and overcoming the complexities and challenges associated with using institutional controls. In recent years, this experience has led EPA to improve its approach to these controls. For example, the agency has hosted numerous meetings and workshops to identify institutional control issues and develop solutions; developed and administered national training programs for federal, state, tribal, and local agencies; developed a national strategy to help ensure that controls are successfully implemented; and established a national management advisory group to work on high-priority policy issues. Furthermore, in addition to issuing guidance in 2000 on evaluating and selecting institutional controls, the agency is currently developing four additional guidance documents covering specific implementation, monitoring, and enforcement issues. These improvements have been targeted at the full life-cycle of institutional controls from identification, evaluation, and selection to implementation, monitoring, and enforcement.

EPA Relied on Controls at Most Sites with Residual Contamination, but Planning of Controls May Not Ensure Protection of the Public

In reviewing selected Superfund and RCRA sites in three different time periods or stages of cleanup, we found an apparent increase in the use of institutional controls over time. Two of the 4 older Superfund sites and 6 of the 8 older RCRA facilities we reviewed where cleanup was completed but residual contamination remained had no institutional controls in place.[5] In contrast, of the 32 Superfund and 4 RCRA sites we reviewed where cleanup was completed during fiscal years 2001 through 2003 but residual contamination remained,[6] 28 and 4, respectively, had one or more institutional controls in place. However, because EPA's guidance is vague and does not specify in which cases controls are necessary, it is unclear whether any of the sites we reviewed were inconsistent with the agency's policy. When considering recent remedy decisions in both programs, we found that, of the 112 Superfund and 23 RCRA remedy decision document sets we reviewed that were issued during fiscal years 2001 through 2003, most documents called for some type of institutional control to prevent or limit exposure to residual contamination. Moreover, although EPA guidance directs staff to include four specific factors in documenting the institutional controls to be implemented at a site, the documents we reviewed frequently included no more than two of these factors, and the language was often vague.

Use of Institutional Controls at Superfund Sites and RCRA Facilities Appears to Be Increasing over Time

In reviewing selected Superfund and RCRA sites in three different time periods or stages of cleanup, we found an apparent increase in the use of institutional controls over time. The proportion of Superfund sites with institutional controls in place increased from 10 percent for those deleted during fiscal years 1991 through 1993 to 53 percent for those deleted during fiscal years 2001 through 2003. The proportion of RCRA facilities with institutional controls in place increased from 5 percent for those sites we examined where corrective action was terminated prior to fiscal year 2001 to 13 percent for those sites where corrective action was terminated during fiscal years 2001 through 2003. Moreover, 83 percent of the Superfund and 65 percent of the RCRA remedy decision documents finalized during fiscal

[5]Sites we reviewed for historical perspective included Superfund sites deleted from the NPL during fiscal years 1991 through 1993 and RCRA facilities from two regions where corrective action was terminated prior to fiscal year 2001. See appendix I for more information about the specific facilities included in our review.

[6]These sites include Superfund sites that were deleted from the NPL and RCRA facilities where corrective action was terminated within the given time period.

years 2001 through 2003 indicated the need for some sort of institutional controls, an increase over the proportion of completed sites with controls. (See tables 1 and 2.)

Table 1: Frequency of Use of or Requirements for Institutional Controls at Superfund Sites

Time periods or stages of cleanup	Percentage of sites with controls
Requirements for controls in 112 Superfund remedy decision documents, fiscal years 2001-2003	83%
Controls in place at 53 Superfund deleted sites, fiscal years 2001-2003	53
Controls in place at 20 Superfund deleted sites, fiscal years 1991-1993	10

Source: GAO analysis of EPA data.

Table 2: Frequency of Use of or Requirements for Institutional Controls at RCRA Facilities

Time periods or stages of cleanup	Percentage of sites with controls
Requirements for controls in 23 RCRA remedy decision documents, fiscal years 2001-2003	65%
Controls in place at 31 RCRA terminated facilities, fiscal years 2001-2003	13
Controls in place at 40 RCRA terminated facilities from 2 regions, corrective action terminated prior to fiscal year 2001	5

Source: GAO analysis of EPA data.

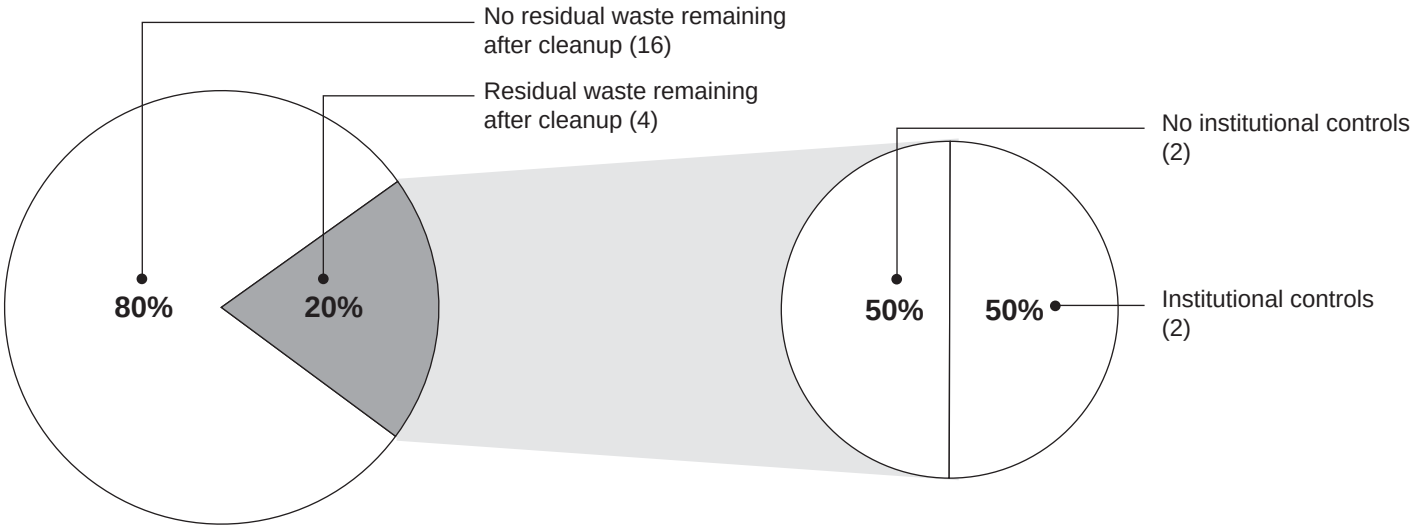
While EPA recognizes that the use of institutional controls is becoming increasingly common, the agency points out that this should not be interpreted to mean that sites are being less thoroughly cleaned up. The EPA project manager for 1 Superfund site deleted with residual contamination and no institutional controls told us that if the site were being remediated today, EPA might consider institutional controls to restrict groundwater use. In addition, EPA is now considering institutional controls for a site that was cleaned up to a level allowing for unrestricted use and unlimited exposure at the time of remediation. The levels of acceptable lead contamination have decreased since completion of this

remedy, so the levels of contamination at the site may now exceed the new standards.

Earlier Completed Sites

Four of the 12 older Superfund and RCRA sites we reviewed where residual contamination remained had institutional controls in place.[7] Waste was left in place after cleanup at 4 of the 20 Superfund sites that were deleted during fiscal years 1991 through 1993; as figure 1 shows, one-half of these sites had institutional controls in place.

Figure 1: Presence of Residual Waste and Institutional Controls at 20 Superfund Sites Deleted during Fiscal Years 1991-1993

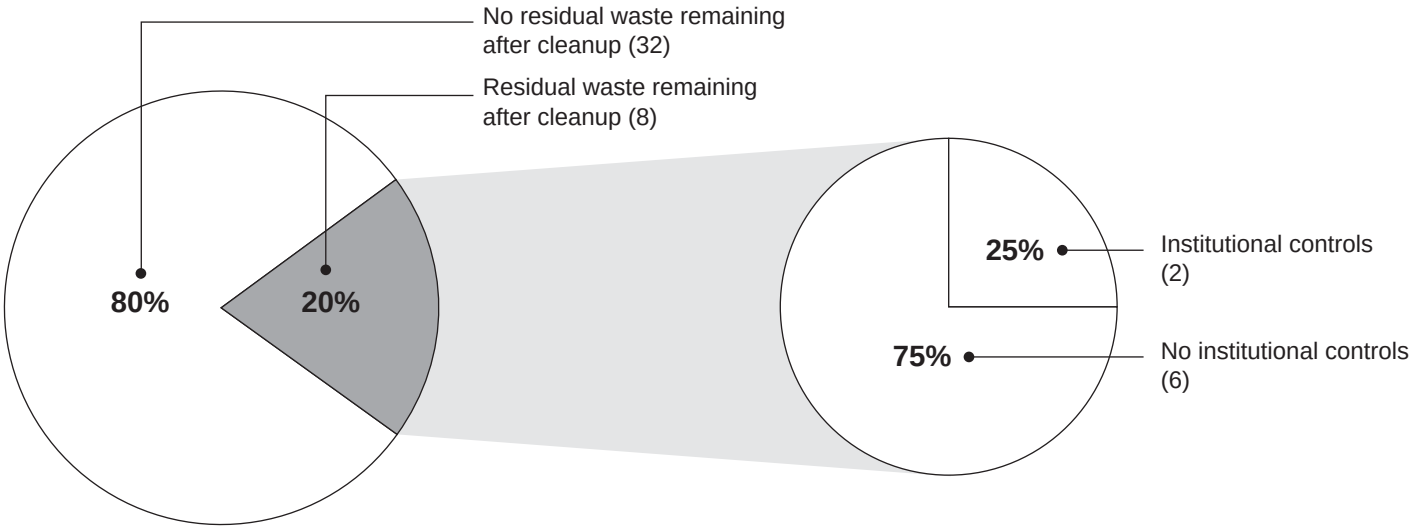


Source: GAO analysis of EPA data.

[7]These sites include Superfund sites deleted from the NPL during fiscal years 1991 through 1993 and RCRA facilities from two regions where corrective action was terminated prior to fiscal year 2001. RCRA facilities reviewed, those where corrective action was terminated both prior to fiscal year 2001 and during fiscal years 2001 through 2003, included those coded in the RCRAInfo database to indicate the termination of corrective action. However, EPA regions differed in their use of this code since it related to facilities with or without institutional controls, and EPA staff raised concerns about whether the code was used consistently over time within some regions. See appendix I for more information about the specific facilities included in our review.

Similarly, of the 40 RCRA facilities we reviewed where corrective action was terminated before fiscal year 2001, 8 had residual waste after cleanup; institutional controls appeared to be in place at 2 of these facilities (see fig. 2).

Figure 2: Presence of Residual Waste and Institutional Controls at 40 RCRA Facilities in Two Regions Where Corrective Action Was Terminated before Fiscal Year 2001



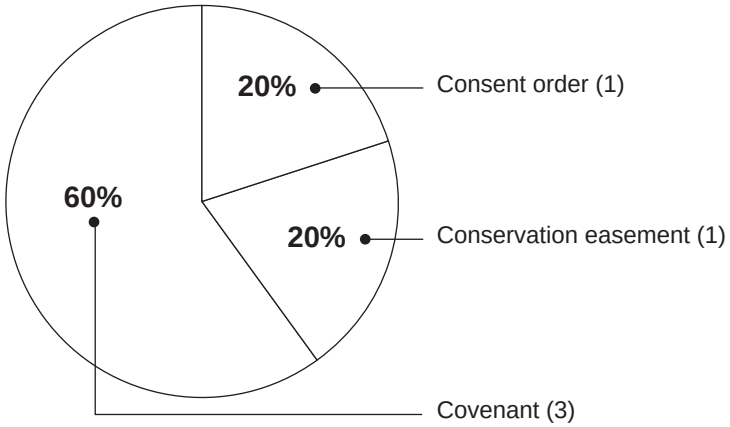
Source: GAO analysis of EPA data.

The most common type of institutional control in place at these older Superfund and RCRA sites was a covenant; there was also a consent order and a conservation easement, as shown in figure 3.[8] A covenant, as used in the institutional controls context, is a promise by a landowner to use or refrain from using the property in a certain manner. A consent order contains elements of both an administrative order (an order issued and enforced by EPA or states directly restricting the use of property) and a consent decree (in this context, a court order that implements the settlement of an enforcement case, which may restrict the use of the land

[8]In some cases where the types of controls were not clear, we categorized them on the basis of our evaluation of documents.

by the settling party, such as prohibiting well drilling).[9] A conservation easement, allowed by statutes adopted by some states, is established to preserve and protect property and natural resources. EPA guidance encourages the use of multiple controls—referred to as "layering"—stating that it is more effective than using only one institutional control.[10] Controls were layered at only 1 of these 4 older sites.

Figure 3: Proportions of Types of Institutional Controls at 4 Superfund and RCRA Sites Cleaned Up before Fiscal Year 2001



Source: GAO analysis of EPA data.

Note: In some cases, our attorneys made determinations based on evaluations of documents in order to categorize institutional controls.

Recently Completed Sites

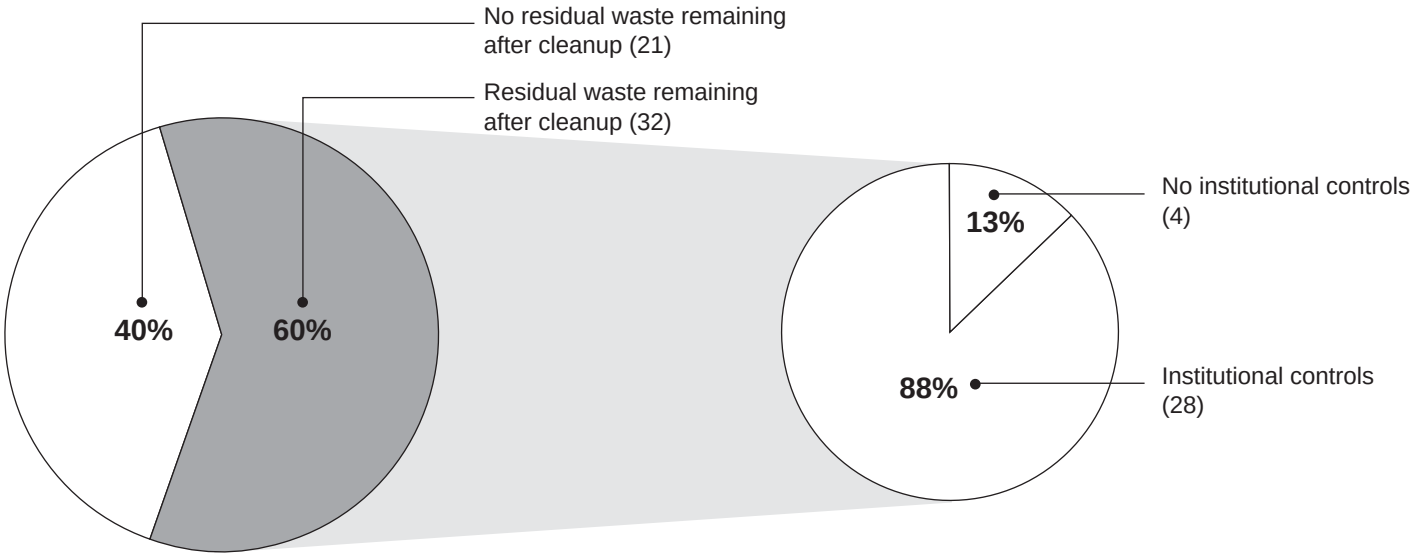
In contrast to sites where cleanup was completed in earlier years, 32 of the 36 Superfund and RCRA sites we reviewed where residual contamination remained after cleanup had one or more institutional controls in place. At

[9]Consent decrees have attributes both of contracts and judicial decrees. While they are arrived at by negotiations between the parties, they are motivated by threatened or pending litigation and must be approved by the court.

[10]EPA, *Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups* (EPA 540-F-00-005, September 2000). This fact sheet is intended to provide an overview of the types of institutional controls that are commonly available and discusses key factors to consider when evaluating and selecting institutional controls in Superfund and RCRA corrective action cleanups.

most of the 53 Superfund sites deleted from the NPL during fiscal years 2001 through 2003, institutional controls were implemented if waste was left in place (see fig. 4). Furthermore, future controls were being considered at 2 of the sites where institutional controls were not originally planned.

Figure 4: Presence of Residual Waste and Institutional Controls at 53 Superfund Sites Deleted during Fiscal Years 2001-2003

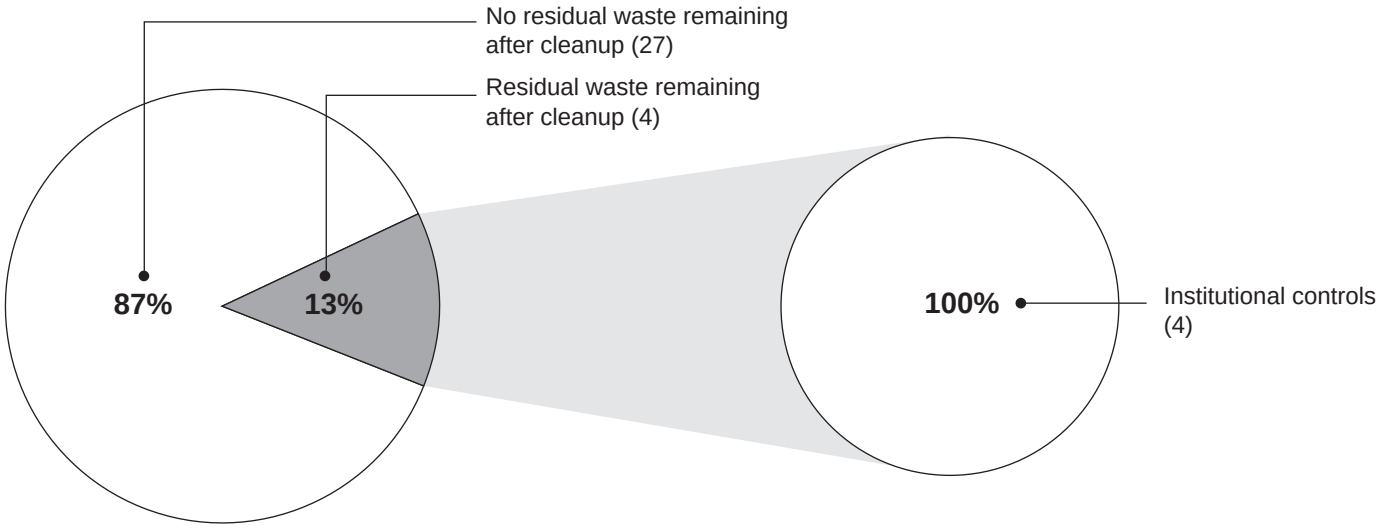


Source: GAO analysis of EPA data.

Note: Percentages presented in this figure do not add up due to rounding.

Of the 31 RCRA facilities we reviewed where corrective action was terminated during fiscal years 2001 through 2003, most corrective actions did not result in waste being left in place and, therefore, the facilities likely did not require institutional controls. As figure 5 shows, only 4 facilities had waste remaining, and all of these had institutional controls in place.

Figure 5: Presence of Residual Waste and Institutional Controls at 31 RCRA Facilities Where Corrective Action Was Terminated during Fiscal Years 2001-2003

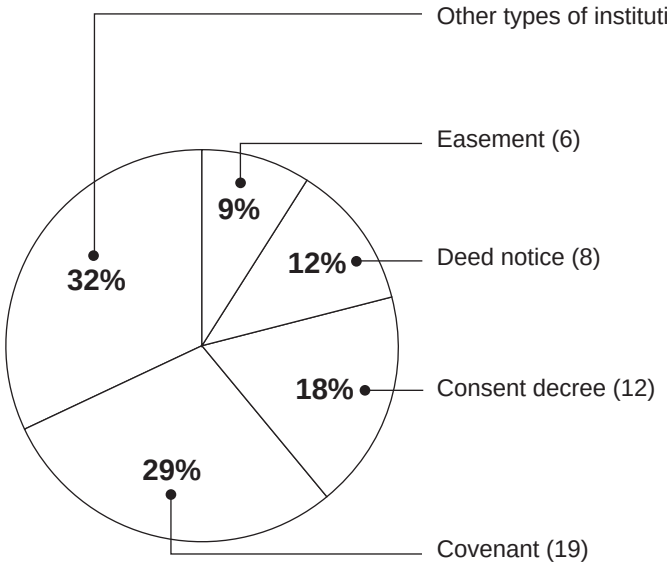


Source: GAO analysis of EPA data.

The most common types of institutional controls in place at these Superfund and RCRA sites were covenants and consent decrees, followed by deed notices and easements (see fig. 6).[11] Deed notices are informational documents filed in public land records, and these notices alert anyone searching the records to important information about the property. Easements are property rights conveyed by landowners to other parties, giving them rights with regard to the owner's land. Of the 28 Superfund sites with institutional controls, 17 included multiple controls, or layering, as encouraged by EPA guidance. One of the 4 RCRA facilities had multiple institutional controls. In total, there were 66 controls in place at the 32 sites.

[11]In addition, there were a number of other types of institutional controls on the sites we reviewed. Some of the sites had governmental controls, including zoning restrictions (ordinances exercised by local governments to specify land use for certain areas) and groundwater management zones. Some were listed on state registries, which are established by state legislatures and include information about properties, such as a list of hazardous waste sites in the state. There were also miscellaneous institutional controls on some sites, including an intergovernmental/corporate cooperative agreement, a tribal ordinance, and groundwater use restrictions.

Figure 6: Proportions of Types of Institutional Controls at 28 Superfund Sites and 4 RCRA Facilities Where Cleanup Was Completed during Fiscal Years 2001-2003



Source: GAO analysis of EPA data.

Note: In some cases, our attorneys made determinations based on evaluations of documents in order to categorize institutional controls. Some documents included aspects of more than one type of institutional control.

[a]"Other types of institutional controls" includes ordinances, groundwater use restrictions, consent orders, state registries, administrative orders, zoning, a conservation easement, and a state use restriction.

For both recently completed and older sites we reviewed, 6 of 36 Superfund sites and 6 of 12 RCRA sites with waste remaining did not have institutional controls in place.[12] EPA site managers told us that the potentially responsible parties or property owners of several sites we reviewed had agreed to file a proprietary or informational control, such as a covenant or deed notice, to limit the use of the contaminated land or water.[13] However, following our request for documents, EPA staff discovered that the controls had not been implemented. EPA is now working to implement institutional controls for some of these sites to ensure the protection of human health and the environment. Finally, at several sites we reviewed where contamination was left in place, the remedy decision documents did not call for institutional controls. Some of these sites were delegated to states for monitoring and possible future action. For example, in one case, groundwater contamination was contained as long as wells at a nearby plant continued to operate—the wells, which pump approximately 10 million gallons a day, provide protection by capturing contaminants from a former landfill on site before they migrate into the off-site groundwater. EPA asked the state to assume responsibility for monitoring the continued operation of the wells and to conduct an examination of groundwater contamination if well operation ceased.

Finally, deleting Superfund sites and terminating corrective action at RCRA facilities where waste remains without implementing institutional controls may be contrary to EPA guidance. Guidance issued in 2000 states that an institutional control is generally required if the site cannot accommodate unrestricted use and unlimited exposure. However, the guidance does not specify under what circumstances controls are necessary. Instead, it uses language like "generally required" and "likely appropriate." Four of the sites deleted during fiscal years 2001 to 2003, after the guidance was issued, had residual contamination but no institutional controls in place. However, because EPA's guidance is vague and does not specify in which cases controls are necessary, it is unclear whether any of the sites we reviewed

[12]One additional site was cleaned up to levels that allowed for unrestricted use and unlimited exposure at the time of remediation; however, the levels of lead contamination that are considered acceptable have decreased since completion of the remedy, so the levels of contamination at the site may now exceed the new standards.

[13]To ensure, as much as possible, that those responsible for the contamination at a site clean up or pay for the cleanup, EPA's Superfund program identifies the companies or people responsible for the contamination and enters into negotiations with them. EPA refers to these companies or people as "potentially responsible parties."

were inconsistent with the agency's policy. EPA's institutional controls project manager believed that some of these deviations from EPA's guidance may have occurred because, during the period between the completion of the cleanup and site deletion, site managers may have inadvertently overlooked the need to implement the institutional controls.

Recent Remedy Decisions

In reviewing files for 135 Superfund and RCRA remedy decisions that were issued during fiscal years 2001 through 2003, we found that most of the documents we reviewed called for some type of institutional control to prevent or limit exposure to residual contamination.[14] As previously mentioned, we reviewed the principal remedy decision documents issued during this time period; however, other remedy decision documents may also include information about institutional controls. Of the 112 Superfund remedy decisions, 85 called for institutional controls. In 8 additional cases, remedy decision documents called for institutional controls under certain circumstances but not others. For example, one Superfund remedy decision document outlined the need for institutional controls if excavated contaminated soil were to be disposed of on-site, rather than at another facility. Finally, some of the Superfund documents we examined were interim remedy decision documents; while some of those documents did not call for institutional controls, future documents may include provisions for such controls if waste is left on-site after remedy construction is completed. Of the 23 RCRA remedy decisions issued between fiscal years 2001 and 2003, 15 called for institutional controls.[15]

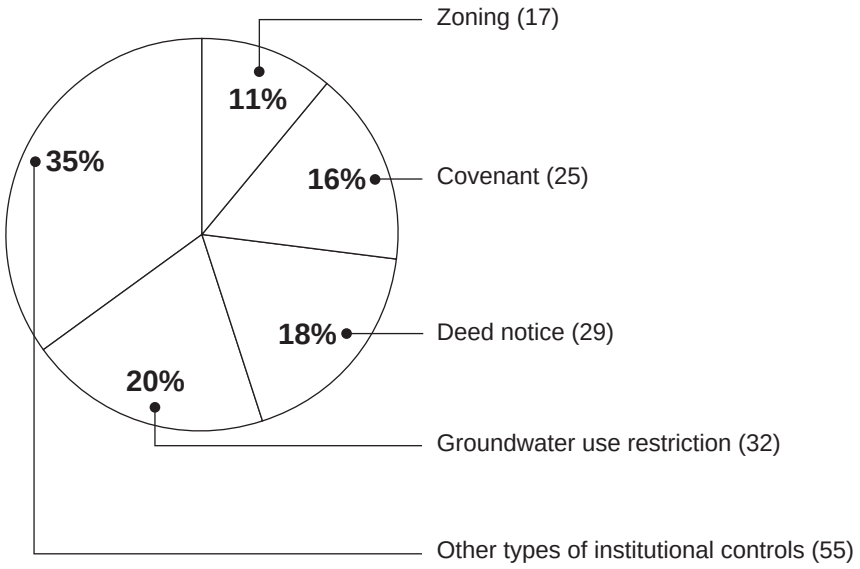
Many remedy decision documents did not identify the specific institutional control mechanism, or type of control, to be used. Of the 93 sets of Superfund remedy decision documents we examined that called for institutional controls under all or certain circumstances, 81 discussed the mechanism to some degree. Almost all of the 15 sets of RCRA remedy decision documents we examined that called for institutional controls discussed the mechanism to a certain extent. However, in both sets of documents, these discussions were often vague, gave a list of options, or

[14]Because sites with recent remedy decisions are still undergoing cleanup, we could not determine which sites had residual contamination, or which sites would have institutional controls. Therefore, we do not provide figures showing these groupings, as we do in the figures for completed sites.

[15]For 3 of the facilities, the documentation provided indicated the presence of or called for institutional controls, but did not indicate whether these controls were required by remedy decision documents.

discussed mechanisms for one planned control but not another (e.g., a document only specified an institutional control mechanism for restricting the use of groundwater and did not specify a control for contaminated soil). For those documents that discussed specific institutional controls—including those that listed options rather than a selected control or controls—deed notices and groundwater use restrictions, followed by covenants and zoning, were most commonly mentioned, as shown in figure 7. Twelve of the documents were vague in describing a mechanism, and, in 13 cases, the documents did not mention a mechanism at all.

Figure 7: Proportions of Types of Institutional Controls Mentioned in 81 Sets of Superfund and 14 Sets of RCRA Remedy Decision Documents Issued during Fiscal Years 2001-2003



Source: GAO analysis of EPA data.

Note: In some cases, we made determinations based on EPA language in remedy decision documents in order to determine the type of planned institutional control. Some controls mentioned in remedy decision documents appeared to include aspects of more than one type of institutional control.

Remedy Decision Documents Often Do Not Demonstrate Sufficient Planning of Controls to Determine the Adequacy of Public and Environmental Protection

Thorough planning is critical to ensuring that institutional controls are implemented, monitored, and enforced properly. EPA guidance specifies that staff should evaluate institutional controls in the same level of detail as other remedy components. Furthermore, it advises staff to make several determinations regarding a number of key factors (see table 3) and to describe them in the remedy decision documents.

Table 3: Provisions in EPA s Guidance Relating to Determinations on Institutional Controls

Factor	Guidance provisions	Sample language
Objective	Managers should clearly state what will be accomplished through the use of institutional controls where contamination remains on the site.	General: Protect human health and the environment. Specific: Restrict the use of groundwater as a drinking water source until the Maximum Contaminant Levels are met.
Mechanism	Managers should determine the specific types of institutional controls that can be used to meet the various remedial objectives.	EPA will work with the local jurisdiction to develop ordinances to restrict well drilling or prohibit groundwater access until cleanup goals are met.
Timing	Managers should investigate when the institutional control needs to be implemented and how long it needs to remain in place.	General: A deed notice may be required in the short term, and a formal petition for a zoning change may be necessary in the long term. Specific: The institutional control should be filed before the Remedial Action is final.
Responsibility	Managers should discuss and document any agreement with the proper entities on exactly who will be responsible for implementing, monitoring, and enforcing the control or outline potential parties.	Work with the state to determine whether it is willing and able to hold an enforceable easement to ensure appropriate land use; in addition, determine whether the local government is willing to change and enforce the applicable zoning requirements.

Source: EPA guidance, September 2000.

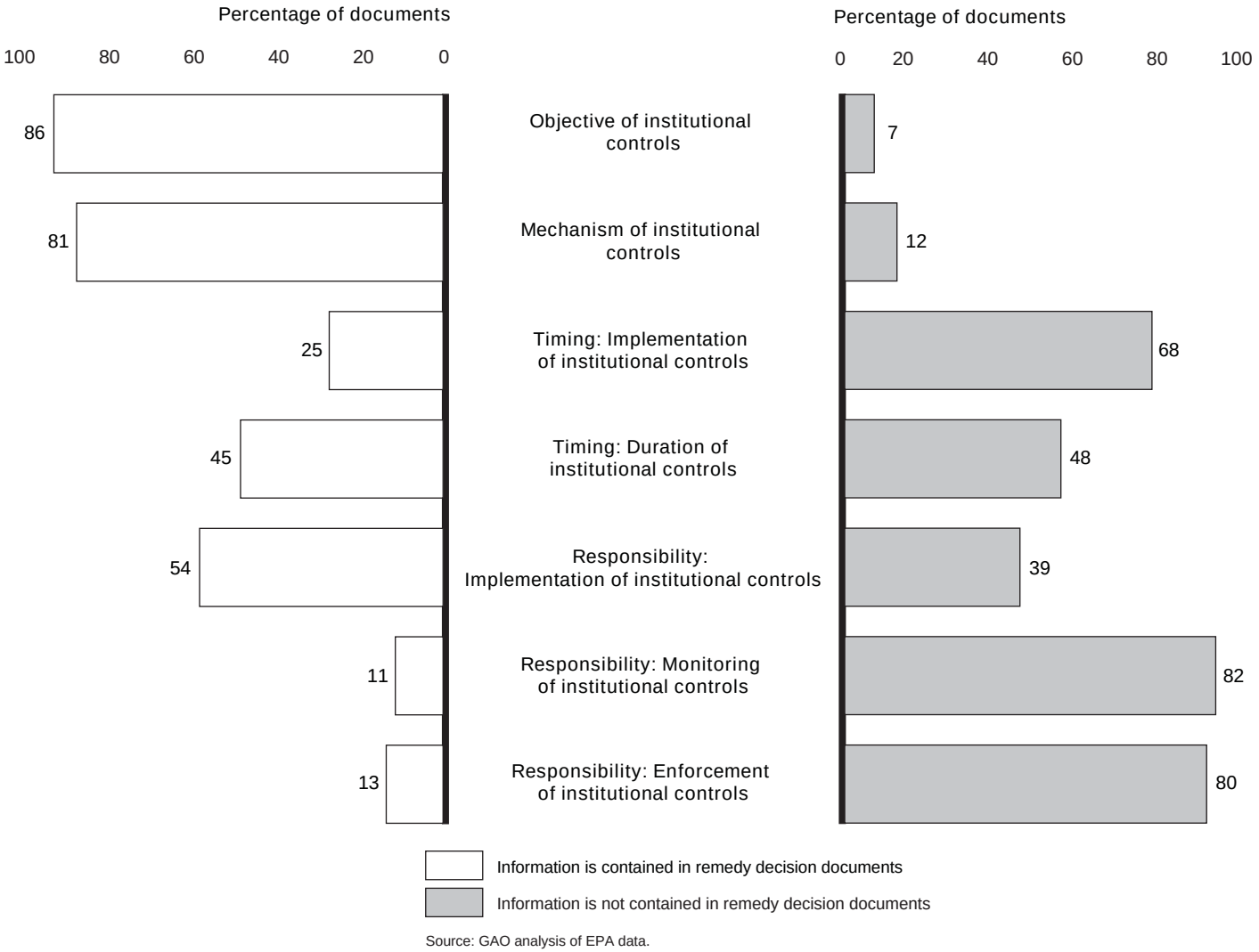
As EPA's draft guidance on institutional controls[16] points out, without specific information on the institutional controls—such as their objectives; the mechanisms (or kinds of controls) envisioned; the timing of their

[16]EPA draft guidance, *Institutional Controls: A Guide to Implementing, Monitoring, and Enforcing Institutional Controls at Superfund, Brownfields, Federal Facility, UST and RCRA Corrective Action Cleanups* (December 2002). This is the second in a series of guidance documents on the use of institutional controls. According to an EPA official, although the draft was issued in December 2002, it had not yet been finalized as of December 2004 due to the large number of comments that EPA received.

implementation and duration; and who will be responsible for implementing, monitoring, and enforcing them—the site manager and site attorney may be unable to interpret the intent of the remedy selection document. For example, managers currently responsible for some sites we reviewed were not involved with the remedial investigation or preparation of the ROD for the sites and, therefore, may not fully understand what types of controls were envisioned when the document was written. In addition, without specific information on the proposed institutional controls for a site, the public may not fully understand the restrictions on site use necessary to prevent exposure to residual contamination. Vague language may also result in creating unintended rights and/or obligations.

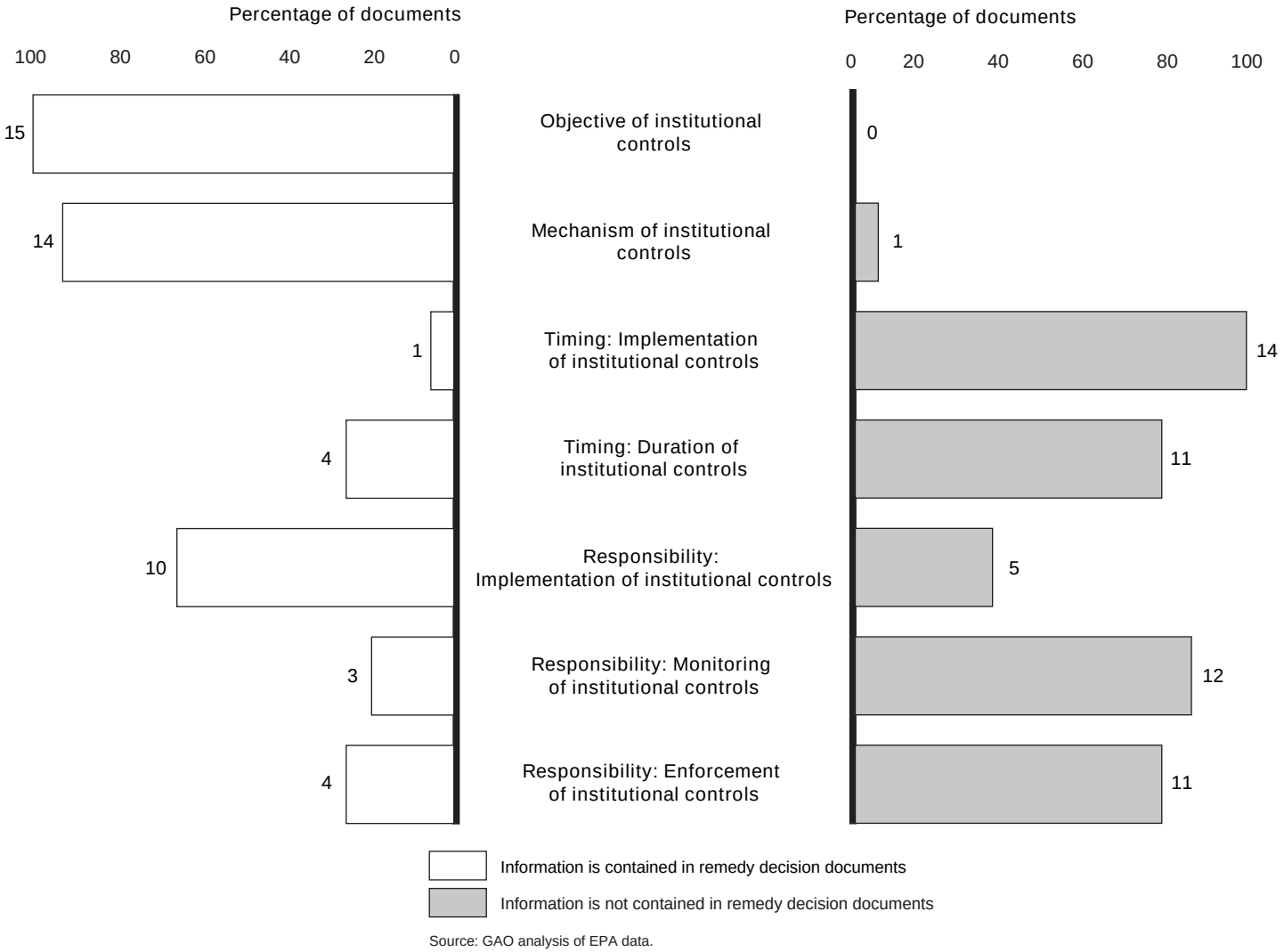
As shown in figures 8 and 9, the remedy decision documents we examined generally discussed the objective of the institutional controls.

Figure 8: Discussion of Key Elements Relating to Institutional Controls in 93 Sets of Superfund Remedy Decision Documents Issued during Fiscal Years 2001-2003



Source: GAO analysis of EPA data.

Figure 9: Discussion of Key Elements Relating to Institutional Controls in 15 Sets of RCRA Remedy Decision Documents Issued during Fiscal Years 2001-2003



Source: GAO analysis of EPA data.

Eighty-six of the 93 sets of Superfund documents we reviewed that addressed institutional controls (whether under all or certain conditions), and all of the document sets for the 15 RCRA sites, discussed the objective, at least in general terms. For both programs, however, the level of detail in the discussion of the objective varied greatly. For example, one Superfund ROD called for "the use of institutional controls to help prevent human exposure to any residual contaminants at the site following the completion

of remedy construction," which is a general purpose of institutional controls rather than a specific objective. Other decision documents included more detailed discussions of objectives; for example, one document discusses institutional controls "for future development that would prevent inappropriate disturbance of remediated mine sites and potential remobilization of contaminants" and "to prevent the use of new drinking water wells where contaminated aquifers exist."

Of the 93 sets of Superfund documents and 15 sets of RCRA documents we examined, 81 and 14, respectively, discussed the mechanism to be used, at least generally. However, the specific mechanism for each institutional control was identified in only 35 of the sets of Superfund documents and in 5 of the sets of RCRA documents.[17] Most discussions were vague, gave a list of options, or discussed mechanisms for one planned control but not another. For example, 24 documents mentioned "deed restrictions" without detailing how the deed would be restricted. EPA guidance points out that the term "deed restriction" is not a traditional property law term, but rather a shorthand way of referring to types of institutional controls. Furthermore, it states that site managers should avoid the generality of "deed restriction" and instead be specific about the types of controls under consideration. Other remedy decision documents were incomplete, suggesting mechanisms for one medium, such as soil, but not another, such as groundwater. In 30 of the Superfund cases and 4 of the RCRA cases, the remedy decision documents gave several options for control mechanisms rather than identifying those that were most appropriate. In contrast, some documents do include a detailed discussion of the institutional control mechanism. For example, one document suggested implementing and monitoring deed notices to ensure that land use is consistent with the cleanup levels selected for the site. If the land is used for residential purposes, additional institutional controls, such as a restrictive covenant, may be needed to limit access to soils. Because some institutional controls—such as informational devices—cannot be enforced, or may not transfer if the property is sold, careful consideration of the institutional control mechanism is generally necessary.

EPA guidance points out that since parties other than EPA often implement institutional controls, site managers should consider the time required to put a control in place. However, as shown in figures 8 and 9, less than one-third of the Superfund remedy decision documents and only 1 of the RCRA

[17]In addition, 13 sets of Superfund documents referred to existing institutional controls.

documents we examined specified the timing of institutional control implementation. Twenty-five Superfund documents and 1 RCRA document specified when the institutional controls should be implemented—for example, "before the RA [Remedial Action] is final"—although some of the documents were vague or only indicated timing for one out of several controls. Moreover, for 14 of the Superfund sites, the institutional controls referred to in remedy decision documents had already been implemented. Documents for 45 Superfund and 4 RCRA sites specified how long the institutional controls should remain in place—which was, in most cases, until the contamination was no longer present or cleanup levels were achieved. However, some of the documents indicated the duration of only one of several planned controls.

In the remedy decision documents we examined, many of the Superfund and RCRA documents did not discuss any of the parties responsible for implementing, monitoring, and enforcing institutional controls. To the extent that responsibility was addressed, most of the discussion centered only on the implementing party, rather than those responsible for monitoring and enforcing institutional controls. Only 11 Superfund and 3 RCRA document sets discussed parties responsible for monitoring institutional controls, and only 13 Superfund and 4 RCRA document sets discussed parties responsible for enforcing institutional controls (see figs. 8 and 9). According to the EPA draft guidance issued in December 2002, early cooperation and coordination between federal, state, and local governments in the selection, implementation, and monitoring of institutional controls is critical to their implementation, long-term reliability, durability, and effectiveness. Where EPA is implementing a remedy, states often play a major role in implementing and enforcing institutional controls. In addition, under the RCRA program, the state typically imposes and oversees the remedial action. Some governmental controls may be established under state jurisdiction. Furthermore, a local government may be the only entity that has the legal authority to implement, monitor, and enforce certain types of institutional controls, such as zoning changes. EPA guidance states that while EPA and the states take the lead on response activities, local governments have an important role to play in the implementation, long-term monitoring, and enforcement of institutional controls. Without the cooperation of these other parties, the successful implementation of institutional controls may not be ensured.

In many cases, remedy documents we examined contained no evidence that planning of institutional controls included consideration of all aspects of the four key elements in the remedy selection process. In total, 34 of the

93 sets of Superfund and 5 of the 15 sets of RCRA remedy decision documents discussed all four elements, at least in part. For example, the documents may have discussed the duration of the institutional controls but not when they will be implemented, or the documents may have discussed who will implement only one of the controls required. EPA's institutional controls project manager stated that discussion in the ROD may be intentionally vague because key decisions on such issues as who may implement the remedy and institutional controls have not yet been made. He also speculated that site managers may not have given adequate consideration to all relevant aspects of institutional controls at the remedy decision stage. Without careful consideration of all four factors, an institutional control put in place at a site may not provide long-term protection of human health and the environment. Furthermore, EPA's 2002 draft guidance recommends planning of the full institutional control life cycle early in the remedy stage—including implementation, monitoring, reporting, enforcement, modification, and termination—to ensure the long-term durability, reliability, and effectiveness of institutional controls. The guidance states that, critically evaluating and thoroughly planning for the entire life cycle early in the remedy selection process could have eliminated many of the problems identified to date. In addition, according to the EPA guidance, calculating the full life-cycle cost is an essential part of the institutional control planning process. This estimate is important to compare the cost-effectiveness of institutional controls with that of other remedy elements and to ensure that parties responsible for implementing, monitoring, and enforcing institutional controls understand their financial liability for these activities. Relying on institutional controls as a major component of a selected remedy without carefully considering all of the applicable factors—including whether they can be implemented in a reliable and enforceable manner—could jeopardize the effectiveness of the entire site remedy.

EPA Faces Challenges in Implementing, Monitoring, and Enforcing Institutional Controls

At the Superfund sites we reviewed, institutional controls often were not implemented before site deletion, as EPA requires. Moreover, efforts to monitor institutional controls after they are implemented may also be insufficient. Finally, EPA may have difficulties ensuring that the terms of certain types of institutional controls in place at some Superfund and RCRA sites can be enforced, and state laws may limit EPA's ability to implement and enforce needed controls.

Institutional Controls Were Often Not Implemented before the End of the Cleanup Process

Institutional controls were often not implemented before site deletion, as required, at the Superfund sites we reviewed. Under EPA guidance, a site may not generally be deleted from the NPL until all appropriate response actions, including institutional controls, have been implemented. Timely implementation of institutional controls is important because, until the controls are in place at a site, there is a greater potential for the public to become exposed to any residual contamination. At 32 of the 53 Superfund sites deleted during fiscal years 2001 through 2003, institutional controls were likely appropriate, according to EPA guidance, because waste remained in place at these sites above levels that allowed for unrestricted use and unlimited exposure. Our discussions with cleanup officials and our review of supporting documentation, however, indicate that all institutional controls were implemented before site deletion at only 24 of these 32 sites. In the case of 4 of the remaining 8 sites, even though EPA site managers believed certain of the institutional controls had been implemented at the site, our subsequent requests for documentation revealed that these controls had not been implemented. At 2 of these sites, there were no institutional controls in place at all. In another 2 cases, institutional controls were implemented, but only after deletion of the site. In 2 other cases, remedy decision documents did not call for institutional controls, but because EPA guidance does not specify in which cases controls are necessary, it is unclear whether these 2 sites were inconsistent with this guidance. Furthermore, institutional controls were implemented before site deletion at only 2 of the 4 Superfund sites deleted during fiscal years 1991 through 1993 that had residual contamination above levels that would allow for unrestricted use of the site. The 2 other sites were deleted without institutional controls, even though the site manager for 1 of these sites believed there were institutional controls in place. EPA's institutional controls project manager believed that sites with residual contamination may have been deleted without institutional controls at least in part because site managers lost track of the need to implement the institutional controls between the time that active remediation of the site ended and the site's deletion.

Implementation of institutional controls at the RCRA facilities we examined generally occurred by the time the corrective action was terminated. RCRA program guidance does not address the timing of implementation of institutional controls relative to termination of corrective actions. Rather, owners and operators of RCRA facilities that treated, stored, or disposed of hazardous waste must submit documentation indicating the location and dimensions of a closed hazardous waste facility before its closure. Facility closure in the RCRA

program occurs after all RCRA-related activities at a site, including corrective action, end and after the facility undergoes a closure process. Among the 6 state RCRA corrective action programs we reviewed, state officials for 3 of the programs stated that if institutional controls are required, they must be in place before the RCRA corrective action is terminated. Of the 4 RCRA facilities where corrective action was terminated during fiscal years 2001 through 2003 that likely required institutional controls, only 2 had all controls in place by the time the corrective action was terminated. At 1 of the remaining facilities, the sole institutional control was implemented about 1 year after the corrective action was terminated; at the last facility, at least one of several controls was implemented after the corrective action was terminated.

Monitoring of Institutional Controls May Be Insufficient to Ensure Their Protectiveness

Monitoring of institutional controls at Superfund sites after they have been implemented may be inadequate to ensure their continued protectiveness. At sites where contamination is left in place above levels that allow for unlimited use of the site and unrestricted exposure to site contaminants, CERCLA requires reviews once every 5 years of the continued protectiveness of the remedy, including any institutional controls in place. According to EPA's guidance, these 5-year reviews usually consist of community involvement and notification, document review, data review and analysis, site inspection, interviews, and a determination of remedy protectiveness. As a part of these reviews, EPA's guidance calls for a determination of whether institutional controls successfully prevent exposure to site contaminants and a specific check on whether they are still in place. EPA officials acknowledged, however, that reviews that only occur every 5 years may be too infrequent to ensure the continued protectiveness of the institutional controls. At some of the sites we examined, 5-year reviews uncovered institutional control violations that could have been discovered and stopped earlier with more frequent monitoring. For example, an institutional control at 1 Superfund site we examined prohibited any use of groundwater without prior written approval from EPA. When EPA conducted its 5-year review in April 2003, agency officials discovered that over 25 million gallons of groundwater from the site had been pumped for use as drinking water during 2002. Moreover, the agency official who conducted the 5-year review did not know how long groundwater had been pumped without EPA's approval. While many Superfund sites are no longer active, sites that are being reused may be especially vulnerable to activities occurring on-site that may violate an institutional control during the time period between 5-year reviews. At 1 Superfund site we visited, for example, the institutional control for the site

requires monitoring for worker safety precautions during digging on the site. At the time of our site visit, however, active digging was occurring at the site about which the EPA official charged with supervising the site was not aware (see fig. 10). The EPA official had not visited the site since the previous 5-year review, which had occurred 4 years earlier.

Figure 10: Digging Under Way at a Deleted Superfund Site without the EPA Site Manager s Knowledge

Source: GAO.

Five-year reviews, even when they do eventually occur, may not ensure that institutional controls are in place. EPA's guidance on conducting 5-year reviews instructs officials conducting the review to verify that (1) institutional controls are successful in preventing exposure to site contaminants and (2) institutional controls are in place. We interviewed officials at the 32 Superfund sites deleted during fiscal years 2001 through 2003 and the 4 Superfund sites deleted during fiscal years 1991 through 1993 with residual contamination. Most of these officials stated that, during 5-year reviews, they confirmed that the site remedy—including

institutional controls—continued to protect the public from exposure to site contaminants. However, while they usually confirmed the protectiveness of the remedy, 8 did not also verify that site institutional controls were in place. For example, EPA site managers in charge of 3 sites told us they generally did not check whether institutional controls were in place during 5-year reviews. Managers of 4 other sites stated that they generally verified that institutional controls were in place during 5-year reviews; our subsequent requests for documentation, however, revealed that the institutional controls these site managers believed to be in place were never actually implemented. One additional site manager was unsure whether the 5-year review process even included a check on the continued presence of institutional controls. A determination that institutional controls successfully prevent exposure to contaminants at a site is meaningless if the controls that are supposed to be at the site are, in fact, not in place, or their presence is unknown. Unless EPA verifies that institutional controls remain in place during its 5-year reviews, the agency cannot ensure the continued protectiveness of site remedies.

Monitoring of Superfund sites by parties other than EPA may occur more often than every 5 years, but this monitoring may not significantly contribute to ensuring the protectiveness of institutional controls at sites. Thirty-two Superfund sites were deleted during fiscal years 2001 through 2003 with contamination left in place. At 26 of these sites, parties responsible for contamination, site owners, or state or local government entities were responsible for conducting some form of site monitoring in addition to the 5-year reviews. In principle, this additional monitoring could help to ensure that site institutional controls remain protective. Often, however, this monitoring is unrelated to the institutional controls on the site. At fewer than half of these 26 sites, for example, do the additional monitoring activities specifically include a review of the sites' compliance with institutional controls; at the other sites, monitoring either focused on analyzing site groundwater or on other activities. Moreover, at none of the 26 sites did monitoring include a specific check on whether site institutional controls were in place, as 5-year reviews do. In fact, at 4 of these sites, monitoring that checked whether institutional controls were in place would have found that controls that had supposedly been implemented were not. In addition, some parties responsible for site monitoring sometimes do not meet their monitoring requirements. In 4 cases, site managers indicated that monitoring parties had either not performed the required monitoring or they were unable to provide documentation of this monitoring. In 1 case, for example, an official in a town with a Superfund site refused to perform monitoring of the site, even

though there was significant evidence of trespassing at the site, according to the responsible EPA site manager.

In contrast with the Superfund program, the RCRA corrective action program does not include any national requirement to review facilities with residual contamination that have been closed.[18] As a result, EPA has no way of knowing whether institutional controls implemented at such facilities remain in place, or whether they remain protective of human health and the environment. At least some states, however, conduct their own monitoring of closed RCRA corrective action facilities, including determining whether institutional controls remain in place and have not been violated. This practice may be in recognition of the necessity to track the status of RCRA facilities that have waste in place after the corrective action process is terminated and they are closed. Officials that we interviewed in 4 of 6 states reported some form of postclosure monitoring of RCRA corrective action facilities in their states; an official in 1 additional state stated that her agency is working to implement such monitoring. Two of these states specifically require that facility owners self-certify the continued presence of institutional controls. One state program, for example, requires facility owners to submit a form every 2 years certifying that facility institutional controls are still in place. In addition, this state's officials conduct inspections of the closed sites every 5 years, during which they verify the self-certifications and ensure that institutional controls remain in place. As of 2001, according to a 50-state survey that an independent research group prepared using funding from EPA, 17 states had established schedules for auditing sites where institutional controls have been implemented, including 7 states that review such sites at least annually.[19]

Ability to Enforce Institutional Controls Depends on the Nature of the Control Selected and State Laws

In addition to potentially inadequate monitoring, EPA may have difficulties enforcing the terms of certain institutional controls currently in place, or planned, for some Superfund and RCRA sites. Some institutional controls selected for sites are purely informational and do not limit or restrict use of the property. Informational institutional controls, according to EPA's guidance, include deed notices, state hazardous waste registries, and

[18]Facility closure in the RCRA corrective action program occurs after all RCRA-related activities at a site, including corrective action, end and after the facility undergoes a closure process.

[19]Environmental Law Institute, *An Analysis of State Superfund Programs: 50-State Study, 2001 Update*, (Washington, D.C.: 2002).

advisories to the public. For example, while a deed notice—which is required by the RCRA corrective action program for certain closed facilities—alerts anyone searching land records to the continuing presence of contamination at the site, such a notice does not provide a legal basis for regulators to prevent a property owner from disturbing or exposing that contamination. Seven of the 32 Superfund sites deleted during fiscal years 2001 through 2003 with waste remaining had some form of informational institutional control in place. Furthermore, EPA recognizes that another mechanism used often at sites to impose institutional controls, a consent decree, is not by itself binding on subsequent property owners or occupants. We found consent decrees in place at 12 of the 32 Superfund sites with residual contamination deleted during fiscal years 2001 through 2003. The use of multiple institutional controls at the same site could alleviate concerns about the use of nonenforceable mechanisms, as long as one of the additional controls is enforceable. In some cases, however, informational, nonenforceable institutional controls were the only controls in place at sites. This was the case at 1 of the Superfund and 2 of the RCRA corrective action sites that we examined that had reached the end of the cleanup process. Moreover, among the sets of remedy decision documents finalized during fiscal years 2001 through 2003 that we examined, 56 of 112 Superfund and 6 of 23 RCRA corrective action sets of documents specified at least one institutional control mechanism; among these, 6 of the Superfund and 3 of the RCRA sets of documents specified only an informational device as the sites' institutional control.

State property laws, which traditionally disfavor restrictions attached to deeds and other land use restraints in order to encourage the free transferability of property, can hinder EPA's ability to implement and enforce institutional controls. EPA's guidance warns that state property laws should be researched to ensure that certain types of institutional control mechanisms can be enforced. For example, one state only allows use restrictions attached to a deed to be enforced for 21 years from the recording of the deed. As an EPA official charged with managing a site with such restrictions in this state recognized, the issue of following up on this site after 21 years presents a planning problem for EPA. In several cases, EPA or state officials stated that property owners had to agree before certain proprietary controls, including covenants, could be put in place. Therefore, EPA officials are forced to negotiate aspects of the institutional control with the property owner. This process has the potential to compromise or dilute the enforceability of the proprietary control that is ultimately negotiated. Because RCRA generally does not authorize EPA to acquire any interests in property, many proprietary controls require that

third parties such as states be willing to be involved. RCRA officials must thus rely on states, localities, or sometimes even adjacent property owners to hold an easement over a facility property. At least one EPA regional official we interviewed was aware of a state that refuses to serve as a third party in such cases, limiting EPA's ability to put in place such institutional controls.

States have legislative options available to help ensure that institutional controls can be enforced. Certain states have enacted statutes that provide the state with the legal authority to restrict land use at contaminated properties. Colorado, for example, passed legislation in 2001 that allows the state's Department of Public Health and Environment to hold and enforce environmental covenants. Colorado's agreements are binding upon current and future owners of the property, thus allowing the state to enforce these agreements should they be violated. These covenants had been used at 11 state sites, including 1 RCRA corrective action facility, as of August 2004. In addition, several states have adopted statutes providing for conservation easements, which override certain common law barriers to enforcement. A recent effort by the National Conference of Commissioners on Uniform State Laws sought a way to allow states to implement enforceable institutional controls.[20] In 2003, this group finalized a Uniform Environmental Covenants Act that is available for state legislative adoption. According to the group, this legislation provides clear rules for state agencies to create, enforce, and modify a valid real estate document—an environmental covenant—to restrict the use of contaminated real estate. The act creates this new type of institutional control and, according to the group, ensures that it can be enforced. Several states have shown interest in adopting the legislation, according to the chairman of the group that drafted it.

Institutional controls help to ensure the protectiveness of remedies at Superfund and RCRA sites where waste remains in place after cleanup. If institutional controls are not properly functioning or cease to apply to the site, the administrative and legal barriers between the residual contamination and potential human exposure to site contaminants disappear. Because of the potential danger of losing these barriers, EPA has

[20]The National Conference of Commissioners on Uniform State Laws comprises more than 300 lawyers, judges, and law professors, appointed by the states as well as the District of Columbia, Puerto Rico, and the U.S. Virgin Islands to draft proposals for uniform and model laws on subjects where uniformity is desirable and practicable, and to work toward their enactment in legislatures.

recognized the importance of monitoring whether institutional controls are still in place and whether they continue to prevent exposure to residual contamination during its 5-year reviews. Current efforts to monitor institutional controls, however, may not occur with sufficient frequency to identify problems in a timely manner and may not always include checks on controls.

EPA Faces Significant Obstacles in Implementing Systems to Better Track Institutional Controls

Institutional controls are often key components of selected cleanup remedies and, as such, need to be monitored, enforced, and kept in place as long as the danger of exposure to residual contamination remains. Residual contamination can remain at a site long after EPA's involvement is completed, and an entity other than EPA may assume responsibility for long-term monitoring and enforcement of the controls. However, historically, EPA had no system in place to readily identify which sites had institutional controls in place or whether the controls were being monitored and enforced. To improve its ability to ensure the long-term effectiveness of these controls, EPA has recently begun implementing tracking systems for its Superfund and RCRA corrective action programs. These systems currently track only minimal information on the institutional controls—as currently configured, they do not include information on long-term monitoring or enforcement of the controls. In addition, initial reports of tracking system data show that there are potential problems in implementing the systems.

Tracking Systems Can Help Ensure the Long-term Effectiveness of Institutional Controls

Regulators must track institutional controls at hazardous waste sites in order to ensure that they remain effective over the long term. Such controls are often intended to remain in place long after cleanup work has been completed to ensure that a site's future use is compatible with the level of cleanup at the site and to limit exposure to residual contamination. EPA maintains that an institutional control tracking system should include information about the selection and implementation of the controls as well as their monitoring, reporting, enforcement, modification, and termination.

According to EPA, several unique characteristics of institutional controls make tracking them particularly challenging. First, the life-span of institutional controls may begin as early as site discovery and can continue for as long as residual contamination remains above levels that would allow for unrestricted use or unlimited exposure. Therefore, institutional controls may remain necessary at a site indefinitely. Second, the long-term

effectiveness of institutional controls depends on diligent monitoring, reporting, and enforcement. Third, institutional controls are often implemented, monitored, and enforced by an entity other than the one responsible for designing, performing, and/or approving the remedy. As a result, an entity other than EPA may be responsible for ensuring that one of the remedy's critical components—the institutional control—is both effective and reliable in the long term.

Historically, EPA has had no way to (1) readily identify which hazardous waste sites relied on institutional controls to protect the public from residual contamination or (2) monitor how the controls were working over the long term. According to EPA's institutional controls project manager, the need for institutional control tracking systems has been discussed since at least the early 1990s, and environmental groups have long advocated the development of such systems. While several existing EPA information systems track basic information on hazardous waste sites, such as cleanup status and selected remedies, these systems were not designed to capture information on institutional controls at the level of detail necessary to allow for effective tracking and monitoring of the use of these controls. As previously discussed, our analysis of EPA's use of institutional controls at Superfund and RCRA sites showed that the agency has generally not ensured that institutional controls are adequately implemented, monitored, and enforced. In some cases, for example, we found that controls had not been implemented on a timely basis, and, in at least 4 cases, controls that agency staff thought were in place had never been implemented. An effective institutional control tracking system may alert EPA management to such situations.

EPA Is Making Progress in Developing Tracking Systems

EPA has recently begun implementing institutional control tracking systems for the Superfund and RCRA corrective action programs. The Institutional Controls Tracking System (ICTS) was designed with the capability to track controls used in a variety of hazardous waste cleanup programs. However, at least initially, ICTS will only include data for Superfund "construction complete" sites.[21] For RCRA corrective action sites, EPA is utilizing its existing RCRA information database to identify sites where institutional controls have been established. In both instances,

[21]EPA defines a "construction complete" site as a site where physical construction of all cleanup actions is complete, all immediate threats have been addressed, and all long-term threats are under control.

the EPA tracking systems include only limited, basic information. EPA has not yet decided the extent to which ICTS may be expanded in the future to include more detailed information. The RCRA program currently has no plans to track more detailed information regarding institutional controls at its facilities.

EPA began developing ICTS in 2001. According to EPA, ICTS is a state-of-the-art tracking system that is Web-based, is scalable, and will serve as the cornerstone for future programmatic and trend evaluations. The system is built around a cross-program, cross-agency, consensus-based institutional control data registry developed by the agency.

The ICTS draft project management plan notes that EPA envisioned an integrated tracking system that would be developed collaboratively using a work group approach that relied on existing data sources for its information. The primary sources of the data to be entered in ICTS include RODs and any amendments; explanations of significant differences; notices of intent to delete; and actual institutional control instruments, such as consent decrees, easements, ordinances, and advisories. The objectives of ICTS are to

- make institutional controls more effective by creating links across all levels of government through a tracking network;
- improve EPA program management responsibilities;
- establish relationships with coregulators (other federal agencies, along with state and local regulatory agencies);
- improve information exchange with individuals interested in the productive use of a site after cleanup; and
- improve existing processes allowing for notification to excavators of areas that are restricted or need protection prior to digging.

EPA designed ICTS to be implemented in three separate phases, or "tiers," of data collection activities. The initial data gathering effort was focused on collecting Tier 1 data for all sites on the Superfund construction complete list, which includes all deleted sites. Data collected during Tier 1 can be used by EPA management to generate reports with basic status information about institutional controls at sites. Tier 1 data consist of information on

- the site name;
- whether site decision documents report the presence of residual contamination at the site above a level that prohibits unlimited use and unrestricted exposure, and if present, whether the documents call for controls;
- the objectives of the institutional control;
- the specific control instruments, including the administrative or legal mechanism that establishes a specific set of use restrictions;
- any person and/or organization that may be directly or indirectly involved with institutional controls at the site; and
- the source of the information that is entered into the data entry form.

The initial version of ICTS was designed to provide some baseline information on institutional controls and a step toward a more comprehensive system. EPA envisions that Tier 2 would (1) identify which institutional controls are in place to prevent use of which media (e.g., soil or groundwater); (2) identify parties responsible for implementing, monitoring, and enforcing the controls; and (3) provide for attaching the latest inspection report. Tier 3 information would include detailed site location information, such as the actual boundaries of the institutional controls. According to the draft ICTS quality assurance project plan, EPA plans to make information from ICTS accessible to EPA and other federal agencies, state and local governments, tribes, and industry groups. Some information may also be made available to the public via the Internet about site-specific institutional controls near and within local communities. Initially, only data for those Superfund sites where construction of remedies has been completed will be entered into ICTS. Although no decision has been made to date, future data collection efforts may include additional sites in EPA's other cleanup programs (RCRA and Underground Storage Tanks). According to ICTS plans, the tracking system also has the flexibility to include data for sites in other programs, such as Brownfields and State Voluntary Cleanup Programs.

Between April and July 2004, EPA regions entered data into ICTS for most of the 899 Superfund construction complete sites, including data on about 280 sites that had been deleted from the NPL. Reports on these data indicate that 154 of the deleted sites had residual contamination;

institutional controls were reported for 106 of these sites. Site decision documents did not report institutional controls for the other 48 sites, or about one-third of the deleted sites with residual contamination. EPA's institutional controls project manager cautioned, however, that the data reported may be inaccurate and need to be verified. The official was concerned, for example, that (1) the standard for what constitutes residual contamination was not consistently applied across all regions, (2) some data may have come from interim decision documents rather than final documents, and (3) some staff entering data into ICTS may have confused whether institutional controls were implemented or only planned. In addition, the EPA official stated that the EPA regions were asked to enter the data into ICTS in 8 weeks, using the best available information and/or their best professional judgment. Because of the expedited data entry, additional research into the status of institutional controls at the site-specific level and significant data quality assurance efforts are necessary to ensure the accuracy of the data.

Upon completing the ICTS Tier 1 data entry, EPA plans to assess the data to evaluate the current status of institutional controls at all construction complete sites for data gaps and site-specific control issues. According to the ICTS strategy, once the agency has determined where data gaps and site-specific institutional control problems may exist, the agency will prioritize the work to address these issues on the basis of a variety of factors, including resources and the number of sites with potential issues. EPA's goal is to identify and review institutional control problems at all construction complete sites over approximately the next 5 years, relying on a combination of special evaluations and scheduled 5-year reviews, focusing on deleted sites as the highest priority. The sites identified as priorities will likely be addressed through a special evaluation, unless a routine 5-year review is scheduled within 12 months of problem identification. Priority evaluations will focus on whether institutional controls were required and properly implemented for all media not cleaned up to levels that allow for unlimited use and unrestricted exposure. EPA does not yet know the scope of these priority evaluations, but expects that these evaluations will be conducted over the next 2 years, resources permitting. After 2 years, the remaining sites will be evaluated in conjunction with or as a component of the normal 5-year review process.

To track institutional controls at RCRA corrective action sites, EPA modified RCRAInfo—the agency's database of information on individual RCRA sites—to identify sites where institutional controls have been established as part of, or to augment, an interim or final corrective action.

Details to be entered into RCRAInfo for pertinent sites include the type of institutional controls (governmental control, proprietary control, enforcement or permit tool, or informational device); the scheduled and actual dates that the controls were fully implemented and effective; and the responsible agency (state or EPA). While EPA currently has no plans to track more detailed information regarding institutional controls at its facilities, the RCRA database requires identifying a location where additional information concerning the specific control can be accessed (e.g., responsible agency contact information). In April 2004, EPA officials asked the regions and/or states to enter the requested information into RCRAInfo by September 30, 2004, for the 1,714 GPRA baseline facilities, and by the end of fiscal year 2005 for the remainder of the 3,800 RCRA facilities in the corrective action workload universe.

Analysis of the RCRA institutional control tracking system information showed that, by November 22, 2004, only 4 EPA regions, and 7 states in those regions, had identified a total of 87 facilities where institutional controls had been established. Moreover, according to the head of EPA's RCRA corrective action program, because the agency asked the regions and states to identify and report on only those facilities with institutional controls, rather than asking for reports on all sites indicating whether or not controls were established, the agency does not know the extent to which the data reported by this minority of regions and states are complete. Additionally, the official stated that the agency does not know whether the institutional controls that were reported were actually verified to be in place and operating as intended. In December 2004, the RCRA corrective action program official reminded officials in all 10 EPA regions of the importance of entering these data. Unlike the Superfund ICTS, the agency has no plans to verify that the institutional control information reported for RCRA corrective action facilities accurately reflects actual conditions.

EPA Systems Used to Track Institutional Controls May Not Include Important Information

Information on institutional controls in the new Superfund and RCRA tracking systems was primarily derived from reviews of decision documents contained in the individual site files. As such, these data reflect the planned use of institutional controls, which may or may not reflect the controls as actually implemented. As previously noted, our review of the use of institutional controls at Superfund sites disclosed four cases where the planned controls had never been implemented. These cases illustrate the need for EPA to determine not only whether institutional controls were required at a site but also whether they were implemented. While EPA

currently plans to review the actual use of controls at all Superfund sites with residual waste, such reviews may take up to 5 years to complete. The RCRA program, on the other hand, has no current plans to determine whether (1) institutional controls have been required in all appropriate situations or (2) all required controls were actually implemented.

Information necessary to determine whether institutional controls are being monitored and enforced is not currently included in either the Superfund or RCRA tracking systems. As previously noted, monitoring of institutional controls at Superfund sites after they have been implemented may be inadequate to ensure their continued protectiveness. Failure to monitor or enforce institutional controls can lead to compromising the protectiveness of remedies put into place and, consequently, potential exposure of the public to residual hazardous waste. While EPA plans to include information on monitoring and enforcing institutional controls at Superfund sites in the Tier 2 data for ICTS, EPA's institutional controls project manager stated that it is uncertain whether ICTS will ever be expanded to include Tiers 2 or 3 data. Further, there is no plan to include such information in the RCRA tracking system, since EPA regulations do not require any review of terminated RCRA corrective action sites. Currently both tracking systems only identify where an interested party may go to obtain more information on a particular site.

As previously noted, the objectives of ICTS include improving information exchange with individuals interested in the productive use of a site after cleanup, and the existing processes allowing for notification to excavators of areas that are restricted or need protection prior to digging. EPA acknowledges that there is an immediate need for disseminating readily available information about institutional controls at contaminated sites. This need will only increase in the future as sites' remediation advances and as more contaminated land and water resources are identified for potential reuse. Without knowledge of the controls at a site, excavators might unknowingly contact or otherwise disturb residual contaminated media. At this time, to obtain information about possible institutional controls at the site of interest, excavators would need to search many different databases and sources of information before operations could begin. While information on institutional controls at RCRA corrective action sites is planned to be available to the public by April 2005 and this capability is planned for ICTS in the future, EPA has not yet determined what information on institutional controls at Superfund sites will be made available to the public. Additionally, EPA currently has no assurance that

the institutional control information on RCRA sites that will be made available to the public accurately reflects actual conditions.

The Superfund ICTS and RCRA tracking systems, together, currently cover a universe of more than 2,600 hazardous waste sites. Expanding the existing tracking system information to reflect the institutional controls as actually implemented and to include long-term monitoring and enforcement information will likely be a resource-intensive task. Nevertheless, without such additional data, EPA has no assurance that the institutional controls actually implemented are continuing to provide the level of protectiveness intended. In this regard, EPA currently has established a task force that will decide what will be done with regard to any expansion of the institutional control tracking systems.

Conclusions

Many of the sites that have been cleaned up under EPA's Superfund and RCRA corrective action programs rely on institutional controls to ensure that the public is not exposed to sites' residual contamination, and it is likely that a growing number of sites remediated in the future will rely on such controls. However, the long-term effectiveness of these institutional controls depends on EPA resolving several issues. First, EPA's guidance does not specify under what circumstances a site with residual contamination should have institutional controls. Rather, the guidance states that an institutional control is "generally required," or "likely appropriate," if the site cannot accommodate unrestricted use and unlimited exposure. In addition, EPA has identified four factors in its guidance that should be considered during the remedy decision stage—the objective of the institutional control; the mechanism, or type of control, used to achieve that objective; the timing of the implementation of the control and its duration; and the party who will bear the responsibility for implementing, monitoring, and enforcing the institutional controls. Adequately addressing these factors is intended to help ensure that the control will effectively protect human health. But without documentation that these four factors are considered at the remedy decision stage, there is no assurance that sufficient thought has gone into designing the institutional controls and ensuring that they can be successfully implemented, monitored, and enforced. Once the controls are implemented, monitoring is necessary to determine their continued effectiveness and to check that they remain in place. Current efforts to monitor institutional controls, however, may not occur with sufficient frequency to identify problems in a timely manner and may not always include checks on controls. Finally, EPA's current efforts to begin tracking

institutional controls could be a positive step toward achieving successful implementation, monitoring, and enforcement of institutional controls at Superfund and RCRA sites. As presently configured, however, these tracking systems may not significantly contribute to improving the long-term effectiveness of institutional controls. Although EPA has recognized many of these problems and is developing draft guidance documents that may address many of them, until these documents are finalized, the extent to which they will resolve the problems we have identified is unclear.

Recommendations for Executive Action

In order to ensure the long-term effectiveness of institutional controls, we recommend that the Administrator, EPA:

- clarify agency guidance on institutional controls to help EPA site managers and other decision makers understand in what cases institutional controls are or are not necessary at sites where contamination remains in place after cleanup;
- ensure that, in selecting institutional controls, adequate consideration is given to their objectives; the specific control mechanisms to be used; the timing of implementation and duration; and the parties responsible for implementing, monitoring, and enforcing them;
- ensure that the frequency and scope of monitoring at deleted Superfund sites and closed RCRA facilities where contamination has been left in place are sufficient to maintain the protectiveness of any institutional controls at these sites; and
- ensure that the information on institutional controls reported in the Superfund and RCRA corrective action tracking systems accurately reflects actual conditions and not just what is called for in site decision documents.

Agency Comments and Our Evaluation

We provided EPA with a draft of this report for its review and comment. EPA agreed with the findings and recommendations in the report and provided information on the agency's plans and activities to address them. Regarding our recommendation that EPA clarify in its guidance when controls are needed, EPA stated that the agency will continue to develop cross-program guidance to clarify the role of institutional controls in cleanups and has a number of such guidance documents in draft form,

under development, or planned. Regarding our recommendation that EPA demonstrate sufficient consideration of all key factors in selecting controls, EPA stated that the agency agrees that sufficient consideration of all key factors should be completed at remedy selection, but does not agree that this information should be included in the remedy decision document. However, our report does not suggest that the information should be included in the remedy decision document, but should be included in some cleanup-related documentation. Regarding our recommendation that EPA ensure that the frequency and scope of monitoring efforts are sufficient to maintain the effectiveness of the controls, EPA noted that it is revising guidance to address this issue. For example, according to EPA, the agency's draft implementation, monitoring, and enforcement guidance will require periodic evaluation and certification from a responsible entity at the site stating that the controls both are in place and remain effective, and the draft implementation and assurance plan guidance will include specific roles and responsibilities for monitoring efforts. Finally, regarding our recommendation that EPA ensure that the information on controls reported in new tracking systems accurately reflects actual conditions, EPA stated that, among other actions, regions are currently undertaking a quality assurance effort to ensure that the information in the system reflects actual conditions. EPA's completion of its ongoing and planned activities should, if implemented successfully, effectively address the concerns we raised in this report.

In addition to comments directly relating to our recommendations, EPA also offered a number of general comments on the draft report. EPA pointed out that a "missing institutional control" does not, by itself, necessarily represent an unacceptable human exposure or environmental risk or suggest a breach of remedy. We agree that the mere presence of residual contamination at a site does not necessarily indicate the need for institutional controls, and we acknowledge that EPA generally—although not always—requires that institutional controls be put in place at sites where total cleanup is not practical or feasible. We believe, however, that in cases where EPA's selected remedy for a particular site includes institutional controls as an integral component of the remedy, the agency has determined that such controls are necessary and, as such, the controls should be effectively implemented, monitored, and enforced. In addition, EPA noted that an evaluation of a small universe of sites may overestimate the number of sites with potential institutional control problems. However, we are not making any population estimates, but are describing only the results for those specific cases we reviewed. This report specifically acknowledges that the results from the nonprobability samples for our

analysis cannot be used to make inferences about a population because some elements of the populations being studied have no chance or an unknown chance of being selected as part of the sample(s). Finally, EPA commented that an increased use of institutional controls does not mean that the agency advocates less treatment; we do not believe that this report implies that this is the case. The full text of EPA's comments is included in appendix II.

As agreed with your offices, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the date of this letter. At that time, we will send copies of this report to the appropriate congressional committees; the Administrator, EPA; and other interested parties. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions, please call me at (202) 512-3841. Key contributors to this report are listed in appendix III.

John B. Stephenson
Director, Natural Resources
and Environment

Objectives, Scope, and Methodology

The primary objective of this review was to examine the long-term effectiveness of institutional controls at nonfederal sites in the Environmental Protection Agency's (EPA) hazardous waste cleanup programs. Specifically, we reviewed (1) the extent to which institutional controls are used at sites addressed by EPA's Superfund and Resource Conservation and Recovery Act (RCRA) corrective action programs; (2) the extent to which EPA ensures that institutional controls at these sites are implemented, monitored, and enforced; and (3) EPA's challenges in implementing systems to track these controls. Although both the Superfund and RCRA programs address federal and nonfederal sites, our review did not address federal sites because federal agencies are generally responsible for cleaning up their own sites and EPA involvement is limited. Furthermore, our review focused on institutional controls that remain in place after site deletion or termination to determine whether these controls are effective in the long run. We also focused our review of RCRA facilities on those whose cleanup was led by EPA.

To examine the extent of the planned use of institutional controls, we examined all 112 Superfund records of decision (ROD)—involving 101 Superfund sites—finalized during fiscal years 2001 through 2003, and statements of basis or other final decision documents for all 23 RCRA corrective action facilities that reached the remedy decision stage during that period. In this regard, we examined only the principal remedy decision documents for the sites in our universe, rather than all remedy decision documents. Institutional controls may be called for in a number of EPA documents. In the Superfund program, at least two types of documents, in addition to RODs, may sometimes include information about institutional controls at the site—ROD amendments and explanations of significant differences. In the RCRA program, a variety of documents may include information about institutional controls, including permits, permit modifications, statements of basis, and other documents. Because of the number of potential sources of information regarding the planned use of institutional controls, we asked regional officials responsible for the sites to provide us with documentation relevant to the remedy decision at the site. In most cases, regional officials provided us with either a statement of basis, a final decision document, or both. Because we did not look at all remedy decision documents for these sites, we may not have captured all institutional controls at the sites we examined.

To address the extent of institutional control use at Superfund sites and RCRA corrective action facilities, we examined EPA's use of institutional controls at a nonprobability sample of nonfederal sites and facilities where

(1) the cleanup process was completed in earlier periods, for historical perspective; (2) cleanup had recently ended; and (3) the remedy had only recently been selected, for insight into the future use of these controls.[1] To gain a broader view of past use of institutional controls, we reviewed files for all 20 Superfund sites deleted from the National Priorities List (NPL) during fiscal years 1991 through 1993; in addition, in the two EPA regions with the most such facilities—Region III in Philadelphia and Region V in Chicago—we reviewed files for all 40 RCRA facilities at which, according to EPA's database, a preliminary investigation was conducted and corrective action was terminated before fiscal year 2001. Regarding sites where the cleanup was recently completed, we examined site documentation for all 53 Superfund sites deleted from the NPL during fiscal years 2001 through 2003 and at all 31 RCRA facilities where corrective action was terminated during the same period. With the exception of the historical RCRA facilities we examined in two regions, for those deleted sites or terminated facilities whose documentation indicated the use, or potential use, of institutional controls, we conducted follow-up interviews with EPA or state officials knowledgeable about the site to obtain detailed information and additional documentation and to determine what institutional controls were actually in place.

To identify the universe of Superfund sites deleted from the NPL during fiscal years 1991 through 1993 and 2001 through 2003, as well as those sites where a remedy decision was reached during fiscal years 2001 through 2003, we obtained data from EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)—a computerized inventory of potential hazardous waste sites that contains national site assessment, removal, remedial, enforcement, and financial information for over 44,000 sites. CERCLIS is a relational database system that uses client-server architecture (i.e., each computer or process on the network is either a client or server), installed on separate local area networks at EPA headquarters and all 10 regional Superfund program offices, and is used by more than 1,900 EPA staff. A September 30, 2002, report issued by EPA's Inspector General found that over 40 percent of CERCLIS data they reviewed were inaccurate or not adequately supported. The Inspector General's review focused on site actions, which it defined as activities that have taken place at a site—such as site inspections,

[1]Results from nonprobability samples cannot be used to make inferences about a population because in a nonprobability sample, some elements of the population being studied have no chance or an unknown chance of being selected as part of the sample.

removals, studies, potentially responsible parties searches, RODs, and remedial actions. As a result of its review, the Inspector General concluded that CERCLIS could not be relied upon to provide error-free data to system users.

For our review, we verified CERCLIS data related to the NPL sites in our universe, but we did not verify detailed site action data for all sites in CERCLIS. To address the reliability of CERCLIS data, we met with the Inspector General's staff to discuss the nature of the errors disclosed in their report. According to the Inspector General's staff, the reliability of CERCLIS data was more of a concern at the action level rather than the site level. They indicated that confirming the data with EPA regions would decrease concerns about data reliability. As a result, we confirmed all relevant CERCLIS data fields for all 53 NPL sites deleted during fiscal years 2001 through 2003 and all 23 NPL sites deleted during fiscal years 1991 through 1993; in addition, we verified information regarding all 232 remedy decisions, including 117 RODs, finalized during fiscal years 2001 through 2003. We verified all relevant CERCLIS data fields with staff in the relevant region, as appropriate, including confirming that sites were nonfederal and had been deleted or had a remedy decision during the time frames of interest. Regional staff found no errors with any of the deleted NPL sites in our universe. Regional staff identified errors regarding 2 of the 232 remedy decisions in our universe, including a change to information regarding 1 ROD, and added 1 remedy decision document to our universe, resulting in a 1 percent error rate. We corrected the CERCLIS site-level data that we used for our analysis to reflect regions' changes. In addition, we obtained remedy documentation, *Federal Register* notices of deletion, and other documents from regional staff that corroborated the accuracy of our data. We also conducted interviews with officials knowledgeable about deleted sites where it appeared there were institutional controls or where it was unclear. As a result of these interviews and further analysis, we amended the number of records of decision finalized during fiscal years 2001 through 2003 to 112 and the relevant number of sites deleted during fiscal years 1991 through 1993 to 20. After taking these additional steps, we determined that the CERCLIS data we used were sufficiently reliable for the purposes of this report.

In addition, we visited 5 Superfund sites that had been deleted from the NPL. For the site visits, we went to EPA Region III, headquartered in Philadelphia, which had (1) the most Superfund sites deleted during fiscal years 1991 through 1993 and fiscal years 2001 through 2003 and (2) the most RCRA facilities reaching corrective action termination during the

latter time period. Over the course of 5 days in July 2004, we visited the 5 sites that had institutional controls in place in EPA Region III. We conducted a physical inspection of each site to verify compliance with the terms of the institutional controls in place, accompanied by either the EPA site manager or a representative of the responsible party, or both. We also visited the relevant county recorder's office to verify that relevant institutional controls for each site had been recorded and to assess the process for accessing these documents. We also met with local officials responsible for informal monitoring of 1 site. In addition, we met with state officials to learn about a statewide system of groundwater management zones, an institutional control in place at 2 of the sites we visited.

To identify the universe of RCRA facilities that reached the corrective action termination or remedy decision stage throughout the life of the program, and specifically during fiscal years 2001 through 2003, we obtained data from the RCRAInfo system—the EPA Office of Solid Waste's national, mission-critical, major application consisting of data entry, data management, and data reporting functions used to support the implementation and oversight of the RCRA Subtitle C Hazardous Waste Program as administered by EPA and State/Tribal partners. RCRAInfo is a relational database management system (Oracle) that is centralized and Web-enabled, stored on a central Unix server at EPA's Research Triangle Park, North Carolina, facility. Access to RCRAInfo is restricted to authorized EPA Headquarters, EPA Regional, and State staff with RCRA program oversight or implementation responsibilities. During our review, we also spoke with officials in each of the 10 EPA regions regarding their use of the code in the RCRAInfo system used to indicate the termination of corrective action. Specifically, we asked them whether a site coded in this way could include an institutional control, as had been indicated by an official in EPA headquarters early in our review. Officials in 6 EPA regions indicated that regional policy dictated that a site coded in this manner should not include institutional controls, while officials in the other 4 regions stated that it could. In addition, officials in 5 of the regions expressed doubts or uncertainty about whether use of the code had been consistent over time, whether personnel within their region used the code consistently, or whether states in the region interpreted the code in a uniform manner. While EPA's Inspector General has not examined the reliability of the RCRAInfo database, at least one previous report about its predecessor system—the Resource Conservation and Recovery Information System—raised additional significant questions about data reliability.

For our review, we verified the data obtained from RCRAInfo with knowledgeable staff in each EPA region. We asked regional officials to verify that (1) the facilities in our universe belonged there and (2) there were no facilities that should be present in our universe but were not. Verifying the facilities in our universe entailed verifying information about each facility, such as whether it was a federal or nonfederal facility, whether corrective action activities at the facility were led by the state or by EPA, and whether the site had reached the relevant milestone within the prescribed time frame. As a result, we checked all relevant RCRAInfo data fields for the 30 EPA-led RCRA facilities where corrective action was terminated during fiscal years 2001 through 2003 and 21 EPA-led RCRA facilities where a remedy decision was finalized during that period, according to data provided by RCRA officials in EPA headquarters. We verified all relevant RCRAInfo data fields with staff in the relevant region, as appropriate, including confirming that facilities were nonfederal and had had corrective action terminated or had a remedy decision during the time frames of interest. From our universe of RCRA facilities where corrective action was terminated, regional officials deleted 1 facility, added 3 more, and edited the data for 1 additional facility, for a total of 32 facilities. Subsequent follow-up work and interviews with site managers brought the relevant universe of RCRA facilities to 31. Similarly, from our universe of RCRA facilities where a remedy decision was finalized, regional officials deleted 1 facility, added 3 more, and edited the data for 1 additional facility, for a total of 23 facilities. We corrected the RCRAInfo data for facilities in our universe to reflect regions' changes. In addition, we obtained documentation of remedy selection and corrective action termination from regional staff that corroborated the accuracy of our data. We also conducted interviews with knowledgeable site officials at terminated facilities where it appeared there were institutional controls or where it was unclear. After taking these additional steps, we determined that the RCRAInfo data we used were sufficiently reliable for the purposes of this report.

To learn the extent to which EPA ensures that institutional controls at Superfund sites and RCRA corrective action facilities are implemented, monitored, and enforced, we interviewed EPA or state officials knowledgeable about particular sites. To identify sites of interest, we examined documentation related to all 20 Superfund sites deleted from the NPL during fiscal years 1991 through 1993, as well as all 53 Superfund sites deleted from the NPL and all 31 RCRA facilities where corrective action was terminated during fiscal years 2001 through 2003. For those deleted sites or terminated facilities among these whose documentation indicated

the use, or potential use, of institutional controls, we conducted follow-up interviews with EPA or state officials knowledgeable about the site to obtain detailed information and documentation regarding the implementation, monitoring, and enforcement of any institutional controls in place.

To understand the extent to which states implement, monitor, and enforce institutional controls in the RCRA corrective action program, we interviewed RCRA program managers in the 2 states with the most corrective action remedy decisions and terminations at state-led facilities during fiscal years 2001 through 2003—Colorado and New Jersey. We also interviewed officials in 4 additional states that were selected at random from the 37 states that, in addition to Colorado, were authorized by EPA to conduct RCRA corrective action activities as of March 2002—California, Nevada, South Dakota, and Texas.[2] In addition, we reviewed *An Analysis of State Superfund Programs: 50-State Study, 2001 Update*, a 2002 report by the Environmental Law Institute, an independent environmental research organization, and interviewed the report's main author. To inform their study, the Environmental Law Institute collected documents from states, requested program information from them, and conducted telephone interviews to clarify responses and reconcile any discrepancies. While a few states declined to participate, the study achieved a 92 percent response rate. As a result of our review, we determined that this study was sufficiently methodologically sound for the purposes of our review.

To identify the challenges of developing a system to track institutional controls, we interviewed the EPA officials in charge of developing tracking systems for the Superfund and RCRA corrective action programs. We also analyzed documentation related to these efforts and initial data drawn from these systems. In addition, we discussed systems to track institutional controls with officials we interviewed in 6 states, including how the states tracked institutional controls, if at all, and whether the states had any concerns about such national tracking systems.

In addition, we collected information about the Superfund program's Institutional Controls Tracking System (ICTS) to inform a data reliability review of this new database. ICTS is an Oracle database accessed through a

[2]Officials we contacted for the state of Idaho, originally selected in our random sample, declined to be interviewed. Therefore, we interviewed officials in South Dakota, the next state on our list of randomly selected states, instead of Idaho.

user interface consisting of HTML Web pages with JavaScript. The current version of ICTS was designed to provide some baseline information on institutional controls but was planned as a step toward a more comprehensive system. The current ICTS has been used to gather baseline information on institutional controls at approximately 900 EPA Superfund construction completion sites. Officials in all 10 EPA regions were asked to populate the system in 8 weeks using the best available information and/or their best professional judgment. Because of the expedited data entry, EPA plans additional research into the status of institutional controls at the site-specific level and significant data quality assurance activities. In light of the uncertain quality of the data, in this report we present data from ICTS with appropriate caveats.

We conducted our work from October 2003 to January 2005 in accordance with generally accepted government auditing standards, including an assessment of the data reliability and internal controls.

Comments from the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 7 2005

Mr. John B. Stephenson
Director
Natural Resources and Environment
Government Accountability Office
Washington, D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to review and comment on the January 2005 Draft Report titled "Hazardous Waste Sites: Improved Effectiveness of Controls at Sites Could Better Protect the Public." The U.S. Environmental Protection Agency (EPA) appreciates GAO's efforts to recognize the challenges that EPA faces when implementing institutional controls (ICs). General comments and comments specific to the GAO recommendations are enclosed. Generally, EPA agrees with the recommendations and has undertaken a number of activities over the past four years to improve implementation and monitoring of appropriate ICs. These activities are summarized below.

EPA and other government agencies have used ICs at cleanup sites for nearly two decades. Over the last ten years, we have focused increased attention on understanding and overcoming the complexities and challenges associated with the use of ICs, many of which are highlighted in the Draft Report. As a result, we have made significant improvements in our approach to ICs in recent years, targeted at the full life-cycle of ICs from identification, evaluation, and selection to implementation, monitoring, and enforcement. By making these changes and more clearly defining EPA's policies and practices, we are confident that the reliability and durability of ICs at sites that have been recently cleaned up has greatly improved. We acknowledge, however, that there are sites addressed earlier in the Superfund and RCRA programs that have not benefitted from our increased understanding of ICs.

We recently undertook a comprehensive effort, beginning with the Superfund program, to improve our practices and to apply them to both old and new sites. In 2004, the Office of Superfund Remediation and Technology Innovation, the Federal Facilities Restoration and Reuse Office, and the Office of Site Remediation Enforcement, developed a comprehensive IC strategy for the Superfund program. The "EPA Strategy to Ensure Institutional Control Implementation at Superfund Sites," issued October 7, 2004 (National Superfund IC Strategy; OSWER document 9355.0-106) is focused on addressing potential IC problems at the Superfund sites that have reached the "Construction Complete" stage of the cleanup. The National Superfund IC Strategy calls for the Agency to evaluate close to 900 Construction Complete sites and determine whether

the ICs are appropriate and effective and, if not, to take the appropriate corrective measures. The baseline information on these Superfund sites is maintained in the recently developed IC Tracking System (ICTS). This state-of-the-art tracking system will serve as the cornerstone for future programmatic and trend evaluations.

For the Superfund program, we also developed a network of Regional experts on ICs to resolve emerging issues quickly and consistently across the country. Each Region in EPA has designated both a Regional IC Program Coordinator and Legal Coordinator (IC Coordinators), as well as at least one person to represent the Region on the Superfund Management Advisory Group for Institutional Controls. The IC Coordinators resolve key implementation issues on a day-to-day basis, and the Management Advisory Group provides direction on emerging national policy issues and monitors Regional implementation of the National Superfund IC Strategy.

The "Framework to Establish National Consistency for Prioritizing Institutional Controls Workload" was developed to help with implementation of the National Superfund IC Strategy. It establishes criteria and requirements for expedited reviews, to be completed by October 2005, and longer term evaluations, to be completed by October 2009. Most of the expedited reviews are of sites deleted from the National Priorities List; consistent with the GAO findings, EPA believes these sites may be the ones warranting more immediate attention. Each Region conducted a critical analysis of its site portfolio to develop Region-specific workplans for all construction complete sites and is currently implementing them, consistent with the National IC Strategy. To date, we have identified over 200 sites from our working universe of Superfund sites, as needing no additional IC evaluation or corrective measures.

EPA's comprehensive approach under its cleanup programs includes development of numerous products to help accurately define and improve the status of ICs. For example, we have developed the following IC guidance documents to address key implementation issues: (1) *Identifying, Evaluating and Selecting ICs for Superfund, Federal Facility and RCRA Cleanups (September 2000; OSWER 9355.0-74 FS-P)*); (2) *Implementing, Monitoring and Enforcing ICs at Superfund, Federal Facility, RCRA, Brownfields and UST Cleanups (draft final; February 2003); (3) ICs and Communities at Superfund, Federal Facility, RCRA, Brownfields and UST Cleanups (draft)*; and (4) *ICs and Five-Year Reviews Guidance Supplement (draft)*. In addition, we have developed and delivered several types of IC training courses nationally.

Currently, EPA is addressing some of the more challenging implementation issues with respect to ICs, including: revising the Superfund Five-Year Review process; improving our understanding and use of title searches; developing guidance to assist with site-specific issues that will arise when determining the appropriate corrective measures; and creating model language and documents to improve reliability and enforceability of ICs in the future. In addition, EPA is piloting some innovative projects that we hope will have transferrable "lessons learned" for ICs. Examples include: collaborating with States and DOE on IC data exchange and tracking; monitoring the successes and shortcomings of a "One-Call" approach for identifying

ICs, which links IC information to utility line information when individuals call before digging on property; and relying on private entities for long-term stewardship responsibilities.

EPA has recognized that there are areas for improvement in how it and the states have selected, implemented, monitored, and enforced ICs at contaminated properties. While the National IC Strategy is focused on Superfund sites, our training efforts and guidance documents are directed at multiple cleanup programs – designed to assist our RCRA and Superfund practitioners. Under the RCRA program, we are working closely with authorized states to ensure effective institutional controls are imposed, where needed, and are applying the lessons learned in the other cleanup programs. We have also recently revised the RCRA Info data system so that it can track imposition and implementation of ICs at RCRA facilities. EPA has also worked with the National Conference of Commissioners on Uniform State Laws in developing the Uniform Environmental Covenants Act. The Agency supports the goals of the Uniform Environmental Covenants Act in seeking to promote greater uniformity in the implementation of institutional controls.

EPA is confident that our efforts will result in vast improvements to the implementation and reliability of ICs at cleanup sites. It is essential to ensure that ICs selected for a particular purpose in fact serve that purpose and remain a reliable and integral part of the remedy. As in-place management of hazardous wastes increases at sites across the Nation, the need for reliable institutional controls and vigilance in administering them increases as well. A "missing IC," as defined in the Draft Report, does not by itself necessarily represent an unacceptable human exposure or environmental risk or suggest a breach of remedy. For example, a landfill cap will still protect humans and the environment, even if no institutional controls exist to prevent digging, as long as no digging occurs and it remains intact. Conversely, a landfill cap with an institutional control preventing digging will not protect human health and the environment if digging has taken place contrary to the restriction.

EPA appreciates the efforts that GAO expended conducting this review. Thank you for the opportunity to provide comments on the Draft Report, and EPA looks forward to working collaboratively with GAO to continue to protect the public.

Sincerely,

Thomas P. Dunne
Acting Assistant Administrator
Office of Solid Waste
and Emergency Response

Thomas V. Skinner
Acting Assistant Administrator
Office of Enforcement and
Compliance Assurance

Enclosure

Enclosure
EPA Comments on GAO Recommendations

I. General Comments

1. The absence of ICs should not be interpreted to necessarily mean remedies are not protective.

One key aspect not considered in the Draft Report, but extremely germane to the findings, is the effect of ICs on the overall protectiveness of remedies. EPA agrees it is essential to ensure that ICs selected for a particular purpose in fact serve that purpose and remain a reliable and integral part of the remedy. As more sites mature into the long-term operation and maintenance phase, the need for reliable institutional controls and vigilance in administering them increases as well. However, a "missing IC," as defined in the Draft Report, does not by itself necessarily represent an unacceptable human exposure or environmental risk, or suggest a breach of remedy. For example, a landfill cap will still protect humans and the environment, even if no institutional controls exist to prevent digging, as long as no digging occurs and it remains intact. Conversely, a landfill cap with an institutional control preventing digging will not protect human health and the environment if digging has taken place contrary to the restriction. Whether a remedy continues to protect human health and the environment is not dependent on the mere presence or absence of an institutional control.

The Superfund Program conducts detailed remedy evaluations no less often than every five (5) years at sites that cannot support unlimited use and unrestricted exposure. This statutory threshold for site remedy reviews is also the policy threshold for determining whether a site requires ICs. The effect of using the same threshold for remedy reviews and ICs is that virtually all sites with ICs receive periodic reviews. The explicit purpose of the "Five-Year Review" is to critically evaluate the remedy to ensure it remains protective. During fiscal years 2003 and 2004 alone, the Superfund Program conducted over 400 Five-Year Reviews at NPL sites. Another 250 NPL sites are scheduled for evaluation in fiscal year 2005. The combined result is that almost the entire Superfund portfolio of construction completion sites will have relatively recent evaluations of whether the remedy remains protective. An analysis of Five-Year Reviews to date indicates that very few remedies have been deemed to not be protective. Further, of the very few sites with issues regarding protectiveness, the vast majority were related to an engineered remedy, rather than ICs. The important message is that the absence of an IC should not be interpreted to mean that a particular remedy results in unacceptable human exposure or environmental risk.

2. Evaluation of a small universe of sites may overestimate the number of sites with potential IC problems.

The second general comment involves the relatively small number of Superfund sites evaluated during the period 1991-1993 and the impact of this small universe on inferences drawn from the Draft Report. Specifically, there were four deleted Superfund sites with residual

contamination evaluated for the period 1991-1993. The Draft Report accurately states that two of the four, or 50%, of the deleted sites evaluated lack ICs. However, use of this statistic to estimate the number of older deleted sites would significantly overestimate the true number of deleted sites with residual contamination and no ICs in place for the Superfund Program. The Superfund Program conducted an evaluation of 890 Construction Complete sites in 2004, 280 of which are deleted. This research indicates that a significantly smaller percentage of deleted sites lack ICs. The Draft Report states that "results from nonprobability samples cannot be used to make inferences about a population;" however, a more direct statement – that the use of this statistic in any other context would be misleading – is likely appropriate. The aggregated average of the universe of sites evaluated in the Draft Report indicates that approximately 17% of the deleted sites may have IC issues. This statistic is much closer to EPA's internal analysis of the deleted sites with potential IC issues and is likely a much better measure of deleted sites with potential IC issues.

3. An increased use of ICs does not mean EPA advocates less treatment.

The final general comment involves the potential for misinterpreting the finding of an increased use of ICs. An increased use of ICs should not be interpreted to mean that less treatment is occurring at Superfund cleanups or under other cleanup programs. The Superfund Program continues to clean up sites consistent with the statutory preference for treatment and permanent remedies. The RCRA program takes a similar approach. The data in this Draft Report were not evaluated for, nor do they support, any inference that an increased use of ICs results in a reduction in treatment.

II. Responses to Draft Report Recommendations

1) Clarify Guidance on When Controls Should be Used

EPA concurs with GAO's recommendation to continue to develop cross-program guidance to clarify the role of ICs in EPA lead cleanups. The specific guidance documents developed or under development include:

a) *Identifying, Evaluating and Selecting ICs for Superfund, Federal Facility and RCRA Cleanups*
b) *Implementing, Monitoring and Enforcing ICs at Superfund, Federal Facility, RCRA, Brownfields and UST Cleanups**
c) *ICs and Communities at Superfund, Federal Facility, RCRA, Brownfields and UST Cleanups**
d) *ICs and Five-Year Reviews Guidance Supplement***
e) *IC Implementation and Assurance Plans***
f) *Regional Best Practices for ICs****

* currently draft final
** currently draft
*** planned draft 05

The combination of these six guidance documents will add significant detail and guidance on the use of ICs.

2) Demonstrate that, in Selecting Controls, Sufficient Consideration Was Given to All Key Factors

EPA concurs with GAO's recommendation that sufficient consideration of all key factors should be completed at remedy selection, but we do not necessarily agree that this information should be included in the remedy decision document. The Checklist for Implementing ICs contained in the September 2000 EPA guidance on identifying, evaluating, and selecting ICs, states explicitly that key criteria should be considered during the remedy selection phase, however, the guidance does not recommend the analysis to be documented in the remedy decision. This was a considered policy decision to allow EPA to present an "enforcement neutral" remedy description.

For example, it is not always clear at the remedy decision stage whether the remedy will be EPA lead versus private party lead, and whether the remedy will be completed under a judicial Consent Decree or Administrative Order. These different leads and enforcement approaches have significantly different enforcement and monitoring responsibilities. Also, flexibility at the remedy decision phase allows for the emergence of new IC tools. For example, many States are actively considering passing legislation like the Uniform Environmental Covenants Act as a new IC tool, and remedy flexibility will allow for these situations. EPA guidance encourages an appropriate evaluation at the Remedial Investigation/Feasibility Study phase and new guidance will recommend additional detail at the remedy design phase. The scope of the GAO review included only principal decision documents rather than all supporting documents. The evaluation of key factors may have occurred in the RI/FS and/or other remedy decision documents. The list of the sites evaluated in the GAO Draft Report was not provided, so EPA was unable to determine whether sufficient consideration was given to all key factors in other documents for the sites evaluated.

In the case of RCRA cleanups, EPA notes that in many cases facilities at the remedy selection phase will be subject to ongoing regulation – for example, under a RCRA permit or interim status standards – and under the control of a viable operator. In such cases, the RCRA permit or security requirements may well provide adequate institutional controls, enforceable by EPA or the authorized states. On the other hand, the situation may be very different if property transfer or redevelopment is contemplated. Therefore, EPA is convinced that flexible approaches are needed in assuring that RCRA facilities have acceptable engineering and institutional controls during and after remedy completion.

3) Ensure That the Frequency And Scope Of Monitoring Efforts Are Sufficient to Maintain the Effectiveness Of Controls

EPA concurs with GAO's recommendation. As noted in the Draft Report, one of the key challenges is that monitoring is often completed by parties other than EPA and often there is little leverage to compel these other parties to action. In response to this concern, EPA's draft Revised

Operation and Maintenance (O&M) checklist identifies additional IC specific O&M requirements; the draft Implementation, Monitoring and Enforcement guidance will require periodic evaluation and certification from a responsible entity at the site that the ICs are both in place and that they remain effective; the draft guidance supplement on ICs and Five-Year Reviews will include criteria on evaluating the effectiveness of ICs; and the IC Implementation and Assurance Plan guidance will include specific roles and responsibilities for monitoring efforts.

4) Ensure That The Information On Controls Reported In New Tracking Systems Accurately Reflects Actual Conditions

EPA concurs with GAO's recommendation regarding IC tracking. EPA has undertaken a concerted effort to gather accurate information on the status and effectiveness of ICs throughout their life-cycle. The Superfund program has added almost 900 sites to its tracking system and regions are currently undertaking a significant quality assurance effort to ensure that the information in the system reflects actual conditions. Over the next year, expedited reviews will be conducted at approximately 80 high priority Superfund sites and reviews will be conducted at the remaining Superfund IC sites over the next five years. Further, the Superfund Program is currently considering enhancing ICTS to include tracking implementation, monitoring, and enforcement responsibilities as well as other IC issues.

GAO Contacts and Staff Acknowledgments

GAO Contacts

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ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Public Health Assessment for

LCP CHEMICALS SUPERFUND SITE
and Adjacent Areas
BRUNSWICK, GEORGIA

EPA FACILITY ID: GAD099303182

APRIL 16, 2014

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. The revised document was released for a 90-day public comment period. Subsequent to the public comment period, ATSDR will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or the U.S. Department of Health and Human Services.

Please address comments regarding this report to:

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PUBLIC HEALTH ASSESSMENT

LCP CHEMICALS SUPERFUND SITE
and Adjacent Areas
BRUNSWICK, GEORGIA

EPA FACILITY ID: GAD099303182

Prepared by:

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Summary

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) in Atlanta, Georgia has evaluated environmental data from the LCP Chemicals Superfund Site in Brunswick, Georgia. The LCP Chemicals Superfund Site (LCP Chemicals Site) is located on Ross Road and occupies approximately 813 acres immediately northwest of the city of Brunswick. Tidal marshland covers more than 670 acres of the property. Former manufacturing operations at the LCP Chemicals Site are located on about 133 acres of dry land (upland), east of the marsh.

The current LCP Chemicals Site has been associated with industrial-related activities since at least 1919 (EPS 2007a). An oil refinery, a paint manufacturing company, a power plant, and a chlor-alkali plant have all operated at this site over the years. During various manufacturing activities by several companies, site soils in the dry-land portion of the site, groundwater beneath the site, and the tidal marsh adjacent to the site became contaminated with waste products from these operations (EPA 2011).

In September 2010, ATSDR released this public health assessment as a draft for public comment. The 2010 public health assessment focused on the evaluation of contaminants in soil in the 133 acres of dry-land area because this area is being redeveloped and could be used for either commercial or residential purposes. We received comments on the 2010 report, which are presented in Appendix F.

In addition, EPA collected environmental data since 2010, in part based on recommendations in the 2010 report. New data are available for soils, sediment, and pond water from the dry-land area and for sediment and seafood samples from a portion of the Altamaha Canal, just south of the site.

This final Public Health Assessment for the LCP Site presents the findings, conclusions, and recommendations that were part of the 2010 report as well as new findings, conclusions, and recommendations based on new environmental data.

ATSDR has conducted numerous activities at the site since it was added in 1996 to the National Priorities List of hazardous waste sites. These activities include the following:

- The 2010 public release of this public health assessment focused on the dry-land area. This public release made numerous recommendations to other agencies to collect additional environmental data, which now are part of this final release of the same report.

- A 2005 health consultation for the Arco neighborhood, which evaluated soil samples from the former Arco neighborhood adjacent to the LCP Site.

- A 1999 report about the consumption of seafood and wild game contaminated with mercury to evaluate self-reported symptoms and illnesses for persons who ate locally caught seafood. The report also assesses person's exposure to mercury and provided information that was used to develop recommendations for a seafood consumption advisory.

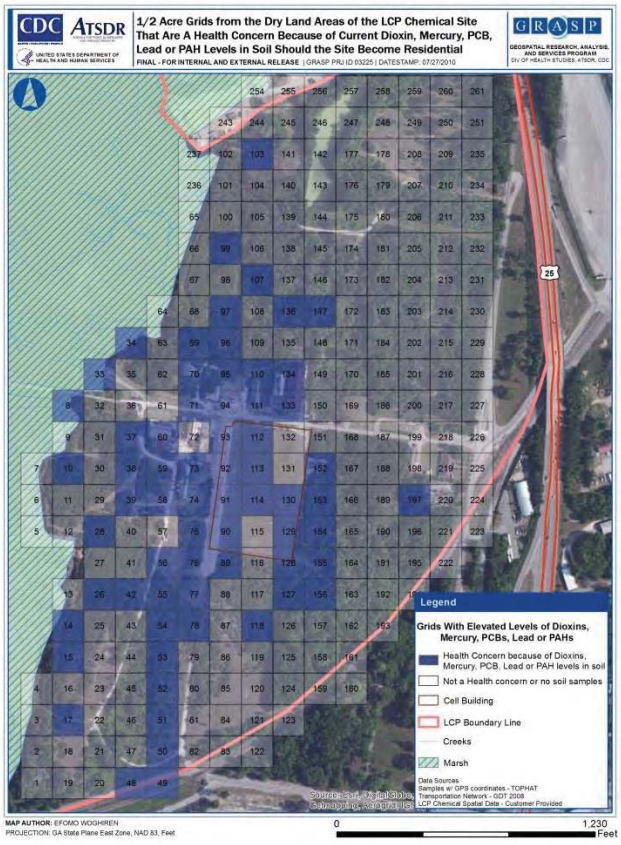
- A series of health consultations from 1994 to 1996 that evaluated the risk of harmful effects from consuming locally caught seafood from the Turtle River System contaminated with hazardous waste from the LCP site. These evaluations were used to develop the initial fish consumption advisory.

Throughout ATSDR's activities at the LCP site, we worked closely with federal, state, and local officials and most importantly with the community to assess the impact that the LCP site may have had on the residents of Brunswick and Glynn County. ATSDR has strived to serve the public by using the best science, take responsive public health actions, and provide trusted health information to prevent people from coming into contact with harmful toxic substances.

Overall Conclusion

ATSDR divided the 133 acres into half-acre grids to determine whether a grid would be a concern for future residential or commercial development. Some of these grids were found to contain harmful soil levels of mercury, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, lead, and dioxins should certain portions of the site be developed.

If the LCP Chemicals Site becomes residential, 66 half-acre grids have at least one chemical in soil that could harm the health of children and adults. If the site becomes commercial or industrial, 9 half-acre grids have at least one chemical in soil that could harm the health of workers (see figures below). Some uncertainty exists in this overall conclusion because uncertainty exists in the amount of chemical exposure that will occur after the site is developed and some dry-land areas were inadequately sampled.



This figure shows the 66 half-acre grids that are a health concern if the LCP Chemicals Site becomes residential.

This figure shows the 9 half-acre grids that are a health concern if the LCP Chemicals Site becomes commercial or industrial.

Conclusions 1-5

Conclusions 1-5 were presented in the September 2010 release of this report for public comment. The basis for these conclusions is environmental soil samples collected by the U.S. Environmental Protection Agency (EPA) predominantly in the 1990s, although a few samples were collected in the early 2000s. These conclusions focus on soil contamination in the dry-land area of the LCP site. During the 1990s, EPA also removed much of the contaminated soils from the site.

Conclusion 1 PCBs in Dry-land Area+

If certain dry-land areas of the LCP Chemicals Site become residential, polychlorinated biphenyls (PCBs) in soil at 41 half-acre grids on the site could harm the health of children and adult.

If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, PCBs in soil in six half-acre grids on the site pose a health risk for commercial and industrial workers.

Basis for Decision (Conclusion 1)

Children and adults who come in contact with high PCBs in soil might experience harmful effects to the immune, dermal, nervous, developmental, and reproductive systems (ATSDR 2000). Specific health effects include

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance problems,
- Problems with attention and impulse control,
- Fewer male births,
- Lower birth weight,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women,
- An increase in deaths from Parkinson disease in women,
- An increase in deaths from dementia in women, and
- An increase in diabetes in women.

Children and especially preschool children, with their nervous systems still developing, may be a particularly susceptible group if they come in contact with high PCBs levels in soil in some areas.

Commercial and industrial workers also are at risk of harmful effects if they have contact with soil in six half-acre grids of the site with the highest PCB

levels. Their estimated exposure to PCBs could cause the same health effects as listed previously.

Daily contact with PCBs in soil over many years poses a high cancer risk for children and adults should the site become residential. PCBs in soil pose a moderate cancer risk for workers if the site becomes commercial or industrial. Such exposure could put residents and workers at increased risk for several cancers, including cancers of the liver, thyroid, biliary tract, intestines and skin.

Some uncertainty exists when deciding if harmful effects might be expected because very little health information is available on the most common type of PCBs found in LCP soils. Therefore, ATSDR relied upon health information from other types of PCBs. Uncertainty also exists in estimating how much PCBs people will contact once the site is developed and from using results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site. In addition, some dry-land areas were insufficiently sampled.

Six half-acre grids on the site exceed the U.S. Environmental Protection Agency's (EPA) 1994 clean-up level for PCBs of 25 parts per million (ppm) while 41 grids have average PCB concentrations greater than 1 ppm. In the text of this report, see Table 4 for a list of grids that are a concern because of residual PCB contamination and see Figure 34 for their location.

Conclusion 2 Mercury in Dry-Land Area

If certain dry-land areas of the LCP Chemicals Site become residential, mercury in soil in 10 half-acre grids on the site could harm the health of children and the developing fetus if women are pregnant.

If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, mercury in soil in four half-acre grids on the site could harm the health of the developing fetus if a female worker is pregnant. One of these half-acre grids also could harm the health of women who are not pregnant and the health of men.

Basis for Decision (Conclusion 2)

For women who live in the 10 half-acre grids on the site with high mercury concentrations in soil, the estimated intake of mercury from soil approaches or exceeds levels that cause harmful neurological effects to the fetus during pregnancy. Children born to these women might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions. The estimated exposure levels in preschool children who live in these areas also approach or exceed levels that could harm their health. They are at risk of the same neurological effects.

Mercury in soil in four half-acre grids on the site also poses a risk for commercial and industrial workers if the site is developed. Pregnant workers who have contact with mercury in soil in these areas are at risk of exposing their developing fetus to mercury levels that might cause harmful effects after birth. Some children born to women exposed to these levels might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions.

Male and female workers who have prolonged contact with soil from the one half-acre grid with the highest remaining mercury contamination also are at risk of harmful effects. Their estimated exposure level might result in damage to their neurological system, such as diminished sensitivity to pain, diminished touch, decreased fine motor performance, impaired vision, and impaired hearing.

Some uncertainty exists concerning the risk of harmful effects from mercury in soil. The chemical form of mercury in soil at the LCP Chemicals Site has not been well-established, although scientific studies from marsh sediment show that almost half the mercury is organic mercury. Therefore, ATSDR assumed that most of the mercury in soil at the LCP Chemicals Site was organic mercury. There's some uncertainty about whether the organic mercury bound to soil would cause harmful effects. In addition, uncertainty exists in the mercury concentrations in surface soil following development of the site and uncertainty exists from using the results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

Ten half-acre grids exceed EPA's 1994 clean-up level of 20 ppm mercury in soil. See Table 29 for a list of the 10 grids that are a concern because of residual mercury contamination and see Figure 37 for their location.

Conclusion 3 Lead in Dry-land Area

If certain dry-land areas of the LCP Chemicals Site become residential, lead in soil in 28 half-acre grids on the site could harm the health of children.

Basis for Decision (Conclusion 3)

If the site becomes residential, exposure to lead in soil at these 28 half-acre grids could increase children's blood lead levels and result in the following harmful effects:

- Small decreases in IQ,
- An increase in attention deficit hyperactivity disorder,
- Reduced attention span,
- Lack of concentration,
- Decreased fine muscle skills,
- Withdrawn behavior,

- Decreased height,
- Small delays in puberty, and
- Small changes in kidney function.

Some uncertainty exists in this conclusion because uncertainty exists in estimating children's exposure to lead in soil if the site becomes residential. Uncertainty also exists from using the results of soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

See Table 31 for a list of the 28 half-acre grids that are a concern because of residual lead contamination and see Figure 40 for their location.

Conclusion 4 PAH in Dry-land Area

If certain dry-land areas of the LCP Chemicals Site become residential, polycyclic aromatic hydrocarbons (PAHs) in soil in six half-acre grids on the site could harm the health of children and adults.

If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, PAHs in soil in two half-acre grids on the site could harm the health of workers.

Basis for Decision (Conclusion 4)

Daily contact with PAHs in residential soil over many years poses a moderate risk of certain cancers for children and adults. Similarly, workers also have a moderate risk of certain cancers should some areas become commercial or industrial. Such exposure could put residents and workers at increased risk for lung and skin cancers.

Some uncertainty exists in these conclusions because uncertainty exists in estimating how much PAHs people will contact once the site is developed. Uncertainty also exists from using the results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

See Table 35 for the list of half-acre grids that are a concern because of residual PAH contamination and see Figure 41 for their location.

Conclusion 5 Mixtures of PCB, Mercury, and Lead in Dry-Land Area

If certain dry-land areas of the LCP Chemicals Site become residential, contact with soil containing a mixture of PCBs, mercury, and lead (or a combination of these) could harm the health of children.

Basis for Decision (Conclusion 5)

Studies have shown that children exposed to low levels of PCBs, mercury, and lead showed impaired learning of a performance task, resulting in problems with attention and impulse control.

Three grids have elevated levels of PCBs, lead, and mercury; eight grids have elevated levels of PCB and lead; and, five grids have elevated levels of PCBs and mercury. See Figure 42 for the location of these grids.

Conclusions 6–12

Conclusions 6–12 are based on new environmental samples collected by EPA after 2010. Many of these samples were collected in response to recommendations from ATSDR in the December 2010 public release version of this report. The new environmental samples consist of soil samples from the dry-land area with a focus on the former drive-in theater and the pond in the northwest corner of the site. EPA also collected sediment and seafood samples from the Altamaha Canal just south of the LCP Site.

Conclusion 6 Dioxin in Dry-land Area

In 2011, EPA collected soil samples from eight, dry-land areas and measured dioxin levels. These dry-land area varied in size and thus consisted of varying numbers of half-acre plots. One sampling area consisting of 30 half-acre plots contained dioxins in soil that could harm the health of children and adults should this area become residential.

Basis for Decision (Conclusion 6)

Daily contact with dioxins in soil in this one area over many years poses a high risk of cancer for children and adults. Human studies have shown that dioxin can cause liver cancer and might be associated with cancers of the lung, colon, prostrate, breast, blood, and lymphatic system. Rodent studies have confirmed that dioxin can cause cancer at multiple sites, including the liver, lung, mouth, and thyroid.

In addition, preschool male children who have daily contact with these soils could be at risk of reproductive effects once they reach adulthood. As adults, they might experience problems with (1) decreased number of sperm, (2) decreased number of motile sperm, and (3) fewer male offspring

The location of this 30 half-acre area contaminated with dioxin is shown in Figure 43 and is labeled as sampling area 8.

Conclusion 7 Former Theater

In 2010, EPA collected soil samples from the former theater area in the northeast section of the site. Glynn County plans to build a detention center in this area so ATSDR evaluated the risk for adult workers and inmates who might come in contact with chemicals in soil. Mercury, lead, and PCBs in soil from the former drive-in theater area is not expected to harm people's health.

Basis for Decision (Conclusion 7)

The mercury and lead levels in soil in the former theater area were either below ATSDR's screening levels or the levels were at or near background levels in soils. Therefore, harmful effects from mercury and lead in soil are not likely.

The exposure of prison inmates and adult workers to PCBs in soil would be at levels far below ATSDR's health guideline for PCBs. Therefore, PCBs in soil are not likely to cause harmful, non-cancerous effects. The risk of cancer from daily exposure to PCBs in soil is insignificant.

Conclusion 8 On-site Pond

In 2010, EPA collected surface water and sediment samples from the on-site pond in the northwest corner of the dry-land area. The levels of PCBs, mercury, PAHs, and lead in surface water and sediment from the on-site pond are not expected to harm people's health.

Basis for Decision (Conclusion 8)

Levels of PCBs, mercury, PAHs and lead in the on-site pond were either below ATSDR's comparison values or at background levels. In addition, the pond does not serve as a source of drinking water nor does the pond support fish.

Conclusion 9 Sampling Sufficiency for Dry-land Area

Some dry-land areas do not have adequate sampling data; therefore, it is difficult to draw conclusions about whether these unsampled soils could harm people's health. Most of the insufficiently sampled areas are in the southeastern portion of the site (including the cell building area) and in the western dry-land area closest to the marsh. For other areas that have been sufficiently sampled, we are able to draw conclusions about potential health impacts.

Basis for Decision (Conclusion 9)

One reason for the limited sampling in some areas is that EPA decided that some environmental data were unusable because of data quality issues. In addition, some areas were not sampled because LCP Chemicals did not perform industrial activities on certain portions of the site. However, numerous industries occupied the site before LCP's chlor-alkali facility, and those industries could have disposed of waste throughout the property.

Approximately half of the grids are considered sufficiently sampled for making a health conclusion for the chemicals PCBs, mercury, and lead. That means that half of the grids require additional sampling in order to be sure that those areas are not contaminated.

See Figures 22 through 25 for the dry-land areas considered to have adequate sampling data.

Conclusion 10 Altamaha Canal

In 2011, EPA collected sediment samples from a portion of the Altamaha Canal that exists south of the LCP Site. ATSDR evaluated the risk of harmful effects from exposure to PCBs, mercury, PAHs, and dioxins in sediment along the Altamaha Canal. Adults and children who visit or play along the canal would not be exposed to contaminants in sediment at levels that could cause harmful, non-cancerous effects. It is unlikely that contact with these chemicals in sediment could cause cancer.

Basis for Decision (Conclusion 10)

These chemicals are not a health concern in Altamaha Canal sediment because:

- The concentration of lead in sediment from the canal is at or near background lead levels in soils and is unlikely to cause harmful health effects from direct contact,
- The concentration of mercury is below ATSDR's comparison value; therefore, mercury in sediment is unlikely to cause harmful health effects from direct contact,
- The estimated exposure to dioxins and PCBs for adults and children who visit or play along the canal is well below ATSDR's and EPA's health guidelines. Therefore, harmful non-cancerous effects are not likely. The estimated exposure to PCBs, PAHs, and dioxins for adults and children who visit or play along the canal results in insignificant cancer risks.

Conclusion 11 Mercury in Seafood from Altamaha Canal

In 2011, EPA collected fish and shellfish samples from the canal. ATSDR estimated exposure to mercury from eating various fish and shellfish from the Altamaha Canal and reached the following conclusions about adults and children with typical and high fish consumption:

- Mercury levels in mullet and shrimp from the Altamaha Canal is not expected to harm people's health.
- Mercury levels in blue crab, red drum, and sea trout is not expected to harm the health of typical fish consumers but could harm the health of high fish consumers.

Basis for Decision (Conclusion 11)

Depending upon age and race, high fish consumers eat about 2 to 7 ounces of fish and shellfish daily. Typical fish consumers eat about a half to 2 ounces of fish daily. These daily fish consumption rates do not necessarily mean that people eat fish every day. Their fish consumption averages out to the rates previously described. For example, someone with a daily fish consumption rate of 2 ounces might eat one 14 ounce fish meal a week or two 7 ounces fish meals a week. This frequency and amount of fish consumption averages out to two ounces of fish eaten daily.

- Typical and high fish consumers of mullet and shrimp from the Altamaha Canal have estimated exposures to mercury that are well below levels that cause harmful effects. Typical fish consumers of blue crab, red drum, and sea trout from the Altamaha Canal have estimated exposures to mercury that are well below levels that cause harmful effects.
- High fish consumers of blue crab, red drum, and sea trout from the Altamaha Canal have estimated exposures to mercury that approach levels that can cause harmful effects in young children and in children born to pregnant women who are high consumers. These children might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions.

Some uncertainty exists in the conclusions for sea trout and red drum because only one fish of each species was collected from the Altamaha Canal.

Conclusion 12 PCBs in Seafood from Altamaha Canal

Fish and shellfish from the Altamaha Canal were also found to contain PCBs. ATSDR estimated exposure to PCBs from eating various fish and shellfish from the Altamaha Canal and reached the following conclusions about adults and children with typical and high fish consumption:

- PCB levels in red drum, blue crab, and shrimp is not expected to cause harmful, non-cancerous effects.
- PCB levels in sea trout is not expected to harm the health of typical fish consumers, but could harm the health of high fish consumers.
- PCB levels in mullet could harm the health of typical and high fish consumers.

The results of the fish and shellfish sampling from the Altamaha Canal support the current fish advisory for the Turtle River system issued by the Georgia Department of Natural Resources (GDNR). The Altamaha Canal is tidally connected to the lower Turtle River through several waterways and GDNR has fish and shellfish consumption advice specifically for the lower Turtle River. See Table 46 for more information about the state's fish and shellfish consumption recommendations for the lower Turtle River.

Basis for Decision (Conclusion 12)

The basis for this decision are:

- Typical and high fish consumers of red drum, blue crab, and shrimp have estimated exposures to PCBs that are well below levels that can cause harmful, non-cancerous effects. Typical fish consumers of sea trout have estimated exposures to PCBs are well below levels that can cause harmful, non-cancerous effects.
- High fish consumers of sea trout and typical and high fish consumers of mullet have estimated exposure to PCBs that approach levels that can cause harmful, non-cancerous effects.

High consumers of sea trout and typical and high consumers of mullet might experience the following harmful effects to the immune, dermal, nervous, developmental, and reproductive systems. Specific health effects include:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance problems,
- Problems with attention and impulse control,
- Fewer male births,
- Lower birth weight,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women,
- An increase in deaths from Parkinson disease in women,
- An increase in deaths from dementia in women, and
- An increase in diabetes in women (ATSDR 2000).

Children and especially preschool children, with their nervous systems still developing, may be a particularly susceptible group.

Children and adults who frequently eat mullet from the Altamaha Canal for many years also have a high increased risk for several cancers, including cancers of the liver, thyroid, biliary tract, intestines and skin.

Next Steps

ATSDR recommends

1. Restricting some LCP Chemicals Site areas from residential development unless further steps are taken to prevent contact with PCB, mercury, lead, PAH, and dioxin contamination that remains in soil on the property.

2. Restricting some LCP Chemicals Site areas from commercial or industrial use unless further steps are taken to prevent contact with PCB, mercury, and PAH contamination that remains in soil on the property.

3. Additional soil sampling in and around the former cell building's footprint because of residual soil contamination if future plans include development of this area.

4. Additional sampling in areas where sampling data are limited. In general, the western portion of the site has been sampled more than the eastern portion. Particular attention should be given to the former cell building area should the land use change and to future enclosed structures built above the caustic brine pool area.

5. Continued monitoring of fish and shellfish in the Turtle River and in the marsh near the LCP Chemicals Site. The Georgia DNR continues to monitor seafood in the area and to maintain the fishing advisory for the Turtle River System.

6. Continuation of the GDNR's fish advisory for the Turtle River System. The major components of this advisory are provided in Tables 43-46 of this health assessment. GDNR's recommendations for the lower Turtle River (see Table 46) apply for fish obtained from the Altamaha Canal.

   The 2013 GDNR fish advisories for rivers, lakes, and estuaries in Georgia, including the Turtle River system, can be found at this website: http://www.gaepd.org/Documents/fish_guide.html. To view their brochure, click on "Guidelines for Eating Fish from Georgia's Waters, 2013".

   In addition, GDNR has a brochure, 'A woman's guide for eating fish and seafood from coastal Georgia'. This brochure is available at http://health.state.ga.us/pdfs/environmental/chemhazard/fish%20consumption/wfcg_coastal.pdf.

For More Information

ATSDR's Public Health Assessment for the LCP Chemicals Superfund Site is available at this internet address: http://www.atsdr.cdc.gov/sites/lcp/.

For more information about ATSDR's work at the LCP Chemicals Superfund Site, you should contact ATSDR at 1-800-CDC-INFO (1-800-232-4636) and ask to be transferred to Dr. David Mellard or you can dial Dr. Mellard direct at 770-488-0727.

I. PURPOSE AND PUBLIC HEALTH ISSUES

The purpose of this document is to describe ATSDR's public health assessment activities at the LCP Chemicals Superfund Site (aka LCP Chemicals Site) and to provide the Agency's opinion about the public health significance of exposure to chemicals at the site. A public health assessment (PHA) is a document prepared after an evaluation of pertinent environmental data, community concerns, and, when appropriate, health outcome data, to determine whether people have been, are being, or will be exposed to hazardous substances; and, if so, whether those exposures are harmful. If the exposure is harmful, ATSDR will recommend actions to prevent or reduce those exposures.

The LCP Chemicals Site was placed on the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) in June 1996. In the 1990s, ATSDR prepared several health consultations (HC) for the site, most of which focused on potential health impacts from eating local fish and seafood. However, the community remained concerned because ATSDR had not prepared a PHA for the LCP Chemicals Site. A local environmental group, the Glynn Environmental Coalition, requested that ATSDR conduct a PHA for the LCP Chemicals Site. ATSDR reviewed its activities at the site and in 2004 agreed that a PHA was warranted. Staff members from ATSDR were assigned and conducted additional site visits to learn about community concerns. During these initial meetings, residents expressed concern about whether site-related contaminants might have migrated into the nearby Arco neighborhood, and whether these potential exposures could result in adverse health effects. ATSDR worked with EPA, Honeywell, [one of the parties responsible for the contamination], and the Glynn Environmental Coalition to create a neighborhood soil sampling plan. These efforts resulted in another HC focused specifically on neighborhood soil issues; this HC was released in 2005.

Since that time, ATSDR staff has worked to understand the extensive environmental data that exist for the LCP Chemicals Site. Because the LCP Chemical property is scheduled for redevelopment, ATSDR focused on potential exposures to future populations once the site is redeveloped.

ATSDR prepared this PHA using available data. At the time of publication of this document, a full evaluation of the nature and extent of groundwater contamination (defined by EPA as Operable Unit 2) had not been completed. Therefore, ATSDR will focus this PHA on the dry-land soils region of the LCP Chemicals Site, with some information about the pond and marsh areas that also are part of the site, and the off-site Altamaha Canal area. EPA documents refer to the dry-land areas as upland soils; EPA's investigations of these areas are part of Operable Unit 3.

The public comment version of this document was released in September 2010. ATSDR received comments on the document from the general public and other third party entities. ATSDR's responses to the comments are in Appendix F of this document. ATSDR has added to this document an evaluation of new environmental data received since the public comment release in September 2010. The evaluation of new data is discussed separately.

II. BACKGROUND

II.A. Site Description

The LCP Chemicals Site is located on Ross Road in Brunswick, Glynn County, Georgia. It occupies approximately 813 acres immediately northwest of the city of Brunswick. The site is bordered by a county land disposal facility and a pistol firing range on the north, Ross Road on the east, the Turtle River and associated marshes on the west, and Georgia-Pacific Cellulose to the south. (See Figure A1 in Appendix A). Tidal marshland comprises more than 670 acres of the property. Former manufacturing operations at the LCP Chemicals Site were located on approximately 133 acres of dry-land area, east of the marsh (EPS 2007a).

II.B. Site History

The current LCP Chemicals Site has been associated with industrial-related activities since at least 1919 (EPS 2007a). An oil refinery, a paint manufacturing company, a power plant, and a chlor-alkali plant have all operated at this site over the years. During various manufacturing activities by several companies, site soils, groundwater, and the tidal marsh became contaminated. The contamination resulted from past manufacturing operations at the site (EPA 2011).

Past industrial operators and activities include:

- ARCO Petroleum (1919–1935), a successor of the Atlantic Refining Company, operated the site as a petroleum refinery that refined crude oil into fuel and oils. At one time, over 100 process and storage tanks were present on site. ARCO may have released petroleum products and wastes onto the ground.

- Georgia Power (1937–1950s) purchased portions of the site at various times between 1937 and 1950. The property purchased by Georgia Power included two parcels of land, two 750 kilowatt (kW) electric generators, and an additional 4.0 megawatts of electric generation capacity. Georgia Power may have released polychlorinated biphenyls (PCBs) onto the ground.

- The Dixie Paint and Varnish Company (later known as the Dixie O'Brien Corporation) (1941-1955) operated a paint and varnish manufacturing facility on a portion of the site south of the Georgia Power parcel. The Dixie Paint and Varnish Company is reported to have generated lead- and mercury-containing wastes at the site. These wastes may have been released by the O'Brien Paint Company operations at the site from 1942 to 1955.

- Allied Chemical and Dye Corporation (aka, AlliedSignal; Honeywell) (1950s–1979) acquired most of the land constituting what is now known as the LCP Chemicals Site. Allied Chemical operated a chlor-alkali facility at the site, principally for the production of chlorine gas, hydrogen gas, and caustic solution. The plant operated using the mercury cell process, which involves passing a concentrated brine solution between a stationary graphite or metal anode and a flowing mercury cathode to produce chlorine gas, sodium hydroxide (caustic) solution, and hydrogen gas, as a by-product. Sodium hypochlorite (bleach) was also produced in a secondary reaction.

Allied Chemical may have released mercury, mercury-containing wastes, and other chemicals onto the ground.

- LCP Chemicals (1979–1994) purchased the property and chlor-alkali plant in 1979. The chlor-alkali process continued with modification following the purchase. Part of the modification included the production of hydrochloric acid by reacting chlorine and hydrogen. LCP Chemicals is reported to have released mercury, mercury-containing wastes, and other chemicals onto the ground at the site before ceasing operations in 1994.

Upon the plant's closing in February 1994, the State of Georgia asked EPA to take immediate action at the site to address the threat of releases of chlorine gas and the flow of contamination into the adjacent saltwater tidal marsh containing endangered species. In 1994, EPA issued a Unilateral Administrative Order for Removal (UAO) which directed cleanup operations at the site. The LCP Chemicals Site was proposed for listing on the National Priorities List (NPL) in October 1995. The site was finalized on the NPL in June 1996 (EPA 2002).

The LCP Chemicals Site is currently divided into operable units to address the different contaminated media at the site. Operable Unit 1 (OU1) previously represented the marsh and dry-land soils and OU2 represented groundwater. In 2005, EPA redefined the operable units as follows: OU1 represents the marsh, OU2 represents groundwater, and OU3 represents the dry-land (upland) soils. OU3, dry-land soils, is the focus of this public health assessment ATSDR also reviewed data from the on-site pond, the marsh, the Altamaha Canal and other off-site areas. Other OUs may be examined when the data are available for review.

II.C. Summary of Removal Response Actions

Between 1994 and 1997, a removal action was performed on the dry-land portion of the Site. The removal action included the excavation of contaminated soils and industrial process waste from 26 discrete areas. A total of approximately 167,000 cubic yards of soil, sediment, and waste was removed during these actions. The removal areas contained material contaminated with constituents including petroleum hydrocarbons (volatile and semi-volatile organic compounds), mercury, alkaline sludge, polychlorinated biphenyls (PCBs), and lead. Between 1998 and 1999, the removal response action was extended to approximately 13 acres within the marsh and 2,650 linear feet of tidal channels (EPA 2011).

During the removal response action, the petroleum process buildings and the mercury cell buildings were among the structures dismantled onsite. The mercury cell buildings were demolished to the slab at grade and the area capped and fenced.

As stated above, the LCP Chemicals Site is comprised of 3 operable units: OU1 represents the marsh, OU2 represents groundwater, and OU3 represents the dry-land soils. The cleanup/removal activities for each operable unit are summarized below.

II.C.1. Marsh (OU1)

A large dispersion of mercury and polychlorinated biphenyls (PCBs) occurred throughout the marshlands as a result of the chemical manufacturing processes undertaken at the site between

1955 and 1979. EPA estimates that more than 380,000 pounds of mercury were "lost" in the area during this period. In addition to mercury and PCBs, lead, other metals, and volatile organic compounds contaminated the marshlands area, a 1-mile portion of the Turtle River, and the entirety of Purvis Creek (EPA 2011).

Mercury and PCBs were detected in aquatic life at levels sufficient to produce a ban on commercial fishing in these areas and a seafood consumption advisory for parts of the river and all of the creek. In 1992, the Georgia Environmental Protection Division (GEPD) issued a seafood consumption advisory for fish, crabs, oysters and other seafood harvested in the Turtle River estuary after mercury and PCBs were found in seafood samples. The seafood consumption advisory remains in effect at the time of the publication of this document and is available at this State of Georgia website: http://www.gaepd.org/Documents/fish_guide.html (GDNR 2012).

Between 1998 and 1999, a removal response action was conducted on approximately 13 acres within the marsh and 2,650 linear feet of tidal marshes. Removal activities included the excavation and off-site disposal of contaminated sediment and waste materials as a part of EPA's Remedial Investigation/Feasibility Study (RI/FS), additional ecological (biota and sediment) sampling was conducted.

II.C.2. Groundwater (OU2)

Groundwater monitoring has occurred periodically at the site since 2001. Leakage of mercury contamination was discovered beneath a sandstone layer. As a result, horizontal wells were installed in 2002 (approximately 75 feet below ground surface). In addition, a caustic brine pool which has a high pH was discovered beneath the site. A phytoremediation project was approved by EPA during November 2003. The purpose was to locally suppress the groundwater table to prevent seepage of groundwater to the marsh and staining of marsh sediments from occurring (EPA 2009). The phytoremediation project is reported to have failed because all of the poplars and many of the pine trees died (GDNR 2010).

EPA negotiated an Administrative Order of Consent (AOC) with Honeywell on April 18, 2007. According to the AOC, the caustic brine pool (CBP) will be extracted to meet the following removal action objectives: 1) reduce the pH of the CBP to less than 10.5, and 2) reduce the density of the CBP. The removal action began on September 25, 2007.

As of 2012, a total of 138 monitoring wells and 12 horizontal wells are on the site (EPS 2012). In 2012, Honeywell tested the feasibility of using CO_2 sparging to remediate the subsurface CBP. The results of the test show that CO_2 sparging is an effective technology for full-scale implementation at the site, and should be conducted over a multiple-year, sequential effort (Mutch Associates 2013). The results of the sparging effort were not available at the time of publication of this document.

II.C.3. Upland Soils (OU3)

A removal response action was performed on the dry-land (upland) portion of the LCP Chemicals Site from 1994 to 1997. The removal action included the excavation of contaminated soils and industrial process waste from 26 geographical areas on the site. A total of

approximately 167,000 cubic yards of soil and waste was removed during these actions. The removal areas contained material contaminated with constituents including petroleum hydrocarbons (volatile and semi-volatile organic compounds), mercury, alkaline sludges, polychlorinated biphenyls (PCBs), and lead. (EPA 2009)

During the removal response action, the petroleum process buildings and the former mercury cell buildings were among the structures dismantled. The mercury cell buildings were demolished to slab and the area capped and fenced.

II.D. Site Features

A dominant physical feature of the site is the approximately 670 acres of tidal marsh located in the western areas of the site. The salt marsh is characterized by a flat, heavily vegetated surface dissected by numerous channels and larger creeks under tidal influence from nearby Turtle River. The dry-land area to the east of the marshland is characterized by gently sloping terrain ranging from approximately 5 feet above mean sea level along the marsh/dry-land border to an elevation of approximately 15 feet along Ross Road. This area of the site is roughly divided in half by the east-west entrance road (EPS, 2007a) (See Figure A2 in Appendix A). Other notable features include an onsite pond and a former drive-in theater in the northern portion of the site (See Figure A3 in Appendix A).

The locations of the site's past industrial operations and staging areas are depicted in Figure A4 in Appendix A. A total of 26 discrete removal areas were delineated on the site. Operations related to the chlor-alkali process were primarily located in the areas south of the entrance road and the area of the boiler house, along with smaller isolated waste disposal areas dispersed over the northern half of the site. Refinery operations were present over most of the dry-land areas (EPA 2009).

II.E. Site Visit

Staff members from ATSDR visited the LCP Chemicals Site on several occasions to conduct activities as part of the PHA process. Beginning in September 2004, ATSDR conducted a public availability session to speak with the community to gather community concerns and to assess site conditions. ATSDR conducted additional visits in October 2006, March 2007, and July 2009. ATSDR also met with state, local, or Honeywell representatives on numerous other occasions from 2004 until present.

During our March 2007 visit, staff members from ATSDR, Honeywell, EPA, and the Glynn County Health Department toured the site by land and car. At the time of the visit, all industrial operations at the site had ceased. Many of the industrial buildings and structures had been removed from the site. An office building and a guard house stood at the entrance of the site. The footprint of several demolished buildings could be observed only by the above ground concrete pads.

The LCP Chemicals Site is currently surrounded by barbed-wired fencing on all sides except for the back of the site which faces Purvis Creek and the Turtle River. Purvis Creek is accessible from the Turtle River. Vehicle entry to the site is controlled by a guard at the main gate. During

site operations, residences were located just outside the fence on the southeastern boundary of the site. Recently, a portion of the Arco neighborhood southeast of the site was torn down. Currently, the closest residential areas are approximately 300 yards north of the site and about 600 yards southeast of the site.

There are no full-time production workers at the facility. However, there are full-time and/or part-time employees who work in the administration and security buildings. Remedial workers occasionally access the site to conduct site-related remedial activities.

II.F. Demographics

Demographic information characterizes the populations potentially affected by the site and the current population trends. Identifying the presence of potentially sensitive populations, such as young children (aged 6 and under), the elderly (aged 65 and older), and women of childbearing age (ages 15 to 44), is particularly important because these sub-groups could be more sensitive to environmental exposures than the general population.

According to the 2010 U.S. census, approximately 4,202 people live within a 1-mile radius of the site. Of this total population, approximately 451 are children aged 6 and younger, 519 are adults aged 65 and older, and 827 are women of childbearing age. See Figure A5 in Appendix A for more detailed demographic information.

II.G. Past ATSDR Health Evaluations

At various times throughout the history of this site, ATSDR has evaluated potential risks for humans near the LCP Chemicals Site, including the Arco neighborhood. A summary of ATSDR's past activities and reports is included below to highlight the progression of events and activities at the site. Full reports may be obtained by contacting any of the contacts listed at the end of this report, by calling ATSDR's toll-free hotline at 1-800-CDCINFO, or by visiting ATSDR's website for the LCP Chemicals Site at this URL: http://www.atsdr.cdc.gov/sites/lcp/.

II.G.1. Health Consultation, Arco Neighborhood 2004 Soil Samples – June 2005

ATSDR prepared a report in June 2005 titled, Health Consultation, Arco Neighborhood 2004 Soil Samples, LCP Chemicals Site (ATSDR 2005a). This health consultation (HC) evaluated the public health significance of certain chemicals in soil in the Arco neighborhood. The HC was prepared in response to residents' concern about soil contamination in their neighborhood because of past industrial activities related to the LCP Chemicals Site. EPA collected soil samples from residential yards and measured for mercury, lead, arsenic, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs), which included Aroclor 1268.

ATSDR concluded that:

- The concentration of lead at all but one of the properties in the Arco neighborhood is not a public health hazard. The lead contamination at one property in the Arco neighborhood was a public health hazard for children aged 6 and younger who might frequently play there.

- The levels of other chemicals (arsenic, mercury, PAHs, and PCBs) in soil from the Arco neighborhood are not a public health hazard.

II.G.2. Final Report, Consumption of Seafood and Wild Game Contaminated with Mercury – July 1999

In July 1999, the Glynn County Health Department (GCHD), in cooperation with ATSDR, conducted a study that evaluated the potential health effects associated with consuming seafood and wild game from the Turtle River and its tributaries (GCHD 1999). The study was in response to concerns regarding the consumption of mercury-contaminated seafood and wild game from these areas. The GCHD conducted a community-based study which compared 211 residents who may have been exposed to mercury by consuming seafood and wild game from the waters of the Turtle River (target group) to 105 residents who reported that they had not consumed seafood and wild game from those areas (comparison group).

The objectives of the study were: 1) to compare the prevalence of self-reported symptoms and illnesses between target and comparison group participants; 2) to determine seafood and wild game consumption levels among study participants and to assess the accuracy of the self-reported consumption levels; 3) to provide a basis for developing sound recommendations for seafood consumption advisories to the community; and 4) to assess individuals for evidence of mercury exposure using biological evidence (24-hour urine mercury test).

GCDH concluded that:

- Participants in the target group reported a statistically higher number of symptoms compared with participants in the comparison group. The symptoms were lightheadedness, difficulty concentrating, trouble remembering, problems retaining reading/conversations, irritability, and sleep changes.
- Respondents generally underestimated their amount of seafood consumption as reported in the questionnaire when compared to the amount they reported actually consuming as measured by the two-week dietary diary.
- Seafood comprised a smaller proportion of protein in study participants' diets than anticipated.
- The current seafood consumption guidelines are protective for the general public because individuals are not consuming more seafood per meal than values used in calculating the consumption guidelines.
- The majority of study participants do not fish in the restricted area; the few that do, however, state that they are aware of the advisory.
- All study participants had urine mercury concentrations levels below the reference level of 20 µg mercury/g creatinine.
- There is evidence that the target group consumed seafood from the restricted area, without evidence of high mercury burden.

Additionally, the GCDH recommended continued public education about the hazards of consuming contaminated seafood and continued monitoring of mercury levels in seafood and wild game.

One of the study objectives was to assess mercury exposure in recreational, commercial, and subsistence fishers. Of the 101 (65%) target group participants who self-reported which type of fisher they were:

- 97 (96%) classified themselves as recreational fishers,
- 3 (3%) identified as commercial, and
- 1 (1%) identified as subsistence fisher.

Therefore, the study results reflect characteristics of recreational fishers and do not necessarily apply to commercial or subsistence fishers.

In addition, urine mercury results might have been influenced by prior knowledge of the risks associated with mercury in fish. Participants might have reduced their fish intake following the dietary recall survey as they realized that they might be consuming too much mercury-contaminated fish. A more appropriate test of mercury exposure would have been hair mercury levels because it is a better indicator of long-term methylmercury exposure than urinary mercury levels. A more appropriate reference level to determine whether excessive urinary mercury levels were present would have been 2 micrograms per gram creatinine (µg/g) instead of 20 µg/g.

And finally, it should be noted that African-Americans made up only 4% (9 out of 211) of the people who participated in the study. African-Americans make up 26% of the population of Glynn County and nearly 40% of the population within four miles of the LCP Chemicals Site. Therefore, African-Americans are underrepresented in the Brunswick fish study.

A study of fishers along the Savannah River showed that African-Americans

- Eat more fish meals per month than whites (average, 5.4 vs. 2.9),
- Eat slightly larger portions than whites (average, 13.7 oz. vs. 13.1), and
- Eat higher amounts of fish per month than whites (average, 75 ounces vs. 41 ounces).

It is reasonable to assume that the fish-eating habits of African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River. Therefore, African-Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites. The results of the Brunswick fish study should not be applied to African-Americans in the Brunswick area for those reasons.

II.G.3. Health Consultation, LCP Chemical – October 1996

ATSDR prepared a HC in October 1996 to evaluate post-removal conditions at the LCP Chemicals Site. The HC was prepared in response to concerns about conditions after on-site removal and containment actions had been completed, and whether contaminant levels in seafood were a public health hazard. [ATSDR had previously identified the site as a public health hazard in August 1994 because the uncontrolled release of mercury into the environment posed an imminent threat to human health (ATSDR 1994)]. From 1994 to 1996, extensive seafood sampling took place and several studies were in progress, including the Emory University Former LCP Workers Health Study and the Brunswick Area Fish Consumption Study. However, at the time of the release of the 1994 health consultation, ATSDR did not have sufficient information to determine whether exposures to contaminants were occurring at levels that could be a health concern.

Therefore, ATSDR concluded in 1996 that:

- The LCP Chemicals Site is an indeterminate public health hazard because there is insufficient exposure information to support any other public health classification. However, this classification may change when additional pending data are evaluated. (e.g., results from the seafood consumption survey).
- The food chain in the LCP marsh, the Turtle River, and Purvis Creek and its tributaries is contaminated with mercury and PCBs because of past disposal practices.
- On-site removal and containment have stopped the movement of contaminants into the marsh.
- Marsh sediments are contaminated because of past disposal practices due to migration from the LCP Chemical Site.
- The nature and extent of groundwater contamination in the shallow aquifer is unknown. The water that people use for drinking is not contaminated.
- On-site surface and subsurface soils are contaminated but do not pose a health threat to people off-site because they have no contact with on-site soils.
- Off-site soils are not contaminated from past disposal practices.
- Several data gaps are yet to be filled (e.g., fish consumption and health studies).

II.G.4. Health Consultation, LCP Chemical – August 1994

In 1994, ATSDR prepared its first HC for the LCP Chemicals Site that evaluated the public health implications of exposure to mercury and PCB-contaminated seafood along areas of Purvis Creek and the Turtle River. Seafood samples collected in 1991, 1992 and 1993, revealed the presence of elevated levels of mercury and PCBs.

After evaluating the data, ATSDR concluded in 1994 that:

- Residents who have consumed fish and shellfish from Purvis Creek and other restricted fishing areas nearby may have been exposed to unsafe levels of PCB and mercury prior to the fish advisory.
- Exposures to contaminated fish may be ongoing due to noncompliance or lack of awareness of the existing fishing advisory.
- Fish and shellfish may continue to bioaccumulate mercury and PCBs until the source of contamination is removed.
- There is no evidence of residents being exposed to on-site or off-site surface water and sediment contamination.
- Since off-site private wells are upgradient from the site, it is unlikely that offsite wells are contaminated.

III. EVALUATION OF EXPOSURE PATHWAYS

To determine whether nearby residents or on-site workers could be exposed to contaminants on the site, ATSDR will now describe the environmental and human components that could result in exposure to remaining contaminants on the site or to contaminants that have migrated off site.

III.A. What is an exposure pathway?

ATSDR's PHAs are driven by exposure to, or contact with, environmental contaminants. Contaminants released into the environment have the potential to cause harmful health effects. Nevertheless, a release does not always result in exposure. People can only be exposed to a contaminant if they come in contact with that contaminant—if they breathe, eat, drink, or come into skin contact with a substance containing the contaminant. If no one comes in contact with a contaminant, then no exposure occurs, and thus no health effects could occur. Often the general public does not have access to the source area of contamination or areas where contaminants are moving through the environment. This lack of access to these areas becomes important in determining whether people could come in contact with the contaminants.

> An exposure pathway has five elements: (1) a source of contamination, (2) an environmental media, (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population.
>
> The source is the place where the chemical was released. The environmental media (such as groundwater, soil, surface water, or air) transport the contaminants. The point of exposure is the place where people come into contact with the contaminated media. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. The people actually exposed are the receptor population.

The route of a contaminant's movement is the *pathway*. ATSDR identifies and evaluates exposure pathways by considering how people might come in contact with a contaminant. An exposure pathway could involve air, surface water, groundwater, soil, dust, or even plants and animals. Exposure can occur by breathing (inhaling), eating (ingesting), drinking (ingesting), or by skin (dermal) contact with a substance containing the chemical contaminant. ATSDR identifies an exposure pathway as completed or potential, or in some cases eliminates the pathway from further evaluation.

III.A.1. Completed Exposure Pathways

Completed exposure pathways exist for a past, current, or future exposure if contaminant sources can be linked to a human receptor population. All five elements of the exposure pathway must be present. In other words, people have contact or are likely to come in contact with site-related contamination at a particular exposure point via an identified exposure route. As stated above, a release of a chemical into the environment does not always result in human exposure. For an exposure to occur, a completed exposure pathway must exist. Completed exposure pathways require further evaluation to determine whether exposures are sufficient in magnitude, duration, and frequency to result in adverse health effects.

IIIA.2. Potential Exposure Pathways

Potential exposure pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring currently, or could occur in the future. It exists when one or more of the elements are missing or uncertain, but available information indicates possible human exposure.

A potential exposure pathway is one which ATSDR cannot rule out, even though not all of the five elements are identifiable.

III.A.3. Eliminated Exposure Pathway

An eliminated exposure pathway exists when one or more of the elements are missing. Exposure pathways can be ruled out if the site characteristics make past, current, and future human exposures extremely unlikely. If people do not have access to contaminated areas, the pathway is eliminated from further evaluation. Also, an exposure pathway is eliminated if site monitoring reveals that media in accessible areas are not contaminated.

Site-specific characteristics are used to determine whether completed, potential, or eliminated exposure pathways exist at a site. The completed, potential, and eliminated exposure pathways for the LCP Chemicals Site are listed in the Table 1. Each of the identified exposure pathways is explained further in the following section.

III.B. Exposure Pathways at the LCP Chemicals Site

This section identifies and discusses completed and potential exposure pathways associated with past, present and future use of the LCP Chemicals Site.

III.B.1. Completed Exposure Pathways

III.B.1.a. On-site Soils

Pre- and post-remedial soil sampling data confirm the presence of contaminants in on-site soils. However, access to the site property is restricted and there are no on-site workers or residents (except for limited security staff and occasionally remedial workers). Thus, current exposure to contaminants in on-site soil is limited to the occasional trespasser who might access the site by breaching security measures or by arriving onsite via the river. The trespasser is assumed to engage in general recreational activities such as walking, hiking, riding a bike, or riding an all-terrain vehicle (ATV). The trespasser may be exposed to soil by accidentally swallowing it (ingestion), inhaling it (inhalation), and touching it (dermal contact). The typical trespasser is assumed to be an older child (7 through 18 years of age) or an adult (19 years and older). However, because trespassing events would occur infrequently, if at all, ATSDR concluded that trespassers are not likely to be exposed to high enough levels of contaminants in soil to cause adverse health effects.

When industrial activities were taking place on the site, workers were likely exposed to contaminants in soil as they performed their job-related duties or otherwise accessed outdoor areas (e.g., outdoor lunches, traveling to and from other buildings, etc.). The frequency, duration, and magnitude of exposure would vary depending on the type of job performed and the area in which it was performed. The typical worker exposure scenario includes incidental swallowing of and dermal contact with soil.

Table 1. Completed and Potential Exposure Pathways Identified at the LCP Chemicals Site, Brunswick, GA (All OUs)

Exposure Pathway	***Exposure Pathway Elements***					***Time Frame***	***Comments***
	Sources of Contamination	***Fate and Transport***	***Point of Exposure***	***Exposed Population***	***Route of Exposure***		
Completed Exposure Pathways							
On-site Soil							
Surface and subsurface soils on the facility property	Wastes from previous industrial operations at the site	Improper disposal or spillage onto ground	On-site property	Former facility workers, remedial workers, future residents/property owners	Ingestion Dermal Inhalation	Past Present Future	Currently, the facility is not operational. Most of the property is fenced and access is restricted. Therefore, contact with on-site soil is limited except to the occasional trespasser. However, the site may be developed in the future for any use (residential, commercial, etc.).
Seafood							
Seafood from nearby rivers and waterways	Wastes from previous industrial operations at the site	Surface water runoff, waste seeps into the Turtle River; uptake and bioaccumulation of contaminants in aquatic organisms	Entire Turtle River system	People eating contaminated seafood from affected areas	Ingestion	Past	Seafood consumption advisories have been issued for the Turtle River system. This advisory should reduce people's exposure to contaminated seafood. Therefore, consumption of contaminated seafood prior to the issuance of the advisory was a past, completed exposure pathway.

Table 1. Completed and Potential Exposure Pathways Identified at the LCP Chemicals Site, Brunswick, GA (All OUs)							
Exposure Pathway	***Exposure Pathway Elements***					***Time Frame***	***Comments***
	Sources of Contamination	***Fate and Transport***	***Point of Exposure***	***Exposed Population***	***Route of Exposure***		
Potential Exposure Pathways							
Groundwater							
Private groundwater wells	Wastes from previous industrial operations at the site	Migration of contaminated groundwater into areas with private wells, municipal supply wells	Residential tap water; other potable water taps	People with nearby private wells and others not connected to public water supply	Ingestion Dermal Inhalation	Past Future	The extent to which private wells are used in the area is uncertain. The groundwater investigation is completed; only groundwater monitoring and treatment (CBP) are ongoing. This pathway remains a potential future pathway in case the plume migrates to areas with private wells. Groundwater is not evaluated in this document.
Off-site Soil							
Off-site Soil	Wastes from previous industrial operations at the site	Surface water runoff ; air deposition; off-site dumping	Residential yards and public places near the site or off-site dumping areas	People in nearby neighborhoods, communities, schools	Ingestion Dermal Inhalation	Past Current Future	Residents report the existence of off-site dumping areas. Also, the nearby Arco neighborhood was previously sampled and did not contain unsafe levels of contaminants, except for lead. These potential off-site areas should be revisited if planned for re-development.
Surface water and Sediment							
Surface water and Sediment	Wastes from previous industrial operations at the site	Surface water runoff; marsh seeps	Turtle River estuaries and tributaries; Altamaha Canal	People recreating in or near the Turtle River or the Altamaha Canal	Ingestion Dermal Inhalation	Past Current Future	Sediment in the marsh was found to contain elevated levels of contaminants. Therefore, contact with sediment or surface water is a potential exposure pathway.

Table 1. Completed and Potential Exposure Pathways Identified at the LCP Chemicals Site, Brunswick, GA (All OUs)							
Exposure Pathway	***Exposure Pathway Elements***					***Time Frame***	***Comments***
	Sources of Contamination	***Fate and Transport***	***Point of Exposure***	***Exposed Population***	***Route of Exposure***		
Soil Gas							
Indoor Air	Wastes from previous industrial operations at the site	Migration of subsurface waste vapors into indoor air	Enclosed structures over contaminated soil or groundwater	People living or working in homes or buildings built over contaminated subsurfaces (e.g., caustic brine pool)	Inhalation	Future	The potential for migration of vapors into indoor structures should be examined if the site is re-developed. Mercury vapors are of particular concern for this potential pathway.

ATSDR's evaluation included residential development as a future use because residential development was considered in EPA's assessment of the property (e.g., EPA's draft Human Health Risk Assessment considers a future on-site resident in the exposure assessment) and because residential use has not been ruled out. Although Honeywell claims in some reports that the site is intended to remain industrial, they acknowledge the potential for some mixed land use of the property and/or the possibility that some portion of the site might be used as residential property in the future. Therefore, ATSDR believes it prudent to evaluate all possible future scenarios to be protective of public health.

In the future, the site property can be developed for any use, including commercial, industrial, or residential use. While the property is zoned for industrial use, land use can change with time; therefore, ATSDR will assume that the intended future land use is mixed-use residential, commercial, or industrial. The exposures in these settings would occur by incidental swallowing, dermal contact, and inhalation of contaminants from contaminated soil. It should be noted that EPA's risk assessment for the LCP Chemicals Site also includes a residential exposure scenario.

III.B.1.b. Fish and Shellfish

Site-related wastes have entered nearby marshes and aquatic areas. These wastes are present in the water column and/or are attached to bottom sediment or particles in the water. PCBs and other contaminants are taken up into the bodies of small organisms and fish in water. They are also taken up by other animals, including humans that eat these aquatic animals as food. Previous data have shown that some species of fish from the Turtle River contain elevated levels of mercury, PCBs, and other contaminants. The GCHD has determined that the levels of these contaminants in some fish are high enough to cause health problems (see discussion above in *Past ATSDR Health Evaluations* section). The GDNR currently monitors contaminant levels in fish and shellfish from the Turtle River system and has issued fish consumption guidelines (*Guidelines for Eating Fish from Georgia Waters*) designed to protect consumers from experiencing health problems associated with eating contaminated fish from the Turtle River system. These guidelines are available on the internet at http://www.georgiawildlife.com/node/705.

A local environmental group, the GEC, published a "Seafood Consumption Advisory for Turtle River" which sets out in plain language the recommended limits on the consumption of fish and seafood from the Turtle River system (see Appendix D.) Along with the GDNR's fish advisory, these public health actions are believed to have reduced the amount of contaminated fish and seafood from the Turtle River system eaten by residents, although it is possible that some contaminated fish are still eaten by people who are not aware of the advisory or who disregard it.

Although the biota pathway is completed, ATSDR will not re-evaluate the data in this document because the agency has released two health consultations on the topic. In addition, the GCHD and the GDNR have already done extensive work evaluating fish and seafood in the Turtle River and have issued consumption advisories for residents to follow. However, in 2011, EPA collected fish and shellfish samples from the Altamaha

Canal. Neither ATSDR nor any other agency had evaluated these data. ATSDR did evaluate in this document the fish and shellfish data for samples collected from the Altamaha Canal in 2011.

III.C. Potential Exposure Pathways

III.C.1. Groundwater

The drinking water supply for the area is composed of private wells and the Brunswick municipal wells. The municipal wells draw water from the Upper Floridan Aquifer while the private wells are drilled at a wide range of depths. Within a 4-mile radius of the site, the municipal system serves approximately 28,000 residents and private wells serve approximately 5,000 residents (EPS 2007a).

A 1995 well inventory report indicated that private wells in the vicinity had not been impacted by site-related contaminants because they are located upgradient of the site (EPS 2007a). More recent sampling efforts have found no site-related contaminants in private or municipal wells. According to local officials, to date, no private or municipal wells in the area have been impacted by site-related contaminants (EPS 2007a). However, given that contaminants in groundwater move over time, it might be possible in the future that contaminants from the site can migrate to previously uncontaminated wells. Although highly unlikely, future developers/residents may drill new wells into the contaminated groundwater. If this happens, future workers/residents would be exposed via ingestion, inhalation, and dermal contact with contaminated water.

III.C.2. Off-Site Soil

The off-site areas are comprised of the current and former Arco community located southeast of the site and the off-site areas along New Jesup Hwy/Newcastle Street that were former tank farms. Portions of the Arco community are currently owned by Georgia-Pacific Cellulose, while other parts of the Arco community remain industrial and residential. The areas formerly occupying the off-site tanks along New Jesup Hwy/Newcastle Street Road have been transitioned to other commercial or industrial uses. One of the former off-site tanks is currently covered by US Highway 341/25 and was not accessible for sampling.

III.C.3. Surface Water & Sediments

Sediment sampling data from the 1990s confirm the presence of contaminants in surface water and sediments near the LCP Chemicals Site. Sediments that contain some contaminants can also release the chemicals into the surrounding water. Impacts to the Turtle River surface water and river sediment have been documented through laboratory testing. Wastes containing contaminants seeped into the marsh at several locations (EPS 2007b). To date, actions have been taken to address the release of contaminants from the site to the surface water pathway.

People who recreated (swim, wade, boat, canoe, etc.) in the Turtle River near the site or downstream of the site in the past could have been exposed to contaminants in surface water and sediment. Exposure would have occurred by swallowing small amounts of water or sediment, or by absorbing some of the chemicals in the water or sediments through bare skin.

III.C.4. Soil Gas

Some of the contaminants currently remaining beneath the ground surface of the site have the potential to evaporate into the air spaces between soil grains ("soil gas") and gradually work their way to the surface. Mercury, in particular, has the potential to evaporate into the air and be carried long distances. If mercury or volatile organic compounds (VOCs) volatilize between soil grains and enter an enclosed structure, these contaminants can accumulate in the air of the structure and be breathed in (inhaled) by humans. This potential pathway is not a current pathway because most on-site buildings have been removed. However, this pathway should be evaluated if the site is re-developed for either residential or commercial uses.

IV. ENVIRONMENTAL CONTAMINATION

An important component of the exposure assessment process is the evaluation of environmental contamination using available environmental sampling data collected on or near the site. Environmental data indicate the levels of chemicals in water, soil, air or the food chain (biota). ATSDR relies on environmental data collected from EPA, Honeywell, other governmental agencies, or other third party sources. ATSDR determines whether the available data for a site accurately and sufficiently reflect past, current, and future exposure conditions, and requests additional data to fill critical data gaps, if necessary.

After evaluating site conditions and determining that people could have been, are being, or could be exposed in the future (i.e., via a past, current, or future exposure pathway) to site-related contaminants, ATSDR must then consider whether chemicals were/are present at levels that might affect people's health. The health effects evaluation consists of two pieces: 1) a screening analysis and 2) based on the results of the screening analysis (and community concerns), a more in-depth analysis to determine possible health implications of site-specific exposures (detailed in Section V).

IV.A. The Screening Analysis – How ATSDR Selects Chemicals to Evaluate

During the screening analysis, ATSDR sorts through the environmental data in a consistent manner to identify substances within completed and potential exposure pathways that may need to be evaluated more closely. ATSDR selects the chemicals for further evaluation by comparing them to health-based *comparison values*.

These are developed by ATSDR and other governmental agencies from available scientific literature related to exposure and health effects. Comparison values are derived for each of the different media and reflect an estimated contaminant concentration that is *not likely* to cause adverse health effects for a given chemical, assuming a standard daily contact rate (e.g., an amount of water or soil consumed or an amount of air breathed) and body weight.

What are comparison values?

Comparison values are chemical concentrations in soil, water, or air that are set well below levels known or anticipated to result in adverse health effects. ATSDR and other governmental agencies develop these values to make consistent decisions about what substance concentrations might require a closer look.

Comparison values are not thresholds of toxicity and therefore should not be used to predict adverse health effects. Although concentrations at or below the relevant comparison value may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. Additional toxicological evaluation is needed to determine if harmful effects might be expected when a comparison value is exceeded.

ATSDR has developed comparison values for substances in drinking water, soil, and air. ATSDR's comparison values include environmental media evaluation guides (EMEGs), reference dose media evaluation guides (RMEGs), and cancer risk evaluation guides (CREGs). Comparison values are developed in a uniform way using health guidelines and standard default exposure assumptions that protect children and adults. ATSDR uses comparison values as a screening tool to compare to the contaminant levels found at the site. This screening process is a way to select contaminants that require further evaluation at the site. When no comparison value is available, the contaminant is generally retained for further evaluation. Other factors that become important in deciding which chemicals to evaluate further include the frequency of detection and a chemical's inherent toxicity.

Analytical data that characterize the post-removal conditions of the site were evaluated by ATSDR. The screening analysis revealed the presence of many chemicals, but most were eliminated because they were below applicable comparison values.

On the basis of the initial screening analysis, site history, and results from previous published assessments of soil (the dry-land soil portion) at the site, ATSDR selected Aroclors (PCBs), polycyclic aromatic hydrocarbons (PAHs), lead, mercury, and dioxins for further evaluation.

IV.B. The Exposure Analysis – How ATSDR Evaluated the Environmental Data

Although completed pathways for past exposure to site contaminants were identified for onsite and offsite receptors, this document focuses on risks to future populations from exposure to soil after the LCP Chemicals Site is redeveloped. Therefore, ATSDR focused the health evaluation on the chemicals left in the soil after clean-up activities (post-removal action) was completed. Most of these clean-up activities were completed in the mid-1990s. The residual contaminants in soil represent current contaminant levels and

pose the greatest likelihood for future exposure and therefore, the greatest potential risk for future populations when the site is redeveloped.

ATSDR made the following assumptions when evaluating the post-removal environmental data.

IV.B.1. Subdivided the Property into Half-acre Exposure Units

Most often, an average chemical concentration is used as a single quantitative measure to determine the risks posed by a particular chemical for a contaminated area. Because the site is so large, ATSDR divided the site into smaller geographic (or exposure) units, which we believe will more accurately reflect whether a particular exposure area contains elevated concentrations of contaminants if the site becomes residential, commercial, or industrial.

ATSDR defined the exposure units as 1/2 acre parcels, or 150 x 150 foot lots. This area is about half the size of the American football field. In the absence of a defined redevelopment plan for the site, ATSDR concluded that each future home or commercial lot would occupy approximately this much space, particularly in a mixed-use community. ATSDR believes that this subdivision produces reasonably sized parcels with which to evaluate risks to potential future residential and commercial populations.

In order to evaluate these ½ acre exposure areas, ATSDR randomly overlaid ½ acre-sized grids onto a map of the site. This produced a series of equal-sized parcels, but with varying amounts of environmental sampling data for each lot. Potential health risks for each parcel were assessed separately. Where possible, ATSDR calculated the concentration of contaminants in each parcel to determine if the level was high enough to cause adverse health effects. In some cases, if the parcel contained too few samples to derive a health conclusion, ATSDR recommended additional sampling for that grid.

ATSDR's exposure unit approach is different than the approach chosen by EPA. Rather than dividing the site into ½ acre parcels, EPA divided the site into 4 large exposure units called quadrants. Each quadrant is roughly equal in size and is based on the location of B-Street and the north-south fence line located by the former guard house on B-Street (See Figure A13 in Appendix A). EPA Quadrant 1 and Quadrant 2 are in the eastern parcel of the site; EPA Quadrant 3 and Quadrant 4 (including the salt dock area) comprise the western parcel of the site. EPA's quadrants range from approximately 20 to 50 acres in size. The quadrants used by EPA are considerably larger than the ½ parcels used by ATSDR. Therefore, it is possible for ATSDR and EPA to reach different conclusions regarding assessing exposure and making health determinations.

IV.B.2. Evaluated Contaminants to Depth of 0-5 and 0-2 Feet

The process for determining which soil samples to include in our evaluation was driven by the groundwater field investigations and our assumptions regarding potential soil exposures of future populations. Previous investigative documents reveal that the depth to groundwater in the area is approximately 5 feet. Also, because the site is slated for

redevelopment, we assumed that various earth-moving activities will occur during the redevelopment process. These earth-moving activities increase the probability that soil that is currently subsurface (and therefore not accessible for human contact) will become surface soil (and vice versa) as it is being moved around. Therefore, ATSDR assumed that a person may be exposed to any soil above the water table (5 ft.). Where the soil sample was collected at less than 5 ft., ATSDR included that sample result in the evaluation. Where the soil sample was collected at 6 ft. or greater, ATSDR eliminated that sample from further consideration. This process was conducted to account for the uncertainty in identifying surface versus subsurface soil. The EPA used a similar evaluation method in their human health risk assessment for the site, although their focus was the top 1 or 2 foot of soil (EPS 2007b).

In addition to estimating descriptive statistics for contamination at the 0-5 ft. depth, ATSDR also determined descriptive statistics for contamination at 0-2 ft. depth as well. The reasons for looking at this depth are that contaminant concentrations might be different in the top few feet, and the possibility that construction activity might be limited to a more shallow depth than 0-5 ft.

IV.C. Previous Sampling – Dry-land Soils

Site dry-land soils were investigated as part of a removal response action and during four phases of a remedial investigation. Removal action sampling was performed on the dry-land soil portion of the site from 1994 to 1997. Remedial investigation sampling was conducted from 1995 to 2004.

IV.C.1. Removal Action

The objective of the removal response action was to mitigate conditions deemed by the EPA to pose an imminent and substantial threat to human life, health or the environment. The dry-land removal response activities included the following components: (i) characterization of the dry-land area of the site; (ii) delineation of removal areas; (iii) removal and off-site disposal of impacted materials; (iv) post-excavation confirmational sampling to verify compliance with the removal action goals; (v) containment and treatment of contaminated water; (vi) permanent abandonment of water-supply wells; (vii) backfilling and grading of removal areas; and (viii) closure of the site sewer system. Decommissioning and removal activities at the Cell Building Area began immediately following the chlor-alkali plant closure in February 1994. The onsite mercury cell buildings were demolished and the area was capped and fenced. Other dry-land removal activities commenced in July 1994 and were completed in June 1997 (Geosyntec 1996, 1997, 1998).

Surface and subsurface soil samples were collected during the removal action using the following methods: 1) hand augering, 2) test trenching, 3) direct push drilling, 4) hollow stem auger drilling, and 5) mud rotary drilling. Lateral and vertical dimensions of each excavation grid were surveyed during the removal action.

Characterization and delineation sampling was performed concurrently with waste removal activities. Analytical results were compared to EPA removal criteria to determine areas requiring cleanup from those areas that did not. Contaminated soil was excavated and disposed off-site. The depth of excavation at the dry-land portion of the site ranged from less than 1 ft. (0.3 m) to approximately 13 ft. (4 m).

The removal response action also included a confirmational (post-excavation) sampling program. Confirmational soil samples were collected to verify attainment of the following removal target action goals identified by EPA (Geosyntec, June 1998). EPA target action levels for the LCP Chemicals Site are shown in Table 2.

Table 2. EPA Target Action Levels used between 1994 and 1997 at the LCP Chemicals Site

Contaminant	*Cleanup Goal*
Total Mercury	20 ppm*
Total Lead	500 ppm**
Total PCBs	25 ppm
Total carcinogenic PAHs	50 ppm

* ppm = parts per million

**When removal actions were taking place between 1994 and 1997, the total lead target action level was 500 ppm. Since that time, the EPA has set 400 ppm as the target action level for lead.

One composite sample was generally collected from the subgrade of each grid excavated to verify that the vertical extent of excavation was sufficient to meet site clean-up goals. The number of points in a subgrade composite sample depended on the size of the excavation grid, and varied from two to five points. An excavation grid comprised an area of approximately 2,500 ft^2-- nominally 50 ft. by 50 ft. To verify the horizontal limit of excavation, a three-point vertical composite sample was collected approximately every 100 linear ft. (30 m) around the perimeter sidewall of the excavations. If confirmational sampling results did not meet cleanup goals, additional excavation and re-sampling was conducted in the corresponding subgrade or sidewall. However, in some deep excavation areas where ground water infiltration and possible unstable slopes were a concern, grids were backfilled before confirmational samples were analyzed. The decision to backfill was based on visual examination of the subgrade and analytical results from nearby excavation grids. Once the confirmational sampling showed that the cleanup goal had been met, the area was backfilled with clean fill from off-site sources to restore the natural grade and promote positive drainage.

Confirmational samples were collected from the dry-land area of the site. Removal performance goals were not met at numerous sampling locations, prompting additional soil excavations. These sampling locations were removed during the additional soil excavations. Final confirmational samples represent the current (i.e., post-removal) conditions of the dry-land soils at the site. ATSDR noted that no samples were collected from the onsite pond; some samples were collected from the on-site theater.

Soil samples that were excavated during the removal action can be used to define past exposures. Soil samples that were not excavated, along with confirmational samples, represent existing conditions at the site, and were used to define present and future exposures.

IV.C.2. Exclusion of Sampling Data Collected during Removal Action

ATSDR was informed by EPA that data generated by Transglobal Environmental Geochemistry (TEG), which analyzed soil and water samples between April 1995 and June 1996, had data quality problems (EPA 2010a). TEG was the onsite laboratory used at the LCP Chemicals site during the removal action. The TEG data produced from approximately April 1995 to June 1996 has been deemed to be of poor quality because of quality control issues with the on-site laboratory. EPA has informed ATSDR that they did not include the TEG data in their baseline Human Health Risk Assessment for the site. However, EPA will use the TEG data in their Remedial Investigation.

Because of the concerns regarding the TEG data quality, ATSDR decided not to include TEG data in this evaluation. ATSDR recommends additional sampling in areas where sampling data are limited due to the exclusion of the TEG data. For example, the following highly contaminated areas were identified by ATSDR as having limited (confirmational) sampling data once the TEG data were removed:

- The scrap yard,
- The former facility disposal area,
- The cell parts area,
- The north and south dredge spoils area, and
- The outfall pond.

These areas are located between the former cell building and the marsh (see Figure 1). With the removal of the TEG data, it is uncertain whether these areas met EPA's target action levels.

IV.C.3. Remedial Investigation

Four separate soil sampling programs were conducted as part of the remedial investigation for dry-land soils.

IV.C.3.a. Phase I investigation

The purpose of the Phase I investigation was to assess the degree of preferential vertical distribution of chemical contaminants in the upper 2 ft. of soil. A set of 9 test trenches were located at two different areas of the site – one in the eastern portion in an area that had little industrial activity; the second in the southern portion in an area suspected to be more heavily contaminated. Each test trench was excavated approximately 5 ft. long and 2 ft. deep; samples were collected from each test trench at typical discrete depths of 0 ft., 0.5 ft., 1.25 ft. and 2.0 ft.

IV.C.3.b. Phase II investigation

The Phase II investigation was focused on verifying removal action characterization previously performed on the eastern portion of the site. Nine random sampling points were identified and collected. Each sampling point consisted of a square with an approximate side length of 25 ft. from which 2 five-point composite samples were collected. The samples were collected from depth ranges of 0 to 1 ft. and 2 to 3 ft.

IV.C.3.c. Phase III investigation

The Phase III investigation was focused on off-site tank farm sampling to characterize surface and subsurface soils at the locations of former refinery tanks east of Ross Road. Fourteen sample points at 3 former tank locations were identified and sampled. Sample points were located in the approximate center and corners or the former tank enclosures. Grab samples were collected from each sample point at typical depth increments of 0 to 1 ft. and 2 to 3 ft.

IV.C.3.d. Phase IV investigation

Soil sampling was conducted in a portion of the nearby ARCO neighborhood in 1995 and 2004. The portion of the ARCO community was southeast of the LCP property and consisted of residential homes. In 1995, the EPA collected two composite samples from the front and back yards of 5 residences in the ARCO community. Each composite sample was comprised of a 5-point sample of the upper 3 inches of soil. ATSDR evaluated the analytical results from the ARCO neighborhood sampling and determined that no contaminants were found at levels that would represent a public health threat [ATSDR 2005].

In 2004, a second sampling event was performed in this portion of the ARCO neighborhood and surrounding areas. City blocks were divided into quadrants to create 36 sampling grids. Samples were collected from each grid as 5-point composites. Composite sampling was conducted from a 0 to 3 inch and 0 to 12 inch depth. Samples for the two depth increments were collected immediately adjacent to each other.

IV.D. Contaminants of Potential Concern

As discussed above, ATSDR selected PCBs, PAHs, lead, and mercury as contaminants of potential concern because of their noted predominance at the site and because of the concerns raised by community members. Therefore, the focus of the health discussion will be on these contaminants. The section below discusses the distribution of these contaminants in and around the LCP Chemicals Site. The discussion will reference specific locations on the LCP property; therefore, the use of the Figure A4 in Appendix A (site map) may be helpful to identify the areas being discussed.

IV.D.1. Polychlorinated biphenyls (PCBs)

IV.D.1.a. What are PCBs?

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs, yet they are found all over the world. With few exceptions, PCBs were manufactured as a mixture of various PCB congeners (EPA 2008b). In general, commercial mixtures with higher percentages of chlorine contained higher proportions of the more heavily chlorinated congeners, but all congeners could be expected to be present at some level in all mixtures (EPA 2008b). While PCBs were manufactured and sold under many names, the most common trade name was the Aroclor series. There are several types of Aroclors and each has a distinguishing suffix number, which usually indicates the degree of chlorination. The numbering standard for the different Aroclors is as follows: The first two digits generally refer to the number of carbon atoms in the phenyl rings (for PCBs this is 12), the second two numbers indicate the percentage of chlorine by mass in the mixture. For example, the name Aroclor 1254 means that the mixture contains approximately 54% chlorine by weight (EPA 2008b). The exception is Aroclor 1016, which has 12 carbons and 42% chlorine by weight. Once in the environment, PCBs do not readily break down and may remain for very long periods of time.

IV.D.1.b. Combined PCB congeners (except Aroclor1016)

For the purposes of this health assessment, ATSDR added all Aroclors (except Aroclor 1016) to arrive at a "total PCB" concentration for a given sample. The Aroclors detected at the site include Aroclor 1016, Aroclor 1221, Aroclor 1248, Aroclor 1254, Aroclor 1260, and Aroclor 1268. Aroclors 1232, 1242, and 1262 were not detected at the site. Aroclor 1016 has its own cancer toxicity values; therefore, it was not included in the Total PCB concentration. Table 3 lists the frequency with which the various Aroclors were detected in soil at the site.

EPA recommends that Aroclors be summed to give "total PCBs" when evaluating cancer (EPA 2009b). The derived cancer slope factor, therefore, applies to total PCBs. ATSDR used the same summing method when assessing non-cancer risk.

Table 3. Frequency of detection for various Aroclors in soil.

Substance	*# Detections*	*# Samples*	*Frequency*
Aroclor 1016	2	891	0.2
Aroclor 1221	1	902	0.1
Aroclor 1232	0	902	0.0
Aroclor 1242	0	902	0.0
Aroclor 1248	2	902	0.2
Aroclor 1254	81	902	9.0
Aroclor 1260	37	902	4.1
Aroclor 1262	0	0	0.0
Aroclor 1268	171	852	20.1

IV.D.1.c. Residual PCB Levels in Soil

Prior to clean-up (removal) actions, elevated concentrations of PCBs were detected in the former facility disposal area, the outfall pond and canal, the anode loading area, the north and south dredge spoils area, the scrap yard, northwest field, the material staging area, the south rail yard, and portions of the marsh, including tidal channels. After clean-up (removal) actions, residual PCB contamination exists in the some of the same areas.

Figure 1 shows the location of each sample collected and tested for PCBs that represents PCB levels in soil following clean-up activities. The figure also depicts where residual PCB concentrations are higher in some areas than in others by using a color scheme. Generally, the western portion of the site contains the most samples; the southwestern portion of the site contains the most residual PCB contamination. The eastern portion of the site contains fewer samples and less residual contamination.

The distribution of total PCBs remaining in soil is shown in Figure 1. Generally, residual PCB concentrations are highest in the north and south dredge spoils area, the scrap yard, the material staging and retort area, and the cell building area.

The exposure units for the site are defined as ½ acre-sized parcels. Figure 2 shows the overlay of the ½ acre grids to reflect residual PCB contamination and distribution at the site. Average PCB concentrations were calculated for each ½ acre grid. Non-detects were assumed to be zero because of irregularities in reporting laboratory detection limits.

0-5 Ft Depth

For the 0 to 5 foot soil depth, six grids have average total PCB levels that exceed EPA's 1994 LCP target action level of 25 parts per million (ppm); 35 grids have average total PCB levels between 1 and 24 ppm (see Table 4). Fifty-five grids have average total PCB concentrations less than 1 ppm, but not including non-detects. The maximum PCB concentration from a single sample remaining at the site is 826 ppm (Grid #93) and is located in the northwest corner of the former cell building area. The highest average PCB concentration for any grid (Grid #93) is 139 ppm.

0-2 Ft Depth

Soil samples with a depth of 0-2 ft. showed similar results as the 0-5 ft. depth. In the 0-2 ft. samples, 6 grids have average total PCB levels that exceed EPA's LCP target action level of 25 ppm; 35 grids have average total PCB levels between 1 and 24 ppm. The highest average PCB concentration for any grid is 240 ppm; however, more uncertainty exists in the average concentration because fewer soil samples are available from the 0-2 ft. depth.

Table 4. Average Total PCB concentration in soil by grid number, all depths								
ATSDR Grid #	*Average Total PCB in ppm*	*Maximum Total PCB in ppm*	*# Soil Samples*		*ATSDR Grid #*	*Average Total PCB in ppm*	*Maximum Total PCB in ppm*	*# Soil Samples*
93	138.6	826	6		75	2.6	23	17
58	122.0	122	1		94	2.4	16.8	22
114	53.0	53	1		38	2.4	4.9	2
53	42.3	167	7		70	2.3	9	9
90	40.9	350	13		92	2.2	11	8
60	34.0	34	1		39	2.1	2.1	1
89	20.6	240	13		42	1.9	10	12
111	15.8	37	3		8	1.6	3	2
37	11.9	28.5	4		69	1.5	28.3	21
128	10.5	19	2		154	1.4	4.3	6
55	9.0	27	3		112	1.4	7.3	8
76	7.3	53	10		74	1.4	10.9	8
10	7.0	13	2		152	1.4	2.7	2
91	6.2	24	6		153	1.4	2.7	2
56	5.6	11	3		71	1.3	7.5	9
155	5.6	10	2		77	1.3	3.3	7
110	4.0	22	12		133	1.3	8.8	17
95	3.5	16	12		197	1.1	3.5	6
59	3.3	12	6		17	1.1	9.5	12
73	2.6	4.3	4		134	1.0	12	12
118	2.6	10	4					

Figure 1. Sampling Locations Showing Residual PCB Levels in Soil, 0-5 ft.

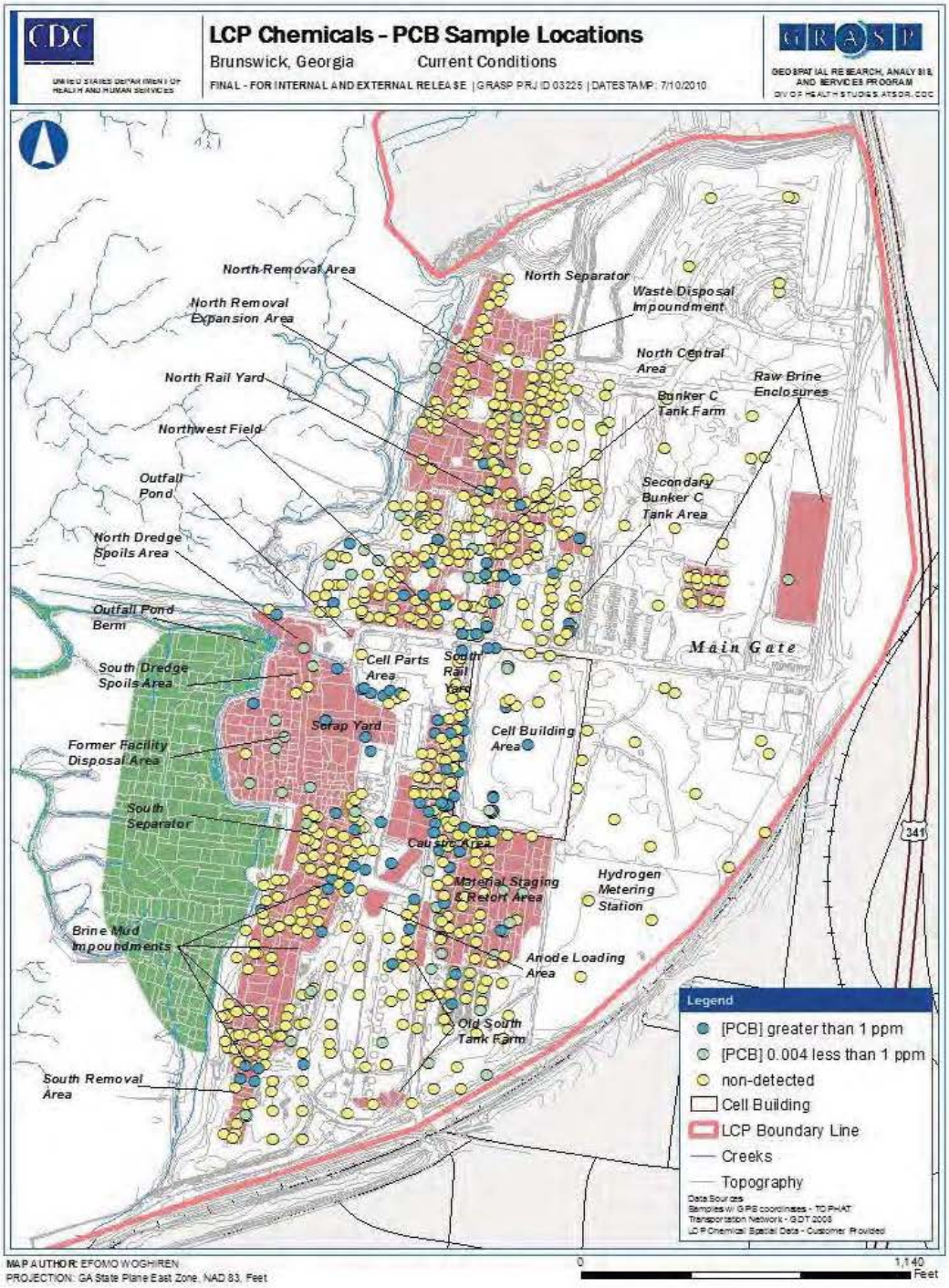
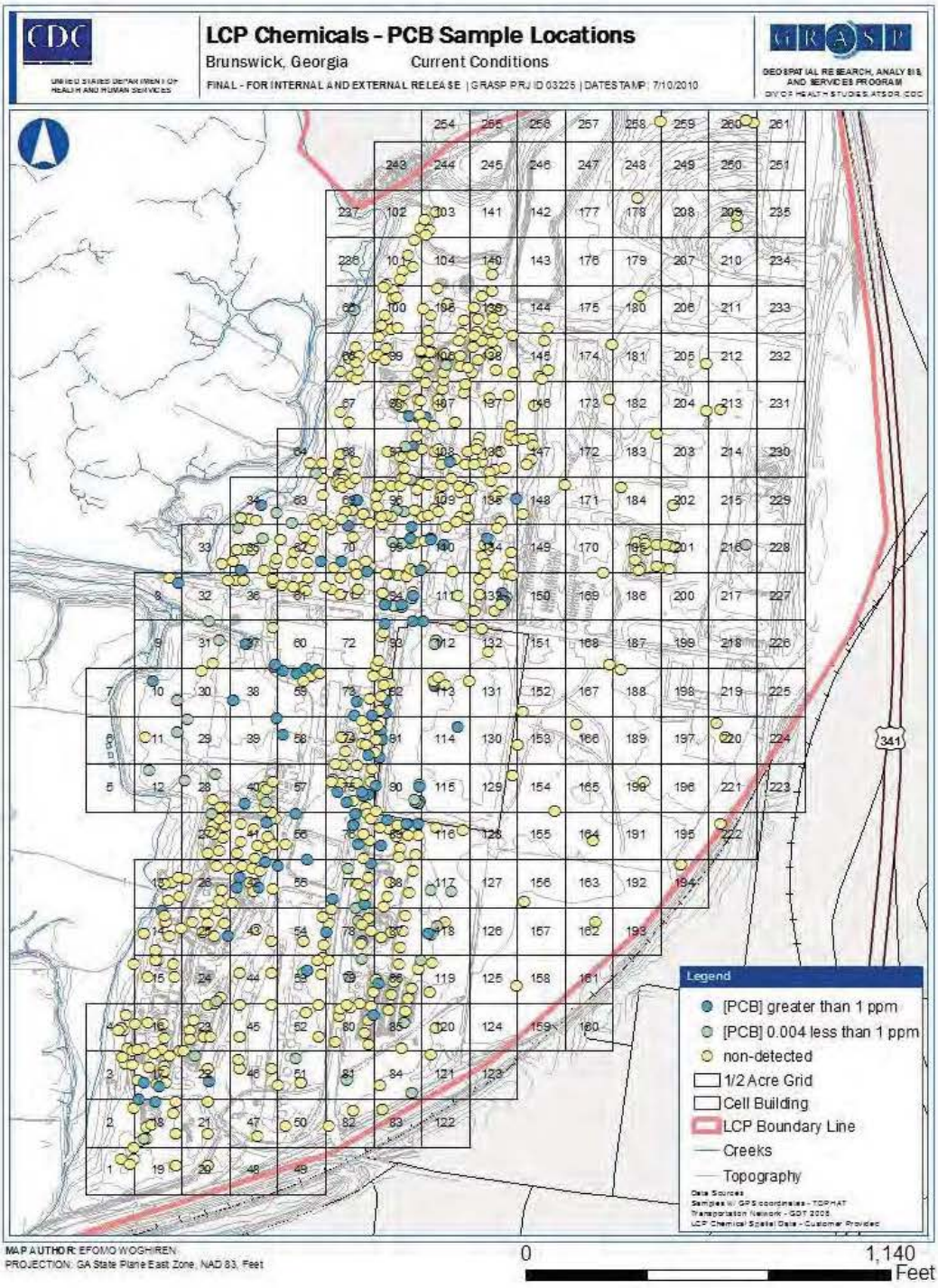


Figure 2. Exposure Units: ½ Acre Grids
PCB Samples and Residual Levels, 0-5 ft.



IV.D.2. Mercury

Prior to removal actions, mercury and mercury-contaminated alkaline sludges were detected in the cell building area, the mercury retort area, the caustic tanks area, the bleach mud at the north removal area, the lime softening mud at the waste disposal impoundment, the brine mud impoundments, the former facility disposal area, and portions of the marsh, including tidal channels. After EPA's clean-up actions, residual mercury still exists in some of the same areas. Figure 3 shows the location of each sample collected and tested for mercury that represents current mercury levels. The figure also depicts where residual mercury concentrations are higher in some areas than in others by using a color scheme. Generally, the western portion of the site contains more samples and more residual mercury contamination.

IV.D.2.a. The Chemistry of Mercury in Soil

Chlor-alkali plants such as LCP use mercury as electrodes in the electrolysis process that liberates dichlorine from a brine solution (Rule *et al*. 1998). The original form of mercury that is discharged into the environment in many cases is elemental mercury (Renneberg and Dudas 2001). Over time, the mercury-containing waste in soil may undergo chemical transformations into new forms. Elemental mercury is likely to be transformed into divalent mercury salts, such as mercuric chloride, mercuric hydroxide, mercuric sulfide, and to organic mercury. In soil, most of the mercuric salts become bound to the organic matter in soil, by reacting with sulfur- and oxygen-containing areas in aromatic and aliphatic chemicals. Some mercuric salts also can be bound to soil minerals, while a small portion can remain as elemental mercury or dissolved mercury (Schuster 1991, Stevenson 1994, Renneberg and Dudas 2001).

When the soil is co-contaminated with industrial hydrocarbons, some of the mercuric salts can react with sulfur- and oxygen-containing areas of these hydrocarbons, much like it does with organic matter in soil (CCME 1997, Renneberg and Dudas 2001). Renneberg and Dudas have analyzed soil that was contaminated with mercury several decades ago. They found 62% to 85% of the mercury in the soil samples was associated with organic matter. Several soil samples, however, showed small amounts of mercury bound to hydrocarbons (i.e., less than 5%), although one sample showed almost 30%. The percentage of mercury bound to minerals ranged from 5% to 10% for some samples and 20% to 30% in other samples. One soil sample showed that elemental mercury made up 30% of the remaining mercury in soil. The authors were not able to identify the specific chemical form of mercury in each sample (Renneberg and Dudas 2001).

In 2003, EPA collected 10 sediment samples from the nearby marsh and performed laboratory tests to determine which form of mercury was present. The organic mercury typically was 45% with individual marsh sediment samples ranging from 3% to 86% organic mercury. The other major components consisted of mercury in a mineral lattice, mercuric chloride, or elemental mercury. The mineral or elemental component typically was 41% with individual marsh sediment samples ranging from 0% to 72% (EPA 2010). These results are consistent with the previously cited studies. It is important to remember

that these are marsh sediment samples and may or may not accurately represent the speciation of mercury in soils.

These results show that a large proportion of mercury in soil at the LCP Chemicals Site is likely to be organic mercury and this mercury is now bound to the organic humic content of soil. However, other forms, such as inorganic mercuric salts, and possibly elemental mercury, might also be present.

IV.D.2.b. Residual Mercury Levels in Soil

The distribution of mercury remaining in soil is shown in Figure 3. Residual mercury concentrations are highest in the footprint of the cell building area and in the areas immediately north and south of the cell building area. Soils beneath the footprint of the cell building area are poorly characterized and were not a significant part of the removal effort. It is likely that significant mercury contamination remains in these soils.

The exposure units for the site are defined as ½ acre-sized parcels. Figure 4 contains the overlay of the ½ acre grids to show residual mercury contamination and distribution at the site. Average mercury concentrations were calculated for each ½ acre grid.

0-5 Ft Depth

In the 0-5 ft. depth, 10 grids have average mercury levels that exceed EPA's LCP target action level of 20 ppm (see Table 5). Approximately 114 grids have average total mercury levels between 0.5 ppm and 19 ppm. Approximately 49 grids have average mercury concentrations less than 0.5 ppm, or levels which are considered background for mercury. The maximum mercury concentration at the site from a single soil sample is 10,400 ppm and is located in the footprint of the cell building area (Grid #113). The highest average mercury concentration for any grid (Grid #113) is 1,470 ppm and is also located in the former cell building area.

Table 5 (0-5 ft. Depth). Grids with average mercury levels in soil above EPA's LCP target action level of 20 ppm

Grid #	***Average Concentration***	***Maximum Concentration***	***Minimum Concentration***	***# Samples***
113	1470	10400	2	13
93	296	3510	0.32	12
112	271	3700	0.55	17
90	184.4	840	0.30	26
60	85	85	85	1
128	81	150	12	2
114	41	260	1.8	8
118	29.8	86	0.03	6
53	23.5	82.0	0.29	5
55	23.4	23.4	23.4	1

0-2 ft. Depth

In the 0-2 ft. samples, 5 grids have average mercury levels that exceed EPA's LCP target action level of 20 ppm (see Table 6). Approximately 103 grids have average total mercury levels between 0.5 ppm and 19 ppm. The remaining 42 grids have average mercury concentrations less than 0.5 ppm, or levels which are considered background for mercury. The maximum mercury concentration at the site from a single soil sample is 280 ppm for grid #90. The maximum average mercury concentration for any grid is 250 ppm, also in grid #90. Many of the grids in the 0-2 ft. depth contained only a single to a few samples. More uncertainty exists in these average concentrations because so few samples are available.

Table 6 (0-2 ft. Depth). Grids with average mercury levels in soil above EPA's LCP target action level of 20 ppm

Grid #	*Average Concentration*	*Maximum Concentration*	*Minimum Concentration*	*# Samples*
90	250	280	220	2
89	142	142	142	1
60	85	85	85	1
53	27.7	82	0.00	3
55	23.4	23.4	23.4	1

Figure 3. Sampling Locations Showing Current Mercury Levels in Soil (0 -5 ft.)

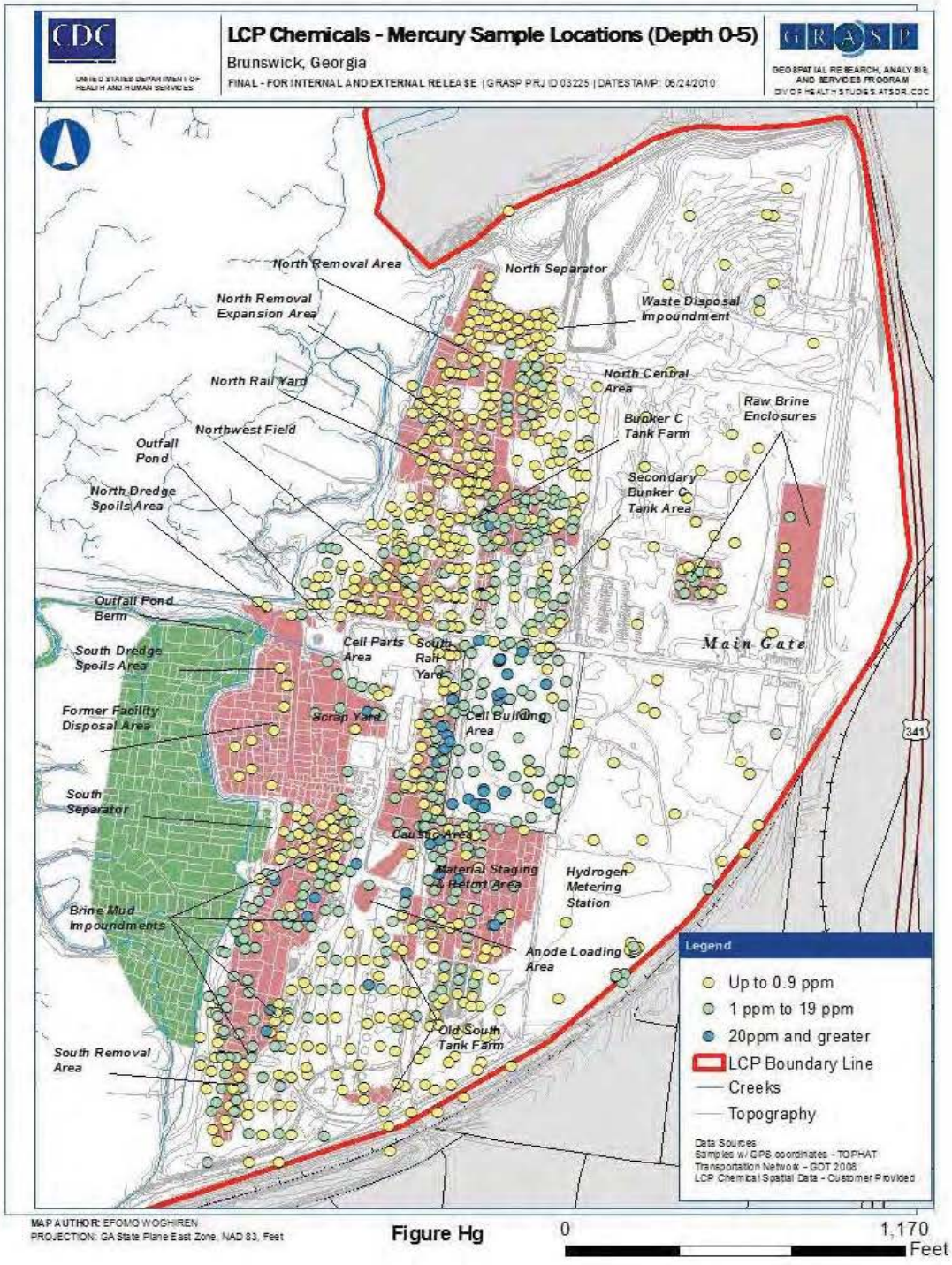
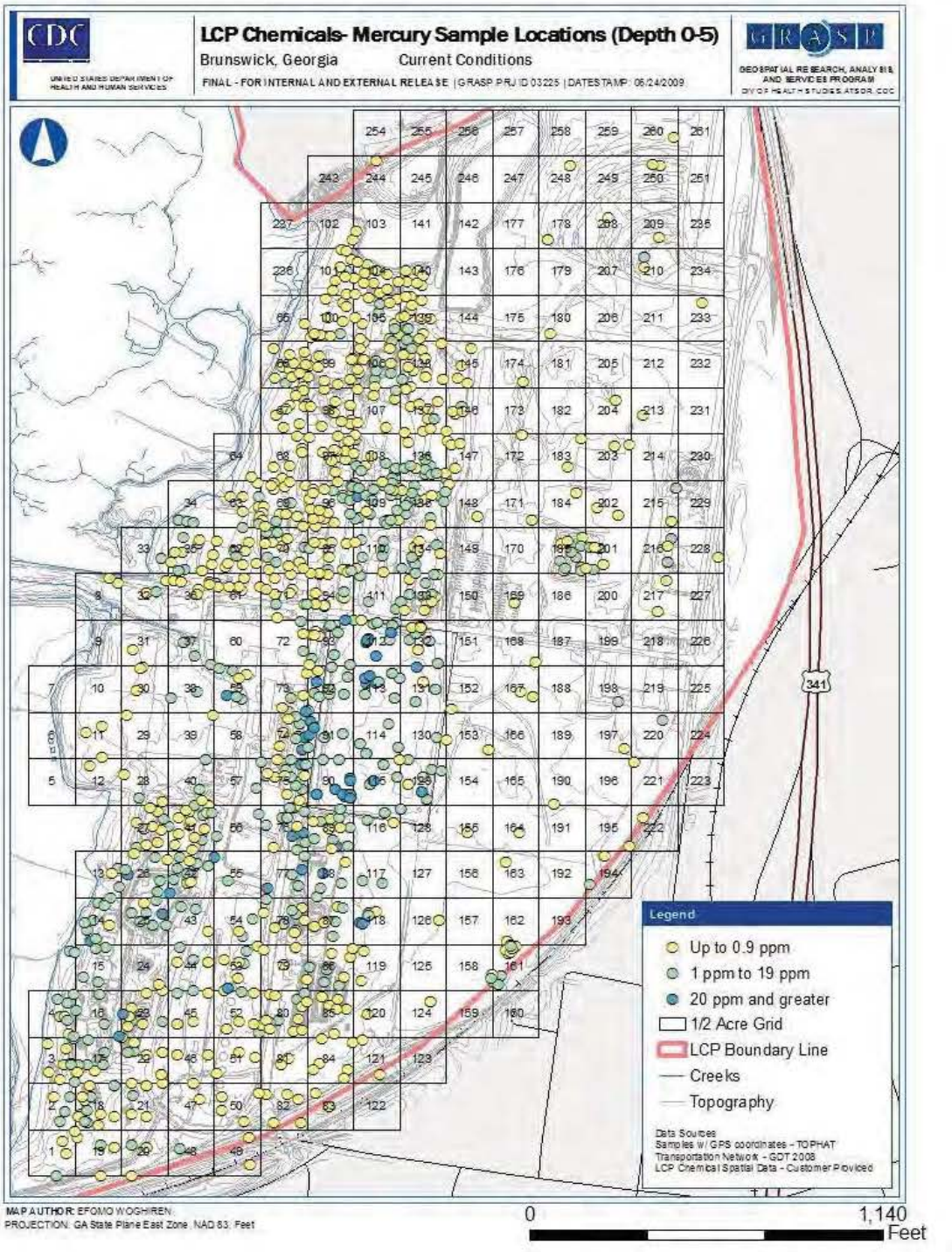


Figure 4. Exposure Units: ½ Acre Grids
Mercury Sampling Locations and Residual Levels, 0-5 ft.



IV.D.3. Polycyclic Aromatic Hydrocarbons (PAHs)

Prior to clean-up actions, PAHs were detected in the north and south removal areas, the north and south separators, and the bunker "C" tank area. Figure 5 shows the location of each sample collected and tested for PAHs. The figure also depicts where residual PAH concentrations are higher in some areas than in others by using a color scheme. Generally, the western portion of the site contains more samples and more residual PAH contamination.

IV.D.3.a. What are PAHs?

Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs may occur naturally or be manufactured. Many products contain PAHs including creosote wood preservatives, roofing tar, certain medicines, dyes, and pesticides. PAHs enter the atmosphere from vehicle exhaust, emissions from residential and industrial furnaces, tobacco smoke, volcanoes, and forest fires (ATSDR 1996b). The PAHs at the LCP Chemicals Site are residues from the distillation of crude oil.

IV.D.3.b. How are Carcinogenic PAHs Evaluated?

PAHs are composed of carcinogenic and non-carcinogenic PAHs. To evaluate the risk of cancer, an approach is used from the California Environmental Protection Agency (Cal EPA) that converts the total PAH concentration in a sample to a total carcinogenic PAH concentration (CalEPA 2005). On the basis of benzo(a)pyrene toxicity, this approach uses potency factors specific for each carcinogenic PAH to change the concentration of that PAH to a benzo(a)pyrene equivalent concentration. Thus, the benzo(a)pyrene equivalent concentration of various individual carcinogenic PAHs in a soil sample are summed to give the total carcinogenic PAHs (cPAH) for that sample. Therefore, in this document benzo(a)pyrene equivalents will be referred to as cPAHs.

More information about this approach can be found at these websites:

- http://oehha.ca.gov/air/hot_spots/pdf/May2005Hotspots.pdf
- http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=194584
- http://www.health.state.mn.us/divs/eh/risk/guidance/pahmemo.html

IV.D.3.c. Current cPAH Levels in Soil

The exposure units for the site are defined as ½ acre-sized parcels. Figure 6 contains the overlay of the ½ acre grids to show residual carcinogenic PAH (cPAH) contamination and distribution at the site. Average cPAH concentrations were calculated for each ½ acre grid. The highest average cPAH in any grid was 29 ppm. No grids had average cPAH levels that exceeded EPA's LCP target action level of 50 ppm in soil at either the 0-5 or 0-2 ft. depths. The highest cPAH concentration for any grid (#93) is 59 ppm in the 0-5 ft. depth.

Figure 5. Sampling Locations and Current cPAH Levels in Soil, 0-5 ft.

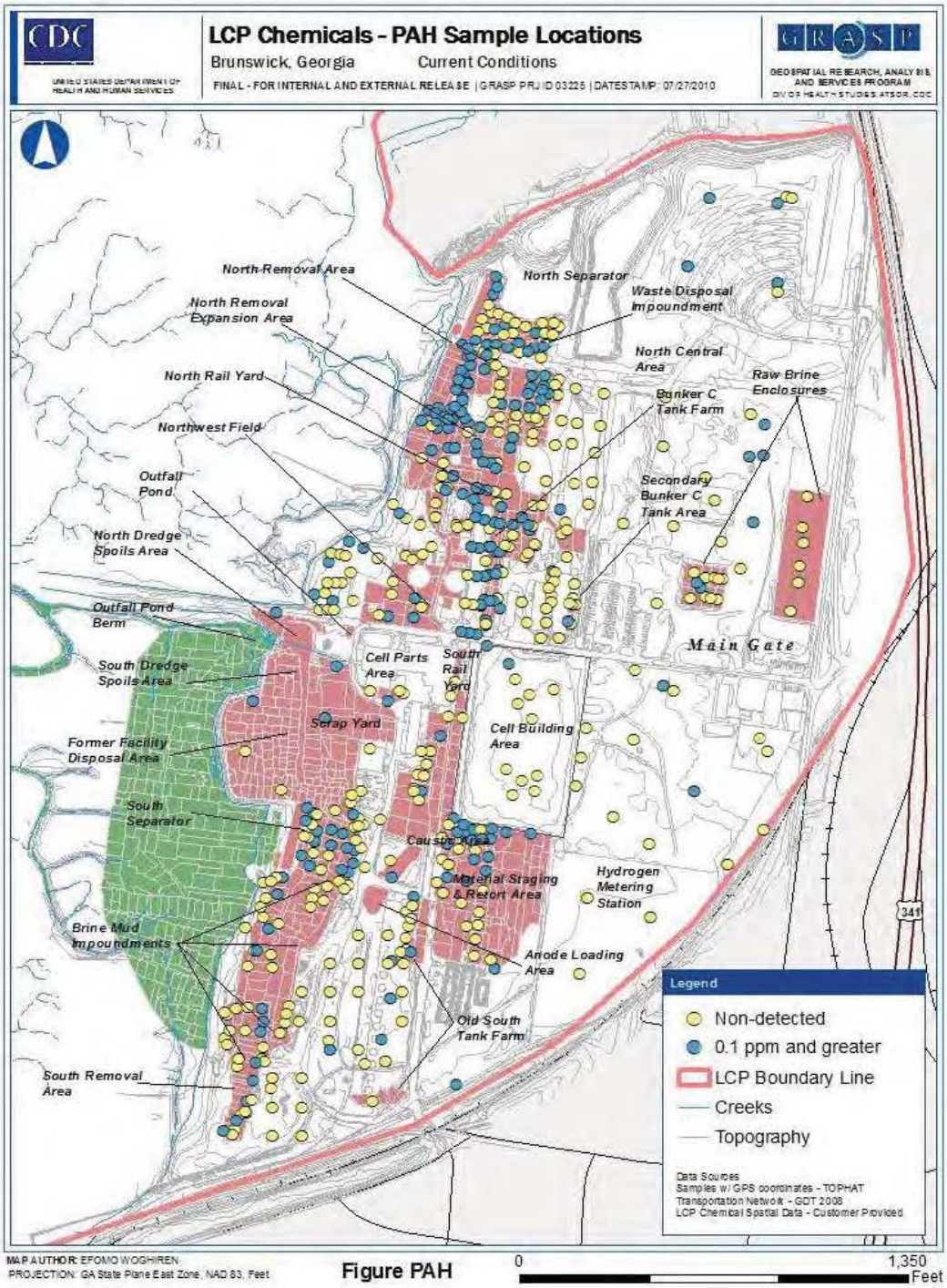
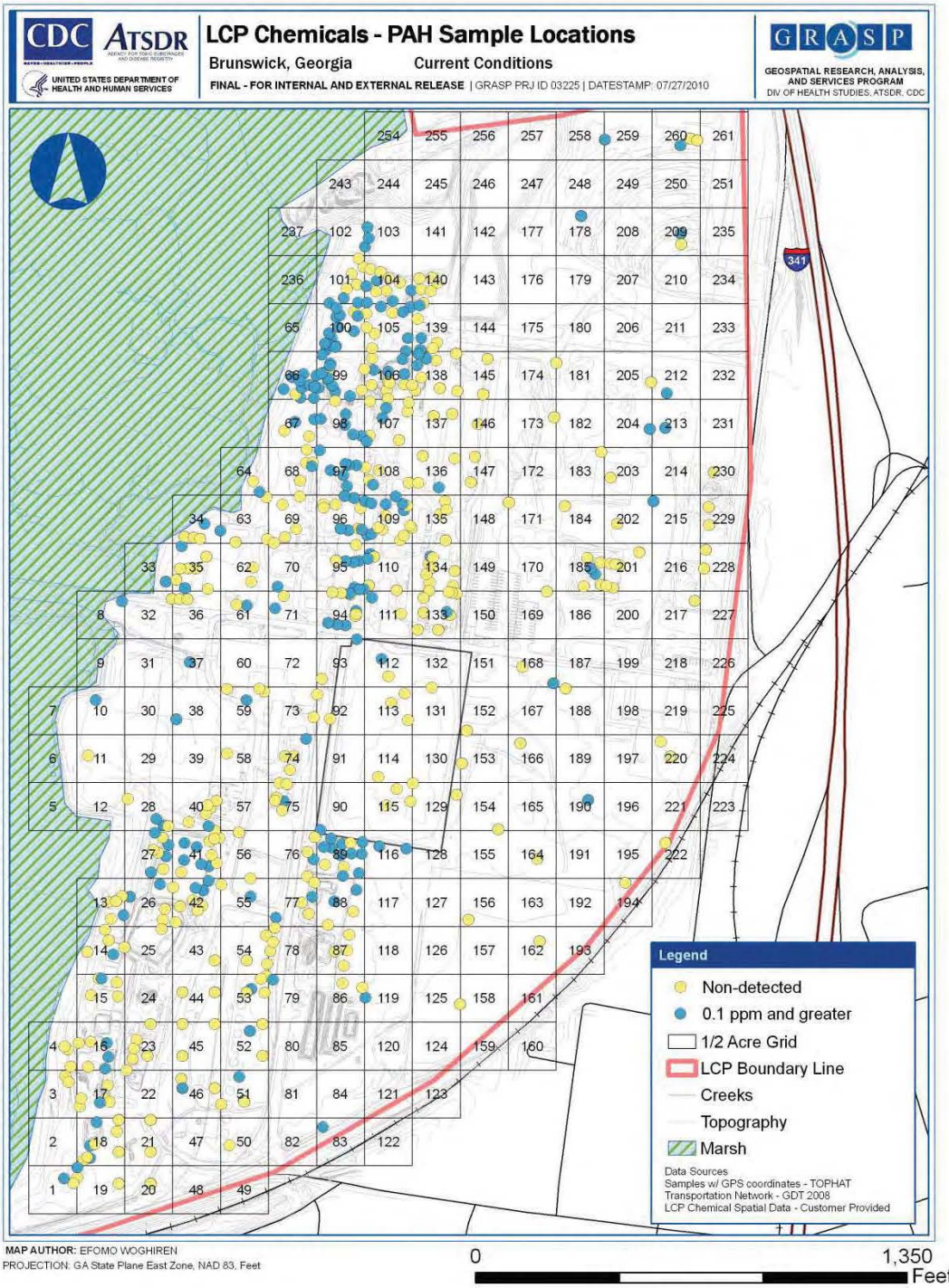


Figure 6. Exposure Units: ½ Acre Grids
cPAH Sampling Locations and Residual Levels in Soil, 0-5 ft.



IV.D.4. Lead

Prior to EPA's clean-up actions, lead was detected in the north removal expansion area, the north central area, the north rail yard, and the old south tank farm. After removal actions, residual lead still exists in some areas. Figure 7 shows the location of each sample collected and tested for lead that represents current lead levels in soil. The figure also depicts where residual lead concentrations are higher in some areas than in others by using a color scheme. Generally, more samples were collected from the western portion of the site. Residual lead levels appear to be evenly dispersed throughout the site.

IV.D.4.a. Current Lead Levels in Soil

The exposure units for the site are defined as ½ acre-sized parcels. Figure 8 contains the overlay of the ½ acre grids to show lead contamination and distribution at the site. Average lead concentrations were calculated for each ½ acre grid.

0-5 Ft Depth

Using samples with any depth between 0 and 5 foot, six grids have average lead levels that exceed EPA's 1994 LCP target action level for this site of 500 ppm (see Table 7); 21 grids have average lead levels between 154 and 499 ppm. (See more discussion in section "*V.F.3.b. Estimating children's lead dose from soil lead levels"* about how 154 ppm was derived). The maximum lead concentration at the site from a single soil sample is 4,430 ppm (Grid #136) and is located slightly northeast of the Bunker C Tank Farm. The highest average lead concentration for any grid (Grid #136) is 745 ppm.

Table 7 (0-5 ft. Depth). Grids with average lead levels in soil above EPA's 1994 site-specific target action level of 500 ppm

Grid #	*Average Concentration*	*Maximum Concentration*	*Minimum Concentration*	*# Samples*
136	745	4,430	52	18
48	728	820	635	2
103	692	1,580	14	6
26	660	3,680	6	7
93	590	3,040	46	6
59	513	1,040	66	6

0-2 Ft Depth

Using samples with any depth between 0 and 2 foot, five grids have average lead levels that exceed EPA's 1994 target action level for this site of 500 ppm (see Table 8); 36 grids have average lead levels between 154 and 499 ppm. (See more discussion in section "*V.F.3.b. Estimating children's lead dose from soil lead levels"* about how 154 ppm was derived). When comparing the 0-2 ft. averages with the 0-5 ft. averages, the maximum lead concentration at the site from a single soil sample is still 4,430 ppm (Grid #136). The highest average lead concentration for any grid (Grid #103) is 1,111 ppm compared to 745 for the 0-5 ft. samples. It is also worth noting that the number of samples per grid decreases, as expected, in the 0-2 ft. depth range.

Table 8 (0-2 ft. Depth). Grids with average lead levels in soil above EPA's 1994 LCP target action level of 500 ppm

Grid #	***Average Concentration***	***Maximum Concentration***	***Minimum Concentration***	***# Samples***
136	745	4,430	52	18
48	728	820	635	2
103	1111	1,580	832	3
26	638	638	638	1
59	513	1,040	66	6

Figure 7. Sampling Locations Showing Current Lead Levels in Soil, 0-5 ft

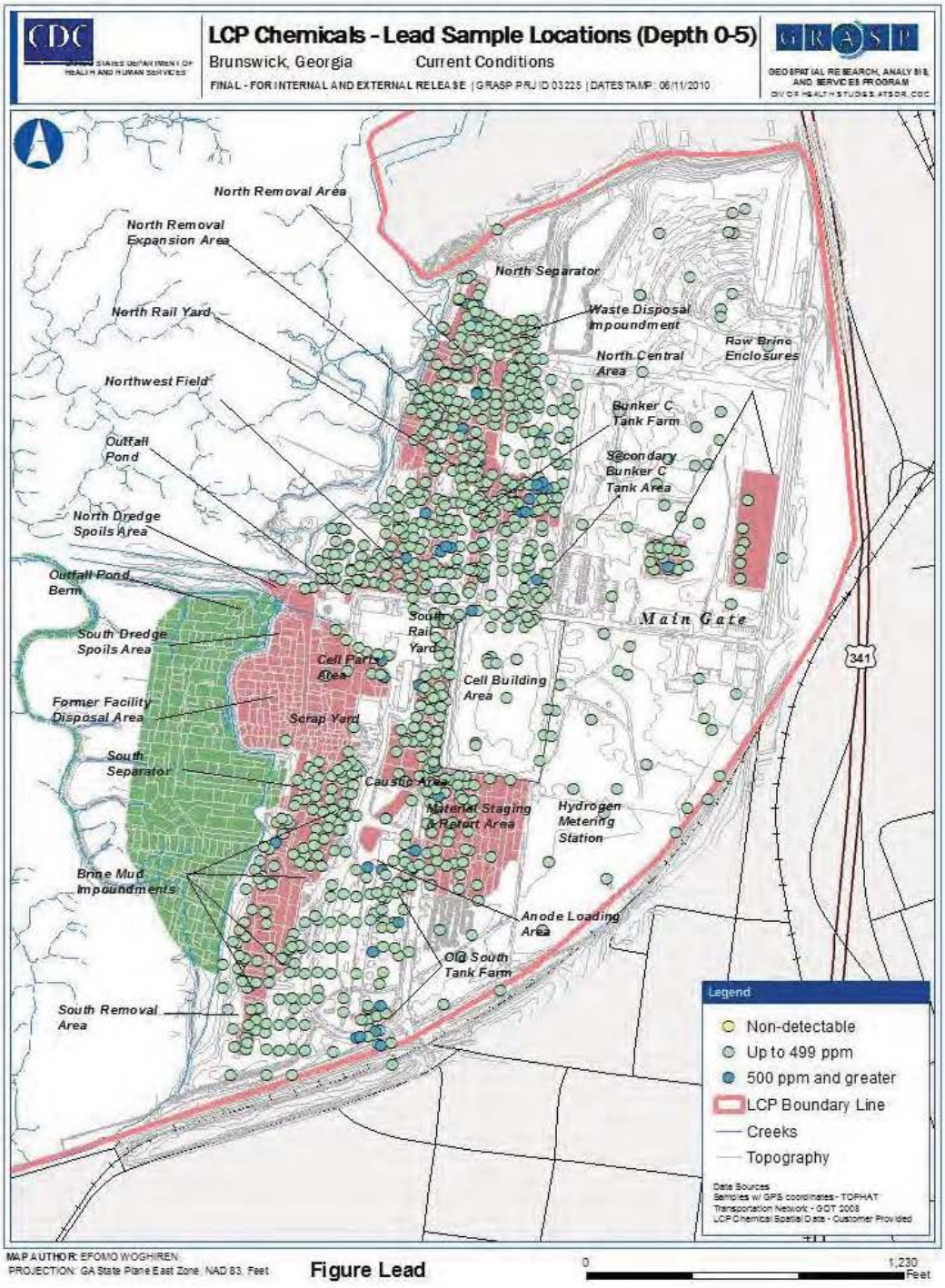
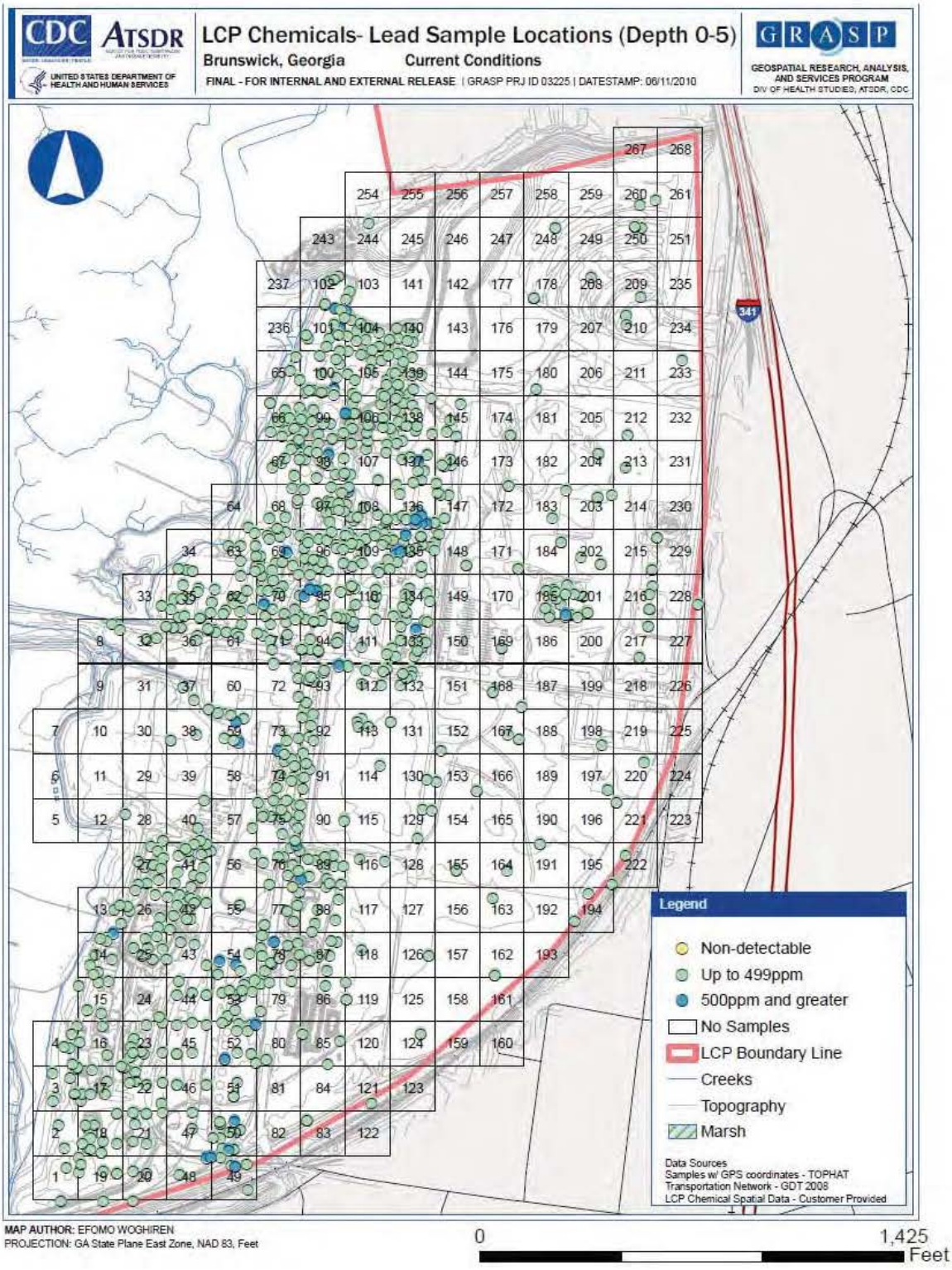


Figure 8. Exposure Units: ½ Acre Grids Lead Sampling Locations and Residual Levels, 0-5 ft.



IV.E. Potential Off-site Disposal Areas

During our assessment of the off-site areas surrounding the LCP Chemicals Site, ATSDR was informed of the existence of four potential historically contaminated areas. These off-site locations are alleged to have been the disposal grounds for various industries in the past. ATSDR has not confirmed, and is not suggesting, that these alleged disposal areas are associated with the LCP Chemicals Site. However, in some instances, historical photos suggest that these off-site locations may be linked to past industrial enterprises, including industries at the (former) LCP Chemicals property. Using historical aerial photos, this link is indicated by the presence of worn paths/roads extending from the LCP industrial facility to a potentially contaminated area.

Because it was raised by the community as a concern, and because some evidence exists to suggest a plausible connection to past industrial activities, ATSDR examined four potential disposal areas. We determined whether environmental samples had been collected in a given area and, when possible, evaluated the results. Below is a list of these potentially contaminated disposal areas:

IV.E.1. Former Tank Areas

Historical photos show the presence of three off-site tanks approximately one-quarter mile from the LCP Chemical property, east of Newcastle Street. The use or content of these former tanks is not known. In the presented historical photo, Figure A6 in Appendix A, the tanks appear as large white circles inside a square enclosure at the rightmost edge of the page. A present-day image of this area shows that the northernmost tank coincides with an area located between Knight Street and Ross Road extension (Former Tank Area 1); the middle tank lies at the western end of Cedar Street and Newcastle (Former Tank Area 2); and the southernmost tank lies at the corner of Cedar and Whitlock Streets (Former Tank Area 3).

EPA conducted limited soil sampling at each of the identified former tank locations (See Figures A7 through A11 in Appendix A).

ATSDR visited each location in July 2009 and made the following observations:

IV.E.1.a. Former Tank Area 1

Former tank area 1 is overgrown in some areas, including thick vegetation covering several mounds of soil currently located on the site. The site also contains piles of rock. Earthmoving equipment (e.g., bulldozers, dump trucks, etc.) was stored on the property. A mobile trailer which appeared to be the office for a car maintenance shop was located on the property. Many vehicles in various stages of disrepair were near the office trailer. A well pump was found on the property and is apparently used to wash trucks.

Limited sampling of the area conducted by EPA revealed the presence of up to 88 ppm of lead and 0.1 ppm of mercury in soil. These levels are not a health concern because they are below ATSDR's comparison values.

IV.E.1.b. Former Tank Area 2

Former tank area 2 contains an abandoned industrial building. The site was posted against trespassing or dumping, so we walked only the public access road along the perimeter of the site. A repair shop appeared to be located approximately 100 yards east of the site.

Ten soil samples were collected from former tank area 2. While the highest lead level was 3,155 ppm, the average lead level from all the samples was 347 ppm. This average lead level is not a health concern for a commercial area but would be a concern for a residential area.

IV.E.1.c. Former Tank Area 3

Former tank area 3 is currently occupied by a business and is fenced; therefore, we could not observe current conditions at the location. Samples collected from former tank area 3 contained lead up to 232 ppm in soil. PCBs were not detected in any of the soil samples. The level of lead detected is not a health concern for a commercial location.

IV.E.2. Clairmont Lane

The Clairmont Lane area is a residential street that intersects Habersham Street and is surrounded by a densely wooded area. Previous community interest arose regarding this area when it was selected by the Glynn County Board of Education for the location of a new elementary school (GEC, undated). The GDNR, Environmental Protection Division, performed environmental sampling at the site to determine if the site was contaminated by historical waste dumping (GDNR 2004a). A total of 35 investigative soils borings were taken across the site in December 2003. Each boring was taken to a depth of 16 feet below existing grade, and sample composites were taken at one foot intervals (GDNR 2004b).

Clinker material, a type of waste product believed to be associated with past industrial activities at the LCP property, and the surrounding soils were analyzed to determine the chemical composition of the clinker for proper disposal, and whether the clinker had caused the immediate surrounding soils to become contaminated (GDNR 2004b). Detectable but low levels of metals were found in the soil. Carbon disulfide was detected in the clinker material at a concentration which exceeded the regulatory level for the chemical. Calcite, a naturally occurring carbonate mineral, was also found in the clinker material. Analytical results found no substances above regulatory limits in the soil samples tested; carbon disulfide was detected above detection limits in the clinker material itself (GDNR 2004b).

In January 2004, approximately 8.8 tons of clinker material were removed from the Clairmont Lane site (GDNR 2004b). Despite the cleanup in 2004, ATSDR staff members observed what appeared to be an area of waste material (i.e. clinker) near the backyard of a home on Clairmont Lane during our visit in July 2009. The material was a black deposit

that had been removed from an area that contained loose clinker rocks. The material was near shrubbery and covered by pine needles, but was easily accessible by walking along the edge of the back yard.

IV.F. Residual Contamination in the Marsh

The marsh near the LCP Chemicals Site contains residual concentrations of PCBs, mercury and dioxins in sediment.

IV.F.1. Residual PCB Levels in the Marsh

Approximately 1,400 sediment samples were collected from the marsh, the Turtle River, off-site areas, and the salt dock area and were tested for PCBs. Total PCB concentrations ranged from non-detect to 570 ppm. The distribution of total PCBs remaining in these areas is shown in Figure 9. Generally, more PCB samples were collected in the marsh areas near the facility; therefore, these areas are more characterized. Samples were also collected from the salt dock area located southwest of the site, along the Turtle River (See Figure 9). Approximately 252 samples had concentrations above 10 ppm total PCBs; approximately 477 samples had concentrations between 1 and 9.9 ppm. The remaining 737 samples had total PCB concentrations less than 1 ppm, including some non-detects.

IV.F.2. Residual Mercury Levels in the Marsh

Approximately 1,500 sediment samples were collected from the marsh, the Turtle River, off-site areas, and the salt dock area and were tested for mercury. Mercury concentrations ranged from non-detect to 450 ppm. The distribution of mercury remaining in these areas is shown in Figure 10. Approximately 110 samples had concentrations above 20 ppm; approximately 693 samples had concentrations between 1 and 19 ppm. The remaining 727 samples had mercury concentrations less than 1 ppm, including some non-detects.

IV.F.3. Residual Dioxin Levels in the Marsh

Dioxins, or chlorinated dibenzo-*p*-dioxins (CDDs), are a class of structurally similar chlorinated hydrocarbons. The basic structure is comprised of two benzene rings joined via two oxygen bridges at adjacent carbons on each of the benzene rings. Dioxins is a term used interchangeably with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCCD or TCDD). TCDD is the most toxic form of the numerous dioxin compounds. Dioxins are not intentionally produced and have no known use. They are the by-products of various industrial processes (i.e., bleaching paper pulp, and chemical and pesticide manufacture) and combustion activities (i.e., burning household trash, forest fires, and waste incineration) (ATSDR 2006).

Not all dioxins have the same toxicity or ability to cause illness and adverse health effects. The most toxic chemical in the group is 2,3,7,8-TCDD. It is the chemical to which other dioxins are compared. The levels of other dioxins measured in the environment are converted to a TCDD-equivalent concentration on the basis of how toxic they are compared to 2,3,7,8-TCDD. These converted dioxin levels are then added

together to determine the total equivalent (TEQ) concentration of the dioxins in a sample (ATSDR 2006). Hereafter, TCDD equivalents will be referred to as dioxins.

A total of 45 samples were tested for dioxins. Of the 45 samples tested, 6 were surface water samples and 1 was a groundwater sample. Two sediment samples were collected to determine background concentrations. The 36 remaining samples were sediment samples collected from the marsh and from selected off-site locations. Figure 11 shows the sample locations and concentration of dioxins at the site using a color scheme.

Dioxin concentrations in sediment ranged from non-detect to 0.003 ppm. ATSDR's current comparison value for dioxin is 35 parts per trillion (ppt), or 0.000035 ppm. Nine samples exceeded had dioxin levels that exceeded 35 ppt. No samples for dioxins were collected from the dry-land area during this round of sampling. Samples from the dry-land area were collected in 2011 and are discussed in Section IV.G. of this document.

Figure 9. Sampling Locations Showing Residual PCB Levels in Sediment
in the Marsh and Off-Site Locations

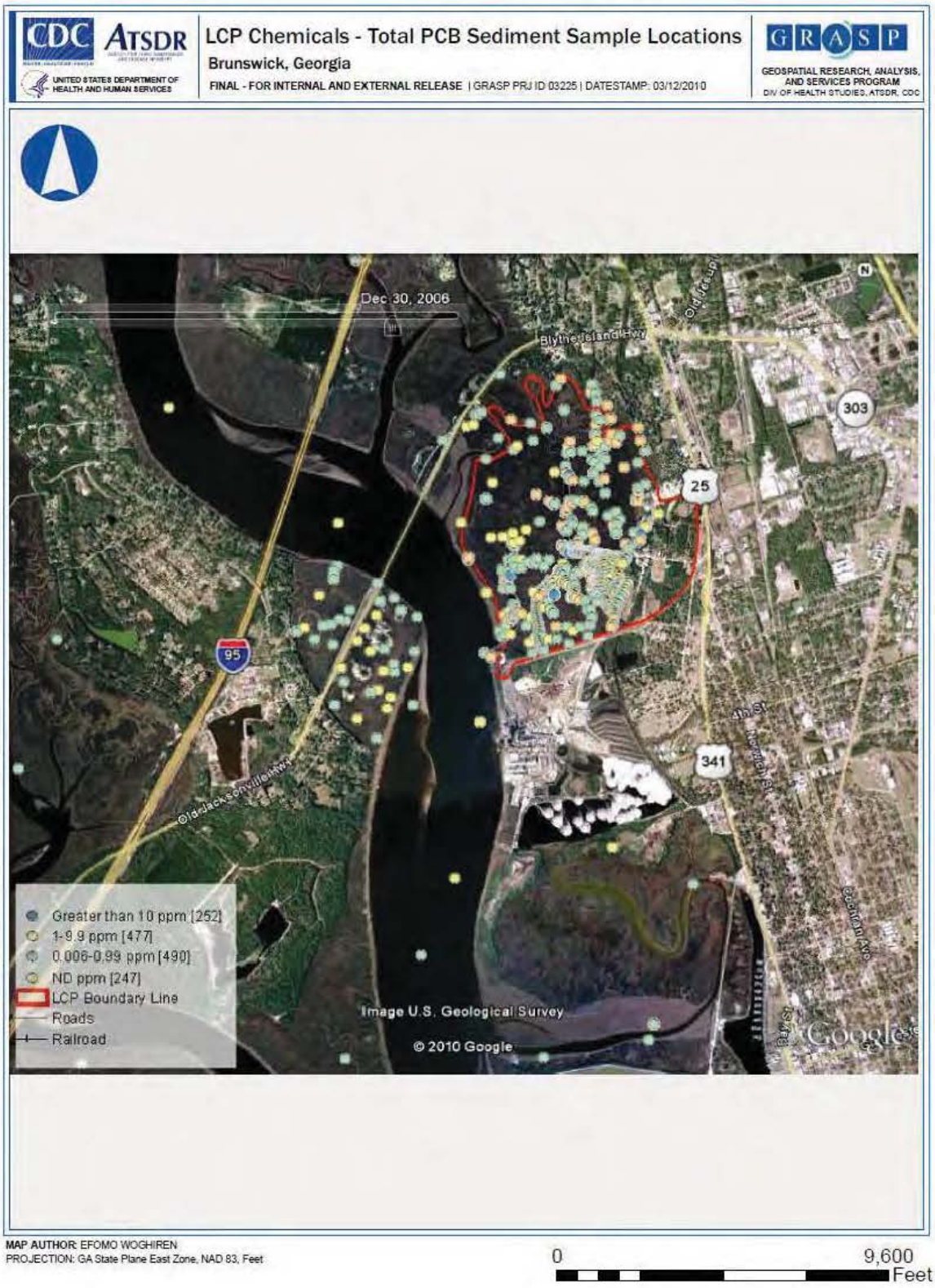


Figure 10. Sampling Locations Showing Residual Mercury Levels in Sediment
in the Marsh and Off-site Locations

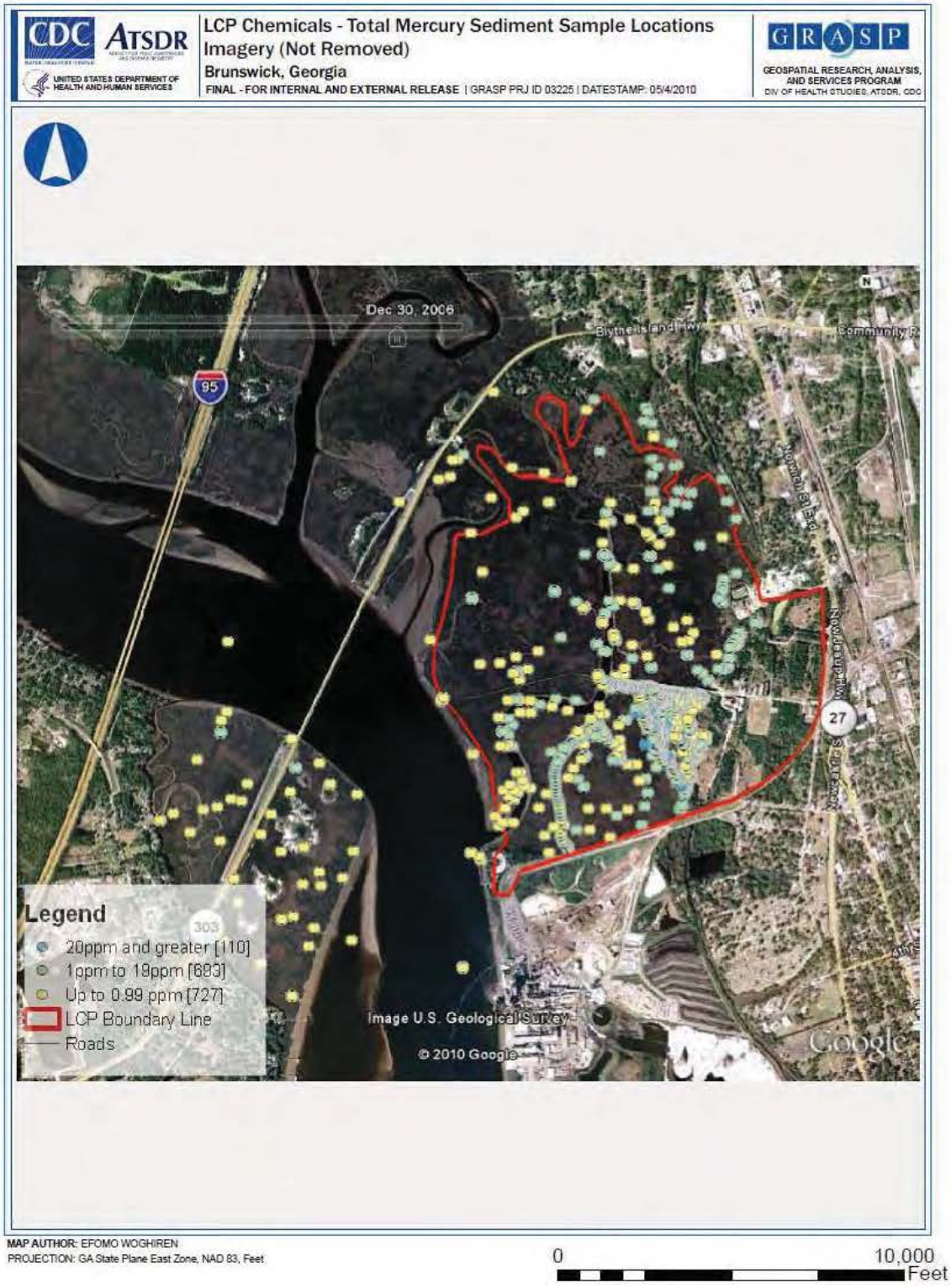
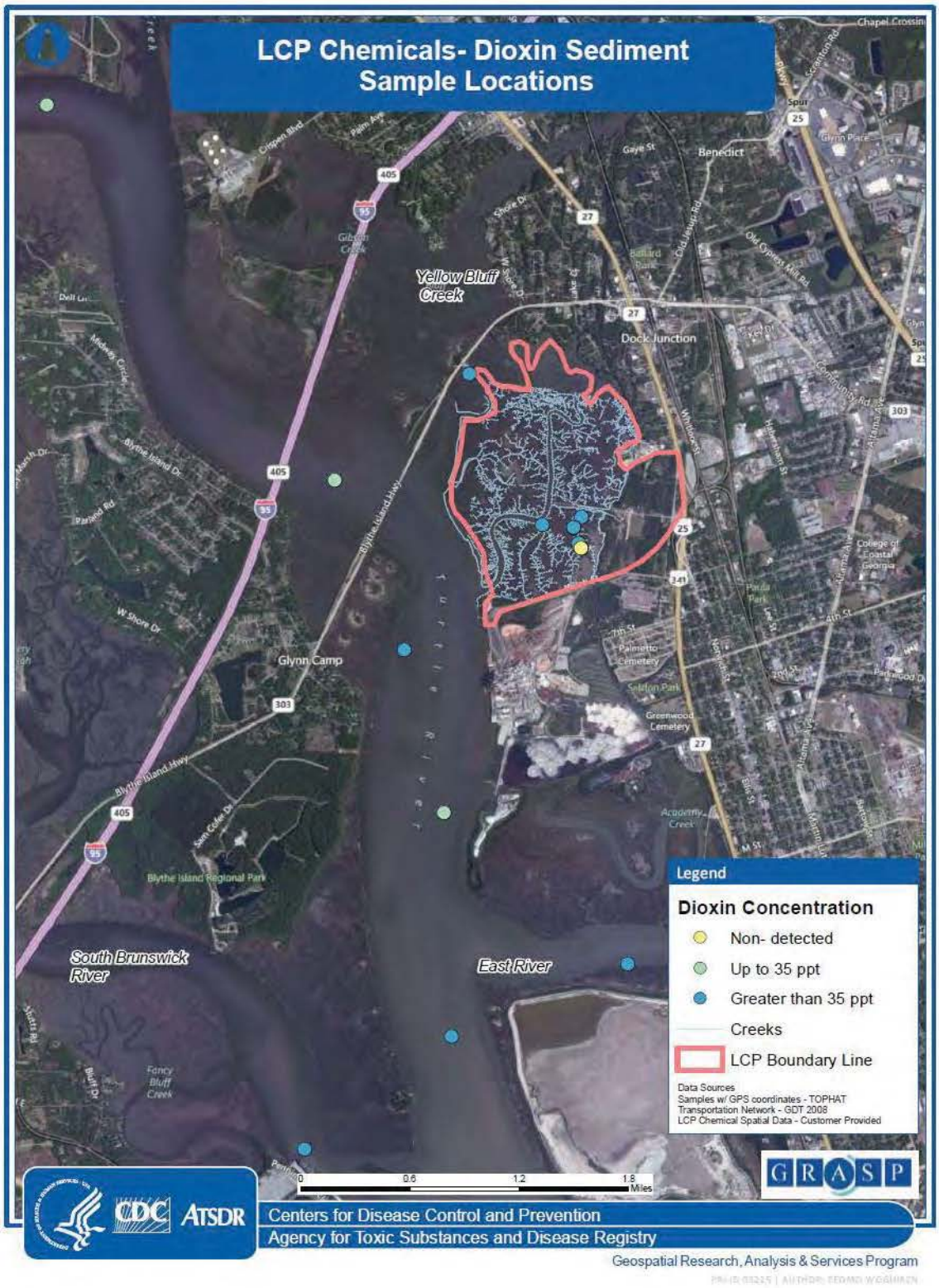


Figure 11. Sampling Locations Showing Residual Dioxin Levels in Sediment
in the Marsh and Off-site Locations



IV.G. New Data Collected Since the Public Release of the LCP PHA in 2010

This section presents the results of environmental samples collected in 2010 and 2011. These data were not part of the data evaluated during the previous public release of this document in fall 2010. Some of the new environmental sampling was conducted in response to recommendations by ATSDR in the public release document. The new sampling was focused in the following areas: 1) the dry-land area (dioxins), 2) the on-site former theater area, 3) the on-site pond, and 4) the Altamaha Canal.

IV.G.1. The Dry-land Area (Operable Unit 3)

In April 2011, Honeywell, with the concurrence of EPA and the Georgia Environmental Protection Division (GEPD), sampled soil from the dry-land area for dioxins. The purpose of the sampling was to determine the concentrations of dioxin in the dry-land area (also referred to by EPA as the upland soil area) of the site. The dry-land area also includes the former theater area and on-site pond, which are discussed separately below. The sampling protocol used Incremental Sampling Methodology (ISM), which is a structured composite sampling method that uses "sampling units" as a way to determine contaminant concentrations in a specified geographical area.

Honeywell divided the site into 4 separate quadrants, which is consistent with the sampling design used in EPA's upland soils Human Health Risk Assessment for the site. Each quadrant identified by EPA contained from 1 to 3 sampling units. The size of the sampling units varied. ATSDR renumbered the sampling units in each quadrant from left to right, top to bottom, for easy referencing (see Figure 12 in Appendix E). Appendix E discusses in detail the use of EPA's quadrants and ATSDR's numbering method.

The new data for the dry-land area included sampling results for dioxins only. The dioxin data were converted to TCDD-equivalent concentrations based on how toxic the congeners are compared to 2,3,7,8-TCDD. These converted dioxin/furan concentrations are then added together to determine the total equivalent (TEQ) TCDD concentration in a sample. Hereafter, TCDD equivalents will be referred to as dioxins.

Table 9 below contains the sampling results for total dioxins for the dry-land area. Two dioxin concentrations were reported for most sampling areas; three dioxin concentrations were reported for sampling area 4. For purposes of this assessment, the highest dioxin value was selected to determine health risks.

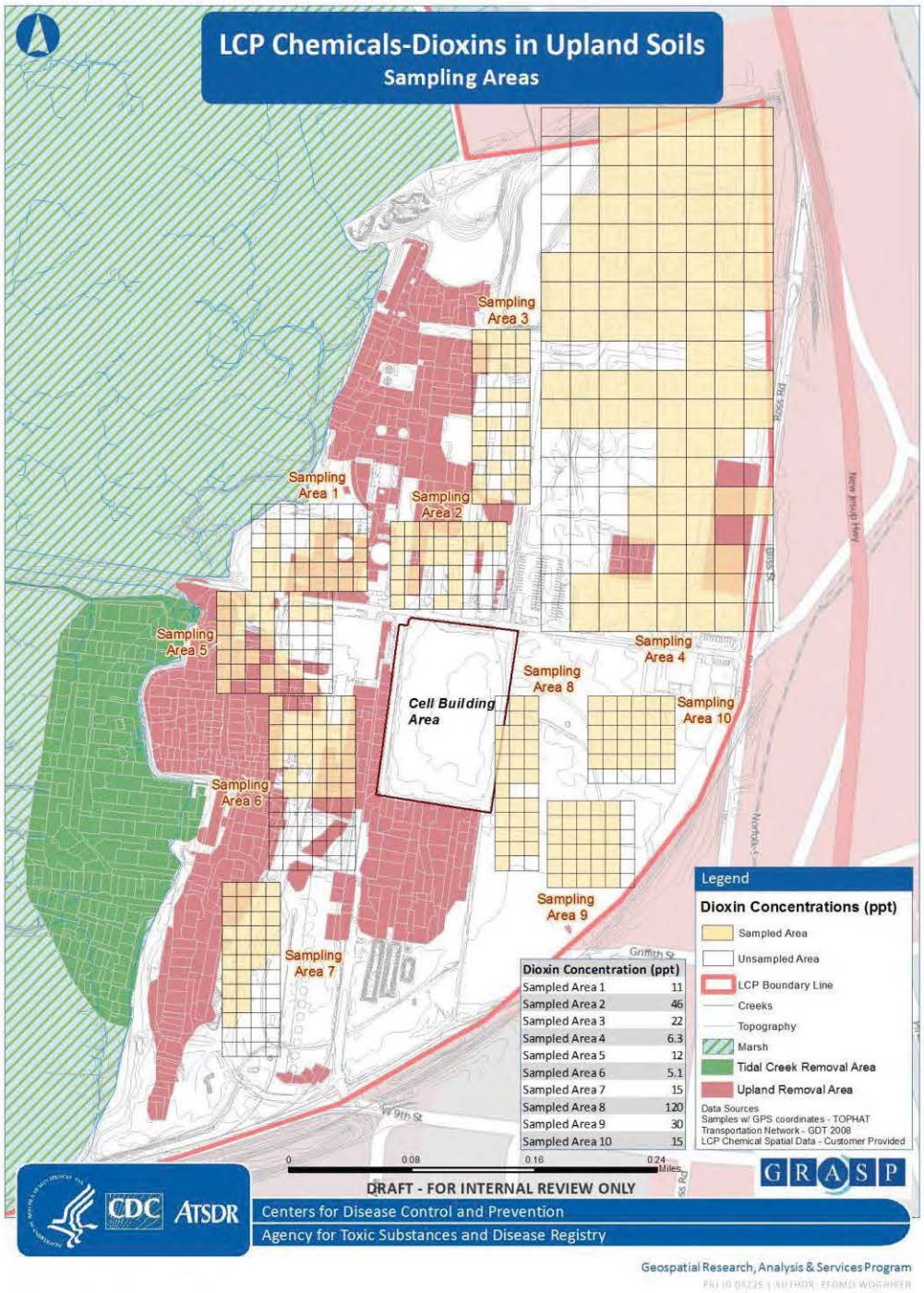
Figure 13 shows the location of the sampled dry-land areas and the dioxin concentration for each sampled area. In some cases, no samples were taken from a smaller block within the larger sampling unit. Where this occurred, ATSDR deleted the smaller block from the sampling unit to show that no sample was taken. The areas not sampled appear as a blank block on the map in Figure 13.

Table 9. List of Sampling Areas and Dioxin Levels in Soil for the Dry-Land Area (See Figure 13)				
Sampled Area	***Dioxin Conc. (ppt)***		***Sampled Area***	***Dioxin Conc. (ppt)***
4	6.2		**2**	**38**
4	5.5		**2**	**46**
4	6.3		3	14
10	13		3	22
10	15		5	12
8	**81**		5	8
8	**120**		6	5.1
9	30		6	1.2
9	30		7	15
1	9.3		7	14
1	11			

Four samples exceed ATSDR's current comparison value of 35 parts per trillion (ppt) for dioxins in soil. The four samples are from two sampling areas – sampling area 8 and sampling area 2 (See Figure 13). Seventeen samples have dioxins concentrations below the comparison value of 35 ppt.

The distribution of dioxins in the dry-land area is shown in Figure 13. Sampling areas 2 and 8 contain the highest concentrations of dioxins. Sampling area 2 is located north of the former cell building area and sampling area 8 is located immediately east of the former cell building area.

Figure 13. Sampling Locations Showing Concentration of Dioxins
for Dry-Land Area (2011)



In some cases, no samples were taken from a smaller section within the larger sampling area. Where this occurred, ATSDR deleted the smaller block from the sampling area to show that no sample was taken. The areas not sampled appear as a blank block on the map.

IV.G.1.a. Former Theater Area

In December 2010, Honeywell sampled the soil at five locations along an arc in the middle of the theater area. Soil samples were collected at two depths: 0 to 1 ft. (surface soil) and 2 to 3 ft. (subsurface soil). Figures 14 through 17 show soil sample locations and sampling results for PCBs, mercury, cPAHs and lead from the December 2010 sampling event.

The soil sampling results from the December 2010 sampling event are summarized in Table 10.

Table 10. Recent Sampling Results, December 2010, for Soil in the Theater Area (ppm)

Contaminant	***Comparison Value (ppm)***	***Concentration Range in Surface Soil (ppm) (0-1 f.t depth)***		***Concentration Range in Subsurface Soil (ppm) (2-3 ft. depth)***	
		Min	***Max***	***Min***	***Max***
PCBs	0.35	0.005	0.13	ND	0.01
Mercury	5*	0.04	0.20	0.01	0.03
cPAHs	0.096	0.003	**0.14**	ND	0.02
Lead	None	8	63	4	43

*indicates comparison value for methylmercury

As shown in the table, only cPAHs in surface soil exceeded its comparison value. None of the other sampling results that had a comparison value exceeded their applicable soil comparison value. Lead does not have a comparison value. The level of PAH exceed the comparison value and therefore will be evaluated further in the public health implications section of this report.

Figure 14. Sampling Locations Showing Concentration of PCBs in Soil
In Theater Area, 2010

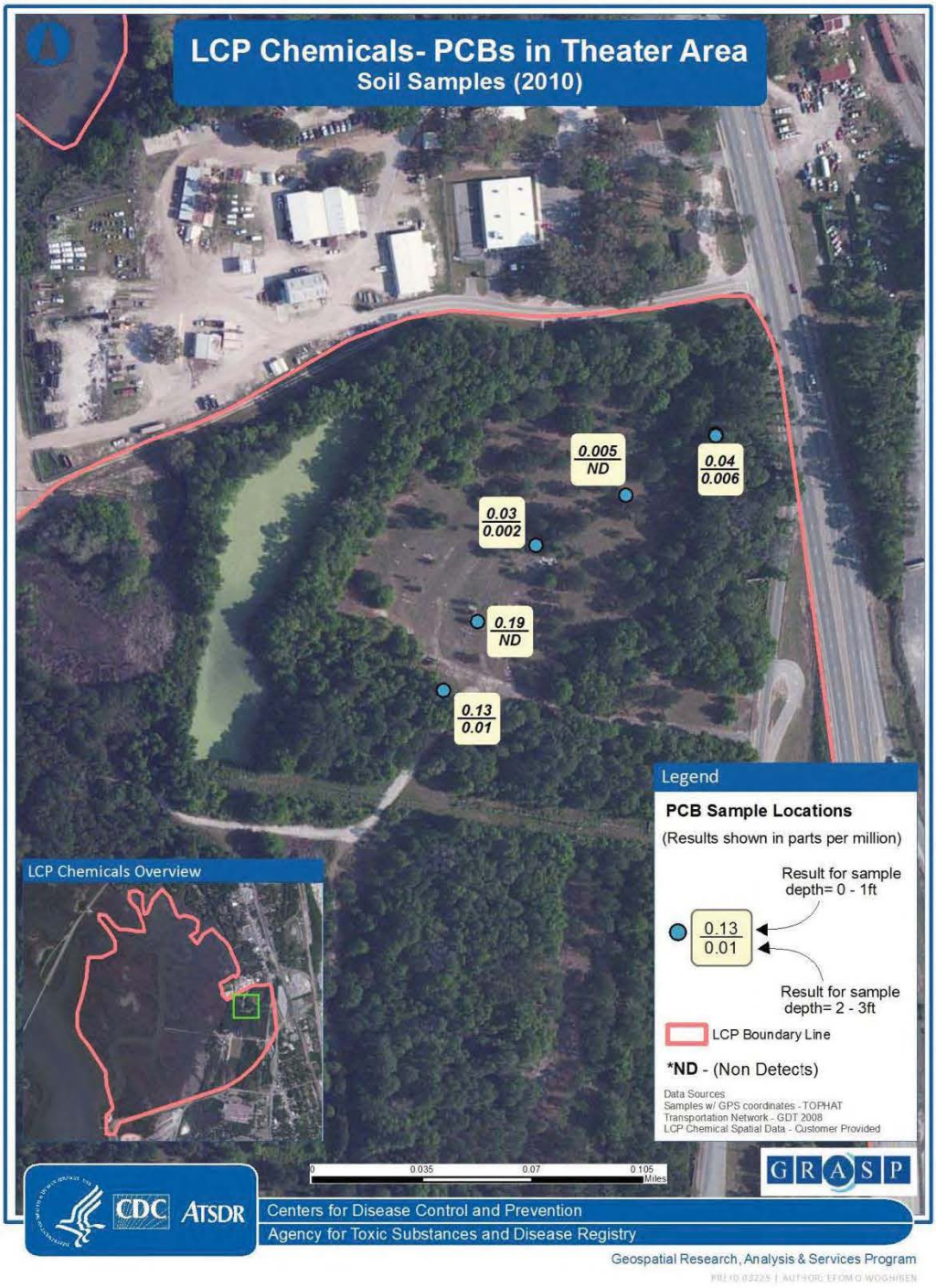


Figure 15. Sampling Locations Showing Concentration of Mercury in Soil
In Theater Area, 2010

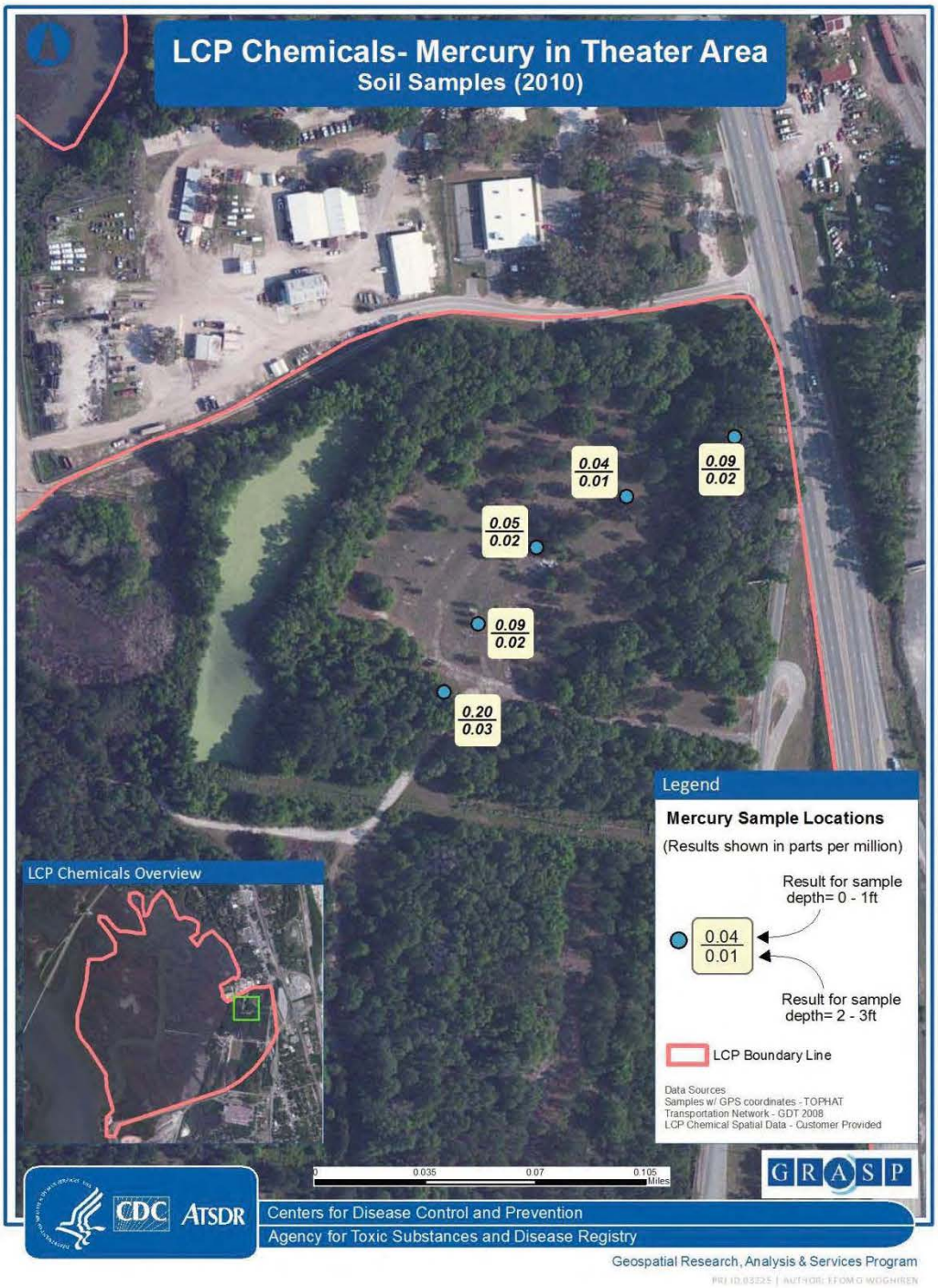


Figure 16. Sampling Locations Showing Concentration of cPAHs in Soil
In Theater Area, 2010

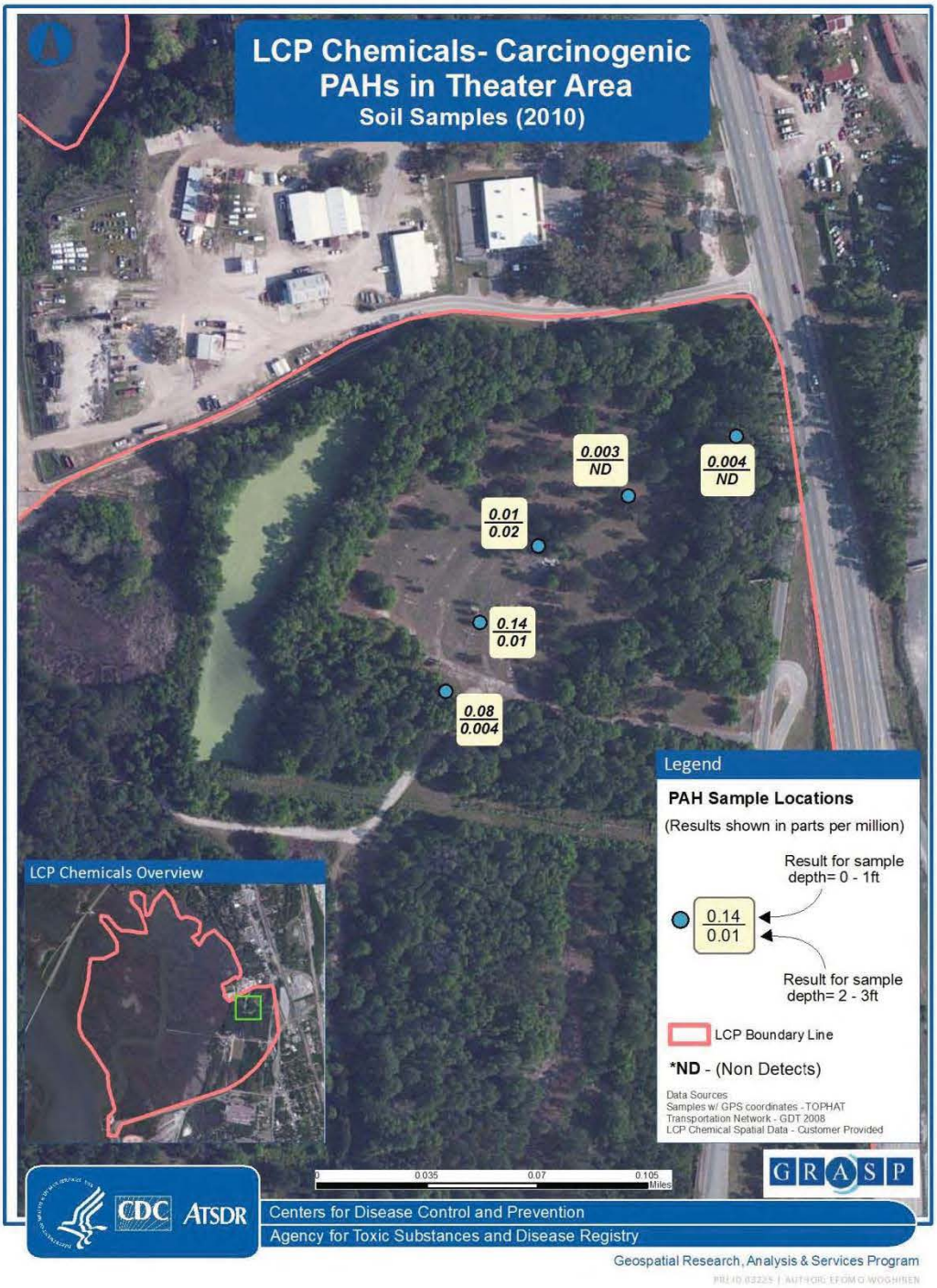
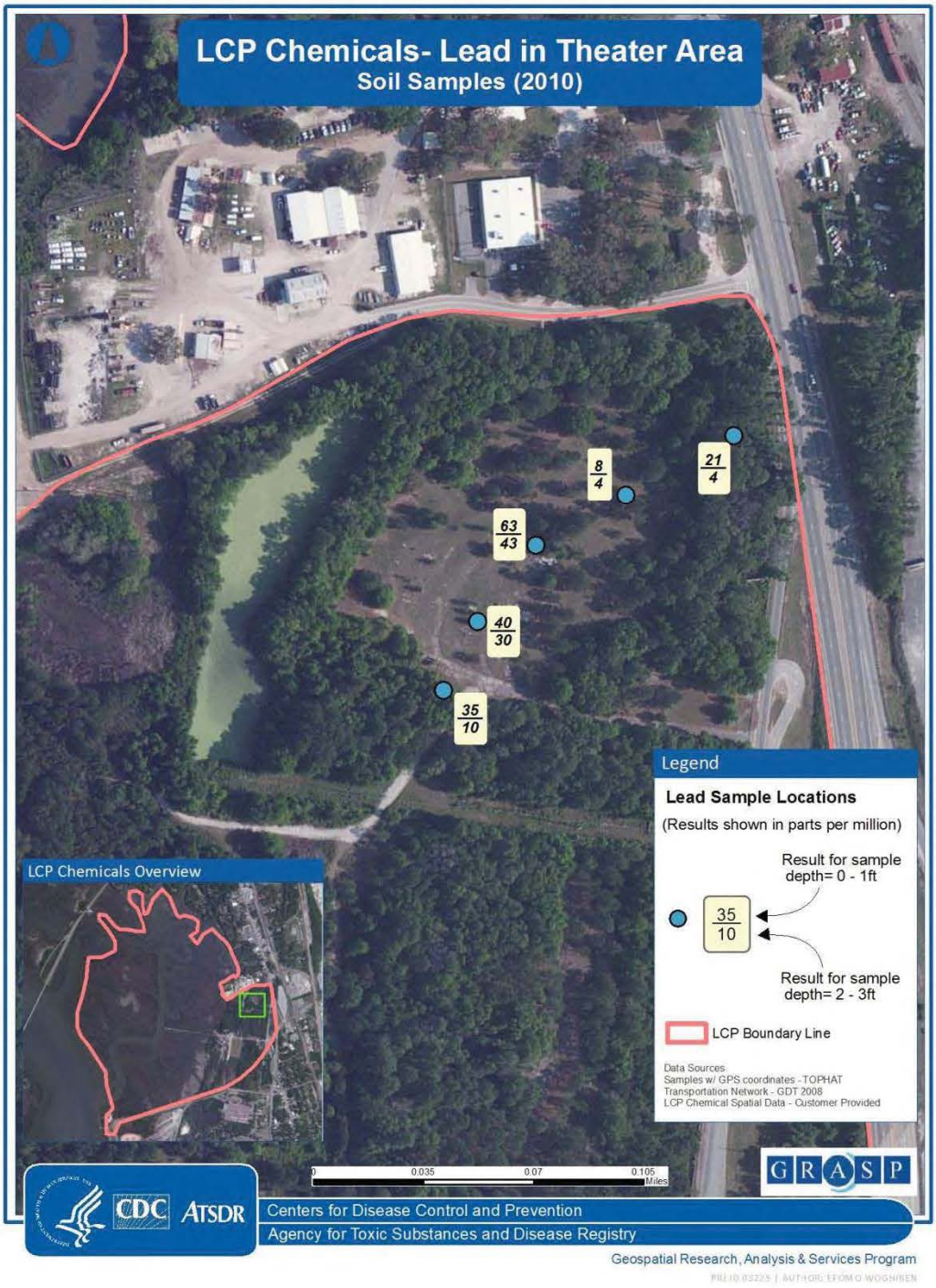


Figure 17. Sampling Locations Showing Concentration of Lead in Soil
In Theater Area, 2010



IV.G.1.b. The On-site Pond

During three different sampling events between 1989 and 2008, a total of 4 surface water and 3 sediment samples were collected from the freshwater pond located in the theater area. The three sampling events are summarized below:

- One surface water sample was collected in 1989;
- One surface water and one sediment sample were collected in 2007; and
- Two surface water and two sediment samples were collected in 2008.

In December 2010, Honeywell collected surface water and sediment samples from three locations in the on-site pond. The three locations were selected to be evenly spaced along the longitudinal axis of the pond near the former drive-in theater. One surface water sample and one sediment sample (0 to 1/2 ft.) were collected from each location. Fish collection was attempted but no fish were caught in the on-site pond.

The location of the surface water and sediment samples and the analytical results are illustrated in Figures 18 through 21 and summarized in Tables 11 and 12.

Table 11. Recent Sampling Results, December 2010, for Surface Water in On-site Pond (ppm)

	Contaminant	***Comparison Value***	***Min Conc.***	***Max Conc.***
Surface Water	PCBs	0.000018	ND	ND
	Mercury	None	0.000002	0.000002
	cPAHs	0.0000048	ND	ND
	Lead	0.015*	0.0002	0.0002

Table 12. Recent Sampling Results, December 2010, for Sediment in On-site Pond (ppm)

	Contaminant	***Comparison Value***	***Min Conc.***	***Max Conc.***
Sediment	PCBs	0.35	0.01	0.14
	Mercury	None	0.03	0.1
	cPAHs	0.096	0.004	0.01
	Lead	None	3	4

*indicates the MCL action level

None of the surface water or sediment concentrations exceeds their applicable comparison value. (Surface water concentrations were compared to drinking water comparison values for conservatism.) Therefore, PCBs and cPAHs in the pond's surface water and sediment will not be evaluated further. The concentrations of mercury (0.004 to 0.01 ppm vs. a background of 0.12 ppm) and lead (3 to 4 ppm vs. a background of 17 ppm) are well below background soil levels (ATSDR 1992); therefore, mercury and lead in sediment will not be evaluated further. Because pond water does not serve as a drinking water source and because the mercury levels are very low, mercury in pond water is not a health concern.

Figure 18. Sampling Locations Showing Concentration of PCBs in Surface Water and Sediment in On-site Pond, 2010

Figure 19. Sampling Locations Showing Concentration of Mercury in Surface Water and Sediment in On-site Pond, 2010

Figure 20. Sampling Locations Showing Concentration of cPAHs in Surface Water and Sediment in On-site Pond, 2010

Figure 21. Sampling Locations Showing Concentration of Lead in Surface Water and Sediment in On-site Pond, 2010

IV.G.2. Adequacy of the sampling in the dry-land area

ATSDR evaluated the adequacy of sampling in the dry-land area of the site. The goal of our evaluation was to determine if the collection of soil samples was adequate for making public health decisions. Our public health decision-making considers all available or proposed uses for the site - residential, commercial and industrial uses.

ATSDR now understands that approximately 32 acres of the dry-land area have been purchased by Glynn County to build a detention center (The Florida Times-Union, 2012) According to the report, a 610-bed detention center will be built on the grounds of the former theater area, which also includes the on-site pond. Using publicly available files, ATSDR was able to approximate the location of the 32 acre detention center facility on the site. The (approximate) prison boundaries are shown in Figures 22 through 25. The area of the detention center will not be evaluated for sampling adequacy because the future land use has already been determined.

Figures 22 through 25 illustrate the areas of the site ATSDR considers to have enough samples to draw health conclusion and which areas do not. Grids shaded in blue are considered to have enough samples to draw a health conclusion. Grids that are not shaded are considered to be under-sampled (i.e., not enough samples taken to make a health conclusion). Generally, ATSDR considered a grid with 3 or more samples to have an adequate amount of samples to make a health call. There are separate sampling adequacy figures for the contaminants of concern - PCBs, cPAHs, mercury and lead.

IV.G.2.a. Dioxin

Generally, the dioxin sampling appears to be adequate to evaluate surface soil (top 3 inches) for the site. However, we do not have adequate sampling from soil below 3 inches. Soils below 3 inches are important because we expect soil at all depths to be moved during future on-site construction activities. Because no samples were collected at depth, it is not possible to evaluate whether dioxin contamination might exist below the surface. The lack of depth samples seems inconsistent with all the other sample designs for the LCP Chemicals Site. For example, recent soil samples collected from the theater area consisted of sample depths 0 to 1 ft. and 2 to 3 ft.

IV.G.2.b. PCBs, Mercury, cPAHs and Lead

Approximately half of the grids are considered sufficiently sampled for making a health conclusion for the chemicals PCBs, mercury, and lead. That means that half of the grids require additional sampling in order to have an adequate amount of samples to make a health determination. For cPAHs, approximately one-third of the grids are sufficiently sampled for ATSDR to make a health conclusion. Most of the insufficiently sampled areas (excluding the area of the proposed detention center) for each chemical of concern is in the southeastern portion of the site. Another area frequently identified as not having

adequate sampling is the western dry-land area closest to the marsh. A possible reason for this is that the TEG data were deemed unusable because of data quality issues.

One reason certain areas may not have been sampled is that LCP Chemicals did not perform industrial activities on that portion of the site. However, LCP Chemicals may have disposed industrial waste anywhere on the property. In addition, numerous other industries existed at this location before LCP Chemicals and those industries may have disposed of waste throughout the property.

Figure 22. Adequacy of Sampling for PCBs in the Dry-land Area

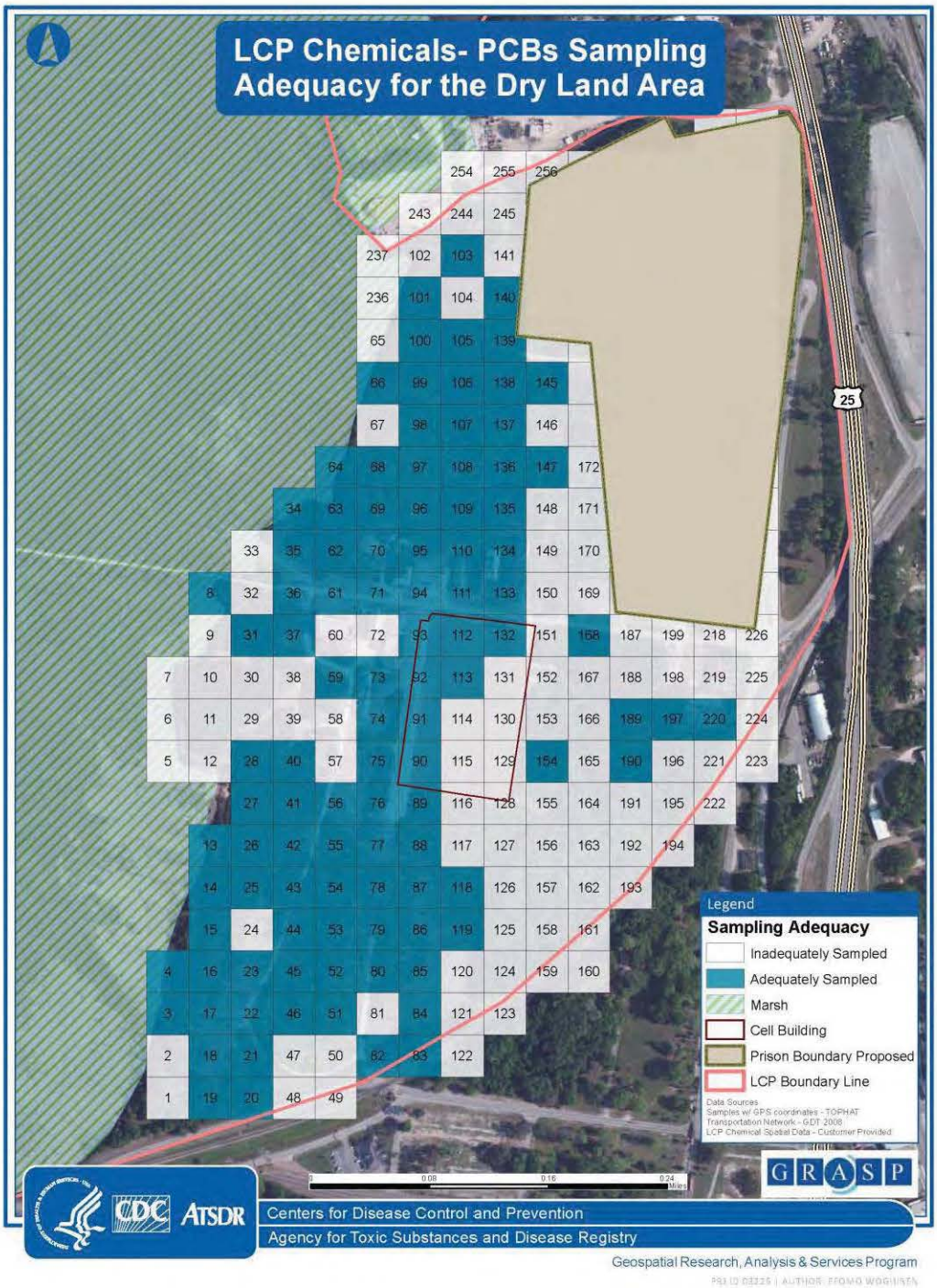


Figure 23. Adequacy of Sampling for Mercury in the Dry-land Area

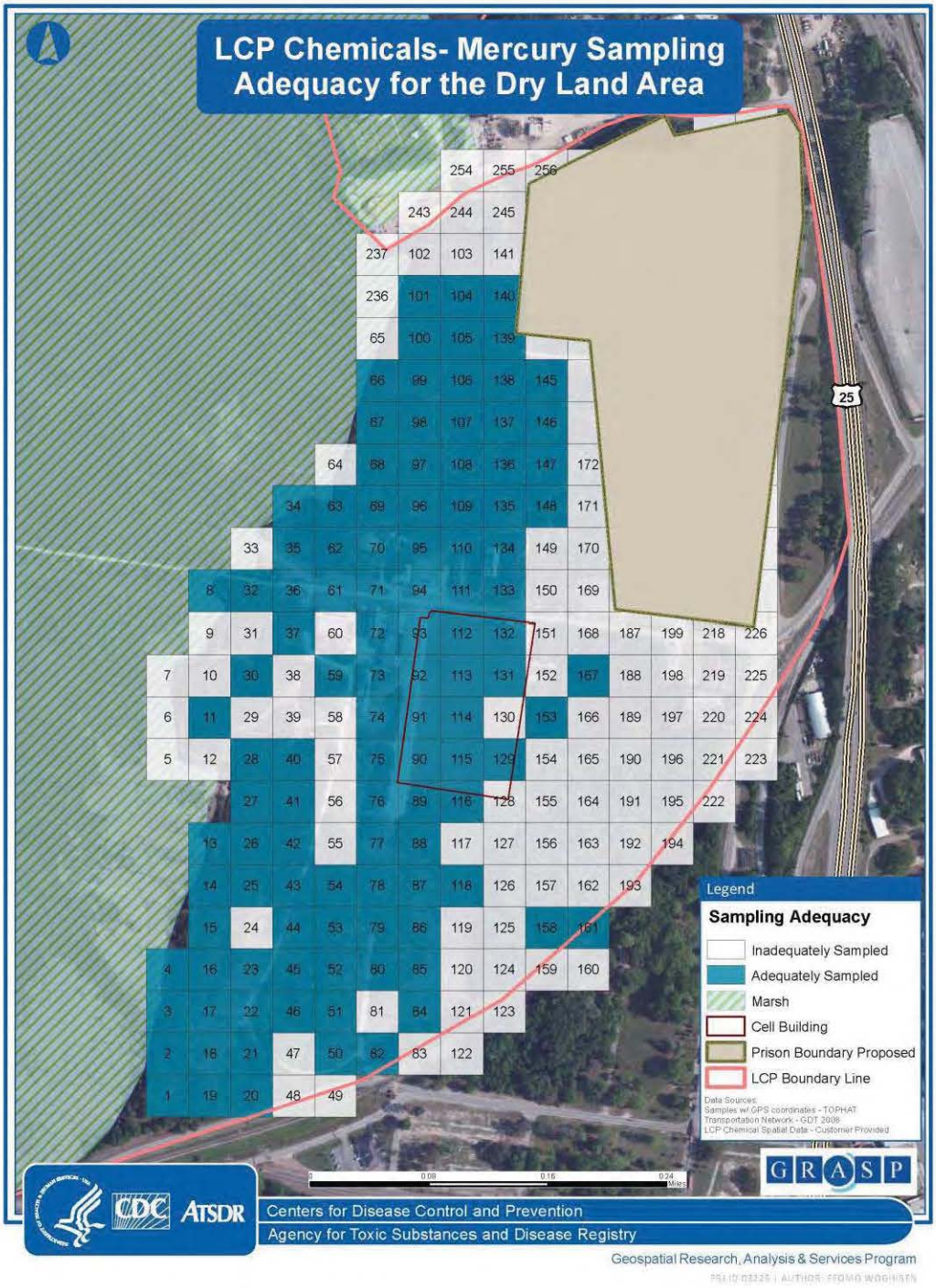


Figure 24. Adequacy of Sampling for PAHs in the Dry-land Area

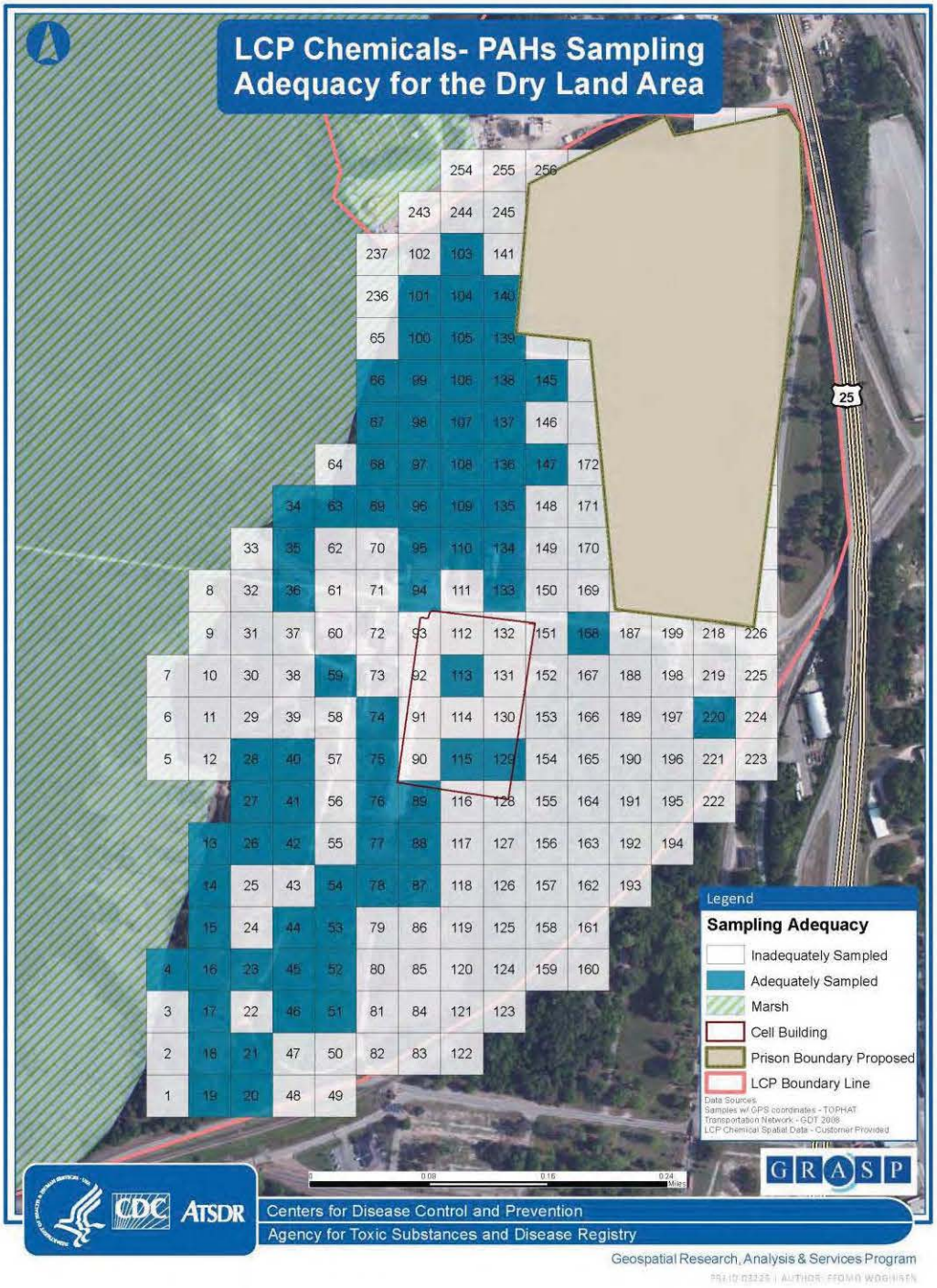
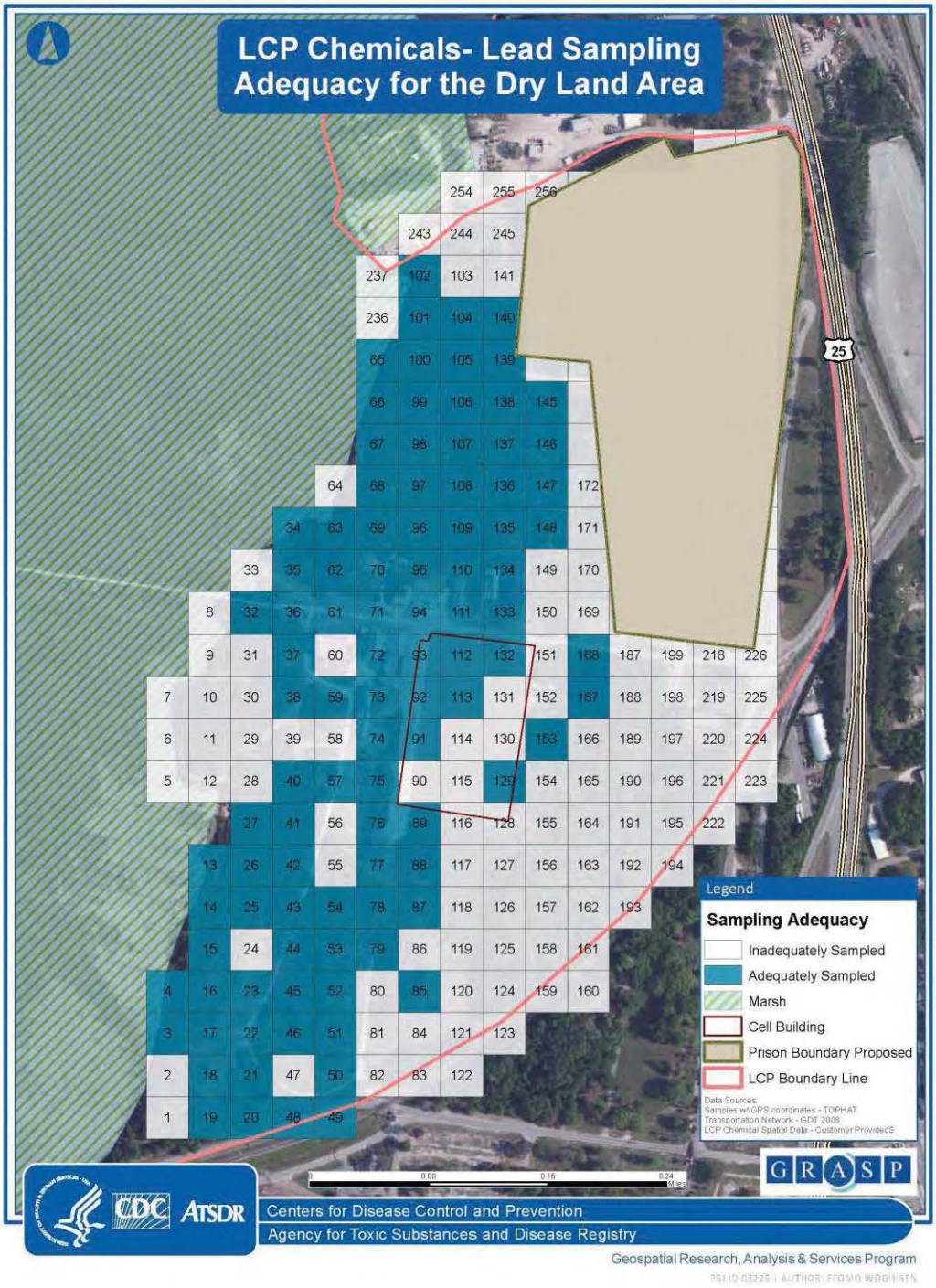


Figure 25. Adequacy of Sampling for Lead in the Dry-land Area



IV.G.3. The Altamaha Canal

In July 2011, Honeywell collected sediment and fish tissue samples from a segment of the former Brunswick-Altamaha Canal ("the Altamaha Canal") south of the LCP Chemical Site (EPS 2011). Honeywell conducted the sampling in response to a recommendation by ATSDR to further characterize the sediment and fish tissue in the Altamaha Canal that lies south of the LCP Chemical site. This section of the canal was identified by ATSDR as a potential pathway for onsite contaminant migration. The sampling was conducted to provide information on the potential for human exposure due to (1) direct contact with contaminants in surface sediments and (2) consumption of contaminated fish or shellfish from the canal.

When the canal was constructed in the mid-1800s, it served as a transportation point between harbors in Brunswick and the Altamaha River, which lies approximately 12 miles to the north (EPS 2011). A portion of the canal once traversed the shoreline area along the western edge of the LCP property but has since been filled in. Today there is no visible presence of the canal on the LCP property. According to Honeywell, there is no direct surface water communication between the LCP marsh and the canal (EPS 2011).

IV.G.3.a. Sediment Sampling

Surficial sediment samples (upper 6 inches) were collected from twenty locations within the canal section between the West 9th Street (northern limit) and the T Street (southern limit). Each sample is comprised of a five-point composite taken along an approximate 1000-ft stretch of the canal. The sampling locations and analytical results are shown in Figures 29 through 33. The sediment sampling results are summarized in Table 13.

Table 13. Recent Sampling Results, July 2011, for Sediment in an Offsite Portion of the Altamaha Canal (ppm)

	Contaminant	*Comparison Value*	*Min Conc.*	*Max Conc.*
Sediment	PCBs	0.35	0.01	**2.3**
	Mercury	5*	0.04	4.96
	cPAHs	0.096†	0.07	**0.69**
	Lead	None	5.82	45.2
	Dioxin	0.000035±	0.000021	**0.000127**

*indicates comparison value for methylmercury
† indicates comparison value for benzo(a)pyrene
±indicates ATSDR's comparison value of 35 ppt for soil

The concentration of lead in sediment from the canal is at or near background lead levels in soils (i.e., 7 ppm) (ATSDR 1992) and the concentration of mercury is below ATSDR's comparison value; therefore, lead and mercury in sediment will not be evaluated further. The levels of PCBs, cPAHs, and dioxin exceed ATSDR's comparison values and therefore will be evaluated further in the public health implications section of this report.

It should be noted that PCBs, specifically Aroclor 1268,were detected in every sediment sample.

It should also be noted that the concentrations of all contaminants (PCBs, mercury, PAHs and lead) except dioxin are higher at the northernmost sampling location, which is also closest to the LCP Chemical site. The general trend is for higher concentrations to be closer to the site (north) and to decrease as the canal flows south. This spatial trend suggests that contaminants might have migrated from the site into the Altamaha Canal.

IV.G.3.b. Fish Tissue Sampling

Fish and shellfish were collected from areas near the southern terminus of the canal (Figure 31) using gill nets, cast nets, and crab traps. Nets were place approximately every 1000 linear feet of canal. The following types and numbers of finfish and shellfish were collected:

- 1 spotted sea trout
- 1 red drum
- 7 striped mullet
- 15 blue crabs
- 108 white shrimp

Three replicate samples from each finfish and shellfish species were tested (except for red drum and spotted sea trout where only one fish of each was caught). Finfish were scaled and filleted; only the edible portion was collected for testing. Shellfish were also processed to remove only edible tissue for testing. Fish tissue samples were analyzed for metals (including mercury and lead), PCBs and PAHs. The results for PCBs and mercury are summarized in Table 14.

It should be noted that Aroclor 1268 was the only PCB congener detected in fish tissue, which suggests that the LCP Chemicals Site is the likely source.

Table 14. Results of Fish and Shellfish Tissue Sampling Altamaha Canal, 2011			
FINFISH	***Contaminant***	***Concentration (µg/kg-ww)****	***No. Fish in Sample***
Red Drum	PCBs (1268)	21	1
	Mercury	88.3	
Striped Mullet	PCBs (1268)	290	3
	Mercury	12.3	
Striped Mullet	PCBs (1268)	260	2
	Mercury	14.9	
Striped Mullet	PCBs (1268)	200	2
	Mercury	12.8	
Spotted Sea trout	PCBs (1268)	81	1
	Mercury	117	
SHELLFISH	***Contaminant***	***Concentration (µg/kg-ww)****	***No. Fish in Sample***
Blue Crab	PCBs (1268)	14	4
	Mercury	67.2	
Blue Crab	PCBs (1268)	21	6
	Mercury	69.2	
Blue Crab	PCBs (1268)	9.4	5
	Mercury	107	
Shrimp	PCBs (1268)	14	36
	Mercury	18.7	
Shrimp	PCBs (1268)	16	36
	Mercury	22.3	
Shrimp	PCBs (1268)	16	36
	Mercury	21.2	

*µg/kg-ww = microgram per kilogram wet weight; dry weight will likely be higher when accounting for the moisture content

Figure 26. Sampling Locations Showing Concentration of PCBs in Sediment in Altamaha Canal, 2011 Just South of the LCP Chemicals Site.

Figure 27. Sampling Locations Showing Concentration of Mercury in Sediment in Altamaha Canal, 2011 Just South of the LCP Chemicals Site.

Figure 28. Sampling Locations Showing Concentration of PAHs in Sediment in Altamaha Canal, 2011 Just South of the LCP Chemicals Site.

Figure 29. Sampling Locations Showing Concentration of Lead in Sediment in Altamaha Canal, 2011 Just South of the LCP Chemicals Site.

Figure 30. Sampling Locations Showing Concentration of Dioxins in Sediment in Altamaha Canal, 2011 Just South of the LCP Chemicals Site.

Figure 31. Sampling Locations for Finfish and Shellfish Collection,
Altamaha Canal South of the LCP Chemicals Site.

V. PUBLIC HEALTH IMPLICATIONS

The public health implication section evaluates whether people's health could be affected should the site become residential or commercial. We know that contact with soil results in soil ingestion that could lead to exposure to contaminants in soil. If that exposure is high enough, it could cause harmful effects in people. This section describes the harmful effects that might be possible from exposure to contaminants in soil. This evaluation was a major component of the public release of the report in September 2010.

Since that time, EPA has collected more soil samples, particularly around the former theater and the pond in the northwest corner of the site. These new data are evaluated for the first time in this report. In addition, EPA collected sediment and fish samples from the Altamaha Canal that exists just south of the LCP site. This section evaluates whether eating fish from the Altamaha Canal might cause harmful effects.

V.A. Soil Ingestion

Children and adults can come in contact with chemicals in soil by accidentally swallowing small amounts of soil that cling to their hands when they put their hands in or near their mouths. This exposure is greatest for preschool children because of their frequent hand-to-mouth activity. When chemically contaminated soil is tracked indoors, people also can be exposed to chemicals by swallowing contaminated dust that clings to their hands. Preschool children, on average, swallow more soil and dust than people in any other age group. This is because some preschoolers often have close contact with soil and dust when they play, and because they tend to engage frequently in hand-to-mouth activity. The amount of soil that people ingest daily is typically somewhere between 30 milligrams to 200 milligrams (ATSDR 2005b; EPA 1997; Calabrese 1997). To put this amount in perspective, it is approximately equal to a pinch (or less than $^1/_{32}$ teaspoon) to $^1/_8$ teaspoon of soil.

V.B. Soil Pica Behavior

Pica behavior, or the eating of non-food items, is well known in children. Children have been observed eating paint chips, matches, paper, clay, soil, and numerous other non-food items. Children who eat large amounts of soil have a behavior called "soil-pica." Soil pica behavior is most likely to occur in preschool children as part of their normal exploratory behavior. Children between the ages of 1 and 2 years have the greatest tendency for soil-pica behavior, and this tendency diminishes as they become older. The exact percentage of children who eat soil is not known. Studies have reported that soil pica behavior occurs in as few as 4 out of every 100 children (i.e., 4%) or in as many as 21 out of every 100 children (i.e., 21%) (Barltrop 1966; Robischon 1971; Shellshear 1975; Vermeer and Frate 1979). A study by ATSDR and the Colorado Department of Health and Environment found 21% of preschool children with soil pica behavior in a predominantly Hispanic population. About 10% of preschool children ate soil within 2

weeks of their parents being interviewed (ATSDR 2005b). Studies on children with soil pica behavior have shown that they can eat up to a teaspoon of dirt (or 5,000 milligrams) (Stanek and Calabrese 2000; Calabrese and Stanek 1993; Calabrese *et al*. 1989; Wong 1988).

Limited information is available concerning how often and how long soil pica behavior occurs in children. Some preschool children might eat soil once during their preschool years, while others might go through a stage of eating soil several times during a week, or even over several months. Soil-pica behavior might occur for several days in a row, or a child might skip days between eating soil (Calabrese and Stanek 1998; Calabrese and Stanek 1993; Wong 1988; ATSDR 2001).

When estimating the intake of chemicals from soil pica behavior, ATSDR estimates a dose assuming that some children eat soil 3 times a week. Because soil pica behavior is habitual, it is reasonable to assume that this behavior can occur for several weeks to several months, especially during late spring, summer and early fall when preschool children might spend more time outdoors (ATSDR 2001).

V.C. Estimating Contact with Chemicals in Soil

As described previously, one way contact with chemicals in soil occurs is from swallowing contaminated soil that clings to a person's hands. The amount of chemical that is swallowed is called a dose. Factors that are important in estimating the dose of chemicals include the following:

- the average concentration of chemicals in soil,
- how much soil is ingested,
- how frequently someone ingests soil, and
- a person's weight.

The following equation is used to estimate chemical dose in people from swallowing soil:

$$\textit{Chemical dose} = \frac{\textit{(chemical concentration in soil, mg/kg)x(mg soil swallowed)x(exposure frequency)x(0.000001 kg/mg)}}{\textit{person's weight in kg}}$$

The resulting chemical dose is milligrams of chemicals per kilogram body weight per day or milligram per kilogram per day (mg/kg/day). A range of chemical doses are possible because different values can be used for various parameters in the equation. For example, the amount of soil ingested varies from about 100 mg for a typical child, to 200 mg for some children, and to 5,000 mg for children with soil pica behavior (ATSDR 2005b; ATSDR 2001; Calabrese 1997). Weight can also vary from 10 kg for a 1-year-old child to 35 kg for elementary age children, and 60 kg for women to 70 kg for men. Since site-specific information is usually not available, we assume that all of the chemical that is swallowed will cross the gut into the body. Therefore, because of differences in weight

and differences in soil intake, the estimated dose of a chemical can vary within an age group and between age groups.

The resulting dose is milligram chemicals per kilogram body weight per day (mg/kg/day). When very small doses are calculated it is often easier to view the doses as micrograms chemicals per kilogram body weight per day (µg/kg/day). A microgram is one-thousandth of a milligram. Therefore, an estimated dose of 0.005 mg/kg/day is the same as 5 µg/kg/day. Most of the doses in this report are presented as µg/kg/day.

To determine whether harmful effects might be possible from ingesting contaminated soil, ATSDR compares the estimated chemical dose to the Agency's "health guideline" dose for that chemical. ATSDR's health guidelines are called Minimal Risk Levels (MRLs) and they are developed for three exposure periods: acute (less than 2 weeks), intermediate (2 weeks to 1 year), and chronic (1 year or more). MRLs are available for oral exposure and for inhalation exposure. We will use the chronic, oral MRL as a guide because the principle route of exposure at the LCP Chemicals site is from swallowing soil and because residential exposures are likely to occur for many years. When appropriate, we may use the acute and intermediate MRLs as a guide, for instance, when evaluating worker exposures that take place for periods less than a year.

An MRL is a chemical dose below which noncancerous harmful effects are not expected. It is important to remember that MRLs cannot be used to evaluate cancer. Cancer risk is evaluated using another method, which will be explained later in the public health assessment. MRLs are derived by reviewing animal and human studies to identify either the lowest level known to cause harmful effects or identifying a level that will not cause harmful effects. Most MRLs are set anywhere from 3 to 1000 times below these effect or no effect levels. Therefore, when an MRL is exceeded, it does not mean that harmful effects will occur but rather that more toxicological evaluation is needed to determine if harmful effects might be expected. This additional toxicological evaluation involves comparing the estimated chemical dose to effect and no effect levels and reviewing additional toxicological information to decide if harmful effects might be expected.

A useful tool in deciding if the estimated dose exceeds an oral MRL or some other health guideline is the use of hazard quotients (HQ). An HQ is a number that shows whether the MRL has been exceeded. If the HQ is greater than 1, then the estimated dose for a chemical exceeds the MRL and further toxicological evaluation is needed. If the HQ is less than one, the estimated dose for a chemical is below the MRL and non-cancerous harmful effects are not expected. Using the HQ allows the reader to look at a table showing multiple dose estimates for various age groups and to easily see if the estimated doses are greater than or lower than the MRL.

The formula for determining the HQ follows:

$$HQ = \frac{\textit{estimated dose of a chemical in mg/kg/day}}{\textit{MRL in mg/kg/day.}}$$

The same HQ can be calculated by using the estimated dose in µg/kg/day and converting the MRL to µg/kg/day.

V.D. Uncertainty in Deciding Harmful Effects

Some uncertainty exists in deciding whether harmful effects are expected because uncertainty exists in estimating the chemical dose in people. This uncertainty exists because we are not sure exactly how much soil people ingest daily, although we have a fairly good idea. As mentioned previously, most children swallow about 100 milligrams of soil and dust daily while some children may swallow up to 200 mg daily. Similarly, adults may swallow only a few milligrams of soil and dust daily or they may swallow 100 mg or more, for instance, if they have frequent contact with soil from yard work or gardening. Uncertainty also comes from deciding the body weight to use for various age groups. In addition to these factors, uncertainty comes from deciding the chemical concentration in soil to use in estimating dose. These uncertainties result in a range of doses that can be estimated for various age groups. One way to encompass this uncertainty is to use average values to estimate the dose to get an estimated dose that represents exposure for most people. For example, to estimate the chemical dose for most children, ATSDR uses 100 milligrams of soil and dust ingested daily. Because ATSDR wants to protect all people from harmful chemicals, it is possible to estimate the highest dose that might be expected in a population. For example, ATSDR uses 200 milligrams of soil and dust ingested daily to represent the chemical dose in the small percentage of children with high soil intake. This dose is presented in the tables.

In addition to the uncertainty that comes from estimating a chemical dose, uncertainty could exist in the human and animal studies that identify the doses that cause harmful effects or the doses that cause no harmful effects. This uncertainty varies with each chemical. When an MRL is exceeded or if an MRL is not available, the estimated chemical dose in people is compared to the doses from human and animal studies that cause harmful effects and to doses that show no effect. This comparison along with a review of other information in ATSDR's chemical-specific toxicological profile is used to decide what harmful effects might be expected.

Uncertainty also exists that is specific to the LCP Chemicals Site. First, uncertainty exists from using soil samples that were collected 15 years ago. These soil samples may not represent current conditions at the site. Second, uncertainty also comes from not knowing how much chemical contamination below the surface will actually become surface soil during construction activity. And lastly, some 1990's data were not useable because of data quality issues, thus not only were fewer samples available but also this made some areas of the site inadequately sampled.

V.E. Background Information About Cancer

Cancer is a complex subject and some background information is provided before discussing cancer evaluations of specific chemicals. The probability that residents of the

United States will develop cancer at some point in their lifetime is 1 in 2 for men (44.9 %) and 1 in 3 (38.5%) for women. Stated another way, half of all men and one-third of all women will develop cancer in their lifetime (ACS 2009). This probability is based on medical data collected on all types of cancer, regardless of whether the cause was identified, the case was successfully treated, or the patient died (directly or indirectly) from the cancer.

Factors that play major roles in cancer development include:

- Lifestyle (what we eat, drink, smoke; where we live);
- Natural (including sunlight) and medical radiation;
- Workplace exposures;
- Drugs;
- Socio-economic factors; and
- Chemicals in our air, water, soil, or food.

Infectious diseases, aging, and individual susceptibility, such as genetic predisposition, are also important factors in cancer development (ATSDR 2000, ACS 2009, NTP 2005).

We rarely know environmental factors or conditions responsible for the onset and development of cancer. For some occupational exposures or for the use of specific drugs, we do have some understanding of cancer development (Tomatis *et al*. 1997). Overall cancer risks can be reduced by eating a balanced diet, getting regular exercise, having regular medical exams, and avoiding high risk behaviors, such as tobacco use and excessive alcohol consumption. Proper safety procedures, appropriate personal protective equipment, and medical monitoring programs can decrease cancer risks in the workplace (ACS 2009).

V.E.1. How to estimate and interpret cancer risk

The EPA has a method for estimating the cancer risk from chemical exposure. The cancer risk is estimated by multiplying the estimated dose for a population by what is called a cancer slope factor. The resulting number is an estimate of the number of cancers in a population over a lifetime that might result from the chemical exposure. The equation for estimating cancer risk follows:

Cancer risk = estimated lifetime dose x cancer slope factor

The resulting risk of cancer is called an excess cancer risk because it is the risk of cancer above the already existing background risk of cancer discussed above.

This additional cancer risk estimate from chemical exposures is often stated as 1×10^{-4}, 1×10^{-5}, or 1×10^{-6} (or 1E-4, 1E-5, or 1E-6). Using 1×10^{-6} (or 1E-6) as an example, it means that a population of one million people exposed to a carcinogen over a lifetime (70 years) at a specific dose may have one additional case of cancer because of the exposure. This estimated cancer risk is in addition to the 412,000 cases expected in

this population of 1 million men and women over a lifetime. The “one-in-a-million” risk level is generally regarded as a low risk. If the exposed population is small, it is difficult to prove that cancer cases in a community are the result of chemical exposures, especially given the large number of people that get cancer from other causes.

An estimated additional cancer risk of 1×10^{-4} means that a population of 10,000 people exposed for a lifetime (70 years) at a certain chemical dose may have one additional cancer case. This one case is in addition to the 4,120 cases expected in this population of 10,000 men and women over a lifetime. This risk is 100 times higher than the one in a million risk described in the previous paragraph. Although a “one-in-ten thousand” risk level may be viewed as a high increased risk, it is good to understand the exposure assumptions that went into estimating this risk.

Mathematically, the excess cancer risk is an estimate of the 95% upper confidence limit of additional cancer risk for adults or children with similar exposures. For this reason, the risk is presented as the number of cancers that might occur in a large number of people (e.g., 10,000, 100,000 or 1,000,000) with similar exposures. The true risk is not known, but will likely be lower. When we talk about the additional or excess cancer risk, we mean the risk above and beyond what is considered background or normal. It is important to remember that we cannot determine an individual’s cancer risk but rather the estimated cancer risk refers to the risk for a population of people with similar chemical exposure.

V.F. Chemical-specific evaluations

As mentioned previously, ATSDR is concerned about people’s contact with soil if land on the LCP Chemicals Site is developed in the future as residences or as commercial or industrial businesses. If a home or business is built on certain grids, contaminated soil from various depths could be moved so that contaminants are now at the surface. It is not possible to predict the concentration of contaminants at the surface from future soil movement. Therefore, ATSDR used the current contaminant soil concentration from samples up to 5 feet below the surface to estimate an average contaminant concentration for a grid. The groundwater at the site is approximately 5 ft. below ground surface. In addition to looking at contamination from 0 to 5 ft. in depth, ATSDR estimated contaminant concentration from 0 to 2 ft. in depth. The reasons for looking at this depth are (1) contaminant concentrations might be different in the top few feet, and (2) construction activity might be limited to a more shallow depth. The following chemical-specific subsections describe ATSDR’s evaluation of each chemical of concern for these two scenarios, residences and businesses.

V.F.1. Polychlorinated Biphyenls

V.F.1.a. ATSDR’s Health Guideline for PCBs

ATSDR has a chronic oral MRL of 0.00002 milligram per kilogram per day (mg/kg/day), which is the same as 0.02 microgram per kilogram per day (µg/kg/day). When deriving

an MRL, ATSDR scientists review the toxicological literature to identify the lowest doses in either animals or humans that cause harmful effect. These doses are referred to as the lowest observed adverse effect level (LOAEL). When appropriate, ATSDR scientists select one of these LOAELs to derive the MRL. For some chemicals, the MRL is derived from a dose that does not cause harmful effects. This dose is referred to as the no observed adverse effect level (NOAEL). For PCBs, ATSDR derived the chronic oral MRL from a LOAEL identified in a monkey study. The lowest dose identified to cause harmful effects in monkeys' immune system is 0.005 mg/kg/day (or 5 µg/kg/day). Monkeys who were exposed daily to this PCB dose for 23 months showed reduced antibody response when the monkeys were injected with sheep red blood cells. To derive the chronic MRL, ATSDR divided the LOAEL of 5 µg/kg/day by an uncertainty factor of 300, which resulted in 0.016 µg/kg/day. This dose was rounded to 0.02 µg/kg/day and became the chronic oral MRL.

For now, it is important to know that estimated PCB doses in people who come in contact with LCP soils will be compared to ATSDR's chronic oral MRL for PCBs of 0.02 µg/kg/day.

V.F.1.b. Estimating Human Doses of PCBs and PCB Hazard Quotients

As mentioned previously, doses were estimated using a range of soil ingestion rates for various age groups. Preschool children were assumed to swallow 200 milligrams of soil daily, while elementary-age children, teenagers, and adults were assumed to swallow 100 milligrams of soil daily. Average body weights were selected for each age group. These and other parameters used to estimate PCB doses in people are shown in Appendix B, Table B1.

The estimated dose of total PCBs for each age group is shown in Table 15 for various PCB average concentrations ranging from 1 ppm to 139 ppm. The resulting estimated dose is presented as micrograms total PCBs per kilogram body weight per day (or µg/kg/day). The estimated dose of total PCBs ranges from 0.001 µg/kg/day in adult men who have daily contact with 1 ppm total PCBs in soil to 2.78 µg/kg/day in 1-year-old children who have daily contact with 139 ppm total PCBs in soil.

As mentioned previously, the PCB HQ is an easier way to determine if the estimated dose is less than or greater than the chronic MRL. The PCB HQ was derived by dividing the estimated PCB dose by the chronic oral MRL of 0.02 micrograms/kg/day. The PCB HQs for various age groups are shown in Table 16 for average soil concentrations of 1, 5, 10, 25, 50 and 139 ppm total PCBs. These PCB HQs are for the people in each age group with high soil intake who might live in a grid having the specified average PCB concentration. People in each group with average or typical soil intake have PCB HQs that are about 2 to 4 times lower than people with high soil intake.

Table 15. Chronic estimated doses for total PCBs by age group for total PCB concentrations ranging from 1 ppm to 139 ppm.						
Age Group	*Average Total PCB Concentrations in ppm*					
	1	*5*	*10*	*25*	*50*	*139*
	Chronic estimated dose in µg/kg/day					
Preschool children (1 yr.)	0.020	0.10	0.20	0.50	1.0	2.78
Preschool children (3 yr.)	0.01250	0.0625	0.125	0.3125	0.625	1.7375
Elementary school children	0.00286	0.01429	0.02857	0.07143	0.14286	0.39714
Teenagers	0.00182	0.00909	0.01818	0.04545	0.09091	0.25273
Adult men	0.00143	0.00714	0.01429	0.03571	0.07143	0.19857
Adult women	0.00167	0.00833	0.01667	0.04167	0.08333	0.26806
Chronic oral MRL in µg/kg/day	0.02	0.02	0.02	0.02	0.02	0.02

Table 16. PCB HQs for total PCB soil concentrations ranging from 1 ppm to 139 ppm.						
Age Group	*PCB Concentrations in ppm*					
	1	*5*	*10*	*25*	*50*	*139*
	Chronic PCB HQ					
Preschool children (1 yr.)	1	5	10	25	50	139
Preschool children (3 yr.)	0.6	3	6	16	31	87
Elementary school children	0.10	0.7	1	4	7	20
Teenagers	0.10	0.5	0.9	2	5	13
Adult men	0.07	0.4	0.7	2	4	10
Adult women	0.08	0.4	0.8	2	4	12

The resulting PCB HQs shown in Table 16 vary by age group and by PCB soil concentration. Whenever the PCB HQ is below 1, then the estimated dose is below the chronic oral MRL and non-cancerous harmful effects are not expected. When the PCB HQ exceeds 1, then the estimated dose exceeds the chronic oral MRL. What follows is brief summary of the PCB HQs shown in Table 16:

- For one-year-old children with high soil intake, the PCB HQ is 1 when PCB concentrations are 1 ppm. For grids that have an average concentration of 5, 10, 25, 50, or 139 ppm, the PCB HQ for 1-year-old children with high soil intake is 5, 10, 25, 50, or 139, respectively.
- For 3-year-old children with high soil intake, the PCB HQ is below 1 when average PCB soil concentrations are 1 ppm. The PCB HQ is 3, 6, 16, 31, and 87 when average soil concentrations are 5, 10, 25, 50, and 139, respectively.
- For elementary age children with high soil intake, the PCB HQ is below 1 for average PCB concentrations of 1 and 5 ppm. The PCB HQ is 4, 7, and 20 when average soil concentrations are 25, 50, and 139 ppm, respectively.
- For adults, the PCB HQ is below 1 for average PCB concentrations of 1, 5, and 10 ppm. The PCB HQ is 2, 4, and 12 when average soil concentrations are 25, 50, and 139 ppm, respectively.

The PCB HQs described previously are shown graphically in Figure 32. The PCB HQs show that as average total PCB concentrations for a grid exceed about 5 ppm in soil, the PCB HQs for preschool children exceed ATSDR's chronic oral MRL. As average total PCB concentrations exceed about 25 ppm, the PCB HQs for older children and adults exceed ATSDR's chronic oral MRL. Depending on the average total PCB concentration for a grid, the PCB HQ for various age groups exceeds ATSDR's oral MRL for PCBs, thus prompting a more thorough toxicological evaluation to determine if harmful effects are expected.

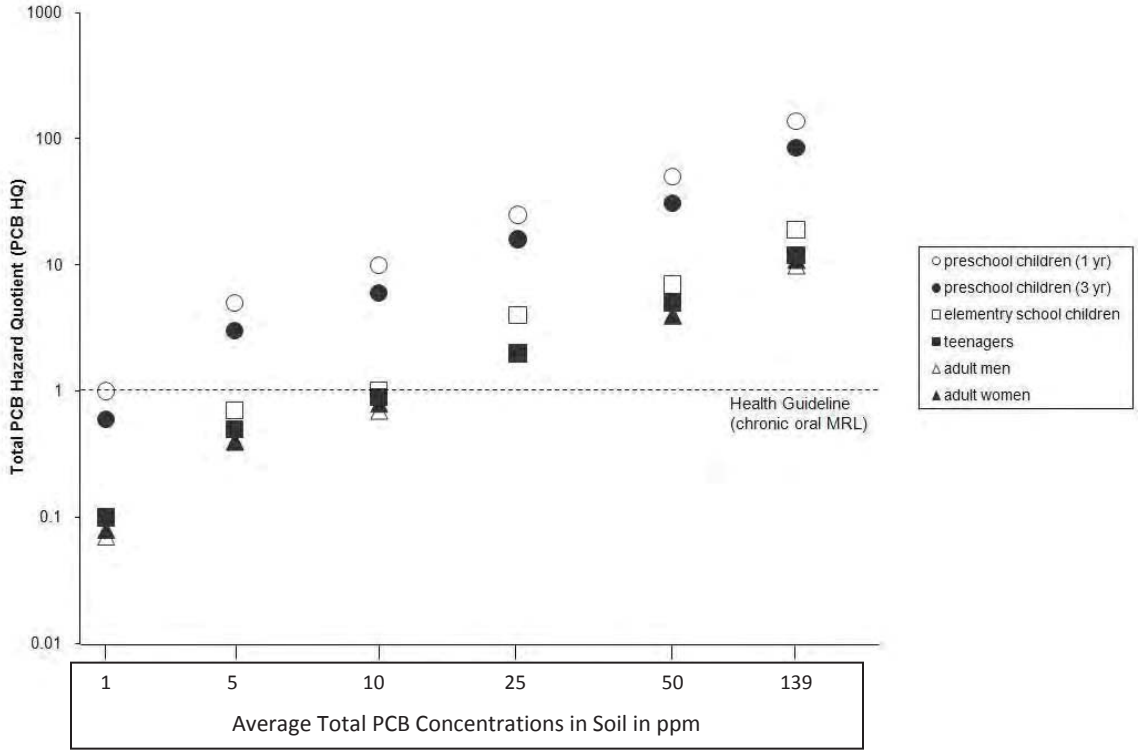


Figure 32. The Total PCB hazard quotient (PCB HQ) for various age groups are shown for average soil concentrations ranging from 1 ppm to 139 ppm. The hazard quotient is an indicator of where the estimated dose is in relation to ATSDR's health guideline for PCBs (i.e., the chronic MRL). When the HQ is below 1, the estimated dose is below ATSDR's chronic oral MRL for PCBs and harmful effects are not expected. Whenever the HQ is greater than one, which is the case for preschool children when average PCB levels exceed 5 ppm in soil, then a more thorough toxicological evaluation is needed to decide if harmful effects might be expected. As average PCB soil concentrations exceed 25 ppm, all age groups have PCB HQs that exceed one.

V.F.1.c. Human Studies and PCBs

As part of a more thorough toxicological evaluation, ATSDR will describe the human and later the animal studies that show the harmful effects of PCBs. This review is not an

exhaustive review of the known harmful effects of PCBs but rather focuses on the lowest PCBs doses that cause harmful effects. These studies are more relevant to deciding what harmful effects might be expected in a human population exposed to low levels of PCBs from the environment.

Recent human studies have shown that small increases in serum PCBs are associated with harmful effects in people involving the reproductive, immune, cardiovascular, and neurological systems. Table B2 in Appendix B summarizes these studies. Specific information about each study follows.

1. The results of a prospective health study showed a 33% reduction in male births for women at the 90^{th} percentile compared to women at the 10^{th} percentile for serum PCB levels. Thus, women with higher PCB levels are more likely to have female children. The authors concluded that each 1 part per billion (ppb) increase in serum PCBs was associated with a 7% decrease in the number of male births. Mean serum (whole-weight) PCB levels were 5.4 ppb with a range of 3.1 ppb to 8.7 ppb for the 10^{th} and 90^{th} percentile, respectively. The authors caution that the findings could be due to other contaminants, metabolites, or PCBs (Hertz-Picciotto 2008).

2. Increasing serum (whole-weight) PCB levels were associated with slightly longer menstrual cycles, increasing the cycle by about a day. The authors stated weaker associations were found for serum PCB levels and irregular menstrual cycles. Serum PCB levels ranged from less than 1 ppb to greater than 5 ppb, and the effect appears in the groups with PCB levels greater than 3.75 ppb. The authors point out that an important limitation to the study is recall bias since women had to answer questions about their menstrual cycles (Cooper 2005).

3. Other human studies have shown lower birth weight for infants exposed during pregnancy via maternal body burdens of PCBs. In one study, this effect persisted to age 4 for children with the highest PCB exposure. Reduced weight persisted in another study in infants at 3 months of age. The consistency with which this finding has been demonstrated strengthens the position that PCBs cause developmental effects. It should be pointed out that birth weight is a sound indicator of newborn development and health (ATSDR 2000).

4. Cord blood PCB levels at birth was associated with impaired learning of a performance task in nine-year-old children. Low-level PCB exposure results in an inability to withhold or delay inappropriate responses, which is a measure of attention and impulse control. Mean cord PCBs levels were 1 ppb. Similar effects were seen in children with lead exposure (mean blood lead level = 4.6 µg/dL) and methyl mercury exposure (mean hair = 0.56 ppm) (Stewart 2006).

5. Serum (lipid-standardized) PCBs were associated with prevalence of cardiovascular disease in women (but not men). Lipid-standardized serum PCB levels ranged from less than 141 ppb to greater than 651 ppb (Ha 2007).

6. Using job characteristics as an indicator of PCB exposure, women (but not men) with the highest suspected PCB exposure had excess mortality from Parkinson disease (SMR = 2.96, CI = 1.08-6.42) and dementia (SMR = 2.04, CI = 1.12-3.42) (Steenland 2006).

7. A two-fold increased incidence of adult-onset diabetes in women (but not men) was associated with higher serum (whole-weight) PCB levels ranging from 5 ppb to greater than 10 ppb. The increased incidence of diabetes was observed in the people with serum PCB levels greater than 5.1 ppb compared to people with serum PCB levels below 5 ppb (Vasiliu 2006).

8. Diabetes

   About 1 out of every 12 Americans (or 23 million) has diabetes, a disease in which the body does not produce or properly use insulin. Insulin is a hormone that is needed to convert sugar, starches and other food into energy the body needs to function properly. About 1 in 5 Americans (or 57 million) have pre-diabetes, a condition that occurs when a person's blood sugar levels are higher than normal but not high enough for a diagnosis of diabetes.

   The cause of diabetes continues to be a mystery, although both genetics and environmental factors appear to play roles. Certain risk factors have been shown to be associated with diabetes. People who are overweight or obese or who are physically inactive are more likely to develop diabetes. Diabetes also leads to unhealthy cholesterol levels, which can affect people’s cardiovascular health, leading to hardening of the arteries and heart disease. People also have inherent risk factors that might increase their risk of diabetes. These factors include age, race, gender, and family history (American Diabetes Association 2009).

   In addition to these risk factors, some chemicals, such as PCBs, have been associated with diabetes. As mentioned previously, a two-fold increased incidence of adult-onset diabetes in women (but not men) was associated with higher serum (whole-weight) PCB levels ranging from 5 ppb to greater than 10 ppb. The increased incidence of diabetes was observed in people with serum PCB levels greater than 5.1 ppb compared to people with serum PCB levels below 5 ppb (Vasiliu 2006).

   People with diabetes also are sensitive to air pollution found both indoors and outdoors. Breathing in harmful particles from air pollutants (for example, vehicle exhaust, industrial emissions, and haze from burning fossil fuels) may increase their risk of heart attack and stroke. A recent study found that in adults living with diabetes the ability of their blood vessels to control blood flow was decreased on days with high particulate matter pollution in the air. Decreased blood flow has been associated with an increased risk of heart attack, stroke, and other heart problems. Other studies have shown that when air pollution levels are high,

people with diabetes have higher rates of hospitalization and death related to cardiovascular problems (EPA 2009d, Goldberg 2001, Zanobetti 2002).

Numerous other human studies have shown an association with PCB exposure and adverse effects, including effects on fertility, growth and development, the immune system and the nervous systems. These studies are described in ATSDR's Toxicological Profile for Polychlorinated Biphenyls and the World Health Organization's (WHO)Concise International Chemical Assessment 55, Polychlorinated Biphyenyls (ATSDR 2000, WHO 2003).

V.F.1.d. Animal Studies and PCBs

Numerous studies have demonstrated that PCBs will cause harmful effects in monkeys at low levels (ATSDR 2000). These studies, many of which are described in ATSDR's Toxicological Profile for PCBs, are summarized in Table B3 in Appendix B.

The most sensitive endpoints identified in animal studies showed developmental, immunological, and dermal effects in monkeys at daily doses of 5 μg/kg/day to 7.5 μg/kg/day. The exposure duration for most of these monkey studies was 23 to 72 months, although one study showed neurological effects in infant monkeys after 5 months exposure. At slightly higher daily doses (i.e., 20 to 40 μg/kg/day), PCBs caused fetal and post-partum deaths in pregnant monkeys along with significantly reduced conception rate and decreased serum cholesterol (ATSDR 2000). The specific effects are described below.

V.F.1.d.1. Immune System Effects in Animals

Low-level PCB exposure in monkeys showed reduced IgM and IgG antibody and a temporary reduction in B lymphocytes in response to sheep red blood cells. While this effect was observed at a daily dose of 5 μg/kg/day Aroclor 1254[1] in monkeys, this and other immunological effects are observed at higher doses. For example, at a daily dose of 200 μg/kg/day Aroclor 1248 for 11 months, monkeys showed decreased anti-SRBC hemolysin titers. At a daily dose of 800 μg/kg/day in guinea pigs for 8 weeks, guinea pigs showed decreased gamma globulin-containing cells in lymph nodes. At very high doses (500 to 1,300 μg/kg/day) ranging from 1 to 6 months, mice showed increased susceptibility to leukemia virus and increased sensitivity to bacterial endotoxin (ATSDR 2000).

V.F.1.d.2. Skin Effects in Animals

Low-level PCB exposure in monkeys at 5 μg/kg/day exposed for 72 months has been shown to damage fingernails and toenails. At slightly higher doses (e.g., 100 μg/kg/day for 2 months), harmful effects in monkeys included facial edema, acne, inflammation of

[1] Aroclor 1254 is a commercial mix of various PCB compounds with an average chlorine content of 54%.

hair follicles, and hair loss. Longer exposure at 100 µg/kg/day in monkeys also caused fingernail loss and cellular changes in the gums (ATSDR 2000).

V.F.1.d.3. Developmental Effects During and After Pregnancy in Animals

Developmental effects refer to effects that occur during gestation and following birth as the infant grows. In animals, lower birth weight and hyperpigmentation of the skin was reported in offspring of monkeys treated before mating and during gestation with 30 µg/kg/day Aroclor 1016. Similarly, monkeys exposed during pregnancy to 5 µg/kg/day (Aroclor 1254) and via breast milk after birth for 22 weeks resulted in offspring with inflamed and enlarged tarsal glands[2], as well as nail and gum lesions (ATSDR 2000).

V.F.1.d.4. Neurological Effects in Animals

PCB exposure in juvenile monkeys for 20 weeks at a daily dose of 7.5 µg/kg/day showed changes in behavioral performance in non-spatial and spatial discrimination reversal tasks. Specifically, treated monkeys showed decreases or variable increases in response latencies across three tasks of non-spatial discrimination reversal as well as retarded acquisition of a delayed alternation task and increased errors at short delay task responses. The study investigators interpreted these findings as a learning and performance decrements. Interestingly, the resulting serum PCB levels after 20 weeks of exposure was 1.8 ppb to 2.8 ppb, levels similar to what is found in the general US population (ATSDR 2000).

V.F.1.d.5. Summary of Health Effects in Humans and Animals

In summary, low-level PCB exposure at 5 to 7.5 µg/kg/day in animals can be expected to cause the following harmful effects:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession, and
- Learning and performance decrements.

In addition, recent human studies have shown that small increases in serum PCB levels are associated with the following:

- Fewer male births,
- Problems with attention and impulse control in children
- Lower birth weight in children,

[2] The tarsal glands (or meibomian glands) are a special kind of sebaceous glands at the rim of the eyelids. They supply sebum, an oily substance that stops evaporation of the eye's tear film, prevents tear spillage onto the cheek, and makes the closed lids airtight. Glands are located on the upper and lower eyelids.

- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women (but not men),
- Increased death from Parkinson disease and dementia in women (but not men), and
- An increase in diabetes in women (but not men).

Unfortunately, it is not possible to assign daily PCB doses to these human studies. Some insight into daily doses might be gleaned from Rice's and Hayward's monkey studies. In a 20 week exposure study, infant monkeys were dosed daily at 7 µg/kg/day. The PCB mixture consisted of congeners that are commonly found in human breast milk. After 20 weeks exposure, PCB levels were 1.7-3.5 ppm in fat and 1.8–2.8 ppb in blood. These levels (1.8–2.8 ppb) are very similar to blood levels (0.8–1.5 ppb) that are typically found in the US general population who do not frequently eat fish (ATSDR 2000). Therefore, the dose of 7 µg/kg/day can be considered an environmentally relevant dose for humans.

V.F.1.e. Groups with Increased Sensitivity to PCBs

Other subpopulations that are potentially more susceptible to PCBs include people with incompletely developed glucuronide conjugation mechanisms (Calabrese and Sorenson 1977; Lester and Schmid 1964), such as people with Gilbert's Syndrome. Gilbert's Syndrome is a relatively common and benign congenital liver disorder that is characterized by mild, fluctuating increase in serum bilirubin, and is estimated to occur in 3–7% of the adult population (American Liver Foundation 2000). Persons with hepatic infections may have decreased glucuronide synthesis, making them more sensitive because of their decreased capacity to detoxify and excrete PCBs (Calabrese and Sorenson 1977). People with compromised liver function, such as in the case of liver cirrhosis or hepatitis B, also could be considered to be more susceptible to PCB toxicity (ATSDR 2000).

V.F.1.f. Uncertainty About the Toxic Effects of PCBs

Some uncertainty exists when deciding whether PCBs are harmful to humans because commercial mixtures of PCBs are made of different combinations of the 209 PCB chemicals. The basic structure of PCBs is a biphenyl ring, which can have from 1 to 10 chlorine molecules attached, thus the name polychlorinated biphenyl. Commercial mixtures of PCBs are classified into several groups depending upon the percent chlorination of the biphenyl compound. One common commercial name used in the U.S. is Aroclor, which is followed by a four digit number that represents the percent chlorine by weight. Examples of commonly produced Aroclors and the average chlorine content are as follows:

Aroclor 1016	42% chlorine
Aroclor 1232	32% chlorine
Aroclor 1242	42% chlorine
Aroclor 1248	48% chlorine
Aroclor 1254	54% chlorine
Aroclor 1268	68% chlorine.

Many of the animal studies use one of these commercial Aroclor mixtures to assess PCB toxicity. For chronic exposures greater than 1 year, the lowest level known to cause harmful effects in monkeys (i.e., 5 µg/kg/day) used Aroclor 1254; therefore, some uncertainty exists when using this value to assess the harmful effects of other Aroclor mixtures. A slightly different situation exists for intermediate exposures of two weeks to one year. The basis for the lowest dose known to cause harmful effects in monkeys (7.5 µg/kg/day) used a mixture of PCBs that simulated breast milk. The next lowest intermediate dose known to cause harmful effects is 100 µg/kg/day. Aroclor 1242, Aroclor 1248, and Aroclor 1254 cause harmful effects at this dose.

Additional uncertainty exists when deciding if harmful effects might be expected because very little toxicological information is available on Aroclor 1268; therefore, ATSDR relied upon toxicological information available on the other Aroclors, particularly Aroclor 1254.

V.F.1.g. Possible Health Effects from PCBs If the Site Becomes Residential

The estimated doses in various age groups with high soil ingestion have already been presented in Table 15, which is repeated here. Because the doses are small, the table shows estimated PCB doses in micrograms/kg body weight/day or µg/kg/day. For comparison, ATSDR's chronic oral MRL for PCBs also is shown in µg/kg/day.

Table 15. Chronic estimated doses for total PCBs by age group for total PCB concentrations ranging from 1 ppm to 139 ppm.

Age Group	***PCB concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Chronic estimated dose in ug/kg/day					
Preschool children (1 yr.)	0.02	0.1	0.2	0.5	1.0	2.78
Preschool children (3 yr.)	0.013	0.063	0.13	0.31	0.62	1.74
Elementary school children	0.003	0.014	0.029	0.071	0.14	0.4
Teenagers	0.002	0.009	0.018	0.045	0.091	0.25
adult men	0.001	0.007	0.014	0.036	0.071	0.2
adult women	0.002	0.008	0.017	0.042	0.083	0.23
Chronic oral MRL in µg/kg/day	0.02	0.02	0.02	0.02	0.02	0.02

Depending on the age group and the average PCB concentration in a grid, estimated doses range from well below 0.02 µg/kg/day (i.e., the chronic MRL) to the highest dose of 2.78 µg/kg/day in one-year-old children who live on soil containing 139 ppm total PCBs.

Because some estimated doses exceed ATSDR's chronic oral MRL of 0.02 µg/kg/day, it is necessary now to compare those doses to doses that cause harmful effects to decide if harmful effects might be expected.

Figure 33 shows the estimated doses in various age groups that exceed the chronic oral MRL. These doses are shown in relation to doses in monkey studies that are known to cause harmful effects. The highest estimated dose is 2.8 µg/kg/day in one-year-old children and this dose is roughly 2 times below 5 µg/kg/day, the lowest level known to cause harmful effects in monkeys.

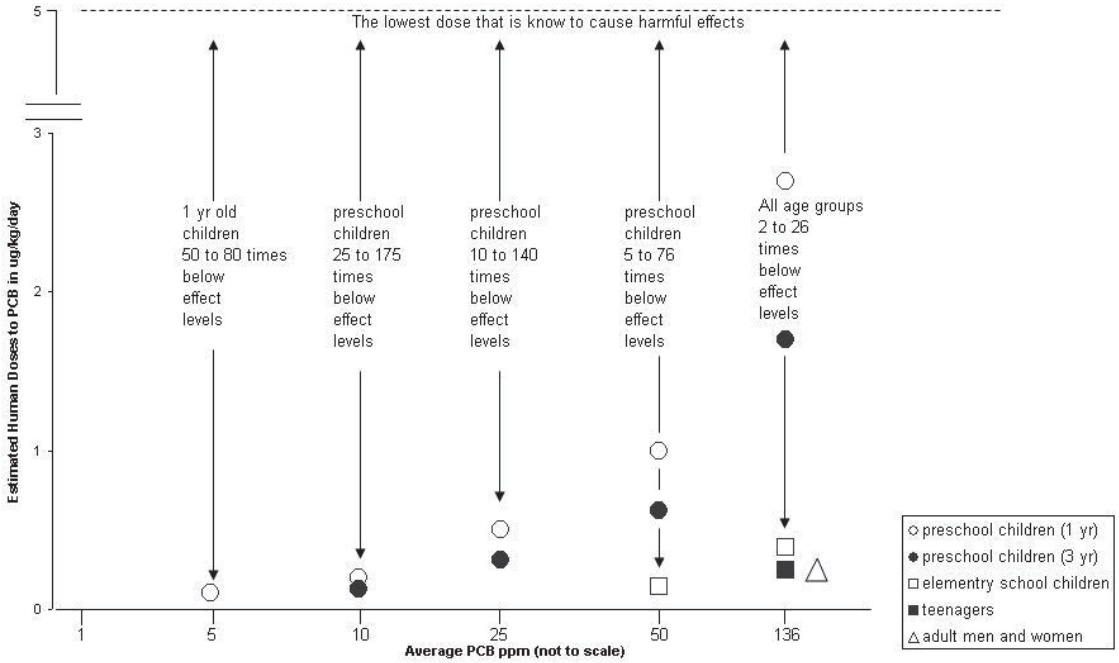


Figure 33. This graph shows the relationship between the estimated PCB doses in various groups in comparison to the lowest dose in monkeys known to cause harmful effects (i.e., 5 µg/kg/day). For example, at 139 ppm PCBs in soil, the estimated dose in 1-year old preschool children (as shown by the open circle on the far right side of the graph) is about 2 times below the lowest dose known to cause harmful effects. The estimated dose in adults (as shown by the open triangle on the far right side of the graph) is 26 times below levels known to cause harmful effects in monkeys..

The other estimated doses can be described as follows:

- At 5 ppm PCBs in soil, the estimated doses in one- and three-year-old preschool children are 50 to 80 times below the lowest effect level,
- At 10 ppm PCBs in soil, the estimated doses in preschool and elementary-age children are 25 to 175 times below the lowest effect level,
- At 25 ppm, the estimated doses in preschool, elementary-age, teenagers, and adults are 10 to 140 times below the lowest effect level,
- At 50 ppm, the estimated doses in preschool, elementary-age, teenagers, and adults are 5 to 70 times below the lowest effect level, and
- At 139 ppm, the estimated doses in preschool, elementary-age, teenagers, and adults are 2 to 25 times below the lowest effect level.

A useful concept in evaluating risk is the margin of exposure. The margin of exposure is the difference between the estimated dose and the dose that causes harmful effects and derived using the following formula:

$$\text{Margin of Exposure} = \frac{\text{Lowest Effect Level from a Study}}{\text{Estimated dose}}$$

The margin of exposure for various age groups at different average PCB soil concentrations is described in the previous bullets. The margin of exposure provides insight into how close an estimated dose is to the doses that cause harmful effects. For example, a margin of exposure of five means that the estimated dose is five times below levels that have been shown to cause harmful effects. The margin of exposure for various age groups is shown in Table 17. It should be noted that ATSDR's chronic oral MRL is 250 times below the lowest level known to cause harmful effects in monkeys. ATSDR provided margin of exposures down to 1 ppm, which is the level that corresponds to the chronic, oral MRL.

Table 17. Chronic margin of exposure to PCBs for various age groups

Age Group	***PCB Concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***136***
	Chronic Margin of Exposure					
Preschool children (1 yr.)	250	50	25	10	5	2
Preschool children (3 yr.)	400	80	40	16	8	3
Elementary school children	1,750	350	175	70	35	13
Teenagers	2,750	550	275	110	55	20
Adult men	3,500	700	350	140	70	25
Adult women	3,000	600	300	120	60	22
Commercial workers	5,096	1,019	510	204	102	37

Children have the greatest risk of experiencing harmful effects from exposure to PCBs that remain in LCP soils because their estimated doses are close to the effect level of 5 µg/kg/day, particularly at the higher PCB concentrations. Children exposed to average PCB concentrations that exceed about 1 to 5 ppm and adults exposed to average PCB concentrations that exceed about 10 to 25 ppm might experience the following harmful effects from PCBs:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance decrements,

- Fewer male births,
- Problems with attention and impulse control
- Lower birth weight,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women (but not men),
- An increase in deaths from Parkinson disease and dementia in women (but not men), and
- An increase in diabetes in women (but not men) (ATSDR 2000).

Six grids exceed EPA's 1994 target action level of 25 ppm total PCBs, while 41 grids have average total PCB concentrations greater than 1 ppm (see Table 18). The location of these grids is shown in Figure 34.

The previous results were derived using soil samples with a depth of 0 to 5 ft. The justification for using 0 to 5 ft. is that future site development might bring soil to the surface that was previously up to 5 feet below the surface. One concern is that more contaminated soil is nearer the surface, and this more contaminated soil might have a greater chance of becoming surface soil in the future because of construction activity. Therefore, ATSDR calculated statistics using soil samples with a depth of 0 to 2 ft.

Using soil samples with a depth of 0 to 2 ft. showed similar results as using 0 to 5 ft. At 0 to 2 ft., 6 grids exceed EPA's 1994 target action level of 25 ppm and 41 grids exceed 1 ppm total PCBs. More uncertainty exists in these average concentrations because fewer soil samples are available from the 0 to 2 ft. depth.

Table 18. Grids That Have Average PCB Concentrations Greater than 1 ppm

Grid #	***Average PCB Concentration in ppm***		***Grid #***	***Average PCB Concentration in ppm***
93	138.6		75	2.6
58	122.0		94	2.4
114	53.0		38	2.4
53	42.3		70	2.3
90	40.9		92	2.2
60	34.0		39	2.1
89	20.6		42	1.9
111	15.8		8	1.6
37	11.9		69	1.5
128	10.5		154	1.4
55	9.0		112	1.4
76	7.3		74	1.4
10	7.0		152	1.4
91	6.2		153	1.4
56	5.6		71	1.3
155	5.6		77	1.3

Table 18. Grids That Have Average PCB Concentrations Greater than 1 ppm				
Grid #	***Average PCB Concentration in ppm***		***Grid #***	***Average PCB Concentration in ppm***
110	4.0		133	1.3
95	3.5		197	1.1
59	3.3		17	1.1
73	2.6		134	1.0
118	2.6			

V.F.1.h. Possible Health Effects in Children with Soil Pica Behavior

As mentioned previously, somewhere between 4% and 21% of preschool children could have soil-pica behavior. Preschool children with soil-pica behavior swallow much more soil than children typically do from putting their hands in their mouth. Therefore, preschool children with soil-pica behavior will have a much greater intake of PCBs in soil.

Using PCB concentrations ranging from 1 ppm to 139 ppm, the estimated doses for 1 year-old and 3 year-old preschool children are shown in Table 19 for soil-pica behavior that occurs 3 days a week. The intermediate MRL for PCBs is shown because soil pica behavior is intermittent (ATSDR 2001).

Table 19. Estimated PCB doses in preschool children with soil-pica behavior at various total PCB concentrations. Doses are estimated for soil-pica occurring three times a week						
Age Group	***PCB Concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Dose in ug/kg/day					
Preschool children, 1 year old, soil pica 3/week	0.21	1.1	2.1	5.4	11	30
Preschool children, 3 years old, soil pica 3/week	0.13	0.7	1.3	3.3	7	19
Intermediate oral MRL	0.03	0.03	0.03	0.03	0.03	0.03

All of the estimated doses in preschool children with soil-pica behavior shown in Table 19 exceed ATSDR's intermediate oral MRL of 0.03 µg/kg/day. For example, the estimated doses in children with soil-pica behavior who swallow soil containing 139 ppm total PCBs range from 19 to 30 µg/kg/day. These doses are significantly greater than the intermediate oral MRL of 0.03 µg/kg/day.

The PCB HQs for children with soil-pica behavior are shown in Table 20. As mentioned previously, whenever an HQ exceeds 1, the estimated dose exceeds the intermediate oral MRL. The HQ exceeds 1 for all PCB concentrations shown in Table 20. Because the estimated PCB doses exceed the intermediate oral MRL, further toxicological evaluation is needed.

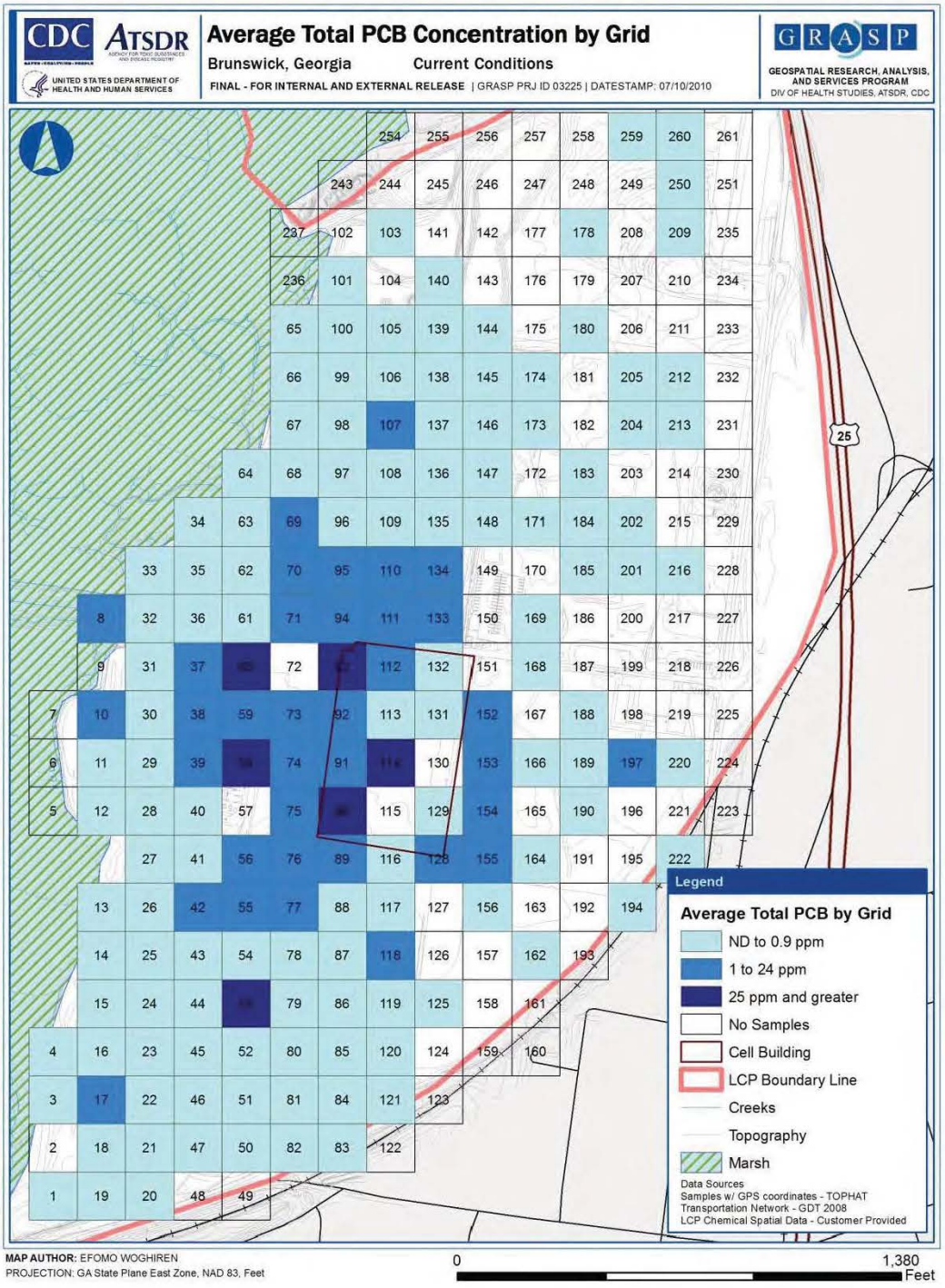


Figure 34. As indicated by the dark blue, six grids exceed EPA's 1994 target action level of 25 ppm PCBs. As indicated by medium blue, 41 grids have average PCB levels between 1 and 24 ppm. Children exposed to average PCB concentrations that exceed about 1 to 5 ppm and adults exposed to average PCB concentrations that exceed about 10 to 25 ppm might experience harmful effects from PCBs.

The lowest PCB dose known to cause harmful effects in monkeys from intermediate exposures (i.e., 2 weeks to 1 year) is 7.5 µg/kg/day, which is the same study as previously described for chronic exposure. This study showed that young monkeys were impaired in their ability organize their behavior temporally and to learn from the consequences of previous actions (Rice 2000)

Table 20. Hazard quotient (HQ) for children with soil-pica behavior						
Age Group	***PCB Concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Intermediate HQ					
Preschool children, 1 year old, soil pica 3 times/week	7	36	71	179	357	992
Preschool children, 3 years old, soil pica 3 times/week	4	22	45	112	223	620

The following comparisons can be made from the estimated doses in children with soil-pica behavior (see Table 20).

- At 139 ppm PCBs in soil, the estimated doses range from 19 to 30 µg/kg/day. These doses exceed the lowest level known to cause harmful effects in monkeys (i.e., 5 µg/kg/day).
- At 25 ppm PCBs in soil, the estimated doses range from 3 to 5 µg/kg/day. These doses are just below the lowest level known to cause harmful effects in monkeys.
- At 5 ppm PCBs in soil, the estimated doses range from 0.7 to 1.1 µg/kg/day. These doses are about seven times below the levels known to cause harmful effects in monkeys.
- At 1 ppm PCBs in soil, the estimated doses range from 0.1 to 0.2 µg/kg/day. These doses are 35 to 75 times below levels known to cause harmful effects in monkeys.

Because their brains are still developing, children with soil-pica behavior at the doses described previously are at risk of impaired learning and performance. Children could be impaired in their ability organize their behavior and to learn from mistakes.

The next lowest dose known to cause harmful effects in monkeys is 100 µg/kg/day. Numerous monkey studies have shown that PCBs can cause harmful effects to the immune system, endocrine system, liver, stomach, skin, and eye. These studies are summarized in ATSDR's Toxicological Profile for PCBs (ATSDR 2000).

The following harmful effects have been demonstrated in monkeys dosed with 100 µg/kg/day for periods ranging from 2 months to 8 months:

- Lipid accumulation in the liver, small areas of dead cells in the liver, and increased liver enzyme in the blood (Barsotti 1976),
- Decreased antibody response to sheep red blood cells (Truelove 1982),

- Decreased thyroid (T_3 and T_4) hormones (Andrews 1989),
- Cyst formation in cells lining the stomach (Becker 1979),
- Facial swelling (Becker 1979)
- Skin acne (Barsotti 1976)
- Hair loss (Barsotti 1976)
- Red eyes (Becker 1979)
- Swelling of eyelids (Gray 1993),
- Increased bone density (Andrews 1989), and
- Lack of weight gain (Becker 1979).

One-year-old children with soil-pica behavior might be expected to experience these harmful effects if they had frequent contact with soil containing 10 ppm or more total PCBs. Their estimated doses are about 50 times below the 100 µg/kg/day effect level (see Table 20). Three-year-old children with soil-pica behavior might be expected to experience these harmful effects if they exhibit soil-pica behavior 3 times a week on soil containing 25 ppm or more total PCBs. Their estimated dose is 30 times below the 100 µg/kg/day effect level. Contact with soil containing 139 ppm total PCBs yields estimated doses in three-year-old children with soil-pica behavior that are 3 to 5 times below the 100 µg/kg/day effect level.

V.F.1.i. Possible Health Effects in Workers

Since specific plans have not been identified as to the eventual use of the property, ATSDR evaluated the possibility of harmful effects for two categories of workers: commercial/industrial workers, and excavation workers.

Once the property is developed, commercial workers and industrial workers might come in contact with contaminated soil. The contact is assumed to be long-term, chronic exposure occurring for many years. Therefore, ATSDR compared estimated doses in these workers to its chronic oral MRL for PCBs. Excavation workers are likely to be exposed for periods less than a year as they move soil during construction activity. Therefore, their estimated doses are compared to ATSDR's intermediate oral MRL for PCBs.

The estimated doses for commercial and industrial workers are shown in Table 21 should these workers ingest 100 mg soil daily, 5 days a week. Estimated doses also are provided for excavation workers should these workers ingest 330 mg soil daily, 5 days a week.

Table 21. Estimated doses of PCBs for commercial and industrial workers						
Age Group	*PCB Concentrations in ppm*					
	1	*5*	*10*	*25*	*50*	*139*
	Estimated dose in µg/kg/day					
Commercial/Industrial workers	0.00098	0.0049	0.0098	0.025	0.049	0.13
Chronic oral MRL in µg/kg/day	0.02	0.02	0.02	0.02	0.02	0.02
Excavation workers	0.0034	0.017	0.034	0.084	0.168	0.47
Intermediate oral MRL in µg/kg/day	0.03	0.03	0.03	0.03	0.03	0.03

As shown in Table 21, the estimated doses in commercial and industrial workers exceed the chronic oral MRL of 0.02 µg/kg/day when average PCB levels exceed about 25 ppm. Six grids have average PCB levels that exceed 25 ppm (see Table 18). At 25, 50, and 139 ppm PCBs in soil, commercial and industrial workers have estimated doses of 0.025, 0.049, and 0.13 µg/kg/day, respectively. The estimated dose of 0.1 µg/kg/day exceeds the chronic oral MRL of 0.02 µg/kg/day and is about 50 times below the lowest dose known to cause harmful effects in monkeys (i.e., 5 µg/kg/day). Workers exposed to 0.1 µg/kg/day PCBs might experience the following harmful effects from PCBs:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance decrements,
- Fewer male births,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women (but not men),
- An increase in deaths from Parkinson disease and dementia in women (but not men), and
- An increase in diabetes in women (but not men) (ATSDR 2000).

ATSDR assumed that excavation workers might conduct excavation activities for 6 months while developing the site. Therefore, the most appropriate health guideline to use is ATSDR's intermediate oral MRL for PCBs, which is developed for exposure periods of 2 weeks to 1 year. ATSDR's intermediate oral MRL for PCBs is 0.03 µg/kg/day. For excavation workers, estimated doses exceed the intermediate oral MRL when average PCB concentrations in soil exceed 10 ppm. Because the intermediate oral MRL is exceeded, a more detailed toxicological evaluation is warranted to decide if harmful effects are expected.

The basis for the intermediate MRL is a study involving infant monkeys, which is not appropriate to use when evaluating the risk for adults. More appropriate studies involve older monkeys and rats. These studies show that harmful effects in animals result from exposure to 100 µg/kg/day for periods of 2 to 8 months (Barsotti 1976, Becker 1979, Andrew 1989, ATSDR 2000). The following harmful effects were observed in older monkeys and rats at 100 µg/kg/day :

- Skin acne
- Hair loss
- Swelling and reddening of the eyelids and facial edema,
- Liver damage (e.g., lipid accumulation, localized cell death, liver enzyme in the blood),
- Cysts in the stomach lining,
- No weight gain,
- Increased bone density in the femur

At 10 and 25 ppm PCBs, the estimated doses in excavation workers are 0.03 and 0.08 µg/kg/day, which are at or below the intermediate MRL. Therefore, non-cancerous harmful effects are not expected. At 50 and 139 ppm total PCBs in soil, the estimated doses in excavation workers are 0.17 to 0.47 µg/kg/day. These estimated doses in excavation workers are 200 to 600 times below doses that cause harmful effects in animals. Non-cancerous harmful effects in excavation workers are not expected.

In summary, workers who have contact with PCBs in some areas on the site could be at risk of small changes in immune function, mild damage to fingernails and toenails, and damage to oil glands around the eyes. In addition, excavation workers who have contact with PCBs in some areas on the site could be at risk of skin problems (e.g., acne, hair loss), damage to the eyes, face, stomach, liver, and bones.

V.F.1.j. PCBs and Cancer

The carcinogenicity of PCBs in humans has been investigated in retrospective, cohort, mortality studies that investigated cancer in exposed workers, and in case-control studies of environmental exposure that examined associations between serum or adipose tissue levels of PCBs and the occurrence of cancer. Some of the mortality studies suggest that occupational exposures to PCBs were associated with cancer at several sites, particularly the liver, biliary tract, intestines, and skin (melanoma). A report of liver cancer in Japanese victims who were poisoned by PCBs appears to support the occupational liver cancer data. There is no clear association between occupational exposures to PCBs and cancer in other tissues, including the brain, hematopoietic, and lymphatic systems. Case-control studies of the general population are inconclusive with respect to associations between environmental exposures to PCBs and risk of breast cancer or non-Hodgkin’s lymphoma, although there are preliminary indications that particular subgroups of women may be at increased risk for breast cancer. Overall, the human studies provide some evidence that PCBs are carcinogenic. There is conclusive evidence, however, that

commercial PCB mixtures are carcinogenic in animals on the basis of induced tumors in the liver and thyroid (ATSDR 2000).

The human studies examining the cancer causing effect of PCBs often have methodological limitations. However, the evidence, taken in totality, indicates a potential cancer causing effect from PCBs. EPA determined that the human data are inadequate, but suggestive, of carcinogenicity. Using animal data, EPA classifies PCBs as a probable human carcinogen (TOXNET 2009). The U.S. Department of Health of Human Services through its National Toxicology Program has designated PCBs as a probable human carcinogen; and, the International Agency for Research on Cancer (IARC) designates PCBs as probably carcinogenic in humans (ATSDR 2000, IARC 2009).

It should be pointed out that the EPA recommends using total PCBs to estimate cancer risk rather than the commercial designations of PCBs into the various Aroclor groups (EPA 2009b).

V.F.1.k. Estimated Cancer Risk If the LCP Chemicals Site Becomes Residential

Numerous studies have shown that several commercial mixtures of PCBs (i.e., Aroclors 1016, 1242, 1254, and 1260) have caused liver and thyroid cancer in rats at doses ranging from 1 mg/kg/day to 5.4 mg/kg/day (or 1,000 μg/kg/day to 5,400 μg/kg/day). The EPA used these studies to generate a cancer slope factor that can be used to estimate an increase in the number of cancers if people come in contact with PCBs in soil for long periods. Because we are looking at future residential development, two cancer risks will be estimated, one for children who live at a house for 18 years and another for adults who live at the same house for 52 years. The estimated cancer risk is for children and adults with high soil intake. The estimated cancer risk for children and adults with typical soil intake is about half of the risk estimated for children and adults with high soil intake.

Table 22 shows the estimated cancer risk at various PCB soil concentrations for children and adults with high soil intake if the LCP Chemicals Site becomes residential. For example, if children with high soil intake live at a property with 139 ppm PCBs in soil for 18 years, their estimated cancer risk is 6 in 10,000. Stated another way, if 10,000 children lived at properties with 139 ppm PCB in soil, one might expect 6 extra cases of cancer. Adults who live at properties for 52 years with 139 ppm PCB in soil have an estimated cancer risk of 3 in 10,000. A lifetime cancer risk is not provided since it is unlikely that children will continue to live in the house as adults for an additional 52 years. It should be pointed out that the cancer risk is greater for children with 18 years of exposure than it is for adults with 52 years of exposure. The estimated cancer risk at 5 ppm PCBs in soil is 2 in 100,000 for children and 1 in 100,000 for adults.

So the public can understand the estimated cancer risk and scientific notation presented in Table 22, the same risks are presented in Table 23 as extra cases of cancers if a million people are exposed to PCBs in soil. For example, if one million children have daily contact with soil containing 139 ppm PCBs, about 600 extra cases of cancers might occur from 18 years of exposure.

In summary, if the site becomes residential, children might have an increased risk of cancer if they have contact with PCB in soil above 5 ppm. Adults might have an increased risk of cancer at PCB soil levels above 10 ppm.

V.F.1.l. Estimated Cancer Risk in Workers If the LCP Chemicals Site Is Developed

If the site is developed in the future, workers doing excavation work and commercial or industrial workers might come in contact with PCBs in soils. The estimated cancer risks for outdoor commercial or industrial workers are shown in Table 24 should these workers ingest 100 mg soil daily, 5 days a week for 20 years. The estimated cancer risk also is provided for excavation workers should these workers ingest 330 mg soil daily for half a year.

The estimated cancer risk for commercial/industrial workers who have contact with soil containing 139 ppm PCBs for 20 years is 8E-5 (or 8×10^{-5}). This means that if 100,000 workers had contact with soil containing 139 ppm PCBs for 20 years, 8 additional cases of cancers might occur. The estimated cancer risk for excavation workers who have contact with soil containing 139 ppm PCBs for 6 months is 7E-6 (or 7×10^{-6}). This means that if 1,000,000 workers had contact with soil containing 139 ppm PCBs for 20 years, 7 additional cases of cancers might occur. The cancer risk in workers at various PCB concentrations in soil are shown in Table 24. So the public can understand the estimated cancer risk and scientific notation presented in Table 24, the same risks are presented in Table 25 as extra cases of cancers if a million workers are exposed to PCBs in soil at 1, 5, 10, 25, 50 or 139 ppm.

In summary, an increased risk of cancer might exist for commercial and industrial workers who have daily contact with PCBs in soil above 25 ppm. The estimated cancer risk for excavation workers is low.

Table 22. Estimated cancer risk at various PCB soil concentrations for children and adults with high soil intake if the LCP Chemicals Site becomes residential in the future. The estimated cancer risk is for children and adults with high soil intake. The estimated cancer risk for children and adults with typical soil intake is about half the risk shown this table.

Age Group	*PCB soil concentrations in ppm*					
	1	*5*	*10*	*25*	*50*	*139*
	*Increase in Cancer Risk**					
Children's cancer risk, 18 years	4 E-6	2 E-5	4 E-5	1 E-4	2 E-4	6 E-4
Adult cancer risk (av. for men and women), 52 yrs.	2 E-6	1 E-5	2 E-5	6 E-5	1 E-4	3 E-4

* Cancer risk estimates are rounded to one significant figure.

Table 23. Estimated cancer risk at various PCB soil concentrations for children and adults if one million people are exposed. Cancer numbers are rounded to one significant figure.						
Age Group	***PCB soil concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Estimated number of cancers if one million people are exposed					
The estimated number of cancers if a million children are exposed to PCBs in soil for 18 years at various PCB concentrations.	4	20	40	100	200	600
The estimated number of cancers if a million adults are exposed to PCBs in soil for 52 years	2	10	20	60	100	300

Table 24. Estimated cancer risk at various PCB soil concentrations for commercial/industrial and excavation workers on the basis of future site development.						
Age Group	***PCB soil concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Increase in Cancer Risk*					
Outdoor commercial/industrial worker cancer risk, 20 yrs.	6 E-7	3 E-6	6 E-6	1 E-5	3 E-5	8 E-5
Excavation worker, 1/2 yr.	5 E-8	2 E-7	5 E-7	1 E-6	2 E-6	7 E-6

* Estimated cancer risks are rounded to one significant figure.

Table 25. Estimated cancer risk at various PCB soil concentrations for commercial/industrial and excavation workers on the basis of future site development. Cancer risks are rounded to one significant figure.						
Age Group	***PCB soil concentrations in ppm***					
	1	***5***	***10***	***25***	***50***	***139***
	Estimated number of cancers if one million workers are exposed					
The estimated number of cancers if one million commercial/industrial workers are exposed to PCBs in soil for 20 years	0.6	3	6	10	30	80
The estimated number of cancers if one million excavation workers are exposed to PCBs in soil for 6 months	0.05	0.2	0.5	1	2	7

V.F.1.m. Uncertainty in Cancer Risk Estimates

Some uncertainty exists in these cancer risk estimates. It is important to remember the assumptions that went into estimating these cancer risks. These assumptions are as follows:

- The PCB-contaminated areas of the site will become residential,
- PCB contamination that is below the surface will be moved to the surface during construction thus allowing human contact,
- The average PCB concentration calculated using the current contaminant levels represents the level of future exposure,
- For the residential scenario, children will live on the property for 18 years or adults will live on the property for 52 years,
- For the commercial/industrial scenario, adults will have contact with the soil for 20 years,
- Children and adults will have high soil intake from hand-to-mouth activity, and
- The carcinogenicity of the various groups of PCBs are similar.

V.F.2 Mercury

V.F.2.a. The Chemistry of Mercury in Soil

During operations at the LCP facility, elemental mercury was used as part of the chemical reactions to produce chlorine. These processes resulted in mercury-containing waste that was discharged to soil and to the nearby marsh, as well as off-gassing of elemental mercury from the cell buildings to ambient air. Over the years, elemental mercury in soil and sediment is likely to be transformed into divalent mercury salts, such as mercuric chloride, mercuric hydroxide, and mercuric sulfide and to organic mercury. In soil, most of the mercuric salts become bound to the organic matter in soil by reacting with sulfur- and oxygen-containing areas in aromatic and aliphatic chemicals. These aromatic and aliphatic chemicals are part of the organic humic component of soil. Some mercuric salts also can be bound to soil minerals, while a small portion can remain as elemental mercury or dissolved mercury (Schuster 1991, Stevenson 1994, Renneberg and Dudas 2001, Biester 2002).

When soil is contaminated with industrial hydrocarbons, some of the mercuric salts can react with sulfur- and oxygen-containing areas of these hydrocarbons, much like it does with organic matter in soil (CCME 1997, Renneberg and Dudas 2001). Renneberg and Dudas have analyzed soil that was contaminated with mercury 20 to 30 years ago. They found 62% to 85% of the mercury in the soil samples was associated with organic matter. Several soil samples showed small amounts of mercury bound to hydrocarbons (i.e., less than 5%), although one sample showed almost 30%. The percentage of mercury bound to minerals ranged from 5% to 10% for some samples and 20% to 30% in other samples. One soil sample showed that elemental mercury made up 30% of the remaining mercury

in soil. The authors were not able to identify the specific chemical form of mercury in each sample (Renneberg and Dudas 2001).

In 2003, EPA collected 10 sediment samples from the nearby marsh and performed laboratory tests to speciate the mercury. The organic mercury typically was 45% with individual marsh sediment samples ranging from 3% to 86% organic mercury. The other major component consisted of mercury in a mineral lattice, mercuric chloride, or elemental mercury. The mineral or elemental component typically was 41% with individual marsh sediment samples ranging from 0% to 72% (EPA 2010). These results are consistent with the previously cited studies. It is important to remember that these are marsh sediment samples and may or may not accurately represent the speciation of mercury in soils.

These results show that a large proportion of mercury in soil at the LCP Chemicals Site is likely to be organic mercury and this mercury is now bound to the organic humic content of soil. However, other forms, such as inorganic mercuric salts, and possibly elemental mercury, might also be present. Because mercury in soil becomes bound to organic molecules, ATSDR will use health guidelines developed for organic mercury, specifically methylmercury.

V.F.2.b. Health Guideline for Mercury

Several health guidelines exist for mercury and they vary depending upon its chemical form. EPA has an oral Reference Doses (RfD) for organic mercury (i.e., methylmercury) and ATSDR will use this health guideline to evaluate exposure to mercury in soil should the site be developed (see Table 26). The EPA defines RfDs as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure in the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious [non-cancerous] effects during a lifetime.

Table 26. Oral health guideline for mercury used to evaluate exposure to mercury in soil should the site be developed.

Chemical	***Exposure Period***	***Type***	***Agency***	***Value in mg/kg/day***	***Value in µg/kg/day***
Methyl Mercury*	Lifetime	Chronic RfD	EPA	0.0001	0.1

*Methylmercury is an organic form of mercury.

V.F.2.c. Estimating Human Doses to Mercury and Mercury Hazard Quotients

The parameters used to estimate mercury doses in children and adults if the site becomes residential are shown in Appendix B, Table B1. As mentioned previously, preschool children were assumed to swallow 200 milligrams of soil daily, while older children and

adults were assumed to swallow 100 milligrams of soil daily. These soil intake rates represent the group of children and adults with high soil intake.

The estimated mercury doses for each age group for average mercury soil concentrations ranging from 1 to 1,470 ppm are shown in Table 27. Because the doses are small, the table shows estimated mercury doses in µg/kg/day. Depending on the age group and the average mercury concentration in a grid, estimated doses range from well below the health guideline for organic mercury of 0.1 µg/kg/day to the highest estimated dose of 29 µg/kg/day in 1-year-old children who live on soils containing an average of 1,470 ppm mercury in soil.

The mercury HQ for various average mercury concentrations was derived by dividing the estimated mercury dose in µg/kg/day by the chronic, oral RfD for organic mercury, which is 0.1 µg/kg/day. The resulting mercury HQs shown in Table 28 vary by age group and by the average mercury concentration in soil. What follows is a brief summary of these mercury HQs:

- For one-year-old children, the mercury HQ is 1 when average mercury soil concentrations are 5 ppm. The mercury HQs are 3, 4, 17, 59, and 294 when average mercury soil concentrations are 15, 20, 85, 296, and 1,470, respectively.
- For 3-year-old children, the mercury HQs are 1.9, 2.5, 11, 37 and 184 when average mercury soil concentrations are 15, 20, 85, 296, and 1,470 ppm.
- For elementary-age children, the mercury HQs are 2.4, 8.5, and 42 when average mercury soil concentrations are 85, 296, and 1,470 ppm, respectively.
- For teenagers, the mercury HQs are 1.5, 5.4, and 27 when average mercury soil concentrations are 85, 296 and 1,470 ppm, respectively.
- For adults, the mercury HQs range from 1.4, 4.9, and 25 when average mercury soil concentrations are 85, 296 and 1,470 ppm, respectively.

These mercury HQs are shown graphically in Figure 35. The HQs show that as a grid's average mercury concentration in soil exceeds 15 to 20 ppm, the HQ exceeds 1. Whenever the HQ of 1 is exceeded, further toxicological evaluation is necessary to determine if harmful effects might be expected.

Organic Mercury Studies

As part of a more thorough toxicological evaluation, ATSDR will describe the human and animal studies that show the harmful effects of mercury. This review is not an exhaustive review of the known harmful effects of mercury but rather it focuses on the lowest organic mercury doses that cause harmful effects since these studies are more relevant to deciding what harmful effects might be expected in a human population exposed to low levels of organic mercury from the environment.

Table 27. The estimated doses of mercury at various mercury concentrations in soil						
Age Group	***Mercury concentrations in ppm***					
	1	***15***	***20***	***85***	***296***	***1470***
	Chronic estimated dose in µg/kg/day					
Preschool children (1 yr.)	0.02	0.3	0.4	1.7	5.92	29.4
Preschool children (3 yr.)	0.012	0.19	0.25	1.06	3.7	18.38
Elementary school children	0.003	0.04	0.06	0.24	0.85	4.2
Teenagers	0.002	0.03	0.04	0.16	0.54	2.67
Adult men	0.001	0.02	0.03	0.12	0.42	2.1
Adult women	0.002	0.02	0.03	0.14	0.49	2.45
EPA's RfD for organic mercury in µg/kg/day	0.1	0.1	0.1	0.1	0.1	0.1

Table 28. Mercury HQs for various age groups and mercury soil concentrations.						
Age Group	***Mercury concentrations in ppm***					
	1	***15***	***20***	***85***	***296***	***1470***
	Chronic Methylmercury HQ					
Preschool children (1 yr.)	0.20	3.0	4.0	17.0	59.2	294
Preschool children (3 yr.)	0.13	1.9	2.5	10.6	37	184
Elementary school children	0.03	0.4	0.6	2.4	8.5	42
Teenagers	0.02	0.3	0.4	1.5	5.4	27
adult men	0.01	0.2	0.3	1.2	4.2	21
adult women	0.02	0.3	0.3	1.4	4.9	25

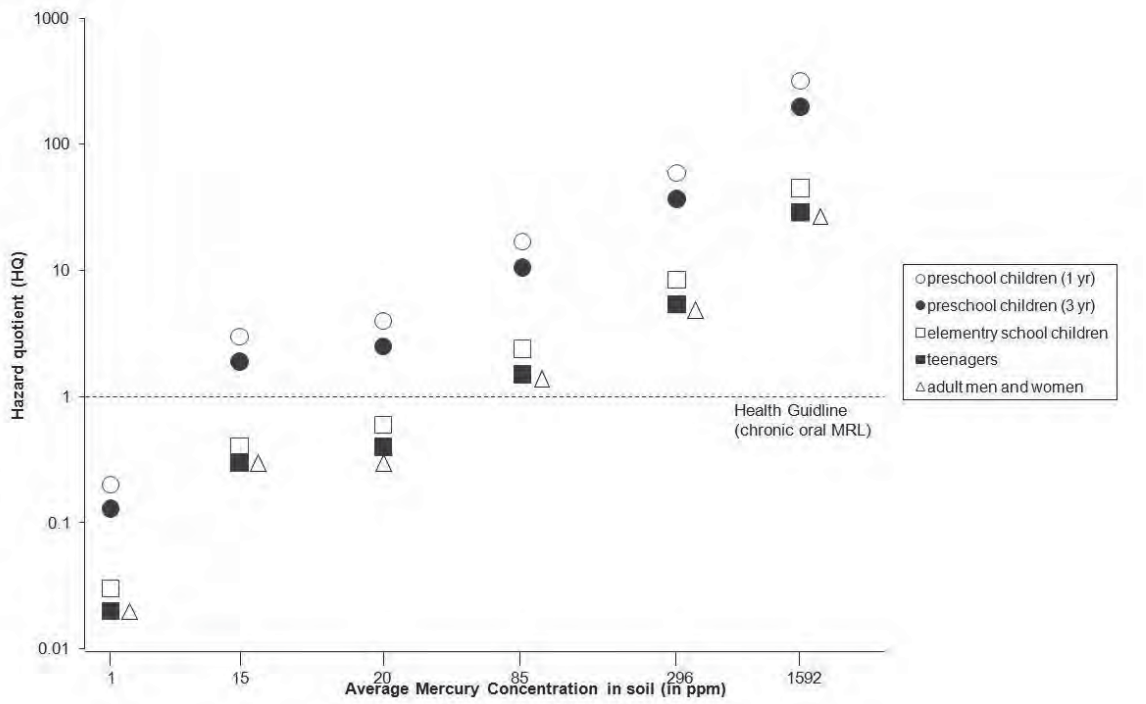


Figure 35. This graph shows the mercury HQ for various age groups at average mercury soil concentrations ranging from 1 to 1,470 ppm. At 1 ppm mercury in soil, the HQs are less than 1 indicating that the estimated doses are below health guideline; therefore, harmful effects are not expected. At 15 to 20 ppm mercury in soil, the HQ for 1-year-old children ranges from 3 to 4. At 85 ppm mercury in soil, all age groups exceed the HQ of 1. At average mercury soil concentrations of 15 or higher, the mercury HQ exceeds 1; therefore, additional toxicological evaluation is needed to determine if harmful effects might be expected.

Several environmental pollution episodes brought to light that contamination of the environment with organic mercury can cause serious harmful effects in humans. In Japan, a local chemical company dumped organic mercury-containing waste into a bay and river that ended up as high levels in fish and shellfish eaten by local residents. Another poisoning episode occurred in Iraq where adults and children ate grain treated with a methylmercury-containing fungicide. These initial human poisoning episodes prompted much research into understanding the harmful effects of organic mercury with the goal of identifying the lowest human doses that might be expected to cause harmful effects.

Several human studies have been conducted that have evaluated the neurological effects of methylmercury exposure in children. A long-term human study of children from the Faroe Islands, a small group of islands in the North Atlantic Ocean, which is affiliated with Denmark, began in 1986 and focused on children born to women who lived on the islands. This population relies heavily on seafood and whales as a source of protein. The investigators used various tests that monitor child development. They concluded that cord

blood mercury levels in the mother at birth were associated with harmful effects in children at age 7 years involving language, attention and memory, and to a lesser extent visual/spatial and motor functions (Grandjean *et al* 1997). Follow-up studies at age 14 years showed similar findings (Debes *et al* 2006). Another human study was conducted in New Zealand in 1978. This study focused on 61 children who were exposed *in utero* to high mercury levels that resulted from their mother's consumption of 4 or more fish meals a week. The authors showed a decrease in children's intelligence quotient (IQ) at age 6 with increasing exposure to methylmercury as measured by their mother's hair mercury levels at birth (Kjellstrom 1991, Crump 1998). The third study came from the Republic of Seychelles, where 85% of the population relies on local seafood for protein. Average ocean fish consumption in this population is 12 meals a week (Davidson 1998). The Seychelles study initially did not find harmful effects in children as they grew older. The investigators report that they occasionally found adverse effects in children but attributed these effects to chance because of the large number of tests being performed (Myers 2003, Davidson 2006, Myers 2009). Much more information about the harmful effects of methylmercury is available in ATSDR's Toxicological Profile for Mercury (ATSDR 1999).

The EPA developed a RfD using a mathematical model that estimates a 5% response in children for neurological effects[3]. Using the Faroe Islands study, EPA determined that the mercury concentration in maternal blood that causes a 5% adverse response in children ranged from 46 to 79 ppb. This mercury concentration in blood equates to a range of 0.8 to 1.5 μg mercury per kilogram per day (μg /kg/day) as a dietary intake. This dose was divided by an uncertainty factor of 10 to arrive at the Reference Dose of 0.1 μg/kg/day. This approach is supported by the U.S. National Academy of Science, which recommended that EPA use the Faroe Islands Study and 58 ppb mercury in cord blood as a LOAEL for deriving their health guideline (NRC 2000).

V.F.2.d. Uncertainty About the Harmful Effects of Methylmercury

It is well-established that high doses of methylmercury will cause neurological effects and will damage other organ systems within the human body. The debate about methylmercury toxicity centers on the lowest dose at which harmful effects might be expected. The Faroe Islands study clearly shows harmful neurological effects in a population that obtains most of its methylmercury exposure from eating whale meat and blubber, although some exposure also comes from other seafood. Similarly, the New Zealand study shows harmful neurological effects in a population that obtains most of its methylmercury exposure from eating seafood. The debate exists because the Seychelles study could not identify consistent harmful effects in a population that relied heavily on seafood. It should be noted that the Seychelles study occasionally identifies an adverse association with methylmercury exposure but the authors conclude that the associations are due to chance because so many tests were administered.

[3] More precisely, EPA estimated the lower 95th concentration of mercury in maternal blood that gave a 5% response for neurological effects in offspring at 7 years of age.

As described previously, the U.S. National Academy of Science through its National Research Council reviewed all three studies and in 2000 recommended that a dose response model be used to estimate the dose at which a 5% adverse response might be expected in children who were exposed *in utero,* that is, during fetal development in the womb. They used the Faroe Islands study to identify a lower 95th percentile of the dose that causes a 5% adverse neurological response. They also conducted an additional mathematical analysis using data from the New Zealand and Seychelles studies and stated that those studies support the results of the Faroe Islands study (NRC 2000).

The investigators of the Seychelles study also conducted a similar dose response analysis. Their conclusion supports in part the conclusion of the National Academy of Science. The Seychelles investigators concluded that they could not exclude a low risk of adverse effects at the upper range of mercury levels in the Seychelles study because of the limited number of data points in the upper ranges (Davidson *et al*. 2004).

Therefore, some uncertainty might exist about the precise lowest dose of methylmercury that might be expected to cause harmful effects. The National Academy of Sciences has recommended that it is reasonable to assume that some risk of harmful effects might be expected in children who were exposed *in utero* to methylmercury at 58 ppb methylmercury in cord blood. This concentration in cord blood equates to 12 ppm mercury in maternal hair (NRC 2000). A cord blood concentration of 58 ppb methylmercury and 12 ppm maternal hair equates to about 1 µg/kg/day methylmercury as a dietary dose, the LOAEL that served as the basis for EPA's derivation of its RfD (EPA 2009a).

V.F.2.e. Possible Health Effects from Methylmercury If the Site Becomes Residential

The estimated doses in various age groups with high soil ingestion have already been presented in Table 27. Because the doses are small, the table shows estimated methylmercury doses in µg/kg/day. For comparison, EPA's Reference Dose for methylmercury also is shown in µg/kg/day.

Depending on the age group and the average methylmercury concentration in a grid, estimated doses range from well below the EPA's RfD of 0.1 µg/kg/day to the highest dose of 29 µg/kg/day in one-year-old children who live on soil containing 1,470 ppm mercury. The estimated doses can be described as follows:

- At 1 ppm methylmercury in soil, all the estimated doses are below EPA's RfD,
- At 15 and 20 ppm methylmercury in soil, the estimated doses in one- and three-year-old children exceeds EPA's RfD,
- At concentrations greater than 85 ppm PCBs in soil, the estimated doses in all age groups exceed EPA's RfD.

Because the estimated doses exceed EPA's RfD for methylmercury of 0.1 µg/kg/day, it is necessary now to compare the estimated doses in various age groups to doses that can cause harmful effects to decide if harmful effects might be expected.

Figure 36 shows the estimated doses in various age groups that exceed EPA's RfD for methylmercury. These doses are shown in relation to the RfD of 0.1 µg/kg/day and in relation to the lowest dose in humans (i.e., 1 µg/kg/day) that might be expected to cause harmful effects to the neurological system in 5% of children.

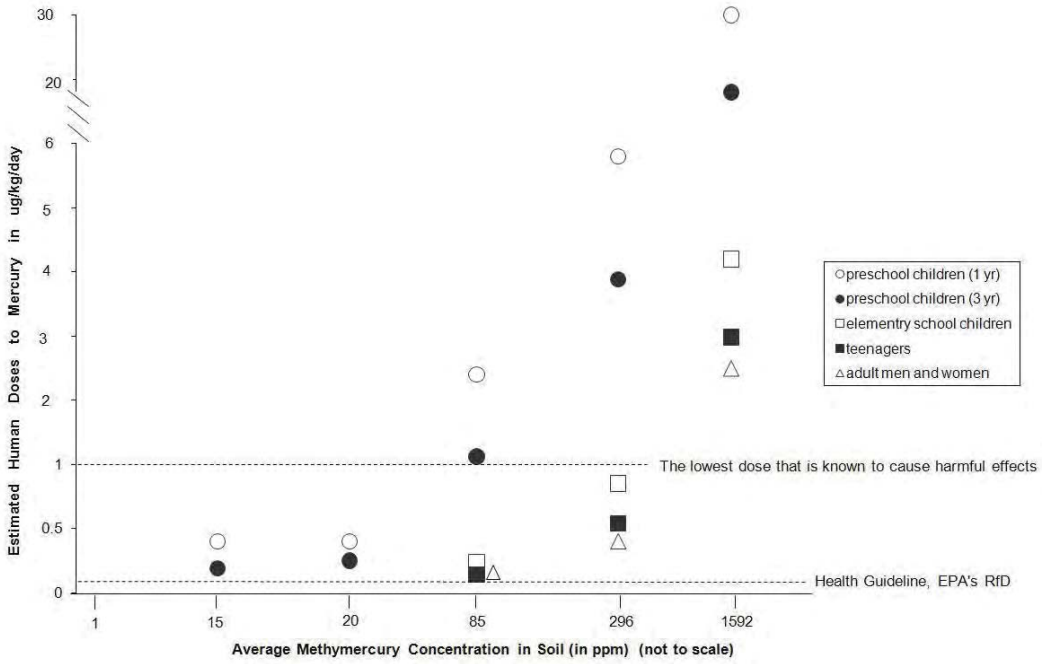


Figure 36. This figure shows the estimated dose in various age groups for various average mercury concentration in soil ranging from 15 ppm to 1,470 ppm. The estimated doses at 1 ppm are below the health guideline for methylmercury of 0.1 µg/kg/day and are not shown. At average soil concentrations of 15 ppm and 20 ppm, the estimated doses in preschool children exceed EPA's RfD. At an average concentration of 85 ppm and 296 ppm in soil, the estimated doses in all age groups exceed the RfD; and, the estimated doses in preschool children exceed the lowest dose known to cause harmful effects in humans. At an average concentration of 1,470 ppm, the estimated doses in all age groups exceeds the lowest dose known to cause harmful effects in humans.

The highest estimated dose in women is 2.5 µg/kg/day for women who live on soil containing 1,470 ppm mercury. This estimated dose is twice the dose that is expected to cause harmful neurological effects to the fetus during pregnancy. Some children born to women exposed to this dose while pregnant might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions. Preschool children who live on properties containing 1,470 ppm mercury have estimated doses of 20 to 32 µg/kg/day and are at risk of similar harmful effects. Preschool children who live on soil containing 85 ppm mercury have estimated doses of 1 µg/kg/day and also are at risk of harmful effects. At 20 ppm mercury in soil, estimated mercury doses in preschool children range from 0.2 to 0.4 µg/kg/day. They have a small risk of harmful effects from mercury in soil.

Some uncertainty exists in these conclusions. First, uncertainty exists in estimating how much mercury people will contact in surface soil if the site becomes residential. This uncertainty comes from assuming that soil below the surface (e.g., several feet down) could become the surface soil (e.g., the top few inches) that people contact during their daily activities. Uncertainty also exists from using soil samples that were collected 15 years ago. These soil samples may not represent current conditions at the site.

Second, some uncertainty exists concerning the risk of harmful effects from mercury in soil. The chemical form of mercury in soil at the LCP Chemicals Site has not been well-established, although analytical studies have been conducted on marsh sediment. Studies by EPA in 2003 showed that almost half the mercury in marsh sediment was bound to organic molecules. Other scientific studies evaluated the weathering of elemental mercury in soil over time. These studies showed that most of the mercury was bound to organic molecules (Renneberg and Dudas 2001). Therefore, ATSDR assumed that the mercury in soil at the LCP Chemicals Site was organic mercury. There's some uncertainty whether the mercury bound to organic molecules in soil would have the same or similar toxicity as methylmercury. Nevertheless, it seems reasonable to assume that grids with average mercury concentrations as high as 1,470 ppm mercury in soil pose some risk to women and children if the site becomes residential.

Ten grids exceed EPA's 1994 target action level of 20 ppm mercury in soil. The location of these grids is shown in Figure 37 and the average mercury concentration in each grid is shown in Table 29. The half-acre grids on the site that are a concern if the site becomes residential are grids 53, 55, 60, 90, 93, 112, 113, 114, 118, and 128.

The previous results were derived using 1990s soil samples with a depth of 0 to 5 ft. The justification for using 0 to 5 ft. is that future site development might bring soil to the surface that was previously up to 5 feet below the surface. One concern is that more contaminated soil is nearer the surface, and this more contaminated soil might have a greater chance of becoming surface soil in the future because of construction activity. Therefore, ATSDR calculated statistics using 1990s soil samples with a depth of 0 to 2 ft. Using soil samples with a depth of 0 to 2 ft. showed overall somewhat similar results as using 0 to 5 ft. At 0 to 2 ft., 5 grids exceed EPA's 1994 target action level of 20 ppm and four of these grids are found in Table 29. More uncertainty exists in these five concentrations because fewer soil samples are available from the 0 to 2 ft. depth.

Table 29. Grid number and average mercury concentrations greater than 20 ppm in soil	
Grid #	***Average Mercury Concentration in Soil (ppm)***
113	1,470
93	296
112	271
90	184
60	85
128	81
114	41
118	30
53	24
55	23

V.F.2.f. Possible Health Effects for Workers

Since specific plans have not been identified as to the eventual use of the property, ATSDR evaluated the possibility of harmful effects for two categories of workers: commercial/industrial workers, and excavation workers.

Once the property is developed, commercial and industrial workers might come in contact with contaminated soil for extended periods. The contact is assumed to be long-term, chronic exposure occurring for many years. Therefore, ATSDR compared estimated doses in these workers to EPA's RfD for organic mercury. Excavation workers are likely to be exposed for periods less than a year as they move soil during construction activity. No health guidelines are available for organic mercury for exposure periods of less than one year; therefore, the estimated doses will be compared directly to doses from human and animal studies to decide if harmful effects might be expected.

The estimated doses for commercial and industrial workers are shown in Table 30 should these workers ingest 100 mg soil daily, 5 days a week. Estimated doses also are provided for excavation workers should these workers ingest 330 mg soil daily, 5 days a week.

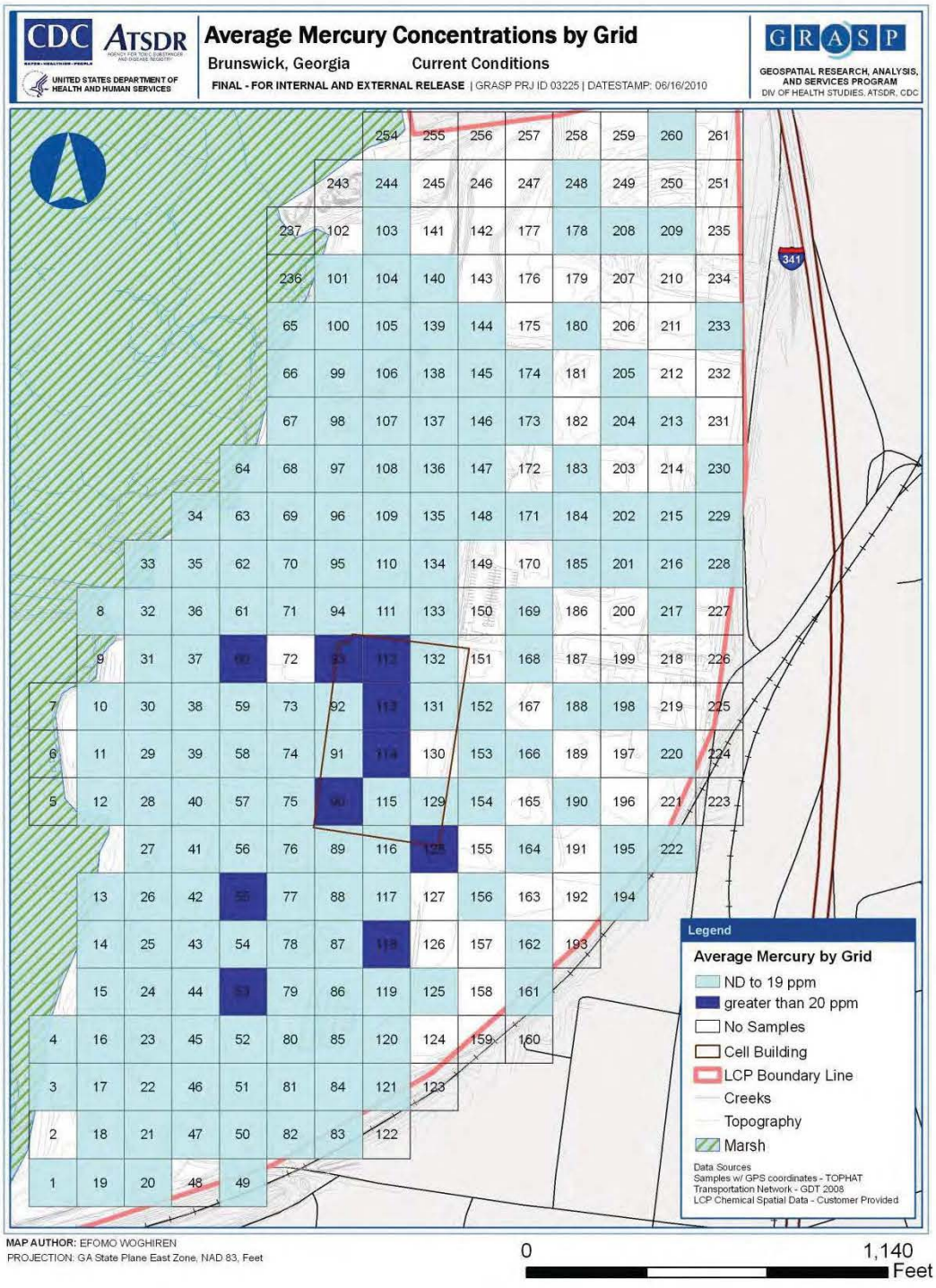


Figure 37. This figure shows the ten grids in dark blue where average mercury levels in soil 0 to 5 ft. exceed EPA's 1994 target action level of 20 ppm. If these grids become residential, mercury in soil is a health concern. Most of the dark blue grids are associated with the former mercury cell building, indicating these soils are still highly contaminated with mercury (see Table 29).

For grids with average mercury concentrations ranging from 184 ppm to 1,470 ppm, the estimated doses for commercial/industrial workers range from 0.2 to 1.4 µg/kg/day. These estimated doses exceed EPA's chronic RfD of 0.1 µg/kg/day. Four grids have estimated doses that exceed EPA's chronic RfD. The average mercury concentration for these grids is 184 ppm (grid 90), 271 ppm (grid 112), 296 ppm (grid 93), and 1,470 ppm (grid 113) (see Table 29).

Table 30. Estimated mercury doses in commercial/industrial workers and in excavation workers if the site is developed.

Age Group	***Mercury Concentrations in ppm***					
	1	***15***	***20***	***100***	***296***	***1470***
	Estimated dose in ug/kg/day					
commercial workers	0.0010	0.015	0.020	0.1	0.29	1.44
excavation workers	0.0034	0.051	0.067	0.34	1.00	4.95

As mentioned previously, the EPA used a mathematical model to estimate a 5% response for neurological effects in children who were exposed *in utero*[4]. Using the Faroe Islands study, EPA determined that an intake of 0.8 to 1.5 µg /kg/day is expected to cause a 5% adverse response in children exposed *in utero*. This intake is supported by the U.S. National Academy of Science, which estimated a mercury intake of 1 µg/kg/day to be associated with a 5% response (NRC 2000). Therefore, an intake of about 1 µg/kg/day in female workers can be considered a LOAEL for adverse effects to the developing fetus from exposure to organic mercury.

Pregnant commercial or industrial workers who have contact with mercury in soil in grids 90, 93, 112, and 113 are at risk of exposing their developing fetus to mercury at doses that are expected to cause harmful effects. Some children born to women exposed to these doses might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions. The mercury soil levels in these grids range from 184-1,470 ppm.

Male and female workers who have contact with soil from grid 113, which has an average of 1,470 ppm mercury, also are at risk of harmful effects. Their estimated dose of 1.4 µg /kg/day is roughly 35 times below levels known to cause harmful effects in monkeys and cats. Male and female workers who have prolonged contact with soil mercury at this grid might experience damage to their neurological system, such as diminished sensitivity to pain, diminished touch, decreased fine motor performance, impaired vision, and impaired hearing, (Charbonneau 1976, Rice and Gilbert 1982, Rice 1989, ATSDR 1999).

Excavation workers exposed to mercury in soil at 1,470 ppm have an estimated dose of about 5 µg /kg/day. It seems unlikely, however, that this dose would be sustained for

[4] More precisely, EPA estimated the lower 95th concentration of mercury in maternal blood that gave a 5% response for neurological effects in offspring at 7 years of age.

more than a few weeks or maybe a month or so before they move on to other grids with lower mercury contaminant levels. If they moved on to the grid containing 296 ppm mercury, their estimated dose would be 1 μg /kg/day. These doses would average out to be about 2 or 3 μg /kg/day over the course of a few weeks or a few months. Exposure at these doses for a few months might cause an increase in a certain type of brain cell called reactive glia cells (Charleston 1994, ATSDR 1999). This increase is a mild adverse response to mercury exposure; however, it does not result in any symptoms of mercury poisoning.

It should be noted that soil beneath the cell building area is likely to have high levels of mercury since this area was not excavated to remove highly contaminated mercury in soil below the surface. Any future excavations in this area could result in mercury exposure for workers who have direct contact with soil and groundwater, or who breathe mercury vapors. Therefore, appropriate worker protection guidelines should be used to prevent exposure and to ensure that mercury in air is not a public health concern.

V.F.3. Lead

V.F.3.a. Levels in Soil at the LCP Chemicals Site

Using half-acre grids, average lead levels in soil (0-5 ft.) exceeded EPA's target action level of 400 ppm in seven grids. Average lead levels in these grids are 745 ppm (grid 136), 728 ppm (grid 48), 692 ppm (grid 103), 590 ppm (grid 93), 513 ppm (grid 59), 422 ppm (grid 60), and 411 ppm (grid 411). The distribution of average lead levels in grids can be described as follows:

- 7 grids have average lead levels above 400 ppm
- 6 grids have average lead levels in the 300 ppm range,
- 10 grids have average lead levels in the 200 ppm range,
- 29 grids have average lead levels in the 100 ppm range,
- 110 grids have average lead levels below 99 ppm.

V.F.3.b. CDC's Reference Level for Lead and Recent Human Studies on the Effects of Lead

Using data from the National Health and Nutrition Examination Survey (NHANES), the Centers for Disease Control and Prevention (CDC) has established a reference value for lead in children aged 1 to 5 years. This new reference value is based on the U.S. population of children aged 1-5 years and was selected based on the blood lead level in the top 2.5% of children. Currently, the reference value is 5 micrograms lead per deciliter (μg/dL) of blood. This reference value replaces CDC's historical value of 10 μg/dL.

More information about CDC's new reference value as well as CDC's recommendations concerning elevated blood lead in children can be found at these CDC websites:

- http://www.cdc.gov/nceh/lead/ACCLPP/activities.htm, and
- http://www.cdc.gov/nceh/lead/tips.htm.

CDC replaced its blood lead 'level of concern' with a reference value following recommendations in January 2012 from CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP 2012). As the advisory committee and CDC pointed out, scientific research has clearly shown that blood lead levels below 10 µg/dL cause serious harmful effects in children. Table C1 in Appendix C summarizes some of these studies.

Blood lead levels below 10 µg/dL have been shown to cause neurological, behavioral, immunological, and developmental effects in young children. Specifically, lead causes or is associated with the following harmful effects:

- Decreases in intelligent quotient (IQ),
- Attention deficit hyperactivity disorder (ADHD),
- Deficits in reaction time,
- Problems with visual-motor integration and fine motor skills,
- Withdrawn behavior,
- Lack of concentration,
- Issues with sociability,
- Decreased height,
- Changes in kidney function, and
- Delays in puberty, such as breast and pubic hair development, and delays in menarche.

V.F.3.c. Estimating Children's Lead Exposure from Soil Lead Levels

The EPA has developed a model to estimate the contribution of soil lead to children's blood lead level. The model is called the Integrated Exposure Uptake Biokinetic (IEUBK) model and the current version is IEUBKwin version 1.1 build 11. More information about the IEUBK model can be found at this EPA web address: http://www.epa.gov/superfund/lead/products.htm#guid. After identifying a set of exposure parameters (e.g., lead concentrations in soil, water, air), the model estimates the percentage of children up to 7 years old that exceed a specified blood lead level. In most situations, the EPA's goal is to limit exposure to lead in soil such that a typical child exposed for 7 years (0 to 84 months) would have an estimated risk of no more than 5% of exceeding a specified blood lead level. When EPA ran the model in the mid-1990s for the LCP Chemicals Site, the standard practice was to set the target blood lead level to 10 µg/dL, CDC's historical level of concern at the time (EPA 1998). For the LCP Chemicals Site, the EPA used the model to select their initial soil lead action level of 500 ppm. They have since lowered the action level to 400 ppm. See this web address for a listing of EPA's recommended default parameters for the IEUBK model: http://www.epa.gov/superfund/lead/guidance.htm#training.

Because CDC has a new reference value for lead in children, ATSDR ran the IEUBK model using 5 µg/dL (instead of 10 µg/dL) as the target blood lead level and using the following default parameters recommended by EPA:

- Lead in air (0.1µg/m^3),
- Lead in drinking water (4 µg/L),
- Soil/dust ingestion (0.085 to 0.135 g/day),
- Drinking water (0.2 to 0.59 L/day),
- Maternal blood lead (1 µg/dL),
- Dietary lead intake (1.95 to 2.26 ug/day),
- Geometric standard deviation of blood lead levels (1.6), and
- Bioavailability (30%).

The results show that if a child lives on soil for 7 years containing 400 ppm lead, the child has a 40% risk of exceeding a blood lead level of 5 µg/dL (see Figure 38). Stated another way, if 100 children lived for 7 years on soil containing an average of 400 ppm lead, 40 children out of 100 would be expected to have blood lead levels that exceed 5 µg/dL, the current CDC reference level.

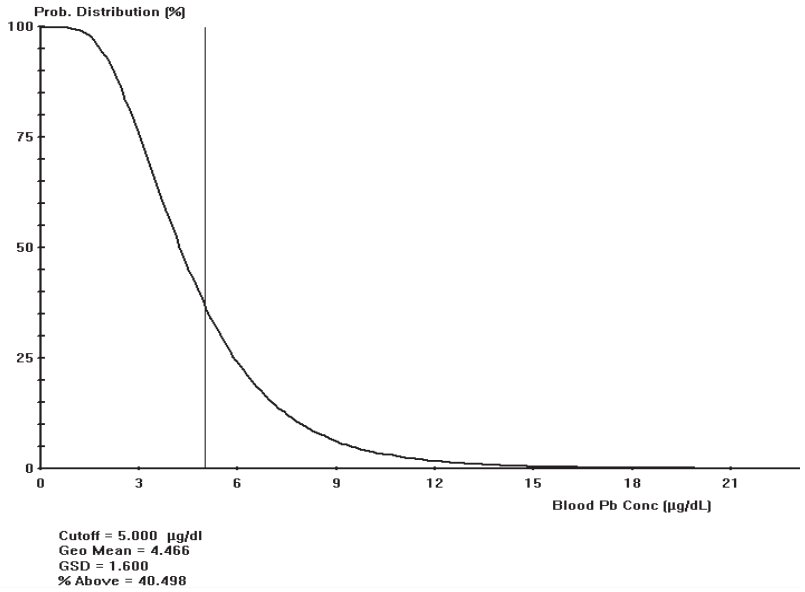


Figure 38. This figure shows the expected distribution of blood lead levels in children using EPA's target action level for lead (i.e., 400 ppm) and CDC reference level for blood lead (i.e., 5 µg/dL). At 400 ppm lead in soil and at a target blood lead level of 5 µg/dL, 40% of children who live there for 7 years (0 to 84 months) might be expected to exceed 5 µg/dL. The geometric mean blood lead level in this population of children would be 4.5 µg/dL.

The IEUBK model also can be run to identify the soil lead concentration that would result in no more than a 5% risk that children's blood lead levels would exceed 5 µg/dL after 7 years of exposure (see Figure 39). The IEUBK model shows that at 154 ppm lead in residential soil, children have a 5% risk of exceeding CDC's reference level of 5 µg/dL. It should be noted that EPA is currently reviewing the IEUBK model in light of CDC's new reference level for lead.

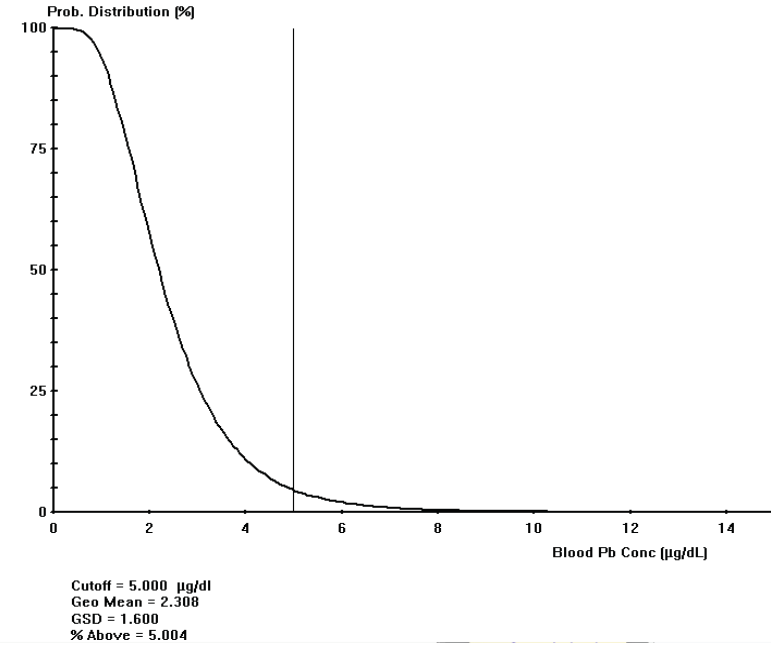


Figure 39. This figure shows the expected distribution of blood lead levels in children after 7 years of exposure (0 to 84 months) if the target blood lead level is set at 5 µg/dL and the average soil lead level is set at 154 ppm. The IEUBK model shows that at 154 ppm lead in residential soil, children have a 5% risk of exceeding CDC's reference level of 5 µg/dL.

V.F.3.d. Possible Health Effects from Lead If the Site Becomes Residential

Most grids on the LCP property have low levels of lead in soil and do not present a health concern for future residential, commercial, or industrial development. However, seven grids have average lead levels that exceed EPA's target action level of 400 ppm and the average lead level in soil at these grids are a health concern if residential properties are built on them. An additional 21 grids have average soil lead levels between 154 ppm and 399 ppm; these grids also are a health concern if residential properties are built on them.

If the site becomes residential, exposure to lead in soil at these levels could increase children's blood lead levels and result in the following harmful effects:

- Small decreases in IQ,
- An increase in attention deficit hyperactivity disorder,
- Reduced attention span,
- Lack of concentration,

- Decreased fine muscle skills,
- Withdrawn behavior,
- Decreased height,
- Small delays in puberty, and
- Small changes in kidney function (Braun 2006, Lanphear 2000, Lanphear 2005, Bellinger 1992, Bellinger 2003, Selevan 2003, Walkowiak 1998, and Burbure 2006, ATSDR 2007).

The location of the grids that are a health concern for lead is shown in Figure 40. Table 31 shows the average lead concentration in soil for each of these grids.

Table 31. Grid Number and Average Lead Concentration in Soil for Those Grids That Are a Health Concern if the Site Becomes Residential

ATSDR Grid #	*Average Soil Lead in ppm*		*ATSDR Grid #*	*Average Soil Lead in ppm*
136	745		96	280
48	728		34	272
103	692		147	250
93	590		37	245
59	513		8	245
60	422		51	237
54	411		73	214
33	394		78	214
58	390		107	208
99	376		97	190
50	371		76	175
111	354		89	170
49	341		53	169
52	292		26	157

The previous results were derived using soil samples with a depth of 0 to 5 ft. Using soil samples with a depth of 0 to 2 ft. showed somewhat similar results as using 0 to 5 ft. At 0 to 2 ft., nine grids have average lead levels that exceed 500 ppm and 36 grids have average lead levels between 154 ppm and 499 ppm. For comparisons, these data are presented in Table 32.

Table 32. Comparison of number of grids that exceed 500 ppm or 154 ppm using soil samples of various depths		
	Greater than 400 ppm average lead	***154 to 399 ppm average lead***
# Grids (0-5 ft.)	7	21
# Grids (0-2 ft.)	9	36

V.F.3.e. Estimating Blood Lead Levels in Workers

The EPA also has an adult lead model that can be used to estimate blood lead levels in the developing fetus. The model is often used for women of child-bearing age to estimate blood lead levels in the developing fetus because the developing fetus is likely to be more sensitive than adult women. More information about EPA's adult lead model can be found at this EPA web address: http://www.epa.gov/superfund/lead/products.htm (EPA 2009c).

Using 5 µg/dL as the target blood lead level, the adult lead model estimates a 5% risk that fetal blood lead levels will exceed 5 µg/dL when average soil lead levels are 773 ppm.
No grids exceed the average lead level of 773 ppm, although two grids with averages of 745 ppm and 728 ppm (grids 136 and 48) approach this concentration (see Table 31). The parameters used in the adult lead model are shown in Table 33. The adult lead model assumes that the typical worker is exposed for 219 days a year (approximately 44 weeks). Should women work longer (e.g., 50 weeks a year), their blood lead levels would exceed 5 µg/dL at three grids (grids 136, 48, and 103). Should they be pregnant, their exposure to lead in soil would put their unborn fetus at risk of the harmful effects previously mentioned.

V.F.3.f. Uncertainty About Lead in Soil

Some uncertainty exists in these conclusions about the risk of harmful effects from lead in soil. Uncertainty exists in estimating children's exposure to lead in soil if the site becomes residential because of uncertainties in the model and because construction activity is likely to alter the concentration of lead in soil that children contact. Uncertainty also exists in estimating adult's exposure to lead in soil for the same reason. In addition, uncertainty exists from using soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

Table 33. Parameters used in EPA's adult lead model to generate the soil concentration that is expected to result in a 5% risk that a fetus will have blood lead levels that exceed 5 µg/dL.			
Variable	***Description of Variable***	***Units***	***Model Parameters***
$PbB_{fetal,\ 0.95}$	95^{th} percentile PbB in fetus	µg/dL	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	µg/dL	1.0
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.05
$AF_{S,\ D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S,\ D}$	Exposure frequency (same for soil and dust)	days/yr	219
$AT_{S,\ D}$	Averaging time (same for soil and dust)	days/yr	365
Soil Lead Concentration	The soil lead concentration that results in a 5% risk that the fetus will have blood lead levels that exceed 5 µg/dL	ppm	773

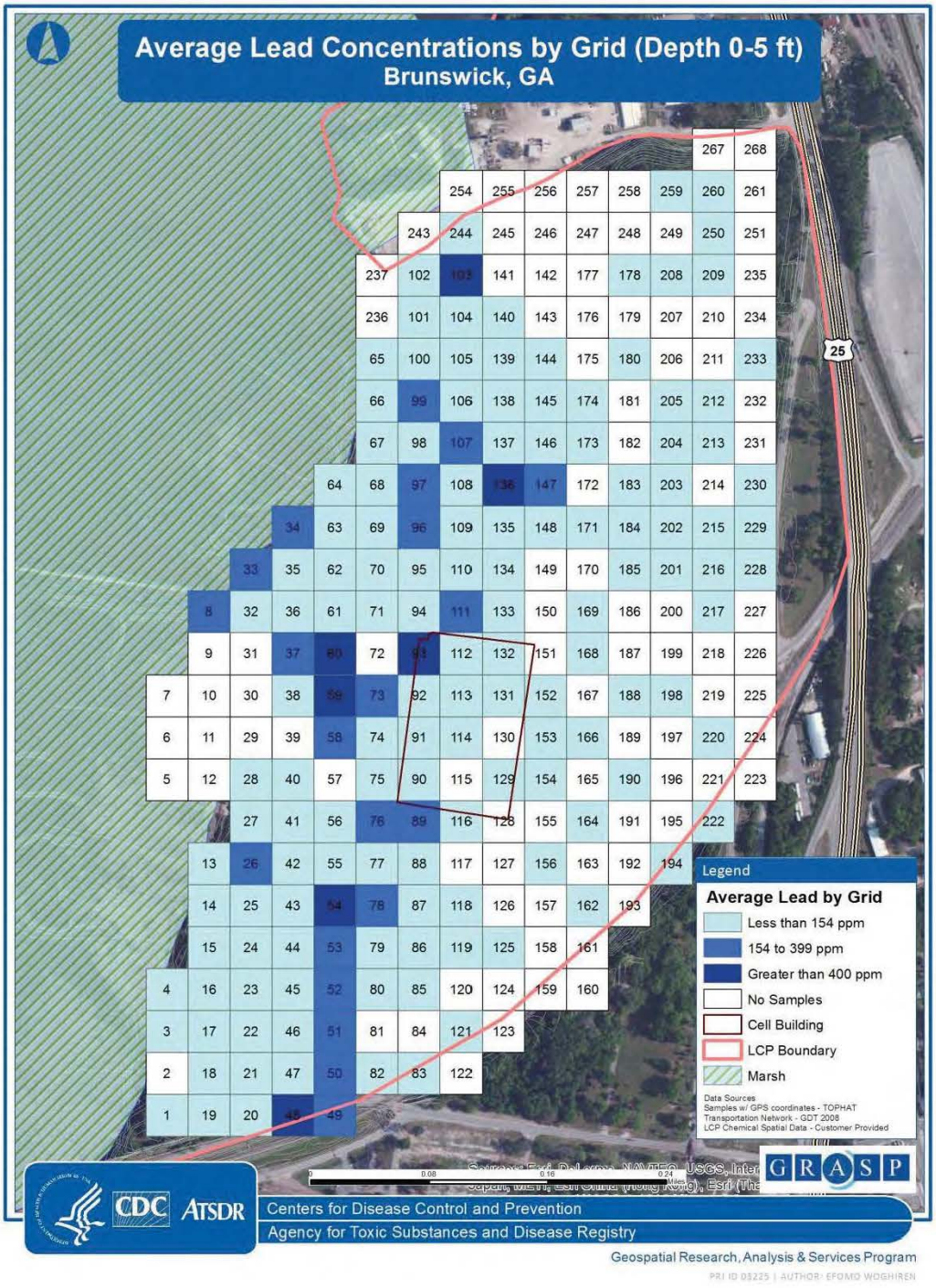


Figure 40. This figure shows the seven grids in dark blue that exceed EPA's target action level for lead of 400 ppm. An additional 21 grids have average lead levels between 154 ppm and 399 ppm. If these half-acre grids become residential in the future, they are a health concern for children.

V.F.4. Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are a group of chemicals with a similar chemical structure and are formed during the incomplete burning of coal, oil, gas, wood, or other organic substances. The PAHs detected in soils from the LCP Chemicals Site are most likely residues from distillation of crude oil that occurred during historical site operations (McNamara 2010). There are more than 100 different PAHs, which occur as complex mixtures in the environment. PAHs can be grouped into the non-carcinogenic PAHs and the carcinogenic (cancer-causing) PAHs (or cPAHs). Table 34 shows the PAHs that were most frequently detected in soils from the LCP Chemicals Site and indicates whether the specific PAH is in the non-carcinogenic or carcinogenic group.

PAHs are composed of carcinogenic and non-carcinogenic PAHs. To evaluate the risk of cancer, an approach is used from the California Environmental Protection Agency (Cal EPA) that converts the total PAH concentration to a total carcinogenic PAH concentration in a sample (CalEPA 2005). Based on the toxicity of benzo(a)pyrene, this approach uses potency factors specific for each carcinogenic PAH to change the concentration of that PAH to a benzo(a)pyrene equivalent concentration. Thus, the benzo(a)pyrene equivalent concentration of various individual carcinogenic PAHs in a soil sample are summed to give the total carcinogenic PAHs (cPAH) for that sample.

The CalEPA PEFs for each cPAH are shown in Table 34. This concentration is used to estimate the dose in BaP equivalents and the cancer slope factor for BaP along with the duration of exposure is used to estimate the risk of cancer from ingesting soil with cPAHs. The exception to this approach is samples with dibenz(a,h)anthracene. This cPAH has its own cancer slope factor; therefore, a separate cancer risk is estimated for this cPAH and combined with the cancer risk estimated using the BaP equivalent concentration.

More information about how to estimate cancer risk from PAHs can be found at these websites:

- http://oehha.ca.gov/air/hot_spots/pdf/May2005Hotspots.pdf
- http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=194584
- http://www.health.state.mn.us/divs/eh/risk/guidance/pahmemo.html

Table 34. The carcinogenic and non-carcinogenic PAHs that were detected most frequently in soils from the site are shown along with descriptive information about the PAHs. This information is described further in the text and is used to evaluate the risk of harmful effects

Substance Name	*Cancer Slope Factor* $(mg/kg/day)^{-1}$	*Potency Equivalency Factor*	*# Samples > ND*	*Total # Samples*	*% Detection*
Carcinogenic PAHs (cPAH)					
Benzo(a)pyrene	7	1	72	651	11.1
Benzo(a)anthracene		0.1	90	651	13.8
Benzo(b)fluoranthene		0.1	56	568	9.9
Benzo(k)fluoranthene		0.1	44	567	7.8

Table 34. The carcinogenic and non-carcinogenic PAHs that were detected most frequently in soils from the site are shown along with descriptive information about the PAHs. This information is described further in the text and is used to evaluate the risk of harmful effects					
Substance Name	***Cancer Slope Factor*** $(mg/kg/day)^{-1}$	***Potency Equivalency Factor***	***# Samples > ND***	***Total # Samples***	***% Detection***
Benzo(b and/or k)fluoranthene		0.1	17	84	20.2
Indeno(1,2,3-cd)pyrene		0.1	43	651	6.6
Chrysene		0.01	116	651	17.8
Dibenz(a,h)anthracene	4		18	650	2.8
Naphthalene	None	None	90	650	13.8
Non-carcinogenic PAHs (PAH)					
Pyrene			139	651	21.4
Phenanthrene			143	651	22
2-Methylnaphthalene			126	631	20
Fluoranthene			69	651	10.6
Benzo(g,h,i)perylene			70	651	10.8
Anthracene			72	650	11.1
1-Methylnaphthalene			107	462	23.2
Acenaphthene			15	649	2.3
Fluorene			14	650	2.2
Acenaphthylene			18	650	2.8

V.F.4.a. Estimating Human Doses of PAHs

The parameters used to estimate doses in children and adults if the site becomes residential are shown in Appendix B, Table B1. As mentioned previously, preschool children were assumed to swallow 200 milligrams of soil daily, while older children and adults were assumed to swallow 100 milligrams of soil daily. These soil intake rates represent the group of children and adults with high soil intake.

Two cancer risks were estimated and then combined to get a total cancer risk. The first cancer risk was estimated using cPAH concentrations and represents the cancer risk from ingesting benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, and chrysene. A separate cancer risk was estimated from ingesting dibenz(a,h)anthracene because this PAH has its own cancer slope factor. The two cancer risks were combined to represent the total cancer risk from all cPAHs in soil.

The average cPAH concentration and the dibenz(a,h)anthracene concentration are shown in Table 35 for the grids with the highest average concentrations. The grids with the highest average cPAH concentration was grid 93 with an average concentration of 29 ppm on the basis of two soil samples. The low number of samples increases the

uncertainty about the average cPAH concentration for this grid. Five other grids have average cPAH concentrations ranging from 1.6 ppm to 9.6 ppm.

Table 35. The grids are listed with the highest average cPAH concentration and dibenz(a,h)anthracene concentration.

Grid Number	*Average cPAH Concentration in ppm*	*Average dibenz(a,h)anthracene in ppm*	*# samples*
93	29.4	0	2
15	9.6	1.9	5
28	2.6	0	4
26	2	0.3	5
14	2	0.3	6
33	1.6	1.4	2

The estimated cPAH doses for various age groups exposed to an average of 1.6 or 29.4 ppm cPAHs in soil are shown in Table 36. Because the doses are small, they are shown as µg/kg/day. These doses are used to estimate cancer risk for the cPAHs in soils. Depending on the age group, estimated doses range from 0.002 µg/kg/day in adults to 0.58 µg/kg/day in 1 yr old preschool children.

In addition to cPAH doses, estimated doses were also calculated for dibenz(a,h)anthracene. Those doses ranged from 0 µg/kg/day for those grids with no dibenz(a,h)anthracene to 0.038 µg/kg/day for preschool children who live on soil containing 1.9 ppm dibenz(a,h)anthracene.

Table 36. Estimated cPAH doses in various age groups exposed to an average concentration of 1.6 or 29.4 ppm cPAHs in soil

Age Group	*1.6 ppm cPAHs*	*29.4 ppm cPAHs*
	cPAH Dose µg/kg/day	
Preschool children (1 yr)	0.0320	0.5880
Preschool children (3 yr)	0.0200	0.3675
Elementary age children	0.0046	0.0840
Teenagers	0.0029	0.0535
Adult men	0.0023	0.0420
Adult women	0.0027	0.0490
Commercial/Industrial workers (20 years)	0.0016	0.0288
Excavation workers (6 months)	0.0054	0.099

V.F.4.b. Possible Health Effects From PAHs If the Site Becomes Residential

The greatest concern from PAH exposure is the potential for cPAHs to cause cancer. The concern is for cancer because non-cancerous effects are not expected at the soil levels found at the LCP site. Human studies has shown that exposure to PAHs is associated with lung and skin cancers in humans. The estimated dose of cPAHs can be multiplied by EPA's cancer slope factor for benzo(a)pyrene and the number of years of exposure to estimate the cancer risk from exposure to cPAHs in soil. The formula for estimating cancer risk follows:

Estimated Cancer Risk =

(cPAH Dose x Cancer Slope Factor) x (# years / 70 years)

The estimated dose for each age group can be used to estimate a cancer risk for that age group. The cancer risks for the 3 age groups that represent children can be added to give the estimated cancer risk for children who live on a property for 18 years. The estimated cancer risk for adults is the average of cancer risk for men and women assuming 52 years of exposure.

A similar procedure is followed to estimate the cancer risk from exposure to dibenz(a,h)anthracene. This approach uses the estimated dose of dibenz(a,h)anthracene and the cancer slope factor that is specific to dibenz(a,h)anthracene. The cancer risks estimated from both cPAHs and dibenz(a,h)anthracene are added to arrive at a total cancer risk from carcinogenic PAHs.

The estimated cancer risks in children and adults who live on soil containing the highest cPAH levels are shown in Table 37. So that the reader can understand the scientific notation, the same cancer risks are presented in Table 38. The grids with elevated levels of carcinogenic PAHs are shown in Figure 41.

Grids 15 and 93 have the highest estimated cancer risks ranging up to 1E-4 (grid 15) and 3.2E-4 (grid 93) for children if they live within these grids for 18 years. The cancer risk for adults is slightly lower. The highest cancer risk estimate is 3.2E-4. This means that should 100,000 children live for 18 years on soil containing 29.4 ppm cPAHs (grid 93), about 30 extra cancer cases might be expected. For adults who live for 52 years on grid 93, their estimated cancer risk is 2.5E-4. This means that should 100,000 adults live for 52 years on soil with 29.4 ppm cPAHs, about 25 extra cases of cancer might be expected. In summary, if the site becomes residential, children and adults might have an increased risk of cancer if they have contact with cPAHs in soil above 2 ppm.

The estimated cancer risks shown in Tables 37 and 38 likely underestimate the cancer risk from carcinogenic PAHs. The EPA is reviewing and updating the potency factors for cPAHs and will be adding more CSFs for various PAHs. These changes will result in a higher cancer risk estimate once EPA makes them final. More information about EPA's potency estimates for cPAHs can be found at

http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=66193&utm_medium=email&utm_source=govdelivery and http://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=194584.

Table 37. Estimated cancer risks in children and adults who live on certain grids with elevated levels of carcinogenic PAHs in soil (using scientific notation). The estimated cancer risk is for children and adults with high soil intake. The estimated cancer risk for children and adults with typical soil intake is about half the risk shown this table

Grid Number	*Cancer Risk*		*# samples*
	Children	*Adults*	
93	3.2E-4	2.5E-4	2
15	1.1E-4	9E-5	5
28	2.8E-5	2.2E-5	4
26	2.5E-5	1.9E-5	5
14	2.5E-5	1.9E-5	6
33	2.6E-5	2.0E-5	2

Table 38. Estimated number of cancer cases if 100,000 children or 100,000 adults were exposed to carcinogenic PAHs in soil in certain grids. The estimated cancer risk is for children and adults with high soil intake. The estimated cancer risk for children and adults with typical soil intake is about half the risk shown this table

Grid Number	*Estimated Number of Cancers if 100,000 Children or 100,000 Adults Are Exposed to Carcinogenic PAHs in Soil**		*# samples*
	Children	*Adults*	
93	30	25	2
15	10	9	5
28	3	2	4
26	3	2	5
14	3	2	6
33	3	2	2

*Estimated cancer risks are rounded to whole numbers.

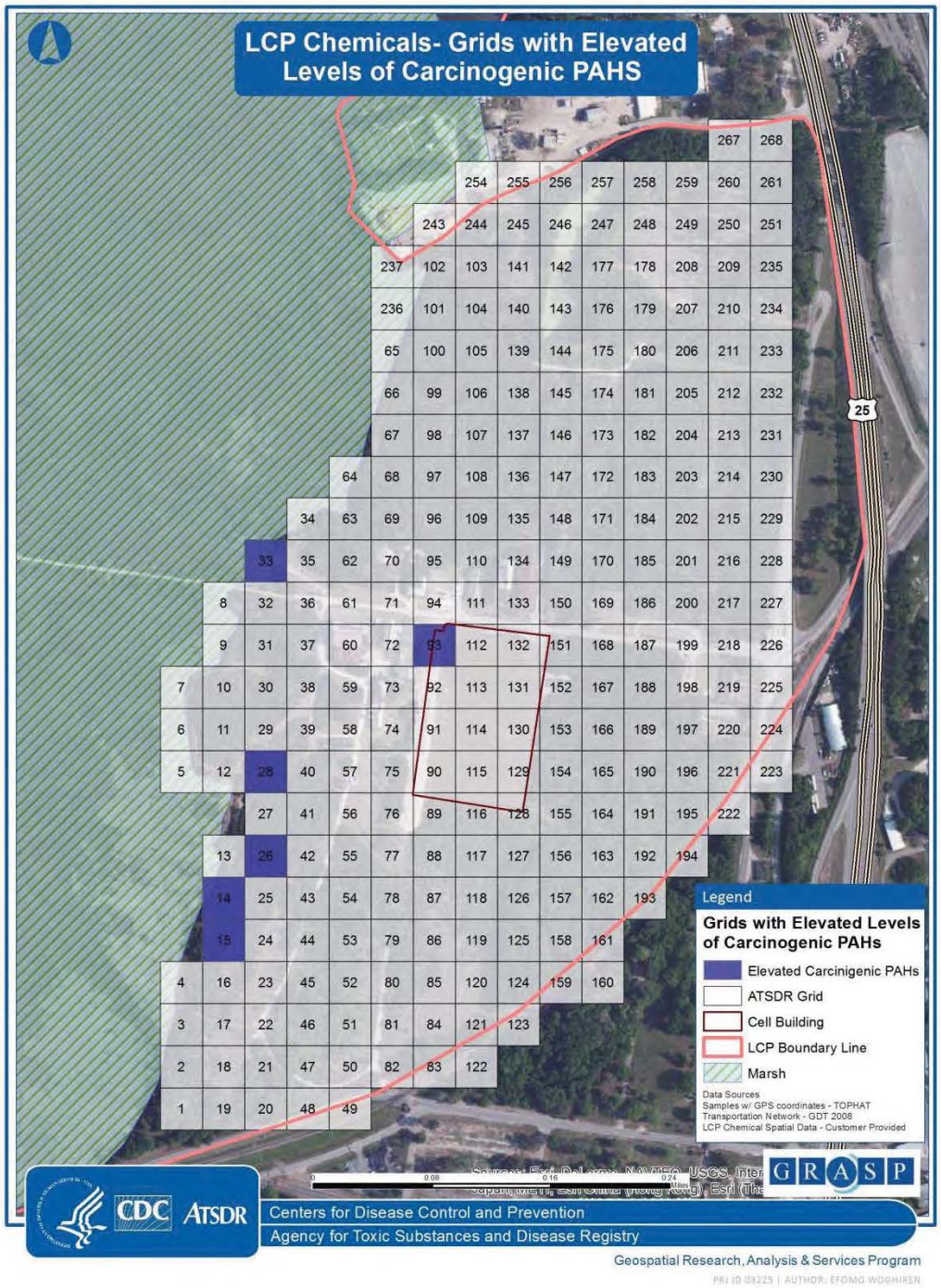


Figure 41. This figure shows the six grids in dark blue where residents might be at elevated risk of cancer from PAHs in soil if the site becomes residential in the future.

V.F.4.c. Possible Health Effects in Workers

Excavation workers who have contact with soil containing cPAHs have negligible risk of harmful effects because their exposure is very low and because their exposures last only a few months. Commercial or industrial workers who have contact with cPAHs in soil have a moderate increased risk of cancer if they have contact with soil in grids 15 and 93. Their estimated cancer risk is 2 (grid 15) or 6 (grid 93) extra cases of cancer for 100,000 workers exposed.

V.F.4.d. Uncertainty in Cancer Risk Estimates

It is important to remember the assumptions that went into estimating these cancer risks. The assumptions are as follows:

- The PAH-contaminated areas of the site will become residential or commercial/industrial,
- PAH contamination that is below the surface will be moved to the surface during construction thus allowing human contact,
- The average cPAH and dibenz(a,h)anthracene concentrations calculated using the current contaminant levels represent the level of future exposure,
- For the residential scenario, children will live on the property for 18 years or adults will live on the property for 52 years,
- For the commercial/industrial scenario, adults will have contact with the soil for 20 years, and
- Children and adults will have high soil intake from hand-to-mouth activity.

In addition, uncertainty exists for grids 33 and 93 because only 2 soil samples were collected. Also, uncertainty exists from using soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site. Nevertheless, the soil samples show that some residual cPAH contamination may still exist at the LCP dry-land area.

V.G. Mixture Effects from PCB, Methylmercury, and Lead

Several studies have shown that PCB, methylmercury, and lead have a mixture effect. Children exposed to low levels of PCBs, methylmercury, and lead showed impaired learning of a performance task. Specifically, children prenatally exposed to PCBs (as well as methylmercury and lead) responded excessively, with significantly lower inter-response times and fewer re-enforcers earned across the test session. In other words, low-level PCB, methylmercury, and lead exposure results in an inability to withhold or delay inappropriate responses, which are measures of attention and impulse control. Mean cord serum PCB level was 0.96 ppb. Maternal hair mercury levels averaged 0.56 ppm, while postnatal blood lead levels averaged 4.6 μg/dL in children aged 2 to 4 years, which are similar to levels found in the US population (Stewart 2006). The impairments of each chemical were statistically independent of the other chemical. While these tests do not prove the chemicals acted synergistically (i.e., greater than just additive), the author

concluded that it is reasonable to assume that the chemicals act in an additive manner (Stewart 2006).

Three grids (53, 60, and 93) have elevated levels of PCBs, lead, and mercury. Eight grids have elevated levels of PCB and lead (8, 58, 59, 73, 76, 89 and 111); and, five grids have elevated levels of PCBs and mercury (55, 112, 114, 118, and 128). Should these grids be developed for residential purposes, children could be at risk for problems with attention and impulse control. See Figure 42 for the location of these grids. Table 39 shows the concentrations of each chemical.

Table 39. Grids with either two or three chemicals above levels of concern

Grid # Residential	***Combination***	***PCB***	***Lead***	***Mercury***
		Average Concentration in ppm		
93	PCBs, Lead, Mercury	139	590	296
53	PCBs, Lead, Mercury	42	169	24
60	PCBs, Lead, Mercury	34	422	85
8	PCBs, lead	1.6	245	0.5
37	PCBs, Lead	12	245	6
58	PCBS, Lead	122	390	18
59	PCBs, Lead	3	513	7
73	PCBs, Lead	3	214	16
76	PCBs, Lead	7	175	13
89	PCBs, Lead	21	170	13
111	PCBs, Lead	16	354	10
90	PCBs, Mercury	41	146	184
55	PCBs, Mercury	9	9	23
112	PCBs, Mercury	1.4	119	271
114	PCBs, Mercury	53	15	41
118	PCBs, Mercury	3	4	30
128	PCBs, Mercury	11	--	81

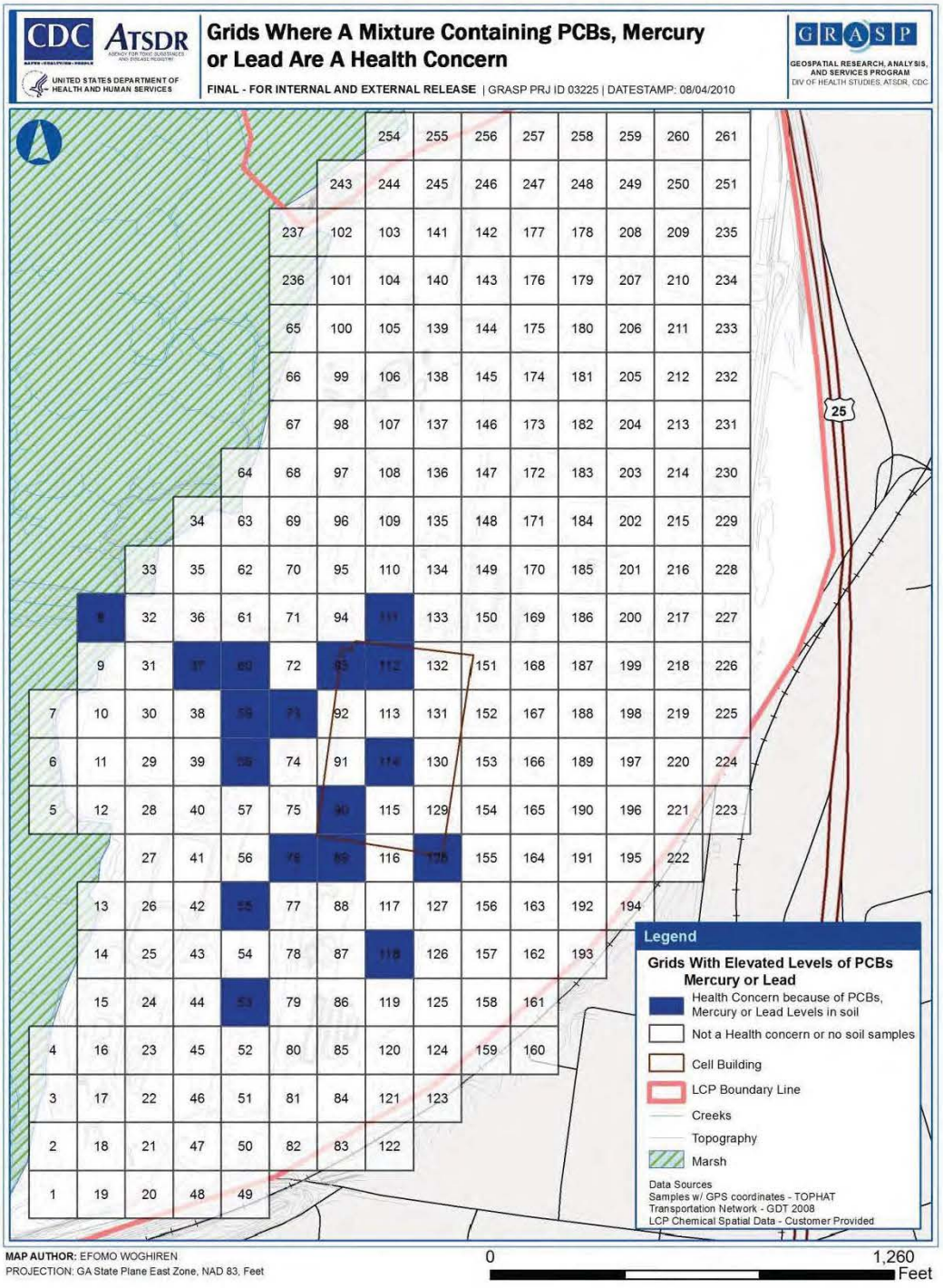


Figure 42 shows those grids that are a health concern because of a possible mixture effect from a combination of PCBs, mercury, or lead in soil. The combination of chemicals in these grids could act together to cause harmful effects.

V.H. Public Health Implications of New LCP Data Collected in 2010-2011

This section describes the public health implications of environmental samples collected from the LCP Chemicals Site in 2010 and 2011. This evaluation was not part of the evaluation presented in the fall 2010 public release document. This new evaluation focuses on several areas:

- Dioxin in soil from the dry-land area,
- PCBs and PAHs in soil from the former drive-in theater,
- PCBs, mercury, and PAHs in sediment and surface water from the on-site pond, and
- PCBs, mercury, and PAHs in sediment and PCBs and mercury in fish from the Altamaha Canal, south of the LCP Chemicals Site.

V.H.1. The Dry-land Area

As stated previously, composite soil samples for dioxins reported as TCDD-equivalent concentrations exceeded ATSDR's comparison level for soil (35 ppt) in two sampling areas (SA). The maximum TCDD-equivalent concentration from SA 8 is 120 ppt and from SA 2 is 46 ppt (See Figure 13). This section will evaluate whether a health concern exists should a home or business be built on SA 8 or SA 2.

V.H.1.a. Health Guidelines for Dioxins

The EPA has an RfD for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). As a reminder, an RfD is an estimate of a daily oral exposure in the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Because TCDD is so toxic, very small doses can cause harmful effects. The RfD for TCDD is 7×10^{-10} mg/kg/day (or 0.0000000007 mg/kg/day or 0.0007 ng/kg/day). A nanogram (ng) is one millionth of a milligram (mg).

Two human epidemiologic studies were chosen as the basis for deriving the RfD (Baccarelli *et al*., 2008; Mocarelli *et al*., 2008). Both of these studies evaluated a human population exposed to TCDD from a 1976 industrial accident in Seveso, Italy. Baccarelli *et al*. reported increased levels of thyroid stimulating hormone (TSH) in newborns exposed to TCDD *in utero.* An increase in TSH in humans indicates a possible dysregulation of thyroid hormone metabolism. The study authors related TCDD concentrations in maternal plasma to newborn TSH levels using a linear regression model. Based on this regression modeling, EPA defined the LOAEL to be a neonatal TSH level of 5 microunits/milliliter (μU/mL). Using the Emond human PBPK model, the corresponding daily oral intake at the LOAEL is calculated to be 0.020 nanogram (ng)/kg day. Adequate levels of thyroid hormone are essential in the newborn and young infant because this is a period of active brain development. Thyroid hormone disruption during pregnancy and in newborns can lead to neurological deficiencies in newborns, particularly in attention and memory (EPA 2012).

In another study, Mocarelli *et al*. (2008) reported decreased sperm concentrations and decreased motile sperm counts in men who were exposed as boys (1–9 years of age) at the time of the Seveso accident in 1976. The lowest exposure group in the Mocarelli *et al*. study (68 ppt serum TCDD) is designated as a LOAEL. Using the Emond PBPK model, EPA calculated the LOAEL over the 10 year period to be 0.02 ng/kg/day (EPA 2012). Mocarelli *et al*. (2000) also reported a lower male to female sex ratio in offspring of men exposed to TCDD less than 20 ng/kg, which supports the findings of reproductive effects involving sperm (EPA 2012, ATSDR 2012). EPA divided the LOAEL of 0.02 ng/kg/day from the Baccarelli and Mocarelli studies by an uncertainty factor of 30 to arrive at the RfD of 0.0007 ng/kg/day (or 7×10^{-10} mg/kg/day).

In summary, exposure to TCDD *in utero* can cause neurological problems in newborns, such as problems with memory and attention. In addition, exposure to TCDD *in utero* or as young boys can cause health effects later in life, such as:

- Decreased number of sperm,
- Decreased counts of motile sperm, and
- Fewer male offspring as adults.

More information about the effects of TCDD and other dioxins can be found at EPA's IRIS website (http://www.epa.gov/iris/subst/1024.htm) and at ATSDR's Addendum for chlorinated dibenzo dioxins (http://www.atsdr.cdc.gov/toxprofiles/cdds_addendum.pdf).

V.H.1.b Estimating Human Doses of Dioxins and Dioxin Hazard Quotients

As mentioned previously, TCDD-equivalent doses were estimated using a range of soil ingestion rates for various age groups. Hereafter, TCDD equivalents will be referred to as dioxins. Preschool children were assumed to swallow 200 milligrams of soil daily, while elementary-age children, teenagers, and adults were assumed to swallow 100 milligrams of soil daily. Average body weights were selected for each age group. These and other parameters used to estimate dioxin doses in people are shown in Appendix B, Table B1.

Figure 43 shows the location of SA 8, which covers portions of grids 127 to 130 and 152 to 156. EPA's composite soil sample contained dioxins at 120 ppt. The estimated dose (in ng/kg/day) of dioxins for each age group is shown in Table 40 for exposure to 120 ppt dioxins in residential soil. As shown by the HQs of 2.1 and 3.4, the estimated doses in preschool children (0.0015 and 0.0024 ng/kg/day) are two to three times higher than the RfD of 0.0007 ng/kg/day. The doses for preschool children require further evaluation to determine the risk of harmful effects from exposure to dioxins in soil should SA 8 within the site become residential. As shown by HQs ranging from 0.2 to 0.5, the doses in older children and adults are below the RfD. Older children and adults are not at risk of harmful, non-cancerous effects.

Table 40. Estimated doses and hazard quotients (HQ) in children and adults exposed to 120 ppt dioxin in residential soil. The estimated doses in preschool children exceed the RfD (HQ = 2.1 and 3.4), while the estimated doses in older children and adults are below the RfD		
	Dose	**HQ**
Age Groups	**ng/kg/day**	
Preschool children (1 yr old)	0.0024	3.4
Preschool children (3 yr old)	0.0015	2.1
Elementary school children	0.00034	0.5
Teenagers	0.00022	0.3
Adult men	0.00017	0.2
Adult women	0.0002	0.3
RfD	0.0007	

The estimated doses for preschool children (0.0015 and 0.0024 ng/kg/day) exceed the RfD (0.0007 ng/kg/day) by two to three fold. The doses for preschool children range from 8 to 13 times below the levels that are thought to cause harmful effects in humans. Because their doses approach those that might cause harmful effects, preschool male children who have contact with soil containing 120 ppt dioxins could be at risk of the following harmful effects after puberty:

- Decreased number of sperm,
- Decreased counts of motile sperm, and
- Fewer male offspring as adults.

The estimated dose for pregnant women is below the RfD; therefore, they and their developing fetus are not at risk of harmful effects.

Another area on site (SA 2) also contained dioxin but at lower levels (i.e., 46 ppt). Should this area become residential, children and adult would not be at risk of harmful effects because their estimated exposures are at or below the RfD.

V.H.1.c. Estimated Cancer Risk from Dioxins If the LCP Chemicals Site Becomes Residential

Several agencies have evaluated the cancer-causing ability of dioxins. The Department of Health and Human Services (DHHS) has determined that it is reasonable to expect that TCDD may cause cancer in humans. The International Agency for Research on Cancer (IARC) also has determined that TCDD can cause cancer in people. Previously, the EPA had determined that TCDD and a mixture of TCDD is a probable human carcinogen; however, EPA is currently reviewing their opinion about the carcinogenic effects of dioxins (ATSDR 1998, EPA 2012).

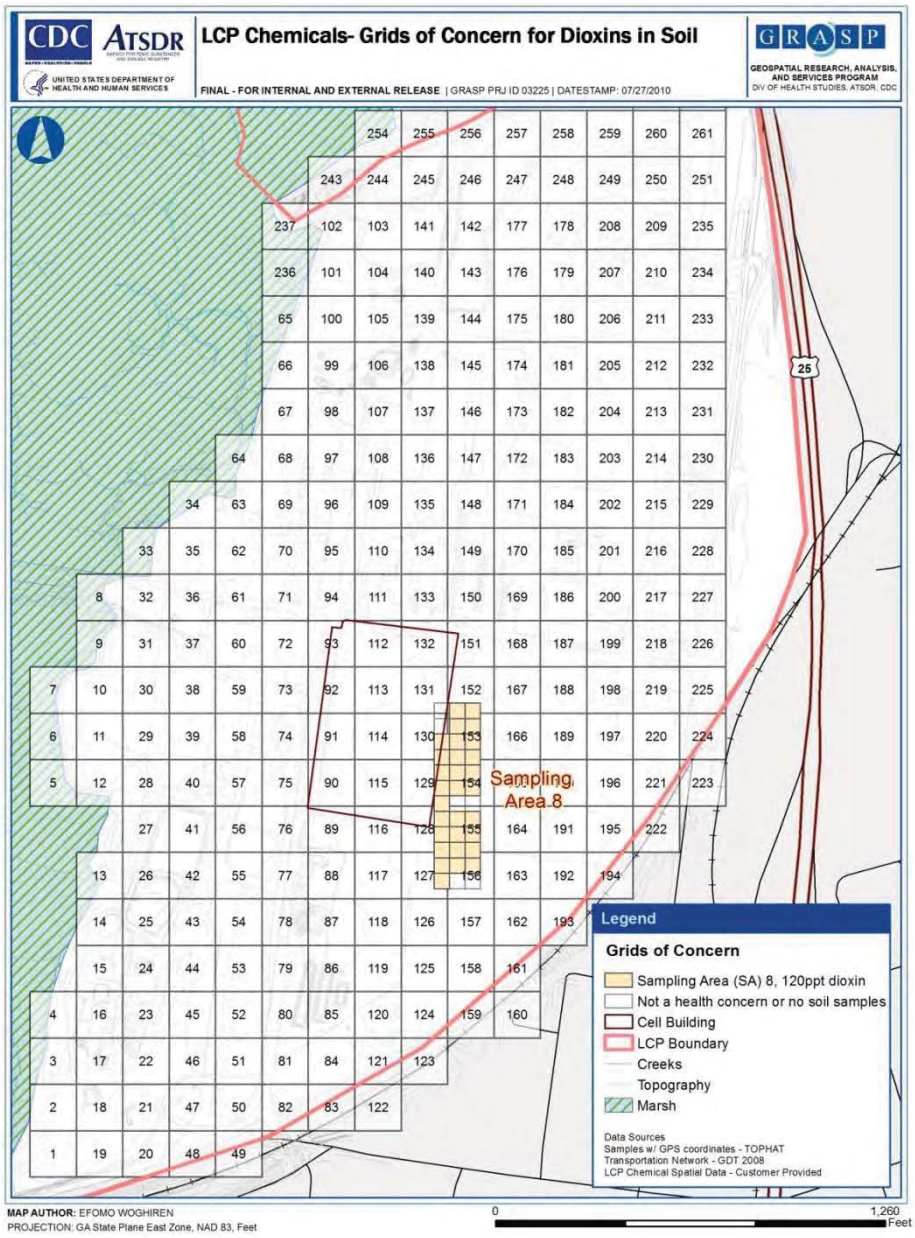


Figure 43. This figure shows the location of sampling area 8 (SA 8), which has dioxins in soil at 120 ppt.

Human studies have shown that TCDD can cause liver cancer and might be associated with lung, colon, prostrate, breast, lymphatic, and hematopoietic cancers (ATSDR 2012). Rodent studies have confirmed that TCDD can cause cancer at multiple sites, including the liver, lung, mouth, and thyroid (ATSDR 1998, 2012).

As mentioned previously, a cancer slope factor (CSF) method can be used to estimate cancer risk using the following formula:

Cancer risk = estimated lifetime dose x cancer slope factor

The California Environmental Protection Agency (CalEPA) has developed a CSF for dioxins, specifically 1.3E5 $(mg/kg/day)^{-1}$. Using CalEPA's CSF, the cancer risk for children exposed to 120 ppt in soil for 18 years is 2 extra cases of cancer for every 10,000 children exposed. The cancer risk for adults exposed to 120 ppt in soil for 50 years is 2 extra cases of cancer for every 10,000 adults exposed. Therefore, a high risk of cancer could exist for children and adults should SA 8 be developed for residential use (see Figure 43).

The EPA is re-evaluating the cancer risk for dioxins and has a draft CSF under review. The estimated cancer risks at LCP could be higher or lower depending on the final CSF that EPA chooses.

In conclusion, should SA 8 be developed as a residential neighborhood, a high risk of cancer exists for children and adults, and preschool children could be at risk of reproductive effects once they reach adulthood.

V.H.1.d. PCBs and cPAHs in Soils from the Former Drive-in Theater

From 1994 to 2010, EPA collected surface and subsurface soil samples from the former drive-in theater area. The results of these sampling events were previously presented in Table 10. PCBs and cPAHs exceeded ATSDR's screening values for residential soils; therefore, those two chemicals will be evaluated further in this section.

It should be noted that Glynn County purchased approximately 32 acres from the northeastern portion of the site, which includes the theater area and an on-site pond. The county plans to build a detention center on this property. Therefore, this portion of the site will not be residential and will be evaluated only for future adult exposures for workers and prisoners at the prison. Appendix B, Table B1 shows the parameters used to estimate adult doses from soil ingestion. Prison inmates were assumed to ingest soil daily and guards were assumed to ingest soil 5 days a week. Insufficient data exist to estimate a reliable average for the theater area; therefore, ATSDR used the maximum concentration of PCBs and cPAHs (see Table 41).

The estimated PCB doses in prison inmates and guards are far below ATSDR's chronic, oral MRL for PCBs. Therefore, non-cancerous harmful effects are unlikely. The risk of cancer in prison inmates and guards is well below one in a million. The estimated dose of cPAHs in prison inmates and guards results in a cancer risk of three in a million.

Table 41. Maximum soil concentrations of PCBs and cPAHs in the theater area.	
Contaminant	***Soil Concentration in ppm***
PCBs	0.57
cPAHs	1.3

V.H.1.e. The On-Site Pond

As previously mentioned, the levels of PCBs, mercury, cPAHs, and lead in surface water and sediment from the on-site pond are not a health concern.

V.H.2. Altamaha Canal

V.H.2.a. Sediment

The Altamaha Canal once traversed the LCP Chemicals Site and a portion of the canal, which is influenced by the tides, still exists south of the LCP Chemicals Site. Sediment samples (upper 6 inches) were collected from twenty locations along the canal from its northern limit at West 9th Street to its southern outflow at T Street. The canal flows into the adjoining marsh where the outflow drains to Academy Creek and eventually to the East River and to the lower portion of the Turtle River. Each sample is comprised of a five-point composite taken along an approximate 1000-ft stretch of the canal. The sampling locations and individual results are shown in Figures 29 through 33. The average concentration of PCBs, cPAHs, and dioxin are presented in Table 42.

When adults or children visit or play along the banks of the Altamaha Canal, they could ingest small amounts of sediments from hand to mouth activity. ATSDR assumed that adults visit the canal once a week to fish and that elementary-age children and teenagers play along the canal three times a week. Because of their age, preschool children are unlikely to play along the canal. It should be noted that even if adults and children visit or play along the canal every day, the same conclusions are reached.

ATSDR evaluated the risk of harmful effects from exposure to PCBs, cPAHs, and dioxins and reached the following conclusions.

- The estimated dose of PCBs for adults and children who visit or play along the canal is well below ATSDR's chronic, oral MRL for PCBs. Therefore, harmful non-cancerous effects are not likely. The estimated cancer risk is less than one in 10 million.

- The estimated dose of cPAHs for adults and children who visit or play along the canal results in a cancer risk well below one in a million.

- The estimated dose of dioxins for adults and children who visit or play along the canal is well below EPA's RfD for dioxin. Therefore, harmful, non-cancerous effects are not likely. The estimated cancer risk for children and adults is 1 in a million.

In summary, the estimated exposure to PCBs, cPAHs, and dioxins in sediment is below health guidelines and the risk of cancer is insignificant.

Table 42. Average concentration of PCBs, cPAHs, and dioxin in sediment collected from the Altamaha Canal south of the LCP Chemicals Site

Contaminant	***Average Concentration in ppm***
PCBs	0.17
cPAHs	0.24
Dioxin	0.00007*

*0.00007 = 70 ppt

V.H.2.b. Fish and Shellfish from the Altamaha Canal

V.H.2.b.1. GDNR Fish and Shellfish Advisory

The Georgia Department of Natural Resources (GDNR) has issued a fish advisory for the Buffalo, Turtle, South Brunswick, and Brunswick Rivers as well as their tributary creeks, such as Purvis and Gibson Creeks, the closest creeks to the LCP Chemicals Site. Figure 44 shows these rivers and creeks in relation to the LCP Chemicals Site, which borders the Turtle River. In Tables 43, 44, 45, and 46, GDNR describes the fish advisory for several sections of the Turtle River system, which includes:

- Purvis and Gibson Creeks,
- Buffalo River and upper Turtle River upstream of Georgia Highway 303,
- Middle Turtle River between Georgia Highway 303 and channel marker 9, and
- South Brunswick River and lower Turtle River from channel marker 9 downstream to channel marker 27 at DuBignon's and Parsons Creek (channel marker 27) (GDNR 2012).

Depending upon mercury and PCB levels in the edible portion of various fish and shellfish from the areas listed in the previous bullets, GDNR recommends one of four consumption guidelines:

- No restrictions,
- One meal per week,
- One meal per month, and
- Do not eat.

This approach allows the greatest flexibility in informing residents about fish consumption. For example, GDNR recommends that residents not eat Atlantic croaker taken from Purvis or Gibson Creeks because the edible portion is highly contaminated with PCB 1268–the PCB most commonly found at the LCP Chemicals Site (see Table 43). GDNR recommends that residents limit consumption of red drum and flounder taken from these creeks to one meal per week because of PCB and mercury levels in the edible portion of those fish. Similar recommendations exist for the upper, middle, and lower Turtle River and adjoining rivers and creeks.

Table 43. GDNR's fish consumption recommendations for Purvis and Gibson Creeks (see Figure 44).

Turtle River System: ***Satilla River Basin***
Purvis and Gibson Creeks , (St. Simons Estuary)

Species	Site Tested	Recommendation	Chemical
Atlantic Croaker	Purvis & Gibson Creeks	Do Not Eat	PCBs
Southern Kingfish (whiting), Black Drum, Spot, Spotted Seatrout		1 meal/month	PCBs
Sheepshead		1 meal/month	PCBs, Mercury
Striped Mullet		1 meal/week	PCBs
Red Drum, Flounder		1 meal/week	PCBs, Mercury
Blue Crab		1 meal/week	Mercury
Shrimp		No Restrictions	
Clams, Mussels, Oysters	Not applicable	Do Not Eat	Shellfish Ban *
* Shellfish Ban: National Shellfish Sanitation Program. For information see Coastal Resources Division website: http://crd.dnr.state.ga.us			

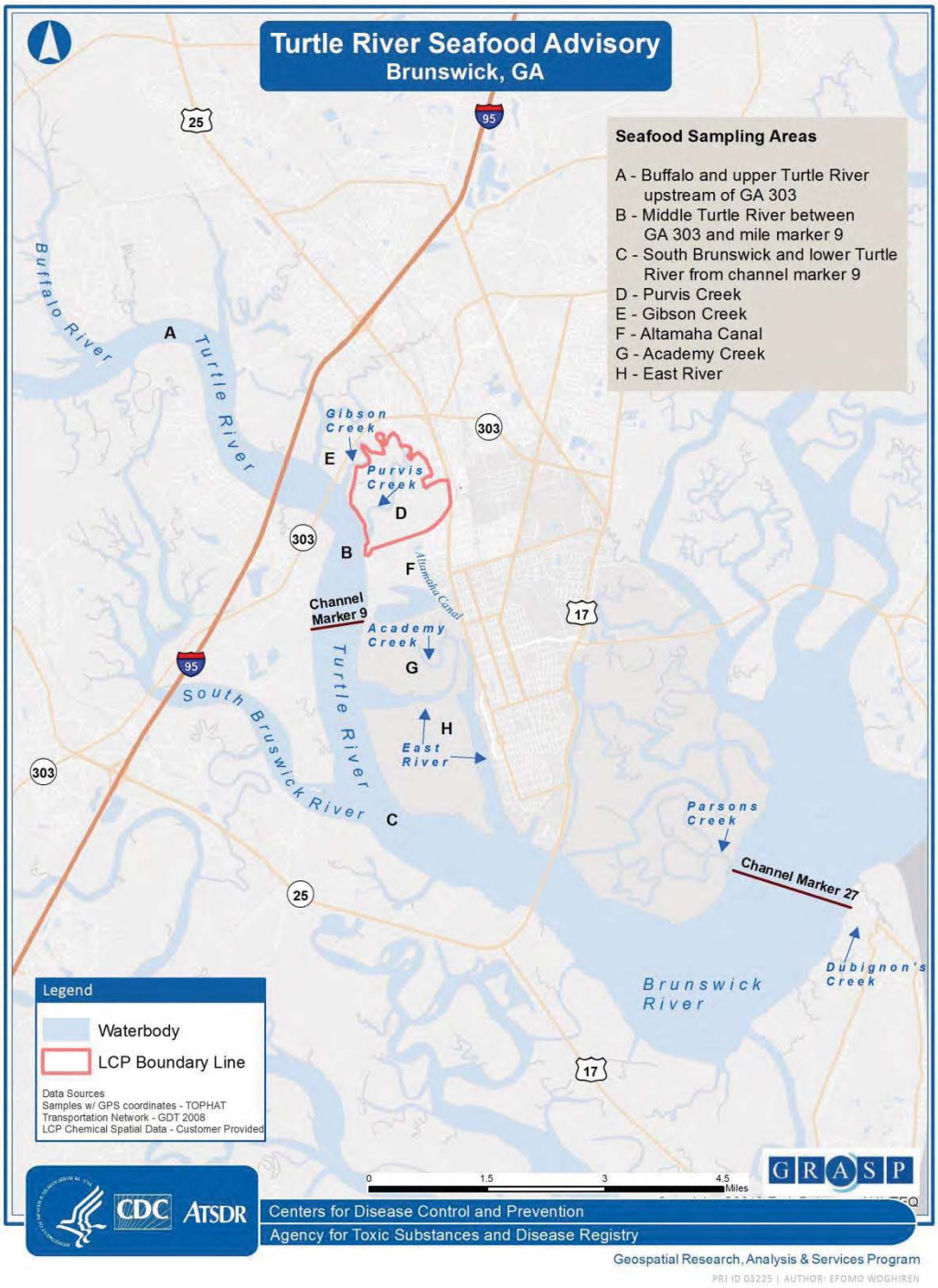


Figure 44. This figure shows the Turtle River system and highlights portions of the river system (see A, B, C, D and E) that are pertinent to GA DNR's fish advisory. The Altamaha Canal (see F) is located just south of the LCP Chemicals Site and connects to Academy Creek, the East River, and lower portion of the Turtle River (See G, H, and C).

Table 44. GDNR's fish consumption recommendations for the Buffalo and Turtle Rivers upriver of Georgia Highway 303 (see Figure 44).

Upper Turtle & Buffalo Rivers (St. Simons Estuary) ***Satilla River Basin***

Species	Site Tested	Recommendation	Chemical
Spotted Seatrout, Spot, Southern Kingfish (whiting), Atlantic Croaker	Turtle and Buffalo Rivers, Upriver of Georgia Hwy 303	1 meal/month	PCBs
Red Drum, Black Drum, Striped Mullet		1 meal/week	PCBs
Sheepshead		1 meal/week	PCBs, Mercury
Blue Crab		1 meal/week	Mercury
Shrimp, Flounder		No Restrictions	
Clams, Mussels, Oysters	Not applicable	Do Not Eat	Shellfish Ban *
* Shellfish Ban: National Shellfish Sanitation Program			

Table 45. GDNR's fish consumption recommendations for the middle Turtle River between Georgia Highway 303 and channel marker 9 (see Figure 44)

Middle Turtle River (St. Simons Estuary) ***Satilla River Basin***

Species	Site Tested	Recommendation	Chemical
Spot	State Hwy 303 to Channel Marker 9	Do Not Eat	PCBs
Spotted Seatrout, Sheepshead, Striped Mullet, Southern Kingfish (whiting)		1 meal/month	PCBs
Black Drum		1 meal/week	PCBs
Red Drum, Flounder		1 meal/week	PCBs, Mercury
Blue Crab		1 meal/week	Mercury
Shrimp		No Restrictions	
Clams, Mussels, Oysters	Not applicable	Do Not Eat	Shellfish Ban *
* Shellfish Ban: National Shellfish Sanitation Program			

Table 46. GDNR's fish consumption recommendations for the South Brunswick and lower Turtle Rivers from channel marker 9 downstream to Dubignon's and Parsons Creeks (See Figure 44).

Lower Turtle & South Brunswick Rivers (St. Simons Estuary) ***Satilla River Basin***

Species	Site Tested	Recommendation	Chemical
Atlantic Croaker, Spot	Turtle River (From Channel Marker 9) and South Brunswick River (Downstream to Dubignon and Parsons Creeks)	1 meal/month	PCBs
Spotted Seatrout, Black Drum, Southern Kingfish (whiting)		1 meal/week	PCBs
Red Drum, Sheepshead, Striped Mullet, Blue Crab, Shrimp, Flounder		No Restrictions	
Clams, Mussels, Oysters	Not applicable	Do Not Eat	Shellfish Ban *
* Shellfish Ban: National Shellfish Sanitation Program			

The 2013 GDNR fish advisories for rivers, lakes, and estuaries in Georgia, including the Turtle River system, can be found at this website: http://www.gaepd.org/Documents/fish_guide.html. To view their brochure, click on "Guidelines for Eating Fish from Georgia's Waters, 2012".

GDNR also has brochures that provide information and recommendations specifically on women who eat fish and shellfish. These brochures cover specific geographic regions within Georgia, and the one for Brunswick, Georgia, states:

> Extensive studies have been performed on the Turtle River System, and Terry and Dupree Creeks. Assessment of contaminants in the species sampled suggests striped mullet and bivalves (oysters, clams, etc.) from this area should not be eaten. Consumption of all other finfish and blue crabs should be limited to once a month for women of childbearing age. However, in most areas there is no restriction on the amount of shrimp that can be eaten from these waters (GDNR 2012).

The brochure "A Woman's Guide to Eating Fish and Seafood in Coastal Georgia" can be downloaded from http://www.gaepd.org/Files_PDF/gaenviron/fish_advisory/wfcg_coastal.pdf.

V.H.2.b.2. Mercury in Fish and Shellfish from the Altamaha Canal

As mentioned previously, EPA collected fish and shellfish samples in 2011 from the tidally influenced Altamaha Canal that flows south of the LCP Chemicals Site. Table 47 shows the average mercury levels in fish and shellfish collected from the canal in 2011. These levels can be compared to fish and shellfish collected from the Turtle River System in 2002. This comparison shows that mercury levels in red drum, mullet, blue crab, and shrimp from the Altamaha Canal are similar to or below the levels found in the same fish and shellfish groups from the Turtle River. Mercury levels are closest to levels in fish and shellfish from the lower Turtle River south of the site. This similarity is probably due to the fact that the Altamaha Canal is connected to the lower Turtle River via Academy Creek and the East River (see Figure 44). Thus, influence by tidal cycles, fish and shellfish move from the lower Turtle River via the East River and Academy Creek to the Altamaha Canal. Comparison data for sea trout from the Turtle River were not available. However, the concentration of mercury in the one sea trout from the Altamaha Canal (0.117 ppm) is lower than average levels reported by the U.S. Food and Drug Administration in a national survey (0.235 ppm) (http://www.fda.gov/food/foodsafety/product-specificinformation/seafood/foodbornepathogenscontaminants/methylmercury/ucm115644.htm).

It should be noted that the red drum and sea trout samples consisted of one fish of each species; therefore, the actual levels in other fish of these species that might be caught in the Altamaha Canal is highly uncertain.

Table 47. Average mercury levels in edible fish and shell fish tissue are provided for Altamaha Canal as well as for various sections of the Turtle River system north of, adjacent to, and south of the LCP Chemicals Site. Data are not available for sea trout from the Turtle River System for 2011 so average mercury levels are reported from an FDA survey.

Date and Location	***Mercury concentrations in mg/kg-wet weight (ppm-ww)***				
	Red Drum	***Mullet***	***Sea Trout***	***Blue Crab***	***Shrimp***
2011 Altamaha Canal	0.09	0.013	0.117	0.081	0.02
2002 Upper Turtle and Buffalo Rivers (north of LCP)	0.27	0.02	NA	0.51	0.05
2002 Middle Turtle River, including Purvis and Gibson Creeks (adjacent to LCP)	0.32	0.02	NA	0.68	0.09
2002 Lower Turtle River south of the site, including South Brunswick and Brunswick River (south of LCP)	0.15	0.01	NA	0.31	0.04
FDA national survey			0.235		

NA = not available

V.H.2.b.3. Mercury Dose Estimates in Fishers

Information about fish intake rates is provided in Table 48. The basis for these rates comes from Burger *et al*., who reported fish consumption rates for adult fishers along the Savannah River between Georgia and South Carolina (Burger *et al*. 2001; Burger *et al*. 1999).[5] Burger also estimated the rates for women at 68% of male intake rates (Burger 2000). The rates for children were estimated using the ratio of adult to children portion sizes reported by EPA (EPA 2011).

[5] The Savannah River is about 80 miles from Brunswick, Georgia.

Table 48. Daily fish consumption rates (95th percentile and median) reported by Burger et al. (2001) for fishers along the Savannah River between Georgia and South Carolina.

Population	***95th %***		***Median***
	oz./day		***oz./day***
Black male	6.6		1.8
White male	4.8		0.7
Black female	4.5		1.2
White female	3.2		0.5
Children 3 to 5 years	1.8		0.5
Children 6 to 10 years	2.5		0.7
Children 11 to 15 years	3.6		1
Children 16 to 17 years	4.1		1.1

The daily fish consumption rates shown in Table 48 do not mean that people eat fish every day. The rates were derived by taking the survey results and reporting them as a daily intake and using those rates to derive daily rates for women and children as previously explained. For example, for children 3 to 5 years old who are typical (median) fish consumers (0.5 oz./day), they could have fish consumption patterns that might look like this:

- One 3.5 oz. fish meal a week,
- Two 1.8 oz. fish meals a week, or
- Three 1 oz. fish meals a week.

These combinations of weekly fish meals represent a daily rate of 0.5 oz./day. For children 3 to 5 years who are high (95%) fish consumers (1.8 oz./day), their consumption pattern might look like this:

- Three 4.2 oz. fish meals a week,
- Four 3.2 oz. fish meals a week, or
- Five 2.5 oz. fish meals a week.

What follows is a sample dose calculation for children 3 to 5 years old who are high consumers of sea trout from the Altamaha Canal, which contain 0.117 ppm (or mg/kg) mercury.

$$\text{Dose} = \frac{\text{Mercury Concentration in Fish} \times \text{Daily Fish Consumption Rate} \times \text{Conversion Factor}}{\text{Body Weight}}$$

$$\text{Dose} = \frac{\left[\left[0.117 \text{ mg/kg} \times 1000 \text{ µg/mg}\right] \times \left[1.8 \text{ oz/day} \times 28.35 \text{ gm/oz} \div 1000 \text{ gm/kg}\right]\right]}{17 \text{ kg}^{6}}$$

$$\text{Dose} = 0.35 \text{ µg/kg/day}$$

This dose exceeds the RfD of 0.1 µg/kg/day and approaches the effect level of 1 µg/kg/day.

As mentioned previously, children and the fetus are particularly sensitive to the effects of mercury. ATSDR reached the following conclusions about adults and children with typical (i.e., median) and high (i.e., 95th percentile) fish consumption:

- Typical and high fish consumers of mullet and shrimp have estimated exposures to mercury that are below EPA's RfD for mercury. The levels of mercury in mullet and shrimp from the Altamaha Canal are not a health concern.
- Typical fish consumers of blue crab, red drum, and sea trout have estimated exposures to mercury that are below EPA's RfD for mercury. The levels of mercury in blue crab, red drum, and sea trout are not a health concern for typical fish consumers.
- High fish consumers of blue crab, red drum, and sea trout have estimated exposures to mercury that exceed EPA's RfD for mercury. Their mercury exposure approaches the level that causes harmful effects. Young children and children born to pregnant women who are high consumers of blue crab, red drum, and sea trout might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions. The levels of mercury in blue crab, red drum, and sea trout are a health concern for high fish consumers.

Some uncertainty exists in the conclusions for sea trout and red drum because only one fish of each species was collected from the Altamaha Canal.

These findings support the fish advisory issued by the GDNR for the lower Turtle River, which is based in part on mercury levels in blue crabs, sea trout, and king fish. Residents should follow GDNR's fish advisory for the lower Turtle River by restricting their

[6] µg = micrograms; mg = milligrams; oz = ounces; gm = grams; kg = kilograms

consumption of certain fish species from the Altamaha Canal and from the lower Turtle River. See Table 46 for more information about the state's fish consumption recommendation for the lower Turtle River.

V.H.2.b.4. PCBs in Fish and Shellfish from the Altamaha Canal

Table 49 shows the average PCB levels in fish and shellfish collected in 2011 from the Altamaha Canal. These levels can be compared to fish and shellfish collected in 2002 from the Turtle River system. This comparison shows that PCB levels in red drum, mullet, sea trout, blue crab, and shrimp from the Altamaha Canal are below the levels found in the same fish and shellfish groups from the Turtle River. It should be noted that the red drum and sea trout samples from the Altamaha Canal consisted of one fish of each species; therefore, the actual levels in other fish of these species that might be caught in the Altamaha Canal is highly uncertain.

ATSDR estimated the dose of PCBs from eating various fish and shellfish from the Altamaha Canal and reached the following conclusions about adults and children with typical (i.e., median) and high (i.e., 95th percentile) fish consumption:

- Typical and high fish consumers of red drum, blue crab, and shrimp have estimated exposures to PCBs that are at or below ATSDR's chronic oral MRL. PCB levels in red drum, blue crab, and shrimp are not a health concern for harmful, non-cancerous effects.
- Typical fish consumers of sea trout have estimated exposure to PCBs that are at ATSDR's chronic oral MRL. High fish consumers of sea trout have estimated exposure to PCBs that exceed the chronic oral MRL and approach levels that put them at risk of harmful, non-cancerous effects.
- Typical and high fish consumers of mullet have estimated exposure to PCBs that exceed ATSDR's chronic oral MRL and approach levels that put them at risk of harmful, non-cancerous effects.

High consumers of sea trout and typical and high consumers of mullet might experience the following harmful effects:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance decrements,
- Fewer male births,
- Problems with attention and impulse control
- Lower birth weight,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women (but not men),

- An increase in deaths from Parkinson disease and dementia in women (but not men), and
- An increase in diabetes in women (but not men) (ATSDR 2000).

In addition to these harmful effects, monkey studies have shown that 4 year old monkeys experience learning and performance decrements when exposed to 7.5 μg/kg/day PCBs from birth to 20 weeks. These studies showed that young monkeys exposed during early life were impaired in their ability to organize behavior temporally, and monkeys were impaired in their ability to learn from the consequences of previous actions. Stated another way, monkeys showed an inability to change an already established response strategy and were unable to prevent inappropriate responses (ATSDR 2000). According to the author, these impairments are consistent with features demonstrated by children with attention deficient hyperactivity disorder (Rice 2000). Therefore, children and especially preschool children, with their nervous systems still developing, may be a particularly susceptible group. These conclusions are supported by human studies that show small changes in serum PCB concentrations are associated with harmful effects to the neurological systems.

Children and adults who frequently eat mullet from the Altamaha Canal also have an increased risk of liver and thyroid cancers. Should 10,000 children eat mullet frequently for 18 years, 3 extra cases of cancer might be expected. Should 10,000 adults eat mullet frequently during their adult life, 10 extra cases of cancers might be expected.

The GDNR has issued a fish advisory for the lower Turtle River, which tidally influences the Altamaha Canal. The advisory is based in part on PCB levels in mullet, red drum, sea trout, and blue crab. For fish and shellfish taken from the Altamaha Canal, residents should follow GDNR's fish advisory for the lower Turtle River. According to GDRN's advisory, residents should restrict their consumption of mullet to one meal per month and their consumption of red drum, sea trout, and blue crab to one meal per week. See Table 46 for more information about the state's fish consumption recommendation for the lower Turtle River and Tables 43-45 for other parts of the Turtle River system.

Table 49. Average PCB levels in edible fish and shell fish tissue are provided for the Altamaha Canal as well as for various sections of the Turtle River system north of, adjacent to, and south of the LCP Chemicals Site. Data are not available for sea trout from the Turtle River System for 2011 so average mercury levels are reported from an FDA survey.					
Date and Location	***PCB concentrations in mg/kg-wet weight (ppm-ww)****				
	Red Drum	***Mullet***	***Sea Trout***	***Blue Crab***	***Shrimp***
2011 Altamaha Canal	0.02	0.25	0.08	0.015	0.015
2002 Upper Turtle and Buffalo Rivers (north of LCP)	0.25	1.4	NA	0.16	0.1
2002 Middle Turtle River, including Purvis and Gibson Creeks (adjacent to LCP)	0.14	2.6	NA	0.02	0.23
2002 Lower Turtle River south of the site, including South Brunswick and Brunswick River (south of LCP)	0.11	0.36	NA	0.1	0.1

*The only PCB detected in fish and shellfish was Aroclor 1268, the most predominant Aroclor at the LCP Chemicals Site.
NA = not available

V.I. Summary of Grids That Are a Health Concern

In summary, numerous grids have elevated levels of mercury, PCBs, lead, PAHs, or dioxins that are a public health concern if the site becomes residential in the future. Figure 45 shows 66 grids that have at least one contaminant that is a health concern if the site becomes residential in the future. Figure 46 shows the nine grids that are a public health concern if the site becomes commercial or industrial in the future. Stated another way, 33 acres are a health concern should the site become residential, and about 5 acres are a health concern should the site become commercial or industrial.

The previous discussions about PCBs, mercury, lead, PAHs, and dioxins provide the justifications for these conclusions. Some uncertainty exists in these conclusions. The reasons for this uncertainty are described previously in the PHA.

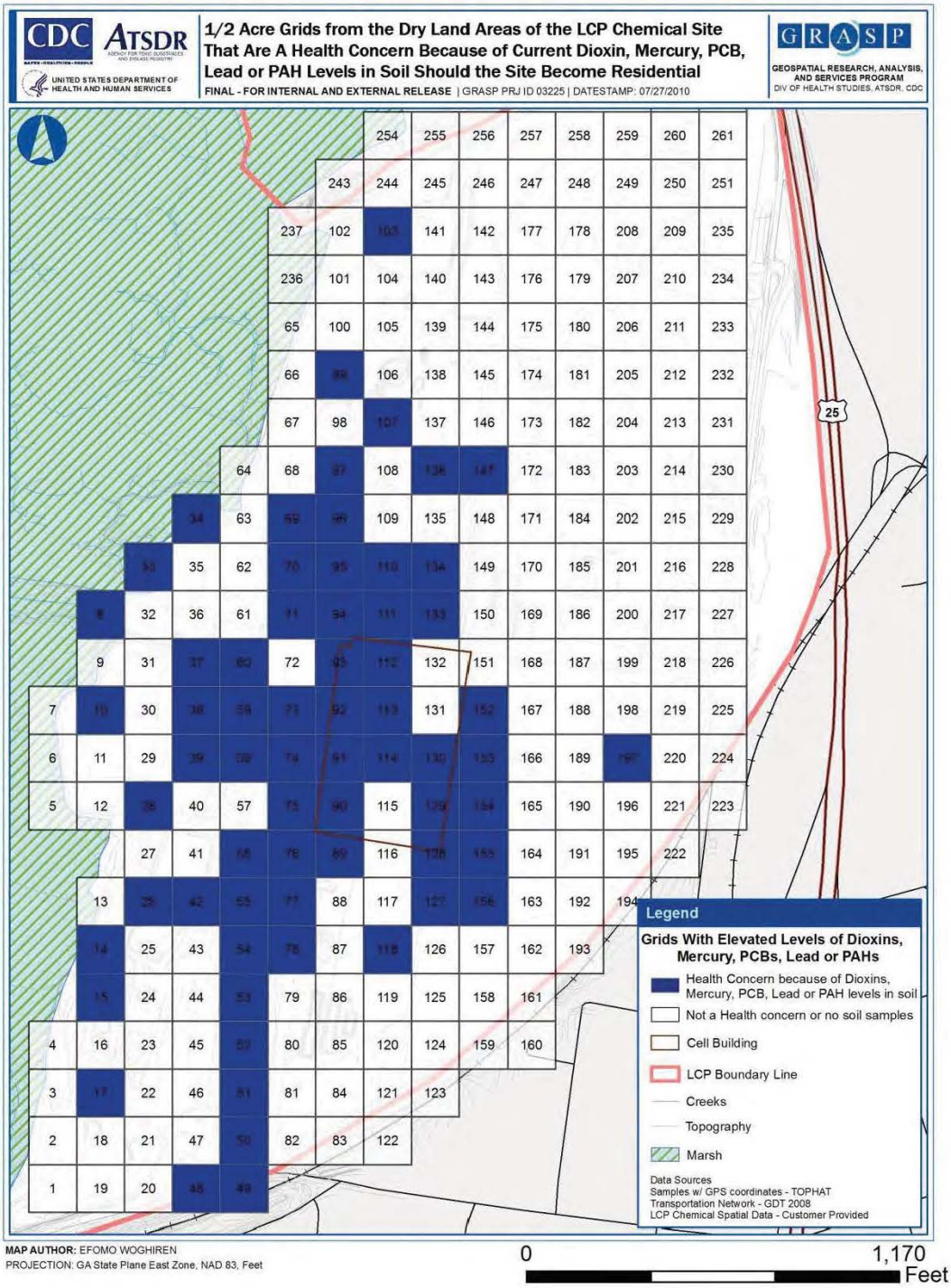


Figure 45. This figure shows the 65 grids that are a health concern if the site becomes residential in the future.

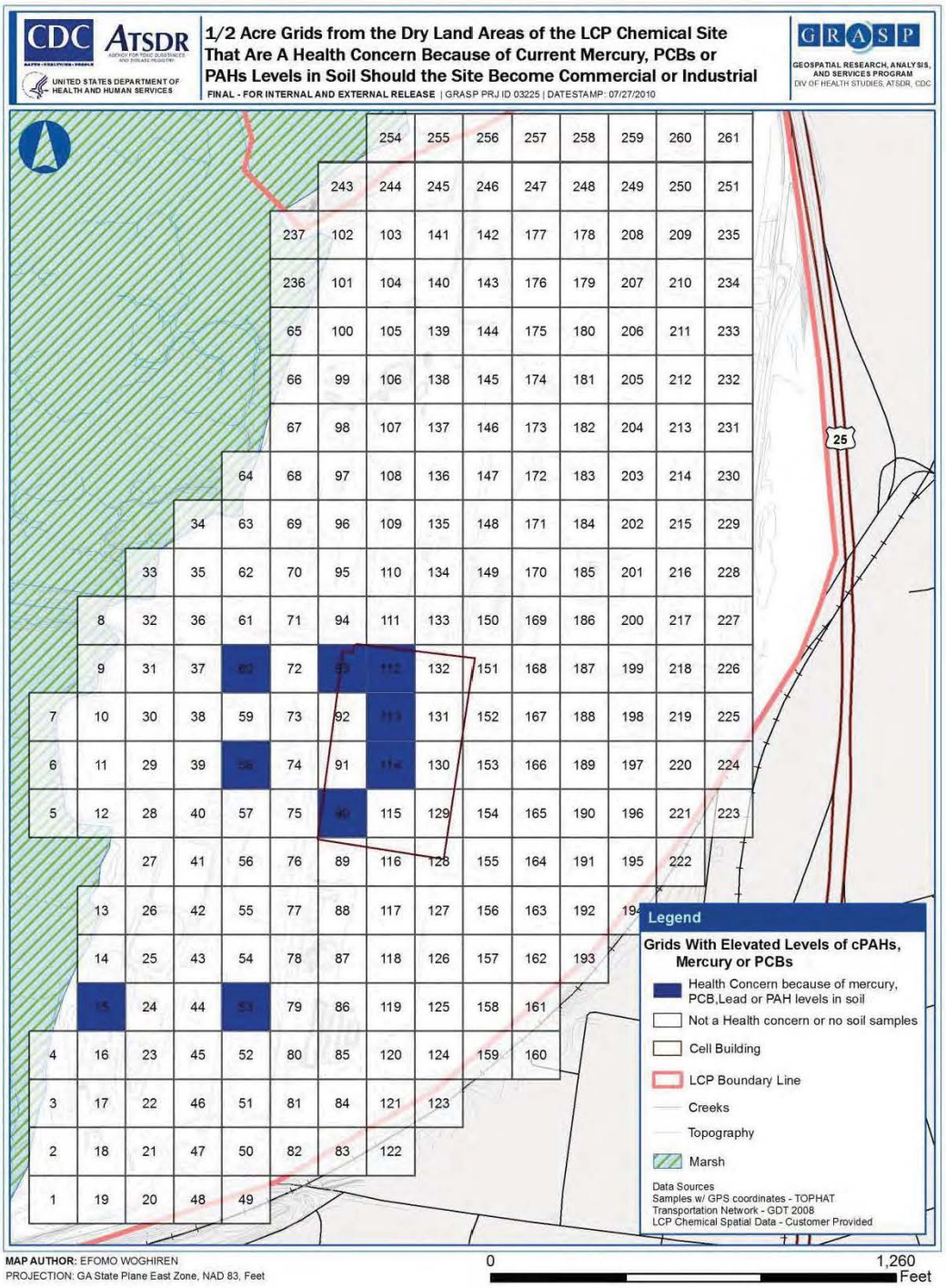


Figure 46. This figure shows nine grids that are a health concern if the site becomes commercial or industrial in the future.

VI. COMMUNITY HEALTH CONCERNS

When performing a public health assessment, ATSDR gathers health concerns from people living in the community. The health concerns that people express help direct the focus of the evaluation. For the LCP Chemicals Site, ATSDR gathered concerns from the community on several occasions dating from October 2004 until present. ATSDR received numerous health concerns from residents who live near the LCP Chemicals site or who worked for LCP Chemicals when it was operating. Below is a list of the health concerns expressed by community members:

1. Community Concern: Residents reported numerous health concerns that they thought might be related to living near the LCP Chemicals Site. Their health concerns fall into these general categories: respiratory, skin, muscular, metabolic, neurological, cardiovascular, and reproductive. A list of their specific health concerns follows:

chronic sinus infections	allergies	hay fever
eczema	arthritis	diabetes
high cholesterol	hives	fatigue
shortness of breath	hypertension	ear infection
poor circulation	sinus infection	hysterectomy
low birth weight	hearing problems	speech problems
glaucoma	low potassium	bones ache
rash	heart trouble	cataracts
stroke	brain tumor	liver disease
breathing problem	nose bleeds	stomach cancer
hardening of the arteries	lung cancer	fibroid tumors
bone deterioration	cancer	fertility problems
poor vision	birth defect	nausea
migraines	bronchitis	poor memory
iron deficiency	bruise easily	heart attack
skin conditions	hair loss	dizziness
balance problems	shortness of breath	heart murmur
visual problems	light headedness	agitation
joint pain	congestive heart failure	slow learning
heart racing	blackouts	confusion
forgetfulness	poor eyesight	prostate cancer
sores on arms and legs	ringing sound in ears	difficulty concentrating
breakout of bumps on skin	getting oxygen to the brain	
sensitive to temperature changes	long and short term memory loss	
difficulty with blood flow to the brain	sarcoidosis (immune disease)	

ATSDR Response: Many of the people with the health conditions or symptoms listed previously report that they lived in the Arco neighborhood for many years or they had family members that worked at the LCP Chemicals facility. Unfortunately, it is not possible to know if these health conditions or symptoms

are related to the LCP Chemicals Site. Some residents report smelling chemicals that they believe were coming from the LCP Chemicals facility when it was operating; however, we could not confirm that the smell was coming from the facility because it happened so many years ago and because, to our knowledge, no air monitoring data are available in nearby neighborhoods.

2. Community Concern: Residents are concerned about contaminated water.

   ATSDR Response: ATSDR is currently unsure if any private wells are impacted by site-related contaminants. During our site visit in July 2009, we noticed numerous private wells in a neighborhood immediately north of the LCP Chemicals Site on the following roadways: Manning Street, Deloach Street, Fader Lane, Roadway Street, Cedar Avenue, Robarts Road, and Lakeside Circle. We also noticed private wells in a neighborhood immediately south of the LCP Chemicals Site on the following roadways: Sycamore Street and Baines Bluff Road. Groundwater flow at the site is westward toward the marsh; therefore, it is unlikely that private wells north, south, and east of the site could be contaminated.

   If you currently receive your household water from a municipal source (e.g., city water), then your water should be safe to drink.

3. Community Concern: Another resident is concerned about historical air contamination when the LCP Chemical Plant was operating.

   ATSDR Response: ATSDR believes that it is likely that past operations at the site created conditions where contaminants were dispersed in the air to nearby, off-site locations. A review of past soil sampling conducted in the Arco neighborhood suggests that mercury levels were elevated in some soil samples well above background levels. It seems reasonable to assume that mercury may have been deposited as a result of aerial releases from LCP operations when the facility was actively making chlorine.

   However, we have no emissions data from the facility to review and no air samples in the Arco neighborhood during that time period. Therefore, it is not possible for us to state with certainty that aerial releases occurred in the past, or for us to quantify the exposures from these releases if they did occur. Therefore, ATSDR cannot reach a conclusion about whether historical air releases could have exposed nearby residents and caused adverse health effects.

4. Community Concern: Residents are concerned about soil contamination.

   ATSDR Response: On-site soil contamination is addressed in this document. Off-site soil contamination, such as in the Arco neighborhood, has been addressed in previous evaluations done by this agency. A summary of those reports can be

found in Section II.G above. Generally, off-site soils do not contain contamination levels high enough to result in adverse health effects.

5. Community Concern: Several residents are concerned about having eaten seafood (shrimp, fish, and crabs) from the Turtle River. Some residents report eating seafood for many decades (e.g., 1960s, 1970s, and 1980s). They report the following signs and symptoms:

> Resident #1: This person has experienced hypertension, diabetes, dizziness, memory loss, balance problems, numbness around the fingers and toes, shortness of breath, heart murmur, sudden headaches, and visual problems.
>
> Resident #2: This person is now experiencing light-headedness, headaches, agitation, diabetes, join pain, and vision problems.
>
> Resident #3: This person is now experiencing memory loss, diabetes, high blood pressure, dizziness, loss of equilibrium, agitation, no feeling in lower extremities, pain around neck and shoulder, congestive heart failure, numbness in fingers, poor vision, heart racing, blackouts, confusion, and forgetfulness.
>
> Resident #4: This person is experiencing diabetes, hypertension, lightheaded, dizziness, loss of equilibrium, stroke, heart attack, long and short-term memory loss, numbness in right side, and difficulty breathing.

ATSDR Response: It is not possible to know if the health conditions, signs, or symptoms described previously are the result of having eaten fish from the Turtle River or from the creeks closest to the LCP Chemicals site (i.e., Purvis and Gibson Creeks).

Residents who caught and ate fish and blue crab frequently from Purvis and Gibson Creeks and from the Turtle River were at greater risk of harmful effects from mercury and PCBs. Pregnant women and their unborn child as well as young children were at greatest risk of harmful effects. It is difficult to be precise because the amount of mercury and PCB intake from eating fish varies with the portion size, the type of fish eaten, and the location the fish came from. In general, pregnant women who ate several fish meals a month were at risk of having children with neurological effects from mercury. Children born to women and young children who ate fish and blue crab frequently from Purvis and Gibson Creeks and from the Turtle River might experience neurological effects involving problems with language, attention and memory, and to a lesser extent visual/spatial and motor functions.

Residents who ate several fish meals a month for several decades were also at greater risk of liver and thyroid cancers because of PCBs in fish and blue crabs. It is important to remember that someone who ate fish or blue crabs from the Purvis

and Gibson Creeks or the Turtle River only a few times are not likely to experience harmful effects from mercury and PCBs. The risk of harmful effects is for those people who for several decades regularly ate several fish and blue crab meals a month from these areas.

The Georgia Department of Natural Resources has issued a fish advisory for the Buffalo, Turtle, and Brunswick Rivers and their tributary creeks. This fish advisory provides advice about the number of fish meals that are safe to eat from these rivers. An example of the fish advisory for Purvis and Gibson Creeks is shown below. The fish advisory for other areas along these rivers are provided elsewhere in this report and at the GDNR website: http://www.gaepd.org/Documents/fish_guide.html.

Turtle River System: ***Satilla River Basin***
Purvis and Gibson Creeks , (St. Simons Estuary)

Species	Site Tested	Recommendation	Chemical
Atlantic Croaker	Purvis & Gibson Creeks	Do Not Eat	PCBs
Southern Kingfish (whiting), Black Drum, Spot, Spotted Seatrout		1 meal/month	PCBs
Sheepshead		1 meal/month	PCBs, Mercury
Striped Mullet		1 meal/week	PCBs
Red Drum, Flounder		1 meal/week	PCBs, Mercury
Blue Crab		1 meal/week	Mercury
Shrimp		No Restrictions	
Clams, Mussels, Oysters	Not applicable	Do Not Eat	Shellfish Ban *
* Shellfish Ban: National Shellfish Sanitation Program. For information see Coastal Resources Division website: http://crd.dnr.state.ga.us			

6. Community Concern: Residents are concerned that the Altamaha canal remains contaminated.

ATSDR Response: Figure A12 (Appendix A) shows the Altamaha Canal as it exists today. This tidal canal begins just south of W. 9th Street and flows to the marsh at T Street. A portion of the Altamaha canal was also located on the LCP Chemical property when it was operating (Figure A13 in Appendix A). During EPA's cleanup activities, contamination was detected in the on-site portion of the Altamaha canal. These on-site portions of the canal have been excavated and filled. However, it is possible that contamination could have been transported to off-site portions of the canal while the LCP facility was operating and before the on-site portions were filled in. The tidal nature of Altamaha Canal most likely facilitated the off-site migration of contaminants from the LCP property along with surface water runoff during heavy rains.

This off-site transport of site-related contaminants is supported by the recent fish samples that were collected from the Arco Quarry Pond (ATSDR 2008). Fish

samples from the pond showed elevated levels of mercury and Aroclor 1268. The presence of Aroclor 1268 in fish tissue from the Arco Quarry Pond is significant because Aroclor 1268 is the predominant Aroclor associated with LCP Chemical waste. The Arco Quarry Pond is located approximately 700 feet south of the southern boundary of the LCP Chemicals Site. During ATSDR's site visit in July 2009, the wooded area around the pond had been cleared and a fence erected to prevent access to pond and surrounding land. The Altamaha Canal currently ends at the Arco Quarry Pond, although it is unclear at this time if the canal and pond are connected.

ATSDR does not currently have sampling data from the existing portion of the Altamaha Canal to support or rule out the possibility of off-site migration of contamination in the canal. Therefore, we will recommend that sediment and fish sampling be conducted to address this data gap. On the basis of this recommendation, EPA collected fish and shellfish samples from the Altamaha Canal in 2011.

VII. CONCLUSIONS

ATSDR has evaluated environmental data from the LCP Chemicals Superfund Site in Brunswick, Georgia, which is located off of Ross Road. The focus of this public health assessment is the 133 acres of dry-land between Ross Road and the marsh. ATSDR divided the 133 acres into half-acre grids to determine whether a grid would be a concern for future residential or commercial development. Some of these grids were found to contain elevated soil levels of mercury, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), lead, and dioxins.

ATSDR's overall conclusion is that if the LCP Chemicals Site becomes residential, 66 half-acre grids have at least one chemical in soil that poses a health risk for children and adults. If the site becomes commercial or industrial, 9 half-acre grids have at least one chemical in soil that poses a health risk for workers. See Figures 45 and 46 for the location of these grids. Some uncertainty exists in this overall conclusion because uncertainty exists in the amount of chemical exposure that will occur after the site is developed and some dry-land areas were inadequately sampled.

ATSDR has more detailed conclusions about the LCP Chemicals Site that fall into two categories: (1) conclusions presented in the 2010 Public Health Assessment for the LCP Chemicals Site that was released for public comment, and (2) new conclusions based upon recent environmental data that was not available for the 2010 PHA.

VII.A. Conclusions from the 2010 Public Health Assessment for the LCP Chemicals Superfund Site

The basis for conclusions presented in the 2010 public health assessment for the LCP Chemicals Site comes from environmental samples collected by EPA predominantly in the 1990s, although a few samples were collected in the early 2000s.

1. Conclusions about PCBs in dry-land soils

   If certain dry-land areas of the LCP Chemicals Site become residential, polychlorinated biphenyls (PCBs) in soil in 41 half-acre grids on the site pose a health risk for children and adult. If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, PCBs in soil in six half-acre grids on the site pose a health risk for commercial and industrial workers.

   Children and adults who come in contact with high PCBs in soil might experience harmful effects to the immune, dermal, nervous, developmental, and reproductive systems. Specific health effects include:

   - Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
   - Mild damage to fingernails and toenails,
   - Inflamed oil-producing glands associated with the eyes
   - Gum recession,
   - Learning and performance problems,
   - Problems with attention and impulse control,
   - Fewer male births,
   - Lower birth weight,
   - Longer menstrual cycles in women,
   - An increase in cardiovascular disease in women,
   - An increase in deaths from Parkinson disease in women,
   - An increase in deaths from dementia in women, and
   - An increase in diabetes in women (ATSDR 2000).

   Children and especially preschool children, with their nervous systems still developing, may be a particularly susceptible group if they come in contact with high PCBs levels in soil in some areas.

   Commercial and industrial workers also are at risk of harmful effects if they have contact with soil in six half-acre grids of the site with the highest PCB levels. Their estimated exposure to PCBs could cause the same health effects as listed previously.

   Daily contact with PCBs in soil over many years poses a high cancer risk for children and adults should the site become residential. PCBs in soil pose a moderate cancer risk for workers if the site becomes commercial or industrial. Such exposure could

put residents and workers at increased risk for several cancers, including cancers of the liver, thyroid, biliary tract, intestines and skin.

Some uncertainty exists when deciding if harmful effects might be expected because very little health information is available on the most common type of PCBs found in LCP soils. Therefore, ATSDR relied upon health information from other types of PCBs. Uncertainty also exists in estimating how much PCBs people will contact once the site is developed and from using results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site. In addition, some dry-land areas were insufficiently sampled.

Six half-acre grids on the site exceed the EPA's 1994 clean-up level for PCBs of 25 parts per million (ppm) while 41 grids have average PCB concentrations greater than 1 ppm. In the text of this report, see Table 4 for a list of grids that are a concern because of residual PCB contamination and see Figure 34 for their location.

2. Conclusions about mercury in dry-land soils

   If certain dry-land areas of the LCP Chemicals Site become residential, mercury in soil in 10 half-acre grids on the site poses a health risk for children and for the developing fetus if women are pregnant.

   If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, mercury in soil in four half-acre grids on the site poses a health risk for the developing fetus if a female worker is pregnant. One of these half-acre grids also poses a health risk for women who are not pregnant and for men.

   For women who live in the 10 half-acre grids on the site with high mercury concentrations in soil, the estimated intake of mercury from soil approaches or exceeds levels that cause harmful neurological effects to the fetus during pregnancy. Children born to these women might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions. The estimated exposure levels in preschool children who live in these areas also approach or exceed levels that could harm their health. They are at risk of the same neurological effects.

   Mercury in soil in four half-acre grids on the site also poses a risk for commercial and industrial workers if the site is developed. Pregnant workers who have contact with mercury in soil in these areas are at risk of exposing their developing fetus to mercury levels that might cause harmful effects after birth. Some children born to women exposed to these levels might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions.

   Male and female workers who have prolonged contact with soil from the one half-acre grid with the highest remaining mercury contamination also are at risk of harmful effects. Their estimated exposure level might result in damage to their

neurological system, such as diminished sensitivity to pain, diminished touch, decreased fine motor performance, impaired vision, and impaired hearing.

Some uncertainty exists concerning the risk of harmful effects from mercury in soil. The chemical form of mercury in soil at the LCP Chemicals Site has not been well-established, although scientific studies from marsh sediment show that almost half the mercury is organic mercury. Therefore, ATSDR assumed that most of the mercury in soil at the LCP Chemicals Site was organic mercury. There's some uncertainty about whether the organic mercury bound to soil would cause harmful effects. In addition, uncertainty exists in the mercury concentrations in surface soil following development of the site and uncertainty exists from using the results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

Ten half-acre grids exceed EPA's 1994 clean-up level of 20 ppm mercury in soil. See Table 29 for a list of the 10 grids that are a concern because of residual mercury contamination and see Figure 37 for their location.

3. Conclusions about lead in dry-land soils

If certain dry-land areas of the LCP Chemicals Site become residential, lead in soil in 28 half-acre grids on the site poses a health risk for children.

If the site becomes residential, exposure to lead in soil at these 28 half-acre grids could increase children's blood lead levels and result in the following harmful effects:

- small decreases in IQ,
- an increase in attention deficit hyperactivity disorder,
- reduced attention span,
- lack of concentration,
- decreased fine muscle skills,
- withdrawn behavior,
- decreased height,
- small delays in puberty, and
- small changes in kidney function.

Some uncertainty exists in this conclusion because uncertainty exists in estimating children's exposure to lead in soil if the site becomes residential. Uncertainty also exists from using the results of soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

See Table 31 for a list of the 28 half-acre grids that are a concern because of residual lead contamination and see Figure 40 for their location.

4. Conclusions about PAHs in dry-land soils

   If certain dry-land areas of the LCP Chemicals Site become residential, polycyclic aromatic hydrocarbons (PAHs) in soil in six half-acre grids on the site pose a health risk for children and adults. If certain dry-land areas of the LCP Chemicals Site become commercial or industrial, PAHs in soil in two half-acre grids on the site pose a health risk for workers.

   Daily contact with PAHs in residential soil over many years poses a moderate risk of certain cancers for children and adults. Similarly, workers also have a moderate risk of certain cancers should some areas become commercial or industrial. Such exposure could put residents and workers at increased risk for lung and skin cancers.

   Some uncertainty exists in these conclusions because uncertainty exists in estimating how much PAHs people will contact once the site is developed. Uncertainty also exists from using the results from soil samples that were collected 15 years ago. These soil samples may not represent current or future conditions at the site.

   See Table 35 for the list of half-acre grids that are a concern because of residual PAH contamination and see Figure 41 for their location.

5. If certain dry-land areas of the LCP site become residential, exposure to a mixture of PCBs, methylmercury, or lead in soil could harm the health of children.

   If the site becomes residential, exposure to a mixture of PCBs, mercury, or lead in soil could impair learning and lead to an inability to withhold or delay inappropriate responses. These impairments are a measure of attention and impulse control.

   Three grids have elevated levels of PCBs, lead, and mercury. Eight grids have elevated levels of PCB and lead; and, five grids have elevated levels of PCBs and mercury. Should these grids be developed for residential purposes, children could be at risk for problems with attention and impulse control. See Figure 42 for the location of these grids.

6. If certain dry-land areas of the LCP Chemicals Site become residential, contact with soil containing a mixture of PCBs, mercury, and lead (or a combination of these) could harm the health of children.

   Studies have shown that children exposed to low levels of PCBs, mercury, and lead showed impaired learning of a performance task, resulting in problems with attention and impulse control.

   Three grids have elevated levels of PCBs, lead, and mercury; eight grids have elevated levels of PCB and lead; and, five grids have elevated levels of PCBs and mercury. See Figure 42 for the location of these grids.

VII.B. New Conclusions Based Upon Recent Environmental Data

The basis for these conclusions comes from environmental samples collected by EPA after 2010. Many of these samples were collected in response to recommendations from ATSDR in the December 2010 public release version of this report.

1. Conclusions about Dioxins in the Dry-land Area

   In 2011, EPA collected soil samples from eight, dry-land areas and measured dioxin levels. One 30 half-acre area contained dioxins in soil that is a public health concern for children and adults should this area become residential.

   Daily contact with dioxins in soil in this one area over many years poses a high risk of cancer for children and adults. Human studies have shown that dioxin can cause liver cancer and might be associated with cancers of the lung, colon, prostrate, breast, blood, and lymphatic system. Rodent studies have confirmed that dioxin can cause cancer at multiple sites, including the liver, lung, mouth, and thyroid.

   In addition, preschool male children who have daily contact with these soils could be at risk of reproductive effects once they reach adulthood. As adults, they might experience problems with (1) decreased number of sperm, (2) decreased number of motile sperm, and (3) fewer male offspring

   The location of this 30 half-acre area contaminated with dioxin is shown in Figure 43 and is labeled as sampling area 8.

2. Conclusions about the Former Theater Area

   In 2010, EPA collected soil samples from the former theater area in the northeast section of the site. Glynn County plans to build a detention center in this area so ATSDR evaluated the risk for adult workers and inmates who might come in contact with chemicals in soil. Mercury, lead, and PCBs in soil from the former drive-in theater area are not a health concern.

   The mercury and lead levels in soil in the former theater area were either below ATSDR's screening levels or the levels were at or near background levels in soils. Therefore, harmful effects from mercury and lead in soil are not likely.

   The exposure of prison inmates and adult workers to PCBs in soil would be at levels far below ATSDR's health guideline for PCBs. Therefore, PCBs in soil are not likely to cause harmful, non-cancerous effects. The risk of cancer from daily exposure to PCBs in soil is insignificant.

3. Conclusions about the On-Site Pond

   In 2010, EPA collected surface water and sediment samples from the on-site pond in the northwest corner of the dry-land area. The levels of PCBs, mercury, PAHs, and lead in surface water and sediment from the on-site pond are not a health concern.

   Levels of PCBs, mercury, PAHs and lead in the on-site pond were either below ATSDR's comparison values or at background levels. In addition, the pond does not serve as a source of drinking water nor does the pond support fish.

4. Conclusions about Sampling Sufficiency for the Dry-land Area

   Some dry-land areas do not have adequate sampling data; therefore, it is difficult to draw conclusions regarding potential health impacts from soils in these areas. Most of the insufficiently sampled areas are in the southeastern portion of the site (including the cell building area) and in the western dry-land area closest to the marsh. For other areas that have been sufficiently sampled, we are able to draw conclusions about potential health impacts.

   One reason for the limited sampling in some areas is that EPA decided that some environmental data were unusable because of data quality issues. In addition, some areas were not sampled because LCP Chemicals did not perform industrial activities on certain portions of the site. However, numerous industries occupied the site before LCP's chlor-alkali facility, and those industries could have disposed of waste throughout the property.

   Approximately half of the grids are considered sufficiently sampled for making a health conclusion for the chemicals PCBs, mercury, and lead. That means that half of the grids require additional sampling in order to be sure that those areas are not contaminated.

   See Figures 22 through 25 for the dry-land areas considered to have adequate sampling data.

5. Conclusions about Sediment from the Altamaha Canal South of the LCP Chemicals Site

   In 2011, EPA collected sediment samples from a portion of the Altamaha Canal that exists south of the LCP Site. ATSDR evaluated the risk of harmful effects from exposure to PCBs, mercury, PAHs, and dioxins in sediment along the Altamaha Canal. Adults and children who visit or play along the canal would not be exposed to contaminants in sediment at levels that would cause harmful, non-cancerous effects. It is unlikely that contact with these chemicals in sediment would cause cancer.

These chemicals are not a health concern in Altamaha Canal sediment because:

- The concentration of lead in sediment from the canal is at or near background lead levels in soils and is unlikely to cause harmful health effects from direct contact,
- The concentration of mercury is below ATSDR's comparison value; therefore, mercury in sediment is unlikely to cause harmful health effects from direct contact,
- The estimated exposure to dioxins and PCBs for adults and children who visit or play along the canal is well below ATSDR's and EPA's health guidelines. Therefore, harmful non-cancerous effects are not likely. The estimated exposure to PCBs, PAHs, and dioxins for adults and children who visit or play along the canal results in insignificant cancer risks.

6. Conclusions about Mercury in Fish and Shellfish from the Altamaha Canal South of the LCP Chemicals Site

In 2011, EPA collected fish and shellfish samples from the canal. ATSDR estimated exposure to mercury from eating various fish and shellfish from the Altamaha Canal and reached the following conclusions about adults and children with typical and high fish consumption:

- Mercury levels in mullet and shrimp from the Altamaha Canal are not a health concern.
- Mercury levels in blue crab, red drum, and sea trout are not a health concern for typical fish consumers but are a health concern for high fish consumers.

Depending upon age and race, high fish consumers eat about 2 to 7 ounces of fish and shellfish daily. Typical fish consumers eat about a half to 2 ounces of fish daily. These daily fish consumption rates do not necessarily mean that people eat fish every day. Their fish consumption averages out to the rates previously described. For example, someone with a daily fish consumption rate of 2 ounces might eat one 14 ounce fish meal a week or two 7 ounces fish meals a week. This frequency and amount of fish consumption averages out to two ounces of fish eaten daily.

- Typical and high fish consumers of mullet and shrimp from the Altamaha Canal have estimated exposures to mercury that are well below levels that cause harmful effects. Typical fish consumers of blue crab, red drum, and sea trout from the Altamaha Canal have estimated exposures to mercury that are well below levels that cause harmful effects.
- High fish consumers of blue crab, red drum, and sea trout from the Altamaha Canal have estimated exposures to mercury that approach levels that can cause harmful effects in young children and in children born to pregnant women who are high consumers. These children might experience neurological effects involving language, attention and memory, and to a lesser extent visual/spatial and motor functions.

Some uncertainty exists in the conclusions for sea trout and red drum because only one fish of each species was collected from the Altamaha Canal.

7. Conclusions about PCBs in Fish and Shellfish from the Altamaha Canal South of the LCP Chemicals Site

Fish and shellfish from the Altamaha Canal were also found to contain PCBs. ATSDR estimated exposure to PCBs from eating various fish and shellfish from the Altamaha Canal and reached the following conclusions about adults and children with typical and high fish consumption:

- PCB levels in red drum, blue crab, and shrimp are not a health concern for harmful, non-cancerous effects.
- PCB levels in sea trout are not a health concern for typical fish consumers, but are a health concern for high fish consumers.
- PCB levels in mullet are a health concern for typical and high fish consumers.

The basis for these decisions is:

- Typical and high fish consumers of red drum, blue crab, and shrimp have estimated exposures to PCBs that are well below levels that can cause harmful, non-cancerous effects. Typical fish consumers of sea trout have estimated exposures to PCBs are well below levels that can cause harmful, non-cancerous effects.
- High fish consumers of sea trout and typical and high fish consumers of mullet have estimated exposure to PCBs that approach levels that can cause harmful, non-cancerous effects.

High consumers of sea trout and typical and high consumers of mullet might experience the following harmful effects to the immune, dermal, nervous, developmental, and reproductive systems. Specific health effects include:

- Small changes in immune function as evidenced by a weakened response to an antigenic challenge,
- Mild damage to fingernails and toenails,
- Inflamed oil-producing glands associated with the eyes
- Gum recession,
- Learning and performance problems,
- Problems with attention and impulse control,
- Fewer male births,
- Lower birth weight,
- Longer menstrual cycles in women,
- An increase in cardiovascular disease in women,
- An increase in deaths from Parkinson disease in women,
- An increase in deaths from dementia in women, and
- An increase in diabetes in women (ATSDR 2000).

Children and especially preschool children, with their nervous systems still developing, may be a particularly susceptible group.

Children and adults who frequently eat mullet from the Altamaha Canal for many years also have a high increased risk for several cancers, including cancers of the liver, thyroid, biliary tract, intestines and skin.

The results of the fish and shellfish sampling from the Altamaha Canal support the current fish advisory for the Turtle River system issued by the Georgia Department of Natural Resources (GDNR). The Altamaha Canal is tidally connected to the lower Turtle River through several waterways and GDNR has fish and shellfish consumption advice specifically for the lower Turtle River. See Table 46 for more information about the state's fish and shellfish consumption recommendations for the lower Turtle River.

VIII. RECOMMENDATIONS

VIII.A. Recommendations for the 2013 Public Health Assessment for the LCP Chemicals Site

ATSR recommends

1. Restricting some LCP Chemicals Site areas from residential development unless further steps are taken to prevent contact with PCB, mercury, lead, PAH, and dioxin contamination that remains in soil on the property.

2. Restricting some LCP Chemicals Site areas from commercial or industrial use unless further steps are taken to prevent contact with PCB, mercury, and PAH contamination that remains in soil on the property.

3. Additional soil sampling in and around the former cell building's footprint if future plans include development of this area because of residual soil contamination.

4. Additional sampling in areas where sampling data are limited. In general, the western portion of the site has been sampled more than the eastern portion. Particular attention should be given to the former cell building area should the land use change and to future enclosed structures built above the caustic brine pool area.

5. Continued monitoring of fish and shellfish in the Turtle River and in the marsh near the LCP Chemicals Site. The Georgia DNR continues to monitor seafood in the area and to maintain the fishing advisory for the Turtle River System.

6. Continuation of the GDNR's fish advisory for the Turtle River System. The major components of this advisory are provided in Tables 43-46 of this health assessment.

GDNR's recommendations for the lower Turtle River (see Table 46) apply for fish obtained from the Altamaha Canal.

The 2013 GDNR fish advisories for rivers, lakes, and estuaries in Georgia, including the Turtle River system, can be found at this website: http://www.gaepd.org/Documents/fish_guide.html. To view their brochure, click on "Guidelines for Eating Fish from Georgia's Waters, 2013".

In addition, GDNR has a brochure, 'A woman's guide for eating fish and seafood from coastal Georgia'. This brochure is available at http://health.state.ga.us/pdfs/environmental/chemhazard/fish%20consumption/wfcg_coastal.pdf

VIII.B. Recommendations for the 2010 Public Health Assessment for the LCP Chemicals Site

ATSDR made these recommendations in the 2010 Public Health Assessment for the LCP Chemicals Site when the assessment was released for public comment.

ATSDR recommended

1. Collecting sediment and fish samples from the existing portion of the Altamaha Canal that flows south of the LCP Chemicals Site to determine whether mercury and PCBs have migrated to and contaminated portions of the canal. In response to this recommendation, EPA collected sediment and fish samples in 2011 from the Altamaha Canal.

2. Collecting sediment, water, and fish samples from the on-site pond to determine whether site-related contaminants are present. In response to this recommendation, EPA collected sediment samples in 2010 from the on-site pond. Fish samples could not be collected from the on-site pond because the pond does not support fish.

3. Collecting soil samples from the on-site theater area. In response to this recommendation, EPA collected soil samples from the theater area in 2010.

4. Continued monitoring of fish and shellfish in the Turtle River and in the marsh near the LCP Chemicals Site. The Georgia DNR continues to monitor seafood in the area and to maintain the fishing advisory for the Turtle River System.

5. Developing health education and community involvement activities to ensure that the findings of this public health assessment are presented to the community, which includes residents who live in the area, elected government officials, and ATSDR's government partners. In September 2010, ATSDR met with elected officials and the agency's government partners and held public meetings to educate and involve the community.

IX. PUBLIC HEALTH ACTION PLAN

1. As part of its health education and community involvement activities at the LCP Chemicals Site, ATSDR met with elected officials and held public meetings in September 2010 as part of the public release of this health assessment. These meetings informed the public and government agencies about the risk from future development at the LCP Chemicals Site in Brunswick, Georgia. As part of these meetings, we also answered questions from elected officials and from concerned residents.

2. During the development of the public health assessment, ATSDR met with US EPA, Honeywell (the principle responsible party), and Glynn Environmental Coalition (a local environmental group) to inform them of our progress and initial findings. One outcome of these meetings was that EPA and Honeywell collected soil, sediment, and seafood samples that are now part of the final release of this public health assessment.

3. ATSDR will inform news outlets, elected officials, and the Glynn Environmental Coalition of the findings in this final release of the LCP Chemicals Public Health Assessment.

4. ATSDR will correspond with staff members from the U.S. Environmental Protection Agency, Region IV to inform officials about our findings and recommendations in this public health assessment.

X. PREPARERS OF REPORT

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APPENDIX A

Site Maps

Figure A1. LCP Chemicals Site Boundary Map Showing Marsh, Purvis Creek, and Dry-land Area

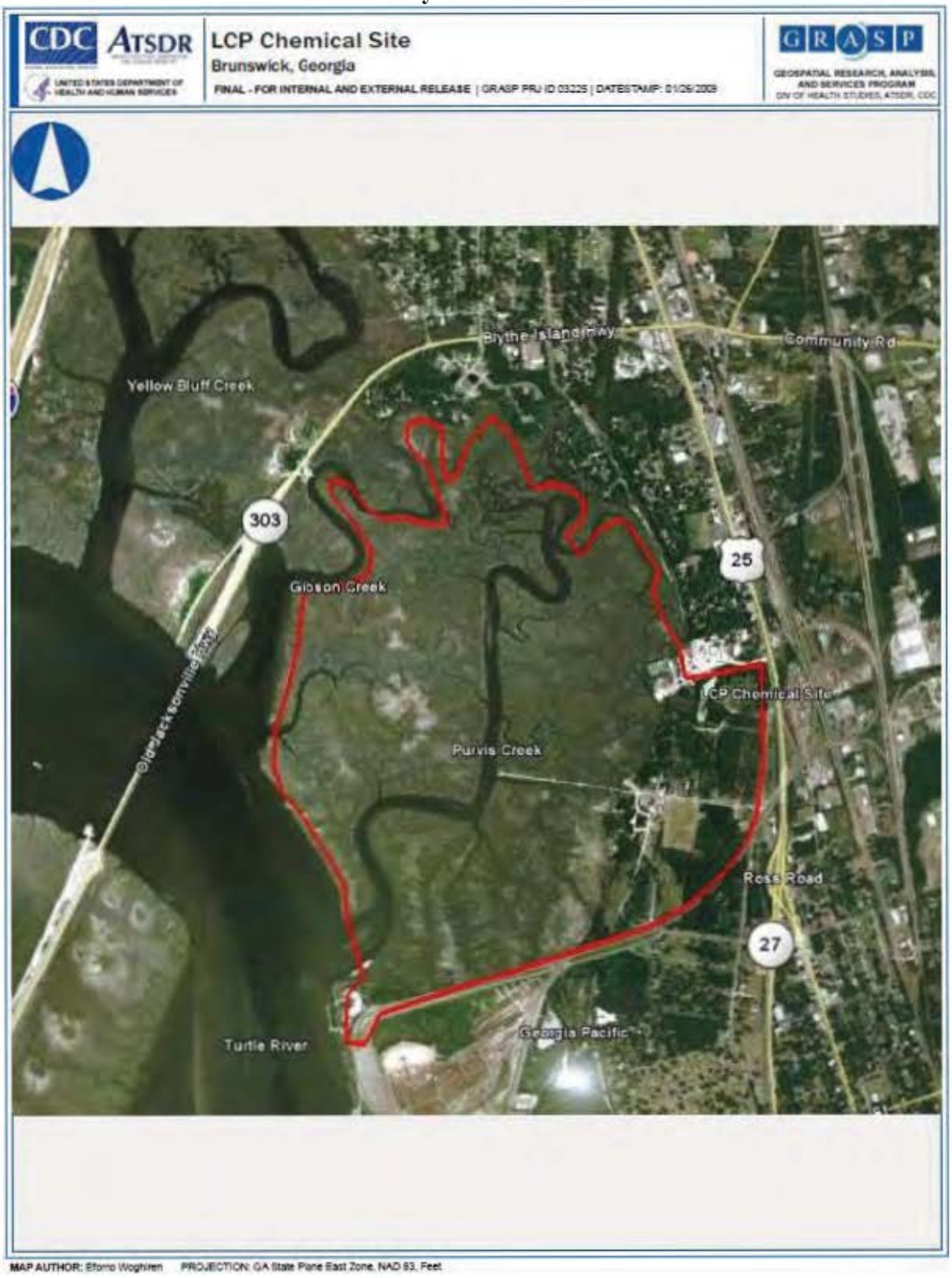


Figure A2. Site Map Showing Current Onsite Structures on Dry-land Area with Marsh in Background (March 2004)

Figure A3. Site Map Showing Onsite Pond and Theater –Current View 2010

Figure A4. Site Map of Dry-land Area Showing Location of Various Activities and Buildings When LCP Was Operational

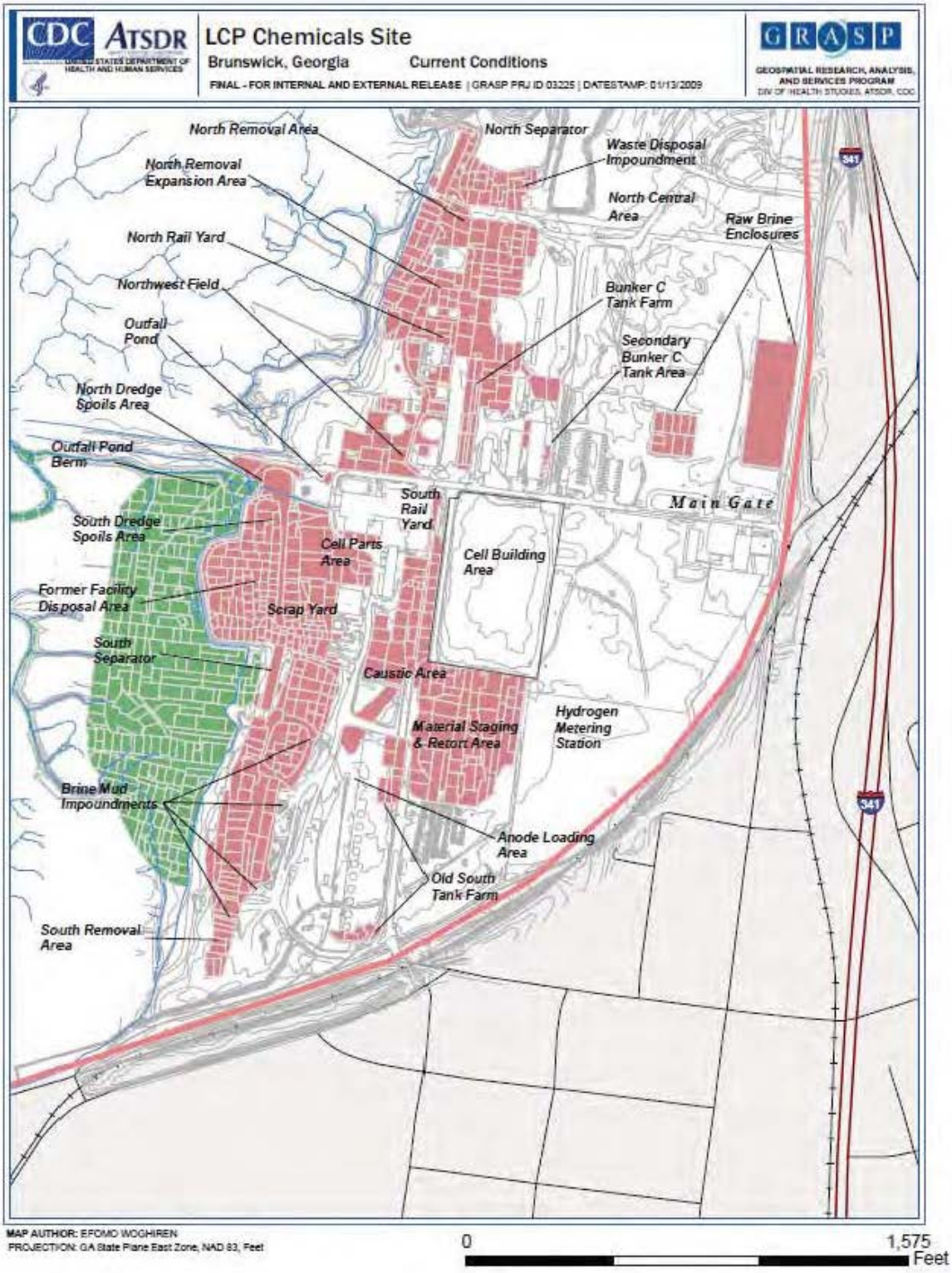


Figure A5. LCP Chemical and Surrounding Area 2010 Demographic Map

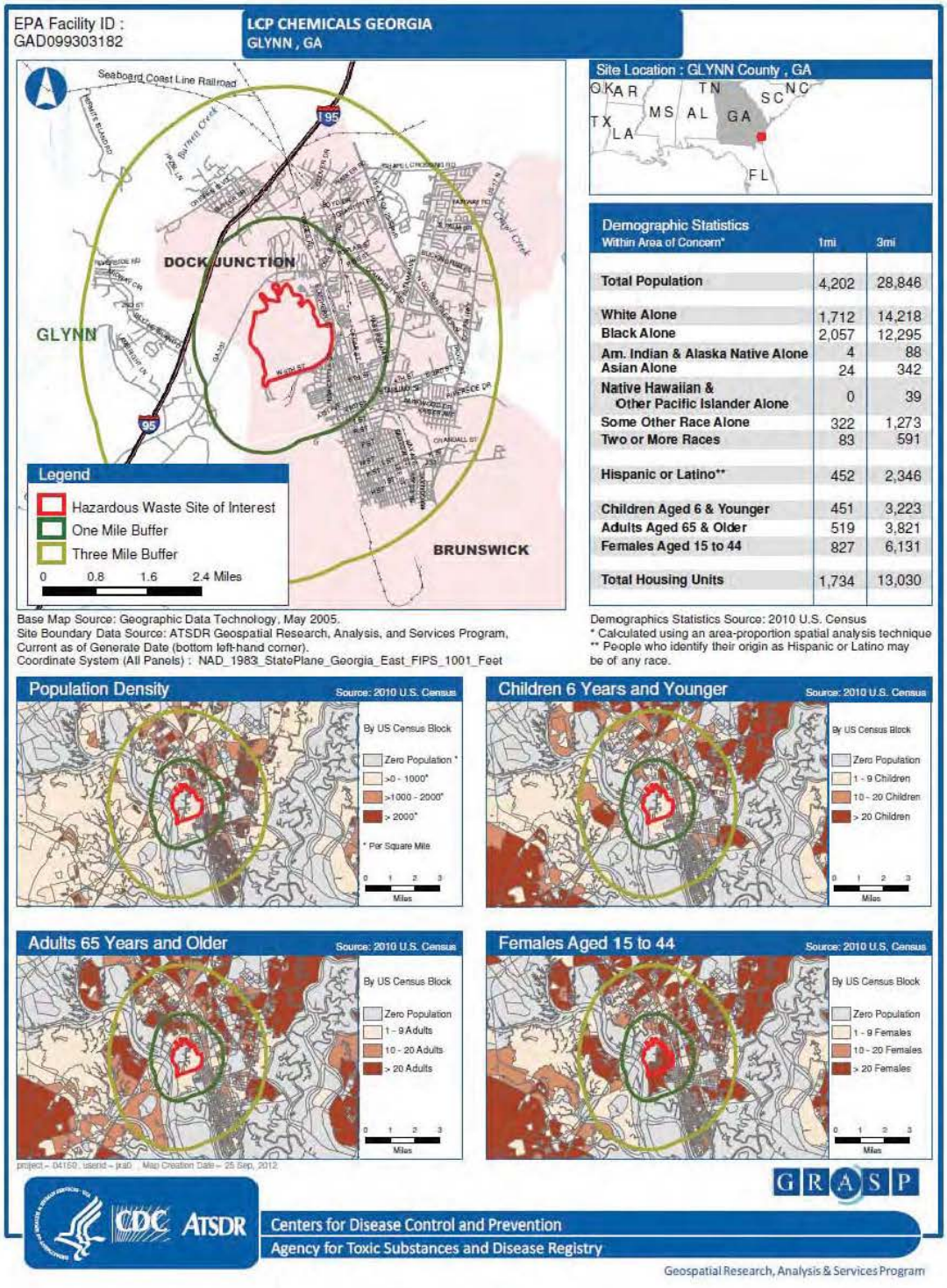


Figure A6. Historical Photo Showing Off-site Tank Farms

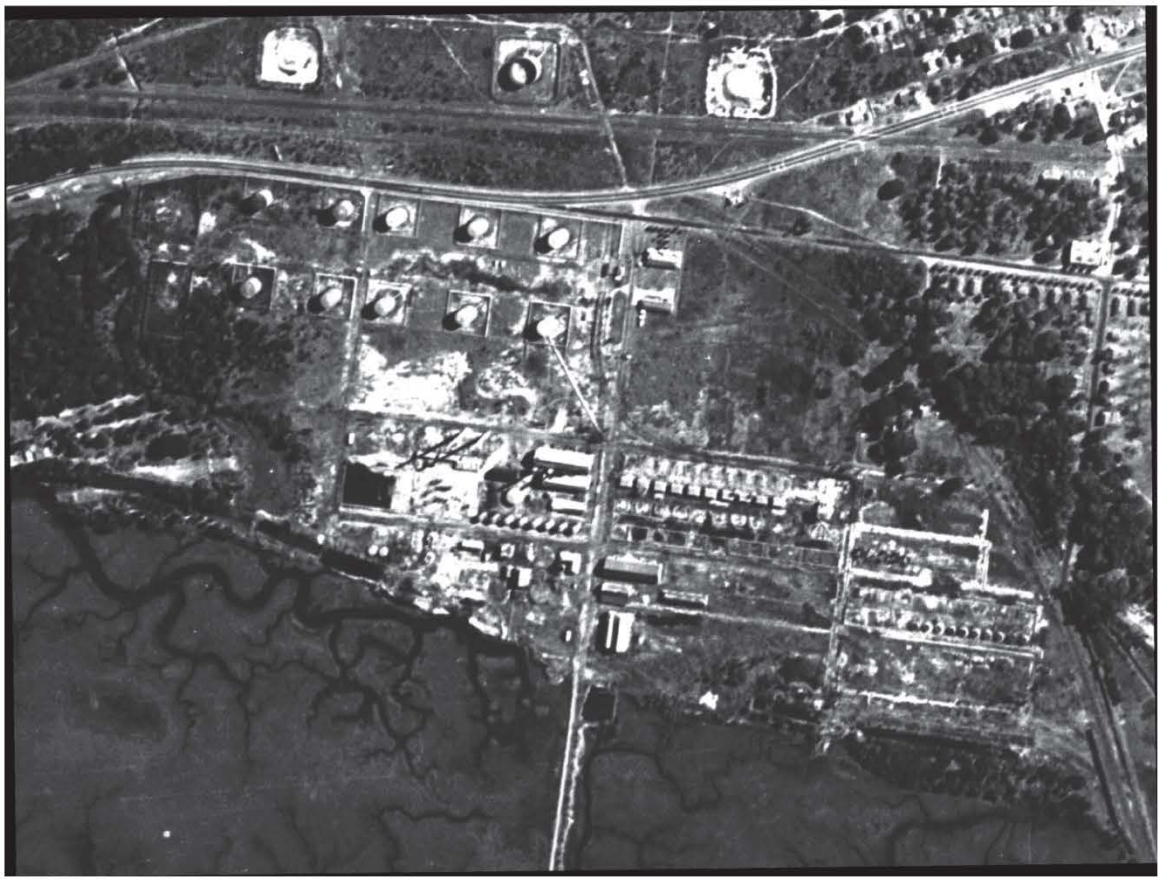


Figure A7. Off-Site Former Tank Farm Area
Mercury Sampling Locations and Concentrations

Figure A8. Off-Site Former Tank Farm Area – Historical Photo Underlay Mercury Sampling Locations and Concentrations

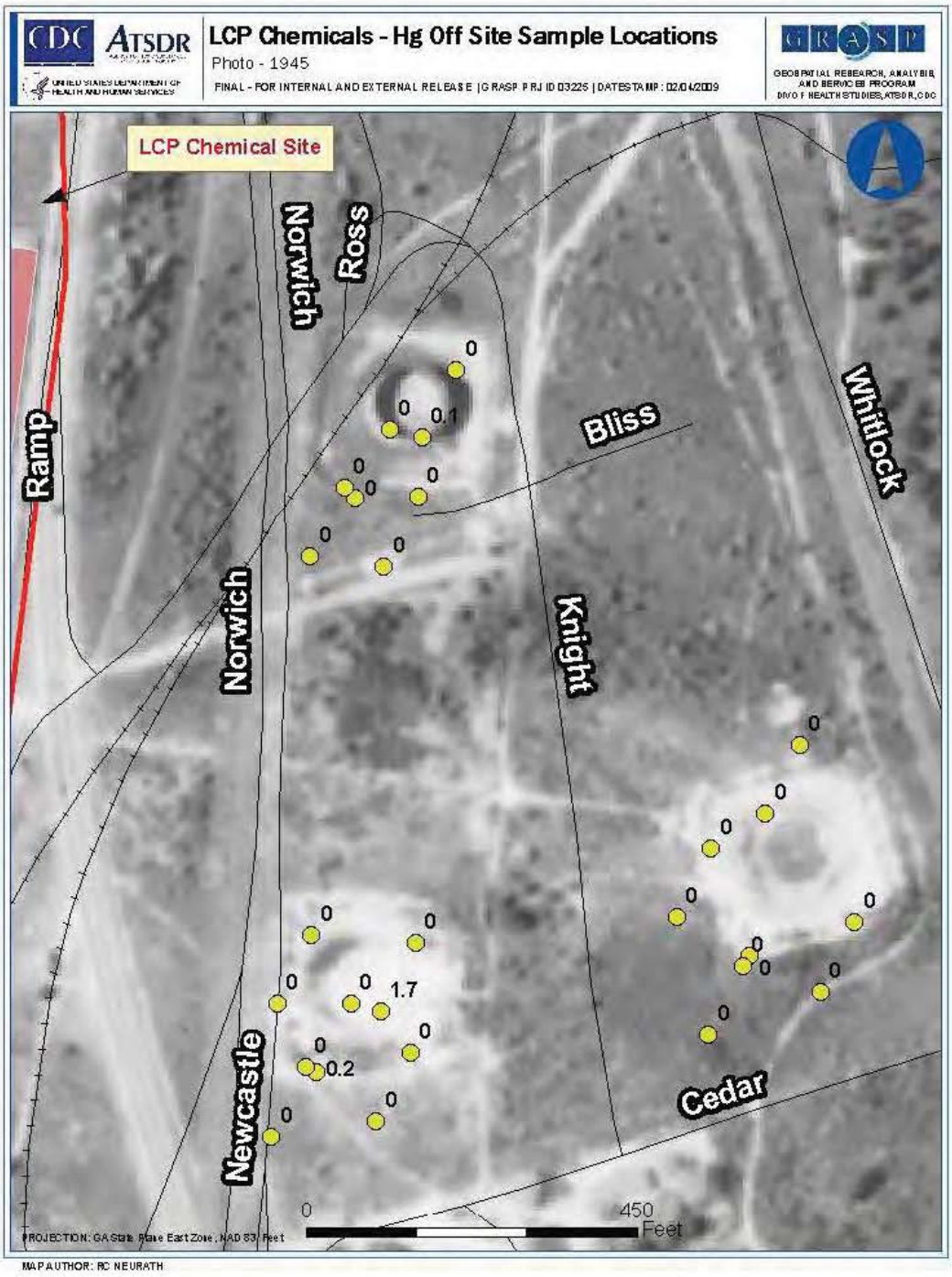


Figure A9. Off-Site PCB Sampling Locations

Figure A10. Former Tank Farm Areas
PCB Sampling Locations and Concentrations

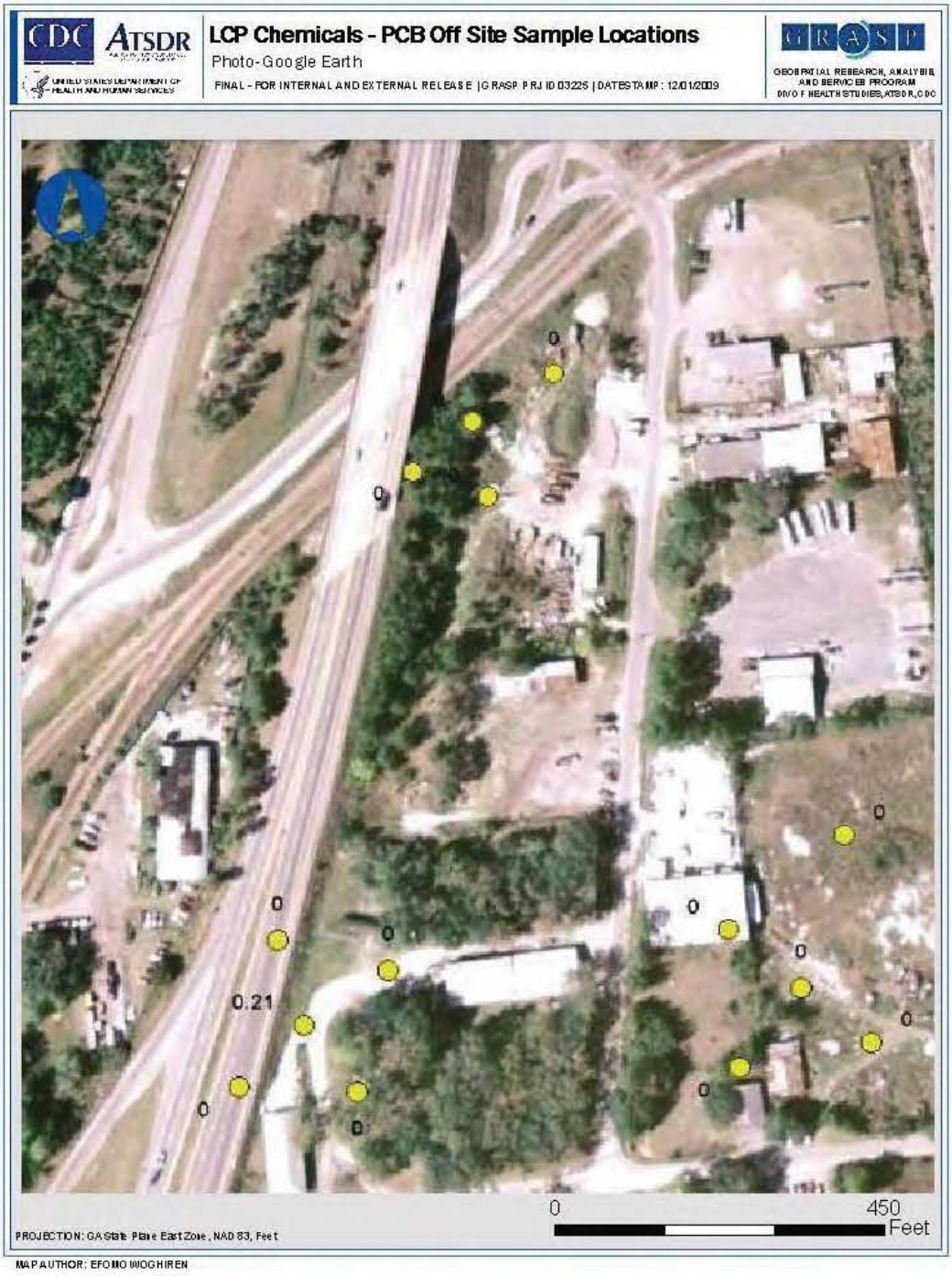


Figure A11. Former Tank Farm Areas
Lead Sampling Locations and Concentrations

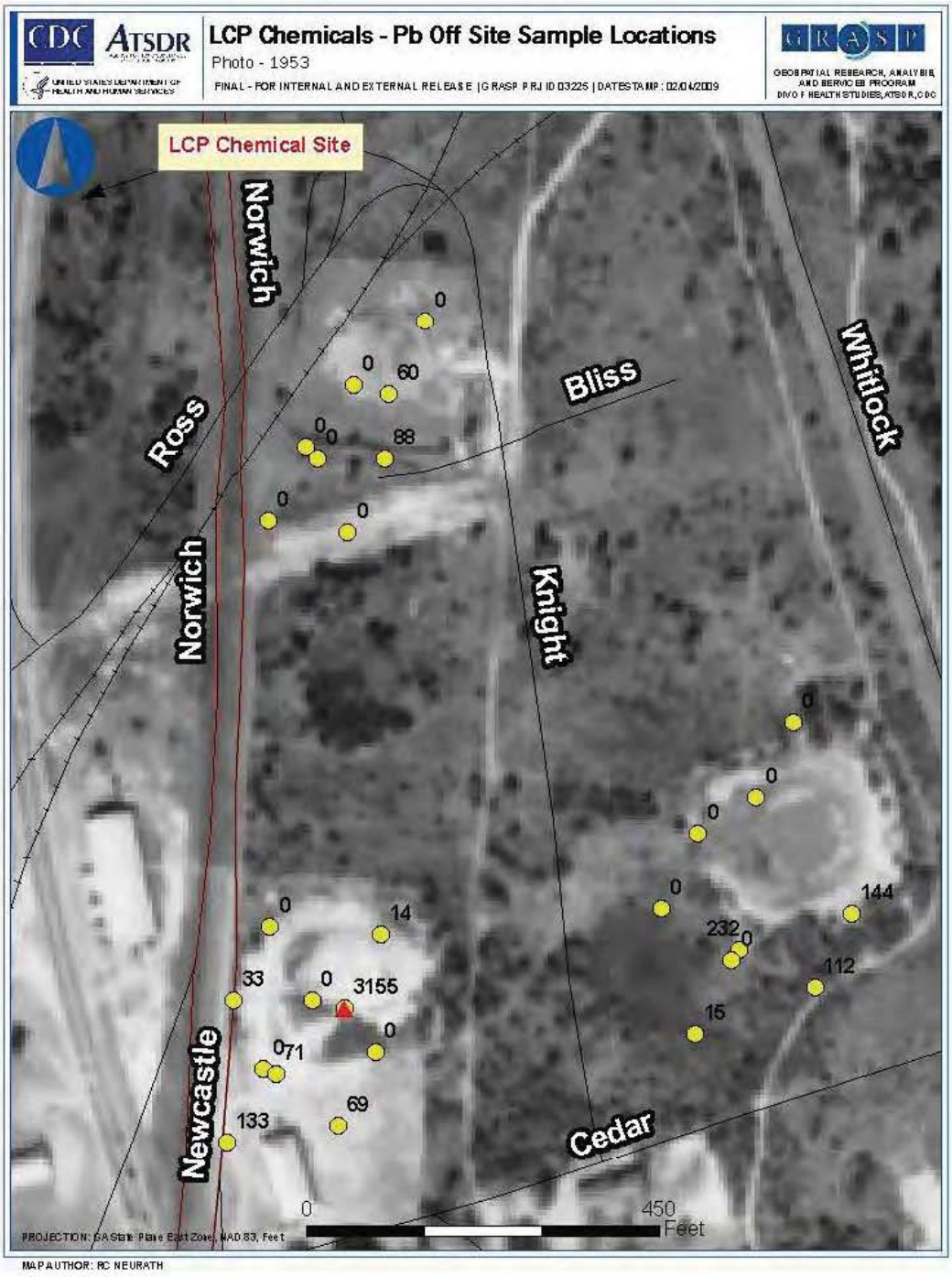


Figure A12. The Altamaha Canal 2010

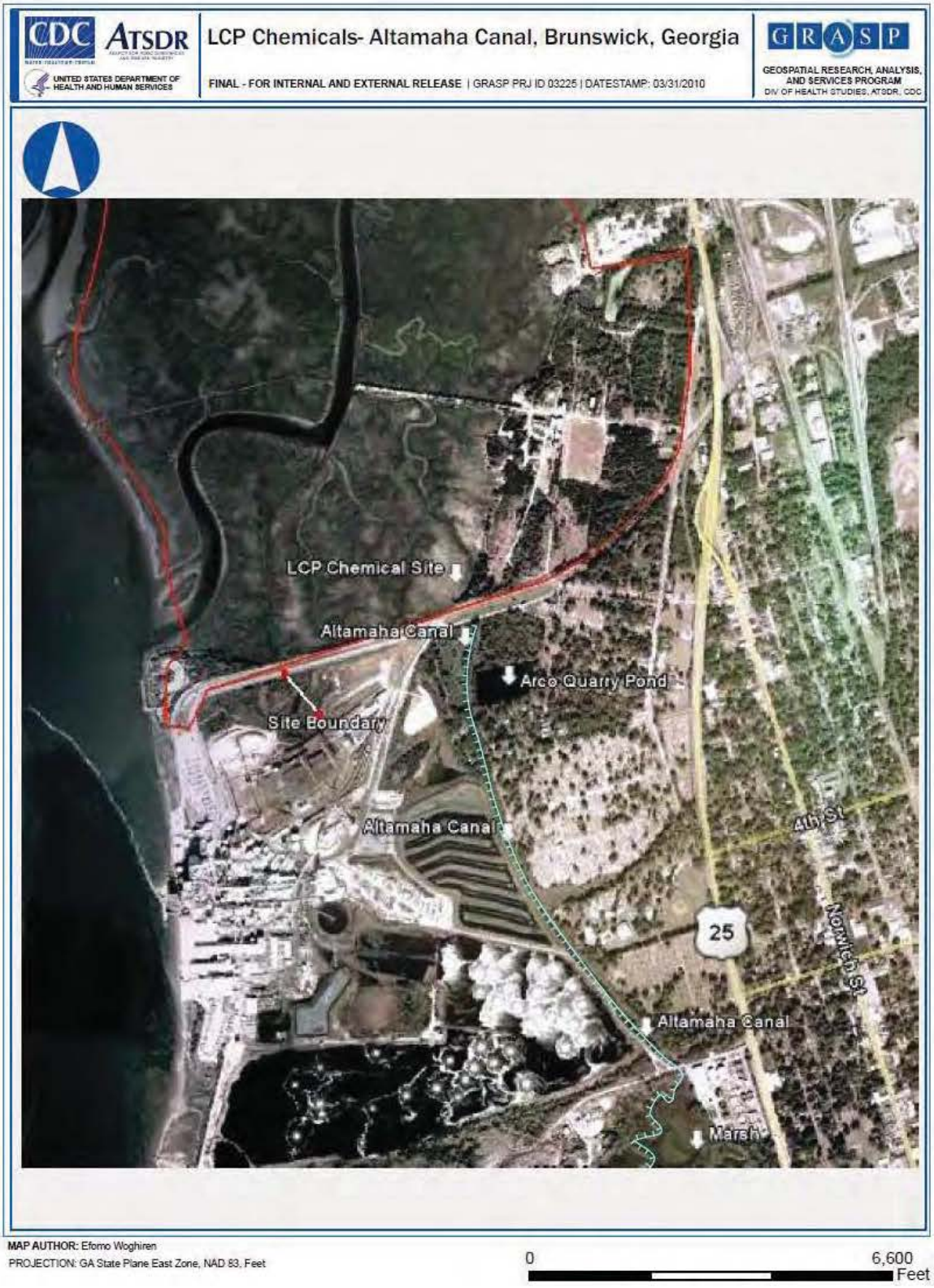
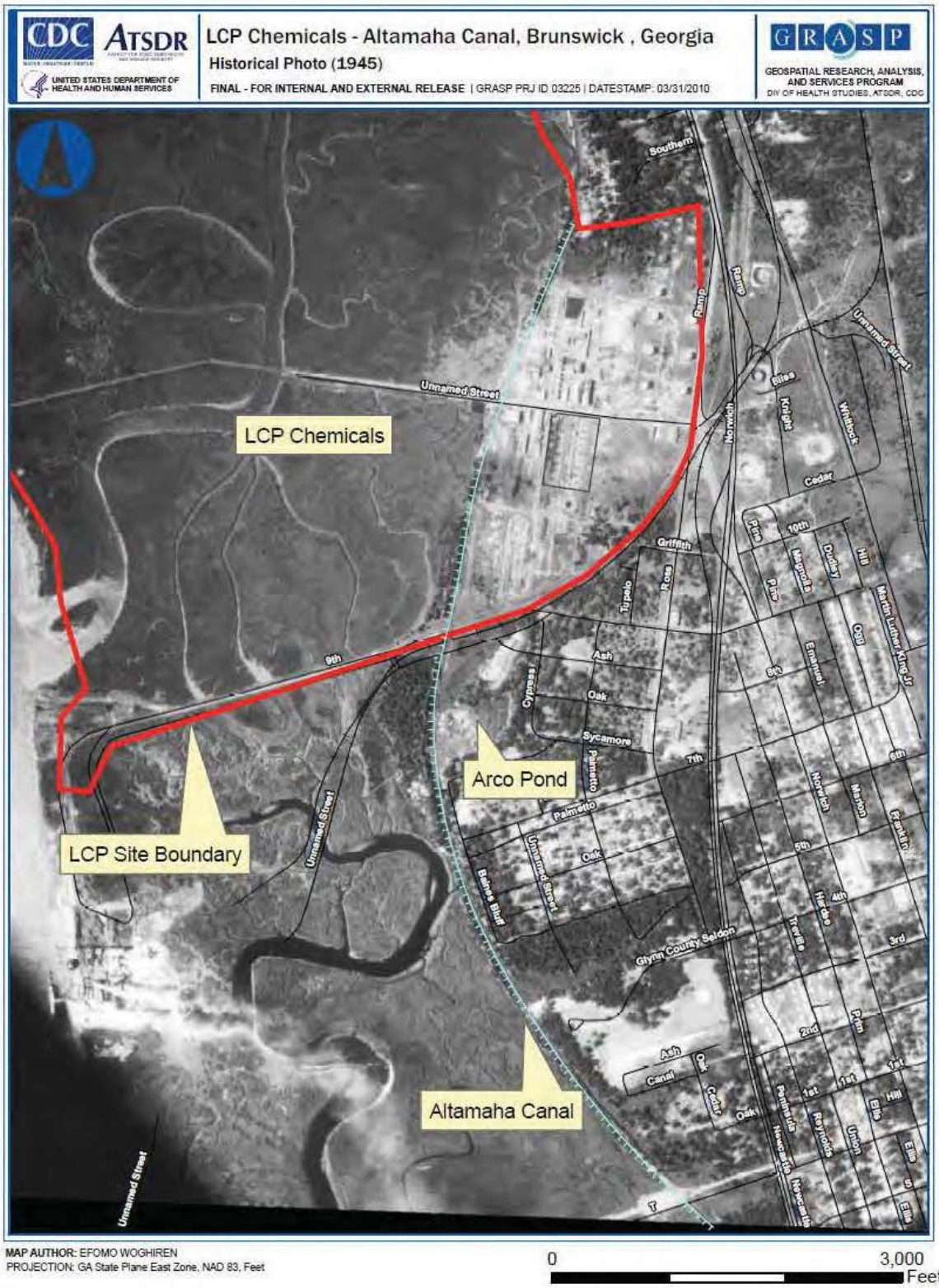


Figure A13. Altamaha Canal (1945) Showing Historical On-site Location



APPENDIX B

Parameters Used to Estimate Chemical Dose in Various Age Groups and Summary of Human and Animal Studies Demonstrating the Harmful Effects of PCBs at Low Levels

Table B1. Parameters used to estimate chemical dose in various age groups		
Parameter	***Quantity***	***unit***
Body weight--preschool children 1 yr	10	kg
Body weight--preschool children 3 yr	16	kg
Body weight--elementary school children	35	kg
Body weight--teenagers	55	kg
Body weight--pica children	10	kg
Body weight--adults men	70	kg
Body weight--adult women	60	kg
Soil intake--preschool children	200	mg/day
Soil intake--elementary school children	100	mg/day
Soil intake--teenagers	100	mg/day
Soil intake--pica children	5000	mg/day
Soil intake--adults	100	mg/day
Soil intake-- outdoor commercial workers	100	mg/day
Soil intake--excavation workers	330	mg/day
Exposure factor, residents	1	---
Exposure factor, workers	0.687	--
Exposure factor, excavation workers	0.714	--
Exposure factor for pica behavior (3 days a week)	0.429	--

Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.

Target	*Study duration*	*Effect Level*	*System*	*Harmful Effects*	*Chemical Form*	*Reference*
Human	Follow-up at 25 years	>5.1 ppb serum PCB (whole weight, not standardized for lipids)	Immunological (endocrine disruptors)	2-fold increased incidence of adult-onset diabetes in women (but not men) with higher serum PCB levels compared to non-detect group. Serum PCBs ranged 5 ppb to 10 ppb.	Not specified	Vasiliu 2006
Human	Prospective cohort study (5 year follow-up)	Serum PCB whole weight (not standardized for lipids) Mean = 5.4 ppb Median = 4.7 ppb 10^{th} = 3.1 ppb 90^{th} = 8.7 ppb	Reproductive	33% reduction in male births for women at the 90^{th} % compared to women at the 10^{th} % Each 1 ppb increase in serum PCB associated with 7% decrease in # male births. Maternal exposure to PCBs may be detrimental to the success of male sperm or to the survival of male embryos. Findings could be due to contaminants, metabolites or PCBs themselves.	Total PCBs and PCB congeners #105 #110 #117 #137 #138 #153 #170 #187	Hertz-Picciotto 2008
Human	Prospective cohort study (recruitment 1959-1965)	Serum PCB whole weight <1 to > 5 ppb Effect observed in 3.75-	Reproductive	Increasing serum PCB levels associated with slightly longer menstrual cycles, increasing by about 1 day.	Total PCBs PCB congeners # 28 # 138 # 52 # 153 # 74 # 170	Cooper 2005

Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.						
Target	***Study duration***	***Effect Level***	***System***	***Harmful Effects***	***Chemical Form***	***Reference***
		4.99 ppb group Effect not statistically significant for serum PCB standardized to lipid (but samples were not fasting)		Weaker evidence for an association with irregular cycles No association with bleeding duration and volume, or dysmenorrhea. Important limitation is recall bias when answering questions about menstrual cycle.	# 105 # 180 # 118 # 194	
Human	NHANES cross-sectional study 1999-2002	Congener concentrations reported Calculated total serum PCBs standardized for lipids <25% = 141 ppb 25th to <50th = 243 ppb 50th to <75th = 370 ppb ≥ 75th = 651 ppb	Cardiovascular	PCBs positively associated with prevalence of CVD among women (but not men). Odds ratio for dioxin-like PCBs 50-<75th % = 2 ≥75th% = 5 Odds ratio for non-dioxin like PCBs 25th to <50th % = 1.2 50th to < 75th % = 1.2 ≥75th % = 3.8	Dioxin-like PCB congeners: 74, 118, 126 156 169 Non-dioxin like PCB congeners: 99, 138, 153, 170, 180, 187	Ha M-H 2007
Human	9.5 years	Total PCBs At birth:	Neurological/ Developmental	Impaired learning of a performance task in children exposed to PCBs,	Total PCBs via sum of all congeners	Stewart 2006

Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.						
Target	***Study duration***	***Effect Level***	***System***	***Harmful Effects***	***Chemical Form***	***Reference***
		Mean cord PCB = 0.96 ppb Maternal hair, Mercury Prenatal = 0.56 ppm Prenatal cord Pb = 1.81 µg/dL Postnatal Pb = 4.6 µg/dL (at 2 to 4 years)		methylmercury, and lead. Children prenatally exposed to PCBs responded excessively, with significant lower inter-response times and fewer re-enforcers earned across the session. (In other words, low-level PCB exposure results in an inability to withhold or delay inappropriate responding, which are measures of attention and impulse control) Exposure to either methylmercury or lead (postnatal only) predicted statistically significant impairments of a similar magnitude to those for PCBs. The associated impairments of all three chemicals were statistically independent of one another.		
Human	Occupational,	> 90 days employment	Neurological	No overall (men/women	Not specified	Steenland

Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.						
Target	***Study duration***	***Effect Level***	***System***	***Harmful Effects***	***Chemical Form***	***Reference***
	Retrospective mortality study	Mean = 5.3 years PCB levels not specified Groups classified into low exposure and high exposure		combined) excess of Parkinson disease, amyotrophic lateral sclerosis, or dementia. Women had an excess mortality from amyotrophic lateral sclerosis, ALS (SMR = 2.26, CI = 1.08-4.15) (SMR = standardize mortality ratio) Among the highest exposed women (based on job-exposure matrix), women had an excess mortality from Parkinson disease (SMR = 2.96, CI = 1.08-6.42) and dementia (SMR = 2.04, CI = 1.12-3.42). Loss of dopaminergic cells in the brain is the hallmark pathologic sign of Parkinson disease. Studies indicate that exposure to PCBs decreases dopamine levels in rats and monkeys.		2006

<table>
<tr><th colspan="6">Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.</th></tr>
<tr><th>Target</th><th>Study duration</th><th>Effect Level</th><th>System</th><th>Harmful Effects</th><th>Chemical Form</th><th>Reference</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Conclusion: suggestive data of an effect of PCBs on neurodegenerative disease for women</td><td></td><td></td></tr>
<tr><td>Human</td><td>NHANES Cross-sectional study 2003-2004</td><td>Not applicable</td><td>Blood</td><td>Serum background levels of PCBs in US population.

Note: serum PCB levels change with year of sample and with age, making it difficult to compare these levels with human studies reported above.

<table><tr><td colspan="2">Total PCBs</td></tr><tr><td>Serum whole weight</td><td>Serum lipid standardized</td></tr><tr><td>GM= 0.8 ppb</td><td>GM = 134.4 ppb</td></tr><tr><td>95%= 3.53 ppb</td><td>95%= 530.7 ppb</td></tr></table>GM = geometric mean</td><td>Total PCBs
Congener-specific PCBs</td><td>Patterson 2009</td></tr>
</table>

<table>
<tr><th colspan="6">Table B2. Human Studies Demonstrating the Harmful Effects of PCBs at Low Levels.</th></tr>
<tr><th>Target</th><th>Study duration</th><th>Effect Level</th><th>System</th><th>Harmful Effects</th><th>Chemical Form</th><th>Reference</th></tr>
<tr><td></td><td></td><td></td><td></td><td>Serum whole weight PCBs in ppb
<table><tr><th>Age-group</th><th>Geometric mean</th><th>95th percentile</th></tr><tr><td>12-29</td><td>0.3</td><td>0.7</td></tr><tr><td>20-39</td><td>0.5</td><td>1.5</td></tr><tr><td>40-59</td><td>1.2</td><td>3.2</td></tr><tr><td>60+</td><td>2.3</td><td>5.9</td></tr></table></td><td></td><td></td></tr>
<tr><td>Human</td><td>9 months</td><td>< 1,04 to > 2.17 pg TEQ/g lipid</td><td>Developmental/ Immunological</td><td>Multivariate analyses showed independently and significantly decreased free T4 (FT4) × thyroid stimulating hormone with increasing non-ortho PCBs (r = –0.2; p < 0.05). This suggests that significant FT4 feedback alterations to the hypothalamus result from in utero exposure to non-ortho PCBs.</td><td>Non-ortho PCBs</td><td>Wang 2005</td></tr>
</table>

Table B3. Animal Studies Demonstrating the Harmful Effects of PCBs at Low Levels.

Target	*Study duration*	*Effect Level in µg/kg/day*	*System*	*Harmful Effects*	*Chemical Form*	*ATSDR Study #**	*Reference*
Monkey	23 months Daily	5	Immunological	Reduced IgM and IgG antibody response to sheep red blood cells	1254	148	Tryphonas 1989
Monkey	37 months Daily	5	Dermal	Elevated and separated toenails	1254	136	Arnold 1993a, 1993b
Monkey (female)	48 months ppm 37; ppw 22 daily	5	Developmental	Inflammation of tarsal glands, nail lesions, gum recession, reduced IgM antibody levels to sheep red blood cell in infant offspring	1254	160	Arnold 1995
Monkey	72 months	5	Developmental	Inflammation of tarsal glands, nails and nail beds in infants	1254	160	Arnold 1995
Monkey	20 weeks Daily, starting at birth	7.5	Neurological	Changes in behavioral performance in non-spatial and spatial discrimination reversal tasks at 3, 4.5, and 5 years of age. Treated monkeys showed decreases and variable increases in response latencies across three tasks of nonspatial discrimination reversal as well as retarded acquisition of a delayed	15 PCBs similar to breast milk	87	Rice 1997, 1998 Rice and Hayward 1997, 1999a

Table B3. Animal Studies Demonstrating the Harmful Effects of PCBs at Low Levels.

Target	*Study duration*	*Effect Level in µg/kg/day*	*System*	*Harmful Effects*	*Chemical Form*	*ATSDR Study #**	*Reference*
				alternation task and increased errors at short delay task responses. Rice interpreted the findings as a learning/performance decrement.			
Monkey	20 weeks Daily, starting at birth	7.5	Developmental	Lowered IgM and IgG antibodies to sheep red blood cell, temporary decrease in B lymphocytes	15 PCBs similar to breast milk	113	Arnold 1999
Monkey (female)	48 months ppm 37; ppw 22 Daily	20	Developmental	Fetal and post-partum deaths in 4 of 4 impregnated monkeys	1254	160	Arnold 1995
Monkey	37 months Daily	20	Blood	Decreased mean platelet volume	1254	136	Arnold 1993a, 1993b
Monkey	37 months Daily	20 LOAEL 5 NOAEL	Reproductive	42% reduced conception rate	1254	152	Arnold 1995
Monkey	37 months Daily	40	Hepatic	Decreased serum cholesterol	1254	136	Arnold 1993a, 1993b
Monkey	72 months	40	Dermal	Nail and nail bed changes	1254	137	Arnold 1997

* The ATSDR study number can be found in Table 3-2 in ATSDR's Toxicological Profile for PCBs and is provided as a reference to the study being described. Additional description of the study can be found in ATSDR's profile at this internet address; . http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=142&tid=26

** ppm = post partum month; ppw = post partum week

Appendix C

Summary of Scientific Studies
Evaluating the Effects of Lead Below 10 µg/dL

Table C1. Summary of scientific studies evaluating the effects of lead below 10 µg/dL.			
Blood Lead Level µg/dL	*Effect*	*Results/Conclusions*	*Author*
2.1	IQ	1. Peak (lifetime) blood lead concentration down to 2.1 µg/dL showed an inverse relationship with IQ for children at 6 years. 2. Lifetime average blood lead levels in children up to 6 years old, showed a 4.9 pt. decrease in IQ in children with average lifetime blood with blood lead level between 5 and 9.9 compared to children below 5 µg/dL.	Jusko 2007
< 10 µg/dL	Immune System	Pre- and post-natal blood lead levels below 10 µg/dL can alter children's adrenocorticol responses to acute stress. The behavioral and health consequences yet to be determined	Gump 2007
> 2	ADHD	Children (4 to 15 years) with blood lead levels between 2 - 5 µg/dL had a 4.5 fold higher risk of ADHD	Braun 2006
< 7.5	IQ	Children with blood lead levels up to 7.5 µg/dL have a greater decrease in IQ scores compared to children with higher blood lead levels. IQ decreases 3.9 points for children with blood lead levels between 2.4 - 10 µg/dL	Lanphear 2005
5 to 10	IQ	Data shows IQ decreased 3 to 5 pts. when blood lead levels increase from 5 to 10 µg/dL. IQ at 5 and 7 yrs. not related to peak lead levels of 20-44 µg/dL at 2 years of age	Chen 2005
1 to 10	IQ	An increase from 1 to 10 µg/dL blood lead is associated with 7.4 point decrease in IQ in children 3 to 5 years. From 10 to 20 µg/dL, IQ declines 2 points. Greater decrease in IQ from 1 to 10 when compared to higher blood lead levels	Canfield 2003
< 5	IQ	Blood lead levels below 5 µg/dL associated with deficits in cognitive and academic skills. Every 1 µg/dL increase in blood lead associated with • 0.7 pt. decrease in math scores • 1 pt. decrease in reading scores • 0.1 pt. decrease in nonverbal reasoning • 0.5 pt. decrease in short-term memory	Lanphear 2000

Table C1. Summary of scientific studies evaluating the effects of lead below 10 µg/dL.			
Blood Lead Level µg/dL	*Effect*	*Results/Conclusions*	*Author*
10.4	IQ	Lead at low levels of exposure probably has a small harmful effect on the performance of children in ability and attainment tests. Authors remark no evidence of a threshold	Fulton 1987
< 5	IQ	IQ at 10 years inversely related to blood lead levels at 2 years. Data suggest that inverse relationship persisted at blood lead levels < 5 µg/dL. Slope of dose response is greater at levels below 10 µg/dL	Bellinger 2006
3	Neurobehavior	3 µg/dL blood lead associated with deficits in attention, including executive function	Selevan 2003
5	Neurobehavior	5 µg/dL blood lead associated with deficits in reaction time, visual-motor integration, fine motor skills, off-task behaviors, and withdrawn behaviors	Selevan 2003
<10	Behavior	Blood Pb levels below 10 in 3 yr old children associated with small effects on behavior (e.g., cannot concentrate, quickly shifts from one thing to another) as measured by the destructive subscale. Between 10 and 20 µg/dL, blood lead causes a very small increase effect on behavior.	Wasserman 1998
1.86 all < 10	Behavior	Lead was significantly inversely related to teacher ratings of girls' sociability and classroom social competence.	Hubbs-Tait 2007
4.2 to 9	Attention	In a population with mean blood lead level of 4.2 µg/dL and 90% blood lead of 9 µg/dL, sustained attention negatively affected by lead levels	Walkowiak 1998
3	Height	Compared to 1 µg/dL, lead at 3 µg/dL associated with decreased height	Selevan 2003
3	Development	3 µg/dL associated with delays in breast and public hair development in African-American and Mexican-American girls. Also delayed menarche by 3.6 months. White girls showed non-statistically significant delays. Conclusion: 3 µg/dL causes delays in puberty	Selevan 2003

Table C1. Summary of scientific studies evaluating the effects of lead below 10 µg/dL.			
Blood Lead Level µg/dL	*Effect*	*Results/Conclusions*	*Author*
3.4	Behavior	Data suggest that social and emotional dysfunctions may be expressions of increased lead exposure. 3.4 µg/dL (SD 2.4) associated with total problem behavior scores Increases in tooth lead associated with internalizing and externalizing scores. Weaker association between tooth lead and extreme problem behavior. Cord blood not associated with later behavioral problems	Bellinger 1994
>5.5	Renal	Inverse relationship between serum levels of creatinine, B2-microglobulin, cystatin C and blood lead, suggesting renal hyperfiltration (i.e., increased glomerular filtration rate (x = 7.8 µg/dL)	Burbure 2006
> 1.5 to 10 µg/dL	Behavior	Children 8 to 15 years of age have an increased likelihood of conduct disorder (persistent behavioral patterns that violate social rules and the rights of individuals). Children with CD display aggression towards other people and animals and intentionally destroy others= property and chronically steal and deceive.	Braun 2008
4.8 µg/dL (cord)	Behavior in infants	Prenatal lead exposure was related to increased frenetic movement in neonates at 11 months. Frenetic movement is associated with hyperactivity and thus consistent with primate studies that have identified agitation as an early behavioral effect of lead and increased hyperactivity in childhood. This impaired ability to maintain attention and regulate one's behavior could be one of the earliest signs of lead neurotoxicity and a possible basis for later cognitive dysfunction. After removing children with blood lead levels greater than 10 µg/dL, authors still observed decrements in sustained attention.	Plusquellec 2007

References for Table C1, Appendix C

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Braun JM, Kahn RS, Froehlich T, Auinger P, Lanphear BP. 2006. Exposure to environmental toxicants and attention deficit hyperactivity disorder in US children. Environ Health Perspectives 114(12);1904-1909.

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Canfield RL, Henderson CR, Cory-Slechta DA, Cox C, *et al*. 2003. Intellectual Impairment in Children with Blood Lead Concentrations below 10 ug per Deciliter. N Engl J Med 348(16);517-1526.

Chen A, Dietrich KN, Ware JH, Radcliffe J, Rogan W. 2005. IQ and blood lead from 2 to 7 years of age: are the effects in older children the residual of high blood lead concentrations in 2-year olds? Environ Health Perspectives 113(5);597-601.

Fulton M, Thomson G, Hunter R, *et al*. 1987. Influence of blood lead on the ability and attainment of children in Edinburgh. The Lancet 329(8544);1221-1226, 1987.

Gump BB, Stewart P, Reihman et al. 2007. Low-level prenatal and postnatal blood lead (Pb) exposure and adrenocortical responses to acute stress in children. Environ Health Perspectives 116(2);249-55.

Hubbs-Tait L, Kennedy TS, Droke EA, Belanger DM, Parker JR. 2007. Zinc, iron, and lead: relations to head start children's cognitive scores and teacher's ratings of behavior. J Am Diet Assoc 107;128-33.

Jusko TA, Henderson CR, Lanphear BP, Cory-Slechta DA, Parsons PJ, Canfield RL. 2007. Blood lead concentrations less than 10 micrograms per deciliter and child intelligence at 6 years of age. Environ Health Perspectives 116(2);243-248.

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Selevan SG, Rice DC, Hogan KA *et al*. 2003. Blood lead concentration and delayed puberty in girls. New England Journal of Medicine 348;1527-1536.

Wasserman GA, Staghezza-Jaramilllo B, Shrout P, *et al*. 1998. The effect of lead exposure on behavior problems in preschool children. Am J Public Health 88(3);481-486.

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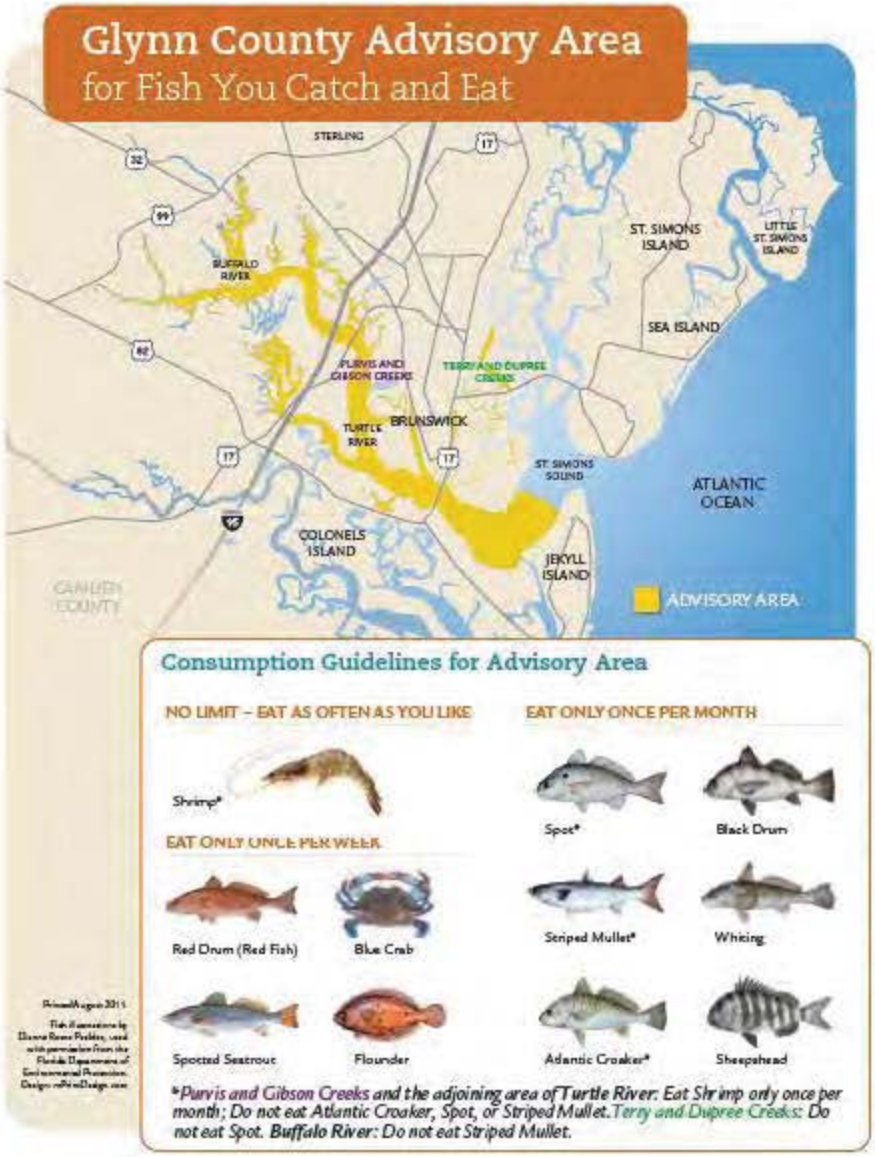
Appendix D

Glynn Environmental Coalition
Seafood Advisory Brochure


Glynn County Advisory Area
for Fish You Catch and Eat
STERLING
ST. SIMONS ISLAND
LITTLE ST. SIMONS ISLAND
BUFFALO RIVER
SEA ISLAND
PURVIS AND GIBSON CREEKS
TERRY AND DUPREE CREEKS
BRUNSWICK
TURTLE RIVER
ST SIMONS SOUND
ATLANTIC OCEAN
COLONELS ISLAND
JEKYLL ISLAND
ADVISORY AREA
Consumption Guidelines for Advisory Area
NO LIMIT – EAT AS OFTEN AS YOU LIKE
Shrimp*
EAT ONLY ONCE PER WEEK
Red Drum (Red Fish)
Blue Crab
Spotted Seatrout
Flounder
EAT ONLY ONCE PER MONTH
Spot*
Black Drum
Striped Mullet*
Whiting
Atlantic Croaker*
Sheepshead
*Purvis and Gibson Creeks and the adjoining area of Turtle River: Eat Shrimp only once per month; Do not eat Atlantic Croaker, Spot, or Striped Mullet. Terry and Dupree Creeks: Do not eat Spot. Buffalo River: Do not eat Striped Mullet.

APPENDIX E

EPA's Quadrant Mapping/Sampling Unit Method for Dioxins Collected in 2011 and ATSDR's Sampling Area Designations

Honeywell divided the site into 4 separate quadrants, which is consistent with the sampling design used in the Human Health Risk Assessment for the site (EPS 2010). Each quadrant contained 1 to 3 different sampling units. Incremental Sampling Methodology (ISM) samples were collected from each sampling unit within each quadrant. Each ISM sample was comprised of multiple equal-mass aliquots of soil collected from 0 to 3 inches below ground surface. For each sampling unit, a replicate sample was taken; two replicates were taken in sampling unit 1. A total of three (2 of which were replicates) ISM samples were collected from Quadrant 1. A total of six (3 of which are replicates) ISM samples, two per sampling unit, were collected from Quadrants 2, 3 and 4 (EPS 2011). ATSDR selected the higher of the two replicate sampling results in our evaluation.

Figure 12 illustrates the quadrants and sampling units established by Honeywell for the site.

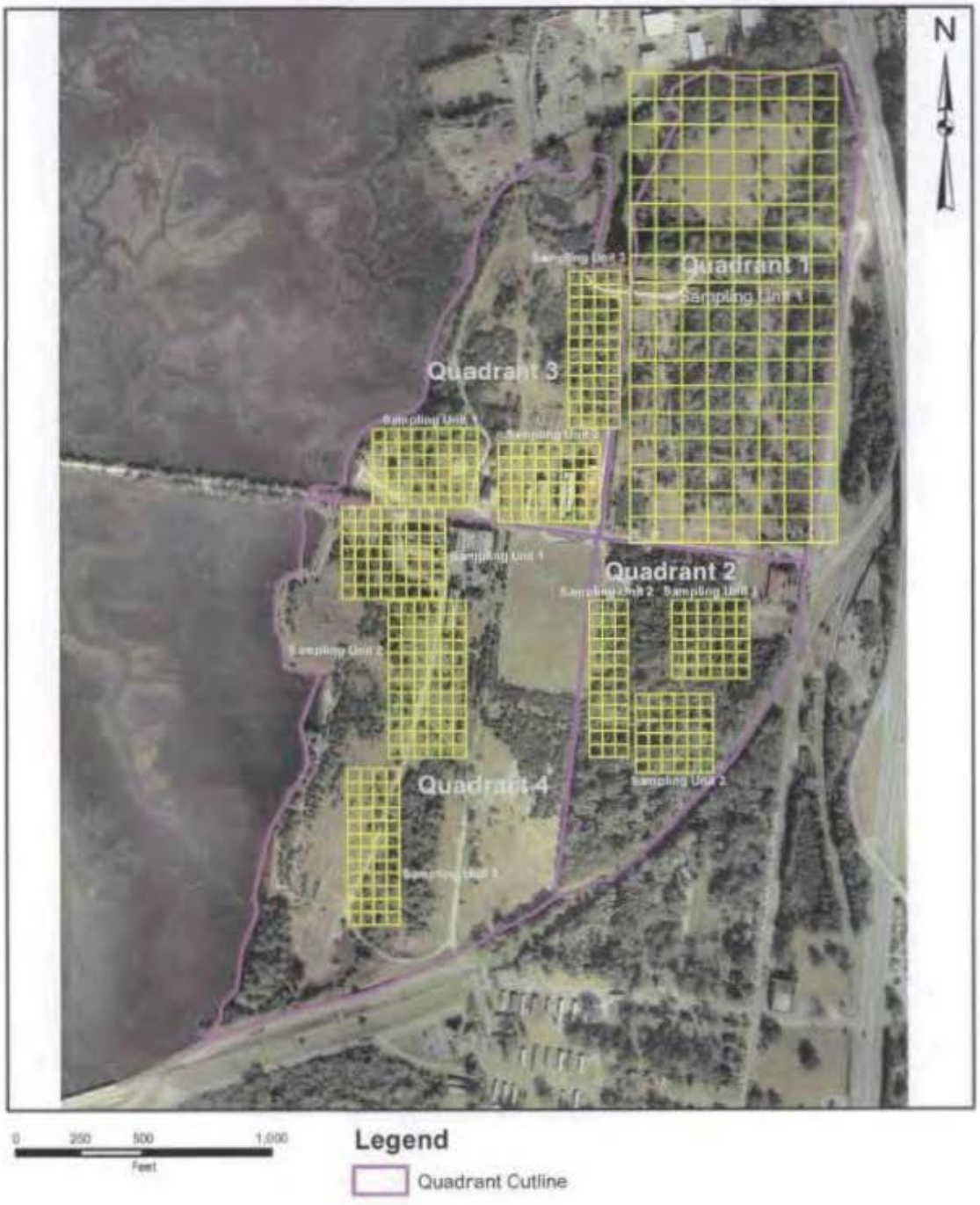
ATSDR consecutively numbered the sampling units (1 through 10) for ease of description. ATSDR's numbering system goes from left to right, top to bottom.

For comparison purposes, the table below shows Honeywell's sampling units and the corresponding numbered sampling area used by ATSDR:

Table 9. Honeywell's sampling units and ATSDR's sampling areas

Honeywell's Quadrant	***Equals***	***ATSDR's Sampling Area Designation***
Quadrant 3, Sampling Unit 1	=	1
Quadrant 3, Sampling Unit 2	=	2
Quadrant 3, Sampling Unit 3	=	3
Quadrant 1, Sampling Unit 1	=	4
Quadrant 4, Sampling Unit 1	=	5
Quadrant 4, Sampling Unit 2	=	6
Quadrant 4, Sampling Unit 3	=	7
Quadrant 2, Sampling Unit 2	=	8
Quadrant 2, Sampling Unit 3	=	9
Quadrant 2, Sampling Unit 1	=	10

Figure 12. LCP Chemicals Site Showing EPA Quadrants and Sampling Units



APPENDIX F
RESPONSE TO COMMENTS

ATSDR released this public health assessment in September 2010 for public comment. We received and responded to comments (shown below) and made changes to the public assessment, as appropriate. The page numbers cited in the responses that follow are to the 2010 public comment release of this public health assessment.

1. **Comment**: The PHA places undue emphasis on a hypothetical future use of the LCP property as a residential development. The PHA fails to acknowledge that the LCP Chemicals Site has been used in an industrial capacity for the last 100 years and that the property remains zoned for commercial/industrial use. The current property owner (Honeywell) has no intention of developing the property for residential use and will be placing institutional controls on the property, restricting future use of the property for commercial use only.

   ATSDR Response: ATSDR's evaluation included residential development as a future use because residential development was considered in EPA's assessment of the property (e.g., EPA's draft Human Health Risk Assessment considers a future on-site resident in the exposure assessment) and because residential use has not been ruled out. Although Honeywell claims in some reports that the site is intended to remain industrial, they acknowledge the potential for some mixed land use of the property and/or the possibility that some portion of the site might be used as residential property in the future. Therefore, ATSDR believes it prudent to evaluate all possible future scenarios to be protective of public health.

2. **Comment**: There are a number of statements in Section II.B. (Site History) for which the Draft Remedial Investigation/Feasibility Study (RI/FS) Report for Operable Unit 3 (OU3) (i.e., "EPS 2007b") is cited. Most of the statements attributed to that reference misrepresent information and/or specific statements presented therein[7]. The PHA should be revised in a manner that either removes all such "EPS 2007b" citations in Section II.B. Alternatively, the wording in Section II.B should be altered in a manner to accurately reflect the wording from the cited documents[8].

[7] Some examples of improper citations occurs on page 2 of the PHA, bullets 1, 2, 4, and 5 with respect to "releases" and references to "large quantities". EPS 2007b is also mis-referenced on page 16 of the PHA where the statement begins "Wastes laced with contaminants…".

[8] Please also note that there appear to be several instances of improper citation references in the document. For example, the first citation of an "EPS 2007" reference appears on page 2; however it is listed with a "b" suffix. The citation of "EPS 2007a" does not appear until page 15. The "a" and "b" suffixes on these references should be reversed. In Section II.B (page 2), there is a citation of "EPA 2007b." There is no "EPA 2007b" in the reference list and given its proximity to the other "EPS 2007b" citations, it is likely that the ATSDR intended to cite "EPS 2007b." There are also numerous citations of "EPA 2009" within Section II. There are four EPA 2009 references in the reference list (each labeled with a, b, c, or d suffix). However, none of these references seem likely to support the statements attributed to the "EPA 2009"

ATSDR Response: This section has been revised.

3. **Comment**: There are a number of statements in the PHA that describe residual contaminated soil within the footprint of the former cell building (e.g., pages 24, 28, 29, 85, 86, 105). None of these statements acknowledge that the cell buildings were razed and the entire area capped and enclosed with a chain link fence as part of the EPA Removal Action in 1994-97. This cap and chain link fence surrounding the area is an effective barrier to human exposure to conditions in the underlying soil (that were also characterized as part of the site investigation). By ignoring the cap and fence, ATSDR's conclusion that there is "a health concern if the site becomes commercial or industrial in the future" (page 105, Figure 22) overstates the risk in at least five of the nine grids. Section IV.C.1, which describes the decommissioning and removal actions in the cell building area, should describe the construction of the soil cap over the razed structures and the chain link fence surrounding this area. The PHA figures should also be modified accordingly.

ATSDR Response: Several sections were revised to acknowledge the construction of the soil cap over the razed cell building structures and the installation of the chain link fence.

Also, we did consider the soil cap and fence in our evaluation of the site. Although we believe that exposures may be mitigated by the presence of the cap and fence in the short term, we think it important to acknowledge the presence of significant residual contamination in case land use changes are considered for the future. The cell building area should be carefully re-evaluated and further characterized if structures are to be built on or near the capped area in the future.

4. **Comment**: The PHA correctly identifies Aroclor 1268 as the primary form of polychlorinated biphenyl (PCB) present in site soils. Neither EPA nor ATSDR, however, have developed default toxicity criteria for Aroclor 1268. The PHA evaluates the Aroclor 1268 using the toxicity criteria developed by those agencies for Aroclor 1254 and goes on to generically characterize the "uncertainty" associated with the toxicological evaluation of Aroclor 1268. There is evidence in the scientific literature to support the conclusion that Aroclor 1268 is considerably less toxic than Aroclor 1254.[9,10] The PHA should be revised to acknowledge that

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citation in Section II. The March 31, 2009 Addendum to the Human Health Baseline Risk Assessment appears in the reference list as "EPS 2009", but is never cited in the document.

[9] Warren, D. A., Kerger, B. D., Britt, J. K. and James, R. C. (2004). Development of an oral cancer slope factor for Aroclor 1268. *Regulatory Toxicology and Pharmacology,* 40: 42-53.

the "uncertainty" associated with the use of the Aroclor 1254 toxicity criteria to evaluate Aroclor 1268 results in a more conservative assessment of potential toxicity.

ATSDR Response: In the absence of substantial toxicity data on Aroclor 1268, it is prudent public health practice to use health guidelines and toxicity information from other mixtures of Aroclor. This approach is commonly used by public health agencies to evaluate Aroclor mixtures. The articles cited by the commenter also have considerable uncertainty so it is not certain that Aroclor 1268 is less toxic than Aroclor 1254. ATSDR has appropriately acknowledged the uncertainty in using health guidelines and toxicity information for Aroclor 1254. ATSDR did not make the suggested change.

5. **Comment**: Section IV.E.2 discusses the presence of "clinker material" at a residential property on Clairmont Lane and suggests that this area be investigated (see page 115). As described in the PHA, the presence of clinker material was the subject of an investigation and removal action conducted by Georgia Environmental Protection Division in 2004. Neither that investigation nor this PHA present demonstrable evidence linking the clinker material to the LCP Chemicals Site. In fact, the material is common to many industrial operations and is known to be associated with other industrial sites in Brunswick. Given that its relevance to this PHA has not been established, it should be removed from the PHA.

ATSDR Response: In the PHA, ATSDR maintains that the alleged disposal sites may not be associated with the LCP Chemicals site. We elected to include the suspected disposal areas in this document because community members raised concerns regarding these areas and because some evidence exists to suggest a connection with past industrial activities in the area, not limited to activity by LCP Chemicals.

6. **Comment**: ATSDR created half-acre grids as "exposure units" that were used to segregate and evaluate the site sampling data. The use of a small exposure unit grid results in the conclusion that many of the grids lack sufficient data to characterize the condition of each grid. This analysis fails to acknowledge that many areas of the site, however, did not warrant the same density of site characterization as did other areas of the site, because of a lack of historical industrial activity in those areas. ATSDR should consider using a more appropriate grid size such as one-acre grids so that there would be fewer instances where ATSDR concludes that there was a "lack of sufficient data".

ATSDR Response: While it is known that industrial activity occurred predominantly in the western portion of the LCP property, on-site disposal of

[10] Simon, T., Britt, J. K. and James, R. C. (2007). Development of a neurotoxic equivalence scheme of relative potency for assessing the risk of PCB mixtures. *Regulatory Toxicology and Pharmacology,* 48: 148-170.

industrial waste could have occurred anywhere on the property during the 83 years that industrial operations took place. The disposal locations are uncertain for the first half of the 20th century when petroleum refining (1919-1935), electric generation (1937-1950s), and paint and varnish manufacturing (1941-1955) took place. The chlor-alkali operations clearly took place in the western portion of the site, although disposal of waste could have occurred anywhere on the property even during these operations. This information is described in more detail the background section of the PHA.

In addition, increasing the grid size to one acre will not change substantially the conclusion that eastern portions of the site are poorly characterized. The basis for half-acre grids is the assumption that the site could be developed for residential, commercial, or industrial activity. Without specific information on future land use, the most prudent grid size to evaluate human exposure is a half-acre. ATSDR did not make the suggested change.

7. Comment: In this PHA the evaluation of potential health effects associated with lead exposure in site soil includes the derivation of a soil lead comparison level of 141 ppm based on the EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model, using the model's default input parameters and a target of 5% of children's blood lead levels exceeding 5 μg/dL. The use of this blood lead target for this purpose is not consistent with Centers for Disease Control (CDC), EPA guidance, and standard practice. The CDC established 10 μg/dL as its "blood lead level of concern" in 1991, and a revision of the 10 μg/dL level of concern was considered and rejected by CDC's Advisory Committee on Childhood Lead Poisoning and Prevention (ACCLP) in 2005. The ACCLP revisited this issue at a recent meeting,[11] without reaching consensus. The committee voted to form a working group to study the issue further. The EPA has long relied on the 10 μg/dL level of concern for establishing cleanup levels for lead in soils and there is no evidence that these levels are not protective of public health. In fact, one of the primary issues confronting the CDC as it considers revisions to the [sic] its level of concern is that no effective interventions have been demonstrated to further reduce blood lead levels in children who already have levels at or below 10 μg/dL.[12] Given this set of circumstances, the ATSDR's use of a 5 μg/dL target blood lead level to draw conclusions about the need for remedial actions to protect the health of hypothetical future residents is arbitrary and out of step with current policy and guidance from the EPA and CDC

<u>ATSDR Response</u>: On January 4, 2012, CDC's Advisory Committee on Childhood Lead Poisoning Prevention (ACCLPP) recommended that CDC adopt the 97.5 percentile for children 1 to 5 years old as the reference value for designating elevated blood lead levels in children. The 97.5% currently is 5

[11] The ACCLP meeting was held in Atlanta, Georgia on November 16-18, 2010.

[12] Brown, MJ and Rhodes, GG. (2008). Guest Editorial: Responding to Blood Lead Levels <10 μg/dL, Environmental Health Perspectives, 116: A60-A61

µg/dL. This came about because of the numerous studies that show health effects at levels below 10 µg/dL. Furthermore, the advisory committee recommended that CDC stop using the phrase 'blood lead level of concern.' (ACCLPP 2012)[13]. The advisory committee's report to CDC and CDC's response is available at http://www.cdc.gov/nceh/lead/acclpp/acclpp_main.htm.

CDC has accepted the advisory committee's recommendation, has dropped the use of the term, 'level of concern', and has adopted the 97.5th percentile as CDC's reference value for lead.

In addition, in a letter dated January 16, 2008 from Dr. Henry Falk (Director, Coordinating Center for Environmental Health and Injury Prevention, CDC) to Mr. Robert Meyers, (Principal Deputy Assistant Administrator, EPA), CDC comments on EPA's use of 10 µg/dL in the IEUBK model to derive the national ambient air quality standard for lead[14]. CDC points out that CDC has developed several blood lead levels (BLL) where CDC recommends public health action (e.g., > 70 µg/dL, > 45 µg/dL, > 15 µg/dL, and 10 µg/dL). Thus, CDC states, "there is no single CDC level of concern". CDC further states that 10 µg/dL should not be used as a safe level, and that 10 µg/dL has frequently been misinterpreted as a toxicological threshold. CDC cautions that using 10 µg/dL as a target for deriving lead standards (and by inference soil clean up level) is an inappropriate interpretation of CDC's historical 10 µg/dL. CDC states that the use of 10 µg/dL in EPA's IEUBK model could needlessly expose children to levels of lead known to adversely affect academic performance and success later in life.

Because CDC's current reference level for lead in children is 5 µg/dL, ATSDR did not make the suggested change.

8. **Comment**: Excerpt from LCP PHA, Site History, Page 2 –

   "ARCO Petroleum (1919-1935), a successor of the Atlantic Refining Company, operated the site as a petroleum refinery that refined crude oil into fuel and oils. At one time, over 100 process and storage tanks were present on site. ARCO is reported to have released large amounts of petroleum products and wastes onto the ground (EPS 2007b)."

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[13] [ACCLPP] Advisory Committee for Childhood Lead Poisoning Prevention. 2012. Low Level Lead Exposure Harms Children: A Renewed Call for Primary Prevention, Report of the Advisory Committee on Childhood Lead Poisoning Prevention of the Centers for Disease Control and Prevention, January 4. Available at http://www.cdc.gov/nceh/lead/acclpp/acclpp_main.htm. [accessed 5 May 2013].

[14] Falk H. 2008. Letter from Henry Falk, Coordinating Center for Environmental Health and Injury Prevention, CDC, to Robert J. Meyers, Principal Deputy Assistant Administrator, US EPA, Washington DC. January 16.

The boundaries of operations on the site during the 1919 to 1935 period have not been described. Areas that are now considered to be off-site are actually part of the original ARCO Petroleum operations area. The boundaries of the site for each operational period described in the Site History section of the Public Health Assessment (PHA) should be described and figures produced and included. Figure A4 should also be accompanied by figures of the land boundaries for all operational periods in the Site History section.

ATSDR Response: It is beyond the scope of the PHA to define and describe all historical site boundaries and it is not needed to perform the evaluation of current on-site and off-site locations. Therefore, this suggestion was not implemented. For example, the current boundaries of the Superfund site, as described by EPA Region 4, do not encompass all the areas where tanks were historically located. However, we still evaluated soil sample results available for these off-site areas. See Figure A6.

9. **Comment**: The commenter served on the seafood consumption advisory group formed to consult and review the results of a seafood consumption study in Brunswick conducted by the state health department.[15] The Principal Investigator of the study was taken to the subsistence fishing areas on the Brunswick peninsula and an effort was made to introduce her to the subsistence fishers. The study design was changed to select only those that owned boats and fished from boats, even though the advisory group objected. The commenter is concerned that the participants in the study do not represent the African-American community and subsistence fishers in the area.

ATSDR Response: The study was conducted by the Glynn County Health Department through a cooperative agreement and funding from ATSDR. The study design targeted three groups: commercial, recreational, and subsistence fishers. The target groups had to meet three criteria:

1. **Consumed or caught seafood from the Turtle River or its tributaries in Glynn County;**
2. **Lived in Glynn County for at least the last two consecutive years prior to the study; and**
3. **Had not been employed at the LCP Chemicals Site since 1956, in order to exclude individuals who may have had occupational exposure to mercury.**

[15] Final Report, Consumption of Seafood and Wild Game Contaminated with Mercury – July 1999.

Much effort went into finding local fishers using multiple methods to identify the target groups. The various methods include:

- **6,200 surveys were distributed to local schools, businesses, agencies, industries, community groups, churches, and professional and civic organizations.**
- **Residents in private homes in the target geographical areas were contacted by door-to-door canvassing**
- **Screening surveys were left at homes of those who could not be contacted during the door-to-door canvassing.**
- **Surveys were distributed at fishing piers, bridges, boat ramps, businesses, and homes adjacent to affects waterways, fish camps, bait and tackle shops, and to the local commercial seafood industry.**
- **The survey was published several times in the local newspapers and the GCHD Hazardous Waste Site Newsletter with instructions on submitting the completed survey for enrollment.**
- **Television and radio coverage was used extensively throughout the recruitment period.**

Of the 282 eligible residents in the target group of recreational, commercial, or subsistence fishers

- **214 (76%) were interviewed,**
- **156 (55%) completed a dietary diary, and**
- **139 (49%) provided urine samples.**

Of the 101 (65%) target group participants who self-reported which type of fisher they were

- **97 (96%) classified themselves as recreational fishers,**
- **3 (3%) identified as commercial, and**
- **1 (1%) identified as subsistence fisher.**

It's important to note that the study results reflect characteristics of recreational white fishers and do not necessarily apply to commercial or subsistence fishers.

No effort was made to select residents who only owned boats or who fished from boats. It should be pointed out, though, that portions of the Turtle River and its tributaries under the advisory are only accessible by boat. Several fishing areas along the shore or from a bridge are possible but the survey did not attempt to distinguish which method was used to catch fish nor was any effort made to not select persons who fish from the shore. The text already explains that the study results do not necessarily apply to the African-American community, who were underrepresented in the target study group.

10. **Comment:** This study design overlooks people of color, who are the predominant population on the Brunswick peninsula bordering the most contaminated areas and the subsistence fishing locations. The PHA correctly states, "It should be noted that African-Americans made up only 4% (9 out of 197) of the people who participated in the study; therefore, the findings of this study may not apply to the African-American community in the Brunswick area." But, the statement should be strengthened to reflect that the most likely to consume contaminated seafood and be the impacted subpopulation – the subsistence fisher population – was not included in the study. Furthermore, the study participants were aware of the advisories and by virtue of having boats could fish outside the advisory areas when obtaining seafood for consumption.

<u>ATSDR Response</u>: ATSDR agrees with the comment that African-Americans are underrepresented in the Brunswick fish study and has already stated this in the main text. According to the 2010 U.S. census, African-Americans make up 26% of the population of Glynn County. Within four miles of the LCP Chemicals site, African-Americans make up almost 40% of the population.

For this reason, we have used information about fish consumption from an African-American population to evaluate fish contaminant levels from the Altamaha Canal. A study of fishers along the Savannah River showed that African-Americans

- **eat more fish meals per month than whites (average, 5.4 vs. 2.9),**
- **eat larger portions than whites (average, 13.7 oz vs . 13.1), and**
- **eat more fish per month than whites (average, 75 ounces vs. 41 ounces).[16]**

It is reasonable to assume that African-Americans in Brunswick, Georgia, are similar to African-Americans along the Savannah River when it comes to fish-eating habits. Therefore, African-Americans who fish along the Turtle River are likely to have higher exposure to mercury from eating fish than whites.
The commenter states that the study participants were aware of the advisories and by virtue of having boats could fish outside the advisory areas when obtaining seafood for consumption. This statement is consistent with one of the conclusions of the Brunswick fish study, which states that most study participants do not fish in the restricted area and the few that do are aware of the advisory.

ATSDR has added several of these points to the main text of the PHA.

11. **Comment:** Regarding the Brunswick fish study, the conclusions of the Glynn County Health Department are of little value and might mislead the public and lead to underestimating the risks from consuming contaminated seafood.

[16] Burger J, Stephens WL, Boring CS, et al. 1999. Factors in exposure assessment: ethnic and socioeconomic differences in fishing and consumption of fish caught along the Savannah River.

Therefore, ATSDR should consider clarifying language in this section to fully reveal the significant flaws in the study methods.

ATSDR Response: The conclusions in the Brunswick fish study apply to persons who responded to the survey and to some extent to non-responders with similar demographic variables. It should not be applied to African-Americans who may fish in restricted areas of the Turtle River and its tributaries. ATSDR has modified the text to make this point more clear.

12. **Comment**: There were other significant flaws in the study, such as educating the study participants to the risk from contaminated seafood prior to the 24 hour urine collection.

ATSDR Response: Awareness of the fish advisory was present long before the Brunswick fish study was conducted. It is not possible to avoid some of the bias that comes with knowing about the dangers of mercury in fish and the effect that knowledge may have had on someone's fish-eating habits. The timeline of events for the study included the following in this order:

- **Administer a screening survey to identify target and control groups,**
- **Administer a detailed survey to identify signs/symptoms and diseases as well as details of fish catching and eating habits,**
- **Complete a dietary diary over a two-week period,**
- **Collect a 24-hr urine sample.**

Additional bias could have been introduced because persons may have changed their fish-eating habits during the two week dietary period when study participants monitored their own fish intake. Even so, the dietary diary showed that residents tended to underestimate their fish intake when filling out those parts of the detailed survey that dealt with their fish consumption. Additional information has been added to the main text of the PHA.

13. **Comment**: Hair testing would have provided a history of exposure and interjected less bias into the study methods and design.

ATSDR Response: Blood and hair testing are more appropriate methods for identifying exposure to methylmercury from fish consumption. The Brunswick fish study decided to use urine to monitor mercury levels for two reasons. First, 10% to 30% of organic (e.g., methyl) mercury may be excreted in the urine. Therefore, the investigators thought that the large amounts of mercury in fish would still show up in fish consumers as elevated mercury urine levels. Secondly, the investigators thought that participation would be higher if non-invasive urine samples were required rather than invasive blood samples. In addition, there could have been problems with collecting hair samples in some older men because of insufficient hair for a sample.

Unfortunately, collecting urine samples diminishes the ability to identify low to moderately exposed individuals. In addition, the selection of 20 ug/L as a reference value was too high. Although not available at the time of the 1999 Brunswick fish study, the 4th National Report on Human Exposure to Environmental Chemicals shows that 2 or 3 ug/L (or 2 ug/g creatinine) would be a more appropriate reference level to identify excessively exposed individuals. The following levels are reported by the 4th National Report for the three 2-year reporting periods covering 2003 to 2008:

	Geo Mean	95th percentile
Urinary Mercury µg/L	**0.44-0.47**	**2.6-3.2 µg/L**
Urinary Mercury µg/g creatinine	**0.44-0.46**	**2.3 µg/g**

The 4th National Report is available at this web address: http://www.cdc.gov/exposurereport.

Additional information has been added to the main text of the LCP PHA.

14. Comment: The section on page 22 of the PHA concerning PCBs should include a section "How PCBs Were Used at the Site". The graphite anodes impregnated with PCBs were used in the chlor-alkali cells. Electricity was passed through the anode to crack the salt brine solution into chlorine, and caustic soda. The electric current created great heat and produced byproducts such as hydrogen and dioxin/furan. Within the chlor-alkali cells, the PCBs were exposed to heat and chlorine as the graphite anode was consumed. Further clarification about how dioxin/furans are produced during the chlor-alkali process, and why dioxin/furans can be presumed to be co-located with PCBs should be included in the PHA. Furthermore, a clear statement that testing for dioxin/furans is needed on the uplands before further residential or commercial development should be included in the section concerning PCBs, dioxin, and in the conclusions and recommendations.

ATSDR Response: Generally, specific comments regarding chemical production and/or use at a site are determined by the regulatory agency conducting the environmental investigation. Although we can include general information about the chlor-alkali process, we do not have specific information about how the chemicals were produced or used at *this* site. Therefore, we would refer the commenter to EPA documents for a more specific explanation of the chlor-alkali process.

We were able to use third party studies and professional experiences to make the case for why dioxins/furans are presumed to be co-located with PCBs. We cite the evidence we used to support our conclusion.

Honeywell conducted further sampling for dioxins in upland soils in 2011. ATSDR evaluated that data and provided recommendations and conclusions based on our evaluation of the data.

15. **Comment**: The discussion of the dioxin/furan group of chemicals should be included in the PCB section. Since PCBs and dioxin/furan were co-located, the removal action was premised upon dioxin/furan being removed with the PCBs. Therefore, the presence of PCBs is presumptive evidence of dioxin/furan. The lack of dioxin/furan data for the uplands is not "data" indicating the chemicals are not present.

ATSDR Response: Honeywell conducted further sampling for dioxins in upland soils in 2011. ATSDR evaluated that data and provided recommendations and conclusions based on our evaluation of the data.

16. Comment: Excerpt from page 43 of the PHA:

"A total of 45 samples were tested for dioxins. Of the 45 samples tested, 6 were surface water samples and 1 was a groundwater sample. Two sediment samples were collected to determine background concentrations. The 36 remaining samples were sediment samples collected from the marsh and from selected off-site locations. " "…Dioxin concentrations in sediment ranged from non-detect to 0.003 ppm. ATSDR's comparison value for dioxin in soil is 0.00005 ppm. Eight samples exceeded ATSDR's comparison value of 0.00005 ppm. No samples for dioxins were collected from the dry-land area."

The source areas for the dioxin found in sediment and surface water can reasonably be expected to be on the upland portions of the site, and these areas should be identified prior to any commercial or residential use of the site.

ATSDR Response: Honeywell conducted further sampling for dioxins in upland soils in 2011. ATSDR evaluated that data and provided recommendations and conclusions based on our evaluation of the data.

17. **Comment**: Excerpt from LCP PHA, Residual Mercury Levels in Soil, Page 29

"The maximum mercury concentration at the site from a single soil sample is 10,400 ppm and is located in the footprint of the cell building area (Grid #113). The highest average mercury concentration for any grid (Grid #113) is 1,470 ppm and is also located in the former cell building area."

The PHA authors have correctly noted that the Cell Building area is poorly characterized. Still, the testing conducted found 10,400 ppm, or 1.4% mercury in the soils. Considering that the mercury leaked to a cement floor and then flowed through cracks in the concrete, even higher levels could be present in the soil

below the Cell Building area. The sampling did not extend further than 5 feet (also around the groundwater table), which means the potential for significant amounts of mercury below the groundwater table exists. More vertical and horizontal characterization is needed in the Cell Building area and should be recommended in the PHA.

ATSDR Response: We acknowledge the lack of proper characterization of the cell building area and recommend additional sampling should the area be considered for future development.

18. **Comment**: The PHA should note that excavation activities in the Cell Building area have the potential to expose workers and the general public. Any work in the Cell Building area should be scheduled for times of the year with the coolest temperatures.

ATSDR Response: ATSDR acknowledges that significant contamination remains beneath the cell building. EPA and/or its contractors will be responsible for developing a plan that is protective of workers and the general public during excavation activities at the site. If requested, ATSDR staff are available to review worker protection plans.

19. **Comment**: The cell building area was not analyzed as thoroughly as the other areas of the LCP Chemicals Site during the EPA Emergency Response and Removal Action since it was assumed extensive remediation would be needed in this area, which has been delayed at this point for 14 years. With soil mercury levels in excess of 1% reported and limited data, the PHA should strongly recommend another timely assessment when the data are obtained.

ATSDR Response: We acknowledge the lack of proper characterization of the cell building area and recommend additional sampling should the area ever be considered for future development.

20. **Comment**: The huge quantity of mercury in the cell building area and the very limited delineation of the vertical and horizontal extent continue to be a concern, as is the continued contaminated groundwater discharge from the uplands to the marsh. The upland contamination, groundwater, and marsh cannot be independently analyzed for risk since they are so interconnected. What happens in one unit directly affects the others.

ATSDR Response: ATSDR agrees that significant mercury contamination is likely to exist in soils beneath and adjoining the footprint of the former cell building. This soil contamination is likely still contributing to groundwater contamination beneath the footprint and is likely still migrating towards and entering the nearby marsh. Several types of risk can exist from this contamination in the environment. There could be risk from direct contact or from breathing air should the soils be disturbed or the area developed for

commercial or residential use. This risk is described in the PHA. In addition, the remaining mercury that contaminates the soil and groundwater is migrating into the marsh and continues to contribute to mercury levels in fish and shellfish from the marsh.

21. **Comment**: Excerpt from LCP PHA, Residual Dioxin Levels in the Marsh (page 42)

    "Dioxins, or chlorinated dibenzo-p-dioxins (CDDs), are a class of structurally similar chlorinated hydrocarbons. The basic structure is comprised of two benzene rings joined via two oxygen bridges at adjacent carbons on each of the benzene rings. Dioxins is a term used interchangeably with 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCCD or TCDD). TCDD is the most toxic form of the numerous dioxin compounds."

    The similarity between the structures of PCBs and Dioxin/furans should be included in this discussion. Also, a TEQ that includes the dioxin, furans, and PCBs at the site should be incorporated into the PHA.

ATSDR Response: The discussion now includes more information about the structures of PCBs and dioxins/furans. WHO TEQs have been included for dioxins/furans for upland soils sampled in 2011.

22. **Comment**: Excerpt from the LCP PHA.

    "Dioxins are not intentionally produced and have no known use. They are the by-products of various industrial processes (i.e., bleaching paper pulp, and chemical and pesticide manufacture) and combustion activities (i.e., burning household trash, forest fires, and waste incineration) (ATSDR 2006)."

    The production of dioxin/furans in the chlor-alkali process should be discussed in this section. At a minimum, how PCBs would react in the presence of heat, pressure, chlorine, oxygen, and hydrogen should be discussed.

<u>ATSDR Response</u>: Generally, specific comments regarding chemical production and use at a site are detailed in reports by the investigative/regulatory agency. We have included general information regarding the formation and fate of dioxins and PCBs in the environment.

23. **Comment**: The figures and tables identifying the grids of concern are a helpful tool in describing where the areas of concern are located, and where additional remedial activities are needed. The PHA is organized in a manner to present the information in an easy to understand and use format.

<u>ATSDR Response</u>: Thank you for the comment.

24. **Comment**: The figures with grids in the PHA are great. If you could use a color to designate the grids where there was no data to make a determination about risk, I think this would strengthen the PHA and would not infer contamination was not present. Currently, the way the PHA is written, it makes it appear the grids identified as contaminated and having risk are the only ones that need be of concern.

ATSDR Response: We have added a map that shows grids that are not adequately sampled.

25. **Comment:** The Salt Dock area is mentioned in the PHA but not discussed. PCB contaminated anodes were removed from this area. The sampling in the salt dock location was minimal and did not sample at depths over 1 foot. The PHA should note that sampling at deeper levels is needed in the Salt Dock area to determine risk from subsurface soils.

ATSDR Response: The Salt Dock area was not considered a significant potential source for exposures because the land use is industrial and the contamination, if any, is at deeper levels. Additional sampling should be considered if the land use changes.

26. **Comment**: Since significant areas of the Site have been allowed to be re-forested, significant soil disturbance should be expected with any future development activity. The PHA should note that potential for exposure and elevated surface soil contaminant levels may occur as a result of soil disturbance.

ATSDR Response: The PHA includes language which acknowledges the potential for surface and subsurface soils to be disturbed during future development. We consider all upland soils (surface and subsurface) to contribute to any potential exposures.

27. **Comment**: The lack of PCB data for the cell building area should be noted. Several more of the grids could contain elevated PCB levels since the cell building area is where the PCB impregnated anodes were used. The lack of PCB data for the cell building area, and other areas, are not data that PCBs are not present or a risk does not exist in these areas. The PHA should note this lack of data and that the adjoining grids do have elevated levels of PCBs. The grids where there is a lack of data are 72, 57, 115, 126, 127, 128, 129, 130, 150, 151, and 165. The number of grids identified as having elevated levels of PCBs (and therefore dioxin/furan) in Figure 14 on Page 66 could be much higher if the PCB data was available. The same comment applies to areas where mercury, lead, and PAH data was not present for a grid due to the lack of data.

ATSDR Response: The commenter makes a valid point. The number of grids of concern could be higher if we had adequate data to analyze for each grid.

We have now included new figures (Figures 22-26) to show the grids/areas where there is inadequate sampling data to make a health call. There are separate figures for each contaminant of concern. These figures should be considered in conjunction with the grids that are determined to be a health concern.

28. **Comment**: ATSDR was asked to consider these references concerning dioxin production and the chlor-alkali process.

    http://www.americanchemistry.com/chlorine/sec_content.asp?CID=1131&DID=5124&CTYPEID=107

    http://yosemite.epa.gov/R1/npl_pad.nsf/148bf278d6a49a3f85256aef005e1bff/94dd5df1d9c0ab95852570c20063f11a!OpenDocument

    "From the late 1800s to the 1960s, chlorine and other chemicals (e.g., caustic soda, hydrogen, chloroform) were produced using electrolytic cells in "cell houses" at the former facility. Diaphragm cells, and also possibly mercury cells, produced chlorine for use in the manufacture of paper at the adjacent pulp mill. The mercury and other contaminants associated with that process, including dioxin and PCBs, were disposed on-site."

    Env Sci Pollut Res 15 (2) 96 – 100 (2008). Dioxin – Contemporary and Future Challenges of Historical Legacies Dedicated to Prof. Dr. Otto Hutzinger, the founder of the DIOXIN Conference Series Roland Weber, Mats Tysklind and Caroline Gaus, POPs Environmental Consulting, Ulmenstrasse 3, 73035 Goeppingen, Germany, Department of Chemistry, Umeå University, 901 87 Umeå, Sweden, National Research Centre for Environmental Toxicology (EnTox), The University of Queensland, 39 Kessels Road, Coopers Plains 4108, Australia

    "The beginning of the chlorine industry and Dioxin history. It has long been recognized that significant CDDs/PCDFs (Dioxins) formation during industrial processes commenced in the early twentieth century with the chloro alkali process and the subsequent high volume production of organochlorines."

    http://www.gcmonitor.org/downloads/Dioxins_India_Study.pdf
    http://www.portaec.net/library/pollution/dioxins/dioxfaq.html "Dioxin has even been identified at the root of chlorine chemistry: in the sludges and residues from the chlor-alkali process, in which chlorine gas is produced by passing a powerful electric current through salt-water.

    http://abstracts.co.allenpress.com/pweb/setac2005/document/56870
    http://abstracts.co.allenpress.com/pweb/setac2005/document/56870

The LCP Chemicals Site is mentioned in this article (site in southeast Georgia).

ATSDR Response: Thank you for the references; they were considered.

29. **Comment**: If you could obtain the Glynn County data concerning diabetes, thyroid function and growth hormone disruption, and hepatic function, this information should be in the PHA. Also, the intelligence quotient (IQ) data for the schools serving the population within the contaminated seafood advisory area. The IQ data should be broken down by grade and school. I believe you can do this without identifying the individual schools. Socio-economic data can be used to reduce the statistical deviation of the target population.

ATSDR Response: It is not possible to link county level data for health conditions (e.g., diabetes, thyroid function, etc.) to chemical exposure from the LCP Chemicals Site (e.g., mercury, PCBs, etc.). Therefore, providing descriptive statistics about health conditions has no ability to determine whether contamination of the environment has increased rates of various health conditions (e.g., diabetes) in Glynn County. The same situation applies to descriptive data about IQ. It is not possible to identify children who were exposed to chemicals from the LCP Chemicals Site; therefore, it is not possible to determine whether contamination of the environment has decreased IQ scores in the area.

30. **Comment**: Glynn County established a tumor registry several years back. You might want to look at the data to see if there are any unusual patterns. Since the tumor registry has been recording data for several years now, there might be enough information to avoid the dreaded "Insufficient number of persons to be statistically significant".

ATSDR Response: When evaluating cancer rates for specific geographic regions (e.g., a county), it is likely that some cancer rates will be higher than expected and this will be useful information for the community. However, it would not be possible to link any increased cancer rates with possible exposure to cancer-causing chemicals from the LCP Chemicals Site. The reason for this is that we cannot identify a sufficient number of persons in the county who were exposed to cancer-causing chemicals from the LCP Chemicals Site. For this reason, ATSDR will not evaluate cancer rates at the county level.

31. **Comment**: Has there been any mercury air monitoring at the LCP Chemicals Site in the last 10 years? The information would be helpful to have in the PHA.

ATSDR Response: ATSDR is not aware of any mercury air monitoring at the LCP Chemical site.

32. **Comment**: Also, a recommendation to do monitoring during any land disturbance activities. This would support the intent to have the ROD and Consent Decree explicitly state the minimum number and placement of air monitors at the site during any remedial activity or land disturbance.

ATSDR Response: A determination regarding what monitoring, if any, is needed is made by the Agency supervising the cleanup. The details of any air monitoring plan should be made on a case-by-case basis.

33. **Comment**: Please add these studies to the PHA.

Yang CY, Wang YJ, Tsai PC, Chen PC, Tsai SJ, Guo YL *. Exposure to a mixture of polychlorinated biphenyls and polychlorinated dibenzofurans resulted in a prolonged time to pregnancy in women. Environ Health Perspect 2008;116:599-604.

Wang SL, Tsai PC, Yang CY, Guo YL*. Increased risk of diabetes and polychlorinated biphenyls and dioxins: A 24-year follow-up study of the Yucheng cohort. Diabetes Care 2008;31:1574-1579.

Hsu PC, Pan MH, Li LA, Chen CJ, Tsai SS, Guo YL*. Exposure in utero to 2,2',3,3',4,6'-hexachlorobiphenyl (PCB 132) impairs sperm function and alters testicular apoptosis-related gene expression in rat offspring. Toxicol Appl Pharmacol 2007;221:68-75.

Hsu JF, Guo YL, Liu CH, Hu SC, Wang JN, Liao PC. A comparison of PCDD/PCDFs exposure in infants via formula milk or breast milk feeding. Chemosphere 2007;66:311–319.

Chen HL, Su HJ, Wang YJ, Guo YL, Liao PC, Chen CH, Lee CC. Interactive effects between CYP1A1 genotypes and environmental polychlorinated dibenzo-p-dioxins and dibenzofurans exposures on liver function profile. J Toxicol Environ Health 2006;69:269-281.

Lambert GH, Needham LL, Turner W, Patterson DG, Lai TJ, Guo YL*. Induced CYP1A2 activity as a phenotypic biomarker in humans highly exposed to certain PCBs/PCDFs. Environ Sci Technol 2006;40:6176-6180.

Chen HL, Su HJ, Guo YL, Liao PC, Hung CF, Lee CC. Biochemistry examinations and health disorder evaluation of Taiwanese living near incinerators and with low serum PCDD/Fs levels. Sci Total Environ 2006;366:538-548.

Tsai PC, Huang WY, Lee YC, Chan SH, Guo YL*. Genetic polymorphisms in CYP1A1 and GSTM1 predispose humans to PCBs/PCDFs-induced skin lesions. Chemosphere 2006;63:1410-1418.

Lee CC, Yao YJ, Chen HL, Guo YL, Su HJ. Fatty liver and hepatic function for residents with markedly high serum PCDD/Fs levels in Taiwan. J Toxicol Environ Health 2006;69:367-380.

Yang CY, Yu ML, Guo HR, Lai TJ, Hsu CC, Lambert GH, Guo YL*. The endocrine and reproductive function of the female Yucheng adolescents prenatally exposed to PCBs/PCDFs. Chemosphere 2005;61:355-360.

Wang SL, Su PH, Jong SB, Guo YL, Chou WL, Päpke O. In utero exposure to dioxins and polychlorinated biphenyls and its relations to thyroid function and growth hormone in newborns. Environ Health Perspect 2005;113;1645-1650.

Hsu PC, Lai TJ, Guo NW, Lambert GH, Guo YL*. Serum hormones in boys prenatally exposed to polychlorinated biphenyls and dibenzofurans. J Toxicol Environ Health A 2005;68:1447-1456.

Guo YL, Lambert GH, Hsu CC, Hsu MML. Yucheng: Health effects of prenatal exposure to polychlorinated biphenyls and dibenzofurans. Int Arch Occup Env Health 2004;77:153-158.

Hsu PC, Huang WY, Yao WJ, Wu MH, Guo YL*, Lambert GH. Sperm changes in men exposed to polychlorinated biphenyls and dibenzofurans. JAMA 2003;289:2943-2944.

Lai TJ, Liu XC, Guo YL*, Guo NW, Yu ML, Hsu CC, Rogan WJ. A cohort study of behavioral problems and intelligence in children with high prenatal polychlorinated biphenyls exposure. Arch General Psychiat, 2002;59:1061-1066.

ATSDR Response: When deciding what PCB-induced harmful effects that residents might experience should the site become residential, ATSDR estimated the amount of their PCB exposure (or dose) from soil ingestion. A toxicologist from ATSDR then reviewed the literature to identify harmful effects that might be possible based on these site-specific, estimated doses from future exposure. The discussion of possible harmful effects was limited to those effects that might occur at or near the site-specific estimated doses. The possible health effects are described in the text and a summary of the human and animal studies that served as a basis for the described health effects are provided in Appendix B in Table B2 and Table B3. If appropriate, these articles will be added to the public health assessment.

34. **Comment**: At a minimum, the PHA should identify all areas where there is insufficient data for one or more chemicals, metals, or other hazards (all on one map, and in the text). A section for just data deficiencies would be desirable and helpful for the RI/FS and post removal sampling.

ATSDR Response: The PHA now includes a discussion regarding areas where sampling is inadequate to make public health decisions. The PHA also includes maps that identify those areas of sufficient and insufficient sampling.

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Distribution and sources of PCBs (Aroclor 1268) in the Sapelo Island National Estuarine Research Reserve

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Abstract Aroclor 1268 is a highly chlorinated PCB mixture that was released into the aquatic environment near Brunswick, GA (BR), as a result of decades of local industrial activity. This extensive contamination has led to US EPA Superfund designation in estuarine areas in and around Purvis Creek, GA. Roughly 50 km to the northeast is the Sapelo Island National Estuarine Research Reserve (SI) where previous studies have documented unexpectedly high Aroclor 1268-like PCB levels in blubber and plasma samples of resident bottlenose dolphins. This result led to a collaborative effort to assess the PCB patterns and concentrations in SI sediment and fish (as potential vectors for PCB transfer to SI resident dolphins). Thirty SI randomly assigned stations were sampled for sediment PCB levels. Additionally, fish were collected and analyzed from SI (n=31) and BR (n=33). Results were pooled with regional assessments of PCB concentrations from South Carolina and North Carolina in an effort to determine the association of Aroclor 1268 levels in SI samples. Results indicated that PCB levels in sediment and fish are much lower in the SI estuary compared to BR sediment and fish concentrations. However, PCB congener profiles for both sediments and fish were similar between the two locations and consistent with the Aroclor 1268 signature, indicating possible transport from the Brunswick area. A likely source of Aroclor 1268 in dolphins from SI is contaminated fish prey.

Keywords Aroclor 1268 · PCB · Regional assessment · Sapelo Island NERRs

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Introduction

Numerous environmental studies have described the magnitude and distribution of PCBs attributed to Aroclor 1268 contamination in the Brunswick, GA, area attributed to the LCP Superfund site (Kannan et al. 1997, 1998; Maruya and Lee 1998). This site was listed on the US EPA National Priorities List (Superfund) in 1994 after nearly 75 years of industrial activities. Contaminants of concern at this site include several metals (Hg, Cr, and Pb) as well as PAHs and PCBs (Aroclor 1268). Aroclor 1268 is an uncommon mixture of PCB congeners dominated by octa- through deca-chlorinated homolog groups (>90 % of total PCB content) (Ishikawa et al. 2007; Kannan et al. 1997). The composition of Aroclor 1268 is dominated by a suite of PCB congeners (IUPAC nomenclature) including 180, 187, 194, 196, 199, 200, 201 202, 206, 207, 208, and 209. Environmental sampling in and around Brunswick, GA, has revealed high levels of Aroclor 1268 contamination in sediments, invertebrates (blue crab), commercially important fishes, turtles, birds, (Kannan et al. 1998) as well as bottlenose dolphins (Balmer et al. 2011; Kucklick et al. 2011, Pulster et al. 2009).

Sapelo Island (SI) is a barrier island located roughly 50 km northeast of the LCP site. SI is mostly undeveloped and is home to NOAA's Sapelo Island National Estuarine Research Reserve (SI NERR). This reserve was established in 1976, but this designation follows decades of agricultural use beginning in the 1800s as well as conservation and land-management efforts led by the State of Georgia. Historically, SI has been lightly populated and used mainly for agriculture and coastal environmental/ecological research (SI NERR Management Plan 2008). In 2007 and 2008, blubber samples from bottlenose dolphins resident to the SI NERR were reported to have elevated levels of PCBs (Kucklick et al. 2011) and these elevated levels of PCBs were suggested to be associated with Aroclor 1268 contamination from the LCP site (Balmer et al. 2011). To date, the levels of PCBs reported in dolphins from the SI estuary are some of the highest values reported for coastal dolphin studies (Kucklick et al. 2011) and in contrast to the undeveloped nature of SI.

The present study was undertaken to characterize the distribution and congener composition of PCBs in sediments and fish in the SI NERR in order to investigate possible linkages between the previously documented PCB concentrations in dolphins and Aroclor 1268 contamination at the LCP Superfund site in Brunswick, GA. The study was a component of a larger study that examined the overall ecological condition of the SI NERR (Balthis et al. 2012). A reserve-wide assessment of ecological conditions, including concentration of chemical contaminants, was lacking prior to this study.

Methods

Station assignment, sample collection, and preservation

Sampling stations (n=30) were randomly assigned within the SI NERR boundary using a generalized stratified methodology detailed in Balthis et al. (2012). Sediment samples were collected during June 2009 from each station (Fig. 1a.) using a 0.04-m^2 Young grab sampler. The top 2–3 cm from multiple grabs at each station was removed, composited for analysis, and frozen. While on station, researchers attempted to collect

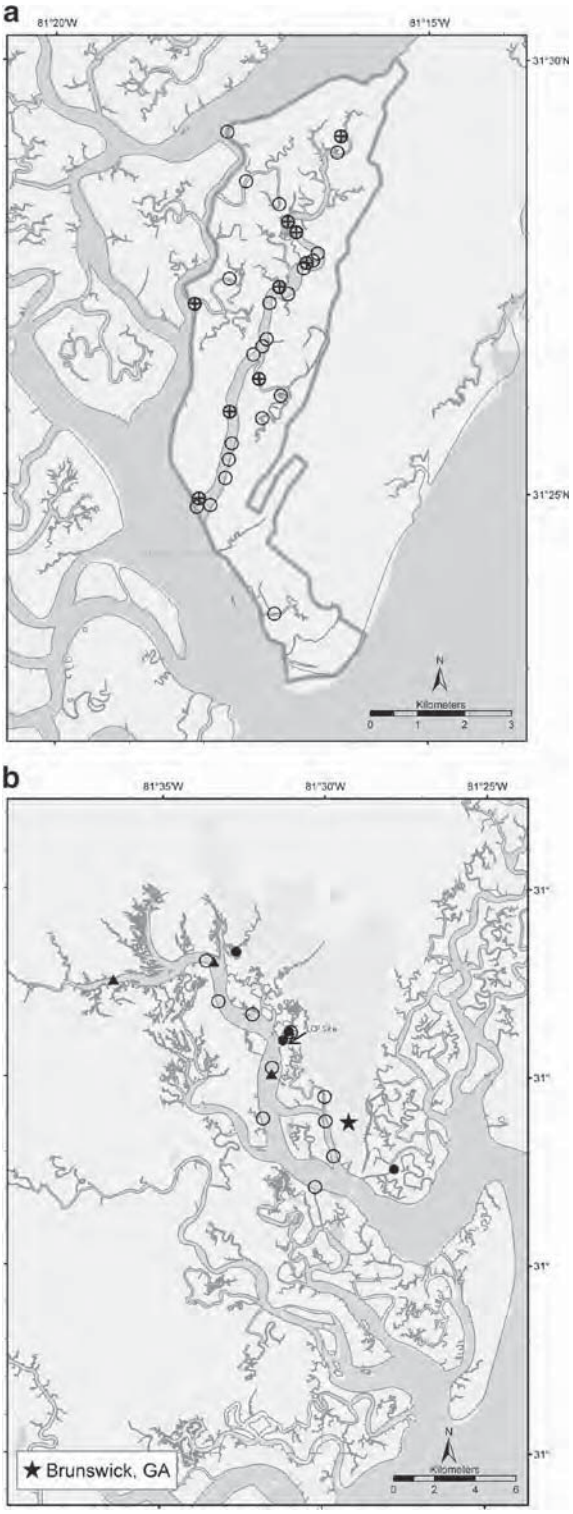

Fig. 1 **a** Sampling stations from within the Sapelo Island NERR; *open circles* are stations where sediment was collected; *cross-hatched circles* are stations where sediment and fish were collected. **b** Stations from the greater Brunswick, GA, estuarine system. *Open circles* are archival sediment samples, *closed triangles* are stations where fish were collected by GA DNR (7/2009), *closed circles* are stations where fish were collected by the authors for this study

specific species of fish by either hook and line or cast net. Targeted species included *Mugil cephalus* (striped mullet), *Micropogonias undulatus* (Atlantic croaker), *Cynoscion nebulosus* (spotted seatrout), *Paralichthys lethostigma* (southern flounder), *Sciaenops ocellatus* (red drum), *Menticirrhus sp*. (whiting), *Bairdiella chrysoura* (silver perch), and *Leiostomus sp*. (spot) based on human recreational consumption or predation by dolphin. Individual fish were wrapped in solvent-rinsed aluminum foil, frozen, and transported to the laboratory. Concurrently and in order to reduce collection costs during this field study, similar fish species were also captured by cast net or obtained from Georgia Department of Natural Resources Annual Shrimp Trawls from estuarine locations near the LCP Superfund site (Fig. 1b.). All samples were transported to National Centers for Coastal Ocean Science (NCCOS) laboratories in Charleston, SC, and stored frozen (−40 °C) until analyzed. Sediment was not collected from Brunswick, GA, estuaries during this study, although sediment from the Turtle-Brunswick River Estuary (TBRE) near the LCP site was previously collected by NOAA staff and has been consistently maintained at the Charleston, SC, facility since collection in 1996 (Long et al. 1998). These archival samples were re-extracted and analyzed for this study to serve as a positive environmental Aroclor 1268 signature.

Sediment extraction and analysis

Sediment samples were thawed and approximately 10 g of wet sediment was extracted using pressurized fluid extraction (PFE) (ASE 200, Dionex Inc.). Prior to extraction, each sediment aliquot was combined with ~27 g of anhydrous sodium sulfate and homogenized using a mortar and pestle. The dried mixture was transferred into a 33 mL ASE cell and spiked with a suite of labeled ^{13}C-PCB congeners (Cambridge Isotope Laboratory, Inc.) and extracted with a mixture of dichloromethane and acetone (50:50 volume fraction). The volume of the resulting extract was reduced under nitrogen and passed through an SX-3 gel permeation column (GPC, J2 Scientific, Inc.) to remove lipids, pigments, and sulfur. Post-GPC extracts were again evaporated under nitrogen to ~1 mL and further cleaned via solid phase extraction (SPE) using ~2 g of 5 % water-deactivated alumina. The final extract was solvent exchanged into hexane and the final volume was adjusted to ~0.5 mL. A recovery standard (^{13}C-δ-hexachlorocyclohexane) was added prior to instrumental analysis in order to evaluate extracted internal standard recoveries.

Tissue preparation and fillet analysis

Fish were prepared by partially thawing the fish, descaling, and removing each fillet with the skin included. At least 20 g of tissue was required for homogenization in Teflon™ containers using a ProScientific Tissue Homogenizer with a titanium or stainless-steel homogenization probe. Wet tissues (~5 g) were weighed into anhydrous sodium sulfate (~33 g) and ground to dryness. Dried samples were transferred into 33 mL ASE extraction cells, spiked with internal standard as above, and samples were extracted by PFE with 100 % dichloromethane. Samples were passed through GPC and SPE cleanup steps, and the final extract was solvent exchanged into hexane. The final volume was diluted to ~0.5 mL. Prior to instrumental analysis, ^{13}C-δ-HCH was also added as a recovery standard to these extractions.

Sample analysis and data quality assurance

Samples were analyzed using an Agilent 6890 GC equipped with a 5973 Mass Selective Detector (MSD; EI mode). GC parameters included a DB-5ms column (J&W; 30 m×0.25 mm diameter×0.25-μm film thickness) and a Programmable Temperature Vaporization (PTV) inlet. Concentrations of 88 PCB congeners were determined for both sediments and tissues. Blanks, fortified samples, and SRMs (NIST 1941b Organics in Marine Sediment and 1944 New York/New Jersey Water Way Sediment for sediment and NIST 1947 Lake Michigan Fish Tissue and 2977 Mussel Tissue (Organic Contaminants and Trace Elements) for tissues) were used to ensure data quality. Recoveries of method spikes and matrix spikes averaged (standard deviation) 103.8 (21.2)% and 98.6 (20.4)%, respectively. NIST SRMs 1941b for sediments and NIST SRMs 1947 and 2977 for tissues were also analyzed; PCB congener concentrations were within 10 % (SRM 1941b), 5 % (SRM 1947), and 20 % (SRM 2977) of certified values.

Data analysis

Congener patterns of PCBs in sediment and fish from both Brunswick and Sapelo NERR were compared to other regional datasets for sediment and fish tissues

from coastal South Carolina (Van Dolah et al. 2013) and North Carolina NERRs (Cooksey et al. 2008). Fish collections for the SC and NC projects were collected in a similar manner as samples for this study. These datasets were chosen because each represented approximately the same spatial scale, were analyzed using similar protocols, and the targeted fish species were similar in nature.

Descriptive statistics for sediment and fish were determined (on a per sample basis) for total PCB (PCB_t), defined as the sum of the 65 PCB congeners common to all four regional assessments. The congener-specific proportion of PCB_t was calculated as well. The geometric mean and the standard error of the mean are reported throughout the manuscript. The standard error of the mean was calculated by determining the standard deviation of the natural log-transformed data that was reportable, converting the transformed data ($\exp^{\wedge stdevln}$) and dividing by the square root of the count data.

The PCB data was also reduced to include 22 congener peaks that were measured across all projects and associated with Aroclor 1268 as detailed in previous publications (Ishikawa et al. 2007; Maruya and Lee 1998; Pulster and Maruya 2008). The PCB congener list (PCB_r) used to define regional differences included 29 congeners (PCBs 3, 8/5, 18, 20, 28/31, 44, 52, 77, 101/90/89, 105, 118/106, 126, 149, 153, 170/190, 180/193, 187, 194, 202, 206, 207, and 209) and is similar to the list used by Pulster et al. (2005) to evaluate regional differences in PCB composition in the southeastern USA. This list of 22 congeners includes 7 congeners (PCBs 180/193, 194, 206, 209, 187, 202, and 207) that are of importance to Aroclor 1268 and account for ~75 % of the Aroclor 1268 profile (Maruya and Lee 1998; Kucklick et al. 2011). The proportion of PCB_r to PCB_t was then calculated, and sites were compared using an ANOVA (SAS version 9.3) for both sediments and tissues. The congener pattern observed in archived Brunswick, GA, sediments collected in 1996 and reanalyzed for this study has previously been associated with Aroclor 1268 (Kannan et al. 1997; Maruya and Lee 1998).

Results

General description of sediments

The mean sediment concentration for PCB_t for the SI NERRS was 0.205 ng/g dry weight (dw) (standard error (SE) of 0.637 ng/g dw). Station concentrations ranged from 0.015 to 3.84 ng/g dw (Table 1). No station exceeded published sediment toxicity guidelines such as the effects range low (ERL; 22.7 ng/g dw) or effects range median (ERM; 180 ng/g dw) (Long et al. 1995) or the probable effects level (PEL; 189 ng/g dw) (Canadian environmental quality guidelines 2002). For comparison, PCB_t concentrations from archived and reanalyzed Brunswick, GA, sediment samples averaged 79.3 ng/g dw (SE 2.47 ng/g dw) and ranged from 5.37 to 4200 ng/g dw. Five of the 10 archived BR stations had PCB levels that exceeded the ERM (180 ng/g dw), and three of the remaining five stations had PCB levels greater than the ERL (22.7 ng/g dw) (Long et al. 1995). Congener profiles were similar in both SI and BR sediment samples. Dominant congeners (in descending rank order; 1–3) for both locations (Table 2) were PCB 206, 209, and 202, accounting for nearly 70 % of PCB_t. The remaining congeners (rank order 4–10) included PCB 194, 187, 207, 195, 198, 180/193, and 52 for BR sediments and PCB 187, 153, 194, 99, 52, 28/31, and 183 for SI sediments.

General description of analyzed fish fillets

A total of 22 fish fillets from the SI NERR were analyzed for PCBs and included *M. cephalus* (n=9), *M. undulatus* (n=3), *C. nebulosus* (n=3), *Menticirrhus sp.* (n=1), *B. chrysoura* (n=3), *S. ocellatus* (n=2), and *P. lethostigma* (n=1). PCB_t concentrations averaged 3.90 (SE 0.577)ng/g wet weight (ww) (Table 3) and individual fillet concentrations ranged from 0.60 (silver perch) to 41.0 (whiting)ng/g ww. A total of 29 fillets were analyzed from the area around Brunswick, GA (BR), and species included *M. undulatus* (n=8), *Menticirrhus sp.* (n=1), *M. cephalus* (n=9), *B. chrysoura* (n=4), *C. nebulosus*

Table 1 PCB_t sediment concentrations (reported as the geometric mean) from BR, SI, SC (van Dolah et al. 2013), and NC (Cooksey et al. 2008)

Site	PCB_t concentration±standard error (ng/g dry mass)	PCB_r/PCB_t proportion
BR	79.3 (2.47)	0.967
SI	0.205 (0.637)	0.904
SC	0.107 (0.3.06)	0.382
NC	0.005 (0.15.1)	0.212

Table 2 Rank order (by congener proportion) of the congeners from BR, SI, SC (van Dolah et al. 2013), and NC (Cooksey et al. 2008) sediments and the associated PCB_t congener proportion

Rank order	BR_sediment	SI_sediment	SC_sediment	NC_sediment
1	PCB 206 (0.611)	PCB 206 (0.665)	PCB 52 (0.079)	PCB 206 (0.589)
2	PCB 209 (0.121)	PCB 209 (0.104)	PCB 66 (0.071)	PCB 37 (0.226)
3	PCB 202 (0.094)	PCB 202 (0.049)	PCB 110 (0.067)	
4	PCB 194 (0.056)	PCB 187 (0.049)	PCB 153 (0.050)	
5	PCB 187 (0.043)	PCB 153 (0.019)	PCB 18 (0.041)	
6	PCB 207 (0.036)	PCB 194 (0.018)	PCB 15 (0.038)	
7	PCB 195 (0.004)	PCB 99 (0.015)	PCB 156 (0.036)	
8	PCB 198 (0.004)	PCB 52 (0.015)	PCB 99 (0.035)	
9	PCB 180/193 (0.003)	PCB 28/31 (0.009)	PCB 92 (0.035)	
10	PCB 52 (0.003)	PCB 183 (0.008)	PCB 101/90/89 (0.024)	

(n=1), and *Leiostomus sp*. (n=6). Tissue fillet concentrations of PCB_t at BR averaged 141 ng/g ww (SE 0.478 ng/g ww) and ranged from 32.0 to 838 ng/g ww (Table 3). Congener profiles were again similar in both SI and BR tissue samples (Table 4). Dominant congeners for both BR and SI included PCB 206, 187, and 202, accounting for between ~45 % (SI) and 65 % (BR) of the PCB_t. The remaining congeners included PCB 194, 209, 207, 183, 180/193, 153, and 154 for BR tissues and PCB 153, 194, 180/193, 99, 209, 101/90/89, and 183 for SI tissues.

Species-specific descriptive statistics are found in Table 5. Comparisons were limited to those species for which there were matched data from the SI NERR and Brunswick, GA, and the sample size was greater than one from both regions (silver perch, mullet, and Atlantic croaker). Mean tissue concentrations were generally between 50 and 100 times greater in fish from the Brunswick, GA, sites relative to the fish from SI. Additionally, when PCB_t for fish was compared to US EPA consumption guidelines (four meals per month) (U.S. EPA 2000), all fish from Brunswick exceeded the lower threshold for non-cancer risks (23 ng/g ww), and of these, 24 exceeded the upper threshold of 47 ng/g ww for non-cancer risks. Only two fish collected from the SI NERR exceeded the lower non-cancer threshold, and none exceeded the upper threshold. An additional 10 fish from the SI NERR were found to have PCB_t concentrations above the lower cancer-risk threshold of 5.9 ng/g ww; five had concentrations that also exceeded the upper cancer-risk endpoint of 12 ng/g ww (Fig. 2.).

Table 3 PCB_t tissue (fillet) concentrations (reported as the geometric mean) from BR, SI, SC (van Dolah et al. 2013), and NC (Cooksey et al. 2008)

Site	PCB_t concentration±standard error (ng/g wet mass)	PCB_r/PCB_t proportion
BR	141 (0.478)	0.881
SI	3.90 (0.577)	0.824
SC	2.93 (0.451)	0.464
NC	0.087 (17.0)	0.470

The dominant congeners in both sediments (Table 2) and tissues (Table 4) from both SI and Brunswick, GA, were PCB 206, 202, and 187 and also included PCB 209, 194, 180/193, and 207. This profile was similar to the Aroclor 1268 profile described in Maruya and Lee (1998) for fish from Purvis Creek near Brunswick, GA.

Regional comparison

The mean PCB_r/PCB_t proportions for sediments ranged from 0.212 (NC) to 0.967 (BR). SI sediments matched closely (0.904) with the BR sediment PCB_r proportion. Results from the ANOVA (least squares means comparison) comparing the PCB_r/PCB_t proportion indicated significant differences between BR and both NC and SC datasets while BR and SI PCB_r proportions for sediments were not different (p=0.936). PCB_r proportions for SI sediments were different from both NC and SC as well (p<0.0001). NC and SC were not significantly different (p=0.106). A similar trend was observed in PCB_r/PCB_t tissue proportions. Mean proportions ranged from 0.881 (BR) to 0.464 (SC). BR and SI PCB_r proportion (tissue) results were not significantly different (p=0.736). PCB_r tissue proportions from SI

Table 4 Rank order (by congener proportion) of the congeners from BR, SI, SC (van Dolah et al. 2013), and NC (Cooksey et al. 2008) fish fillets and the associated PCB_t congener proportion

Rank order	BR_tissues	SI_tissues	SC_tissues	NC_tissues
1	PCB 206 (0.311)	PCB 206 (0.170)	PCB 153 (0.159)	PCB 187 (0.401)
2	PCB 202 (0.181)	PCB 187 (0.143)	PCB 99 (0.093)	PCB 206 (0.388)
3	PCB 187 (0.148)	PCB 202 (0.130)	PCB 15 (0.047)	PCB 101/90/89 (0.057)
4	PCB 194 (0.063)	PCB 153 (0.093)	PCB 63 (0.043)	PCB 153 (0.049)
5	PCB 209 (0.045)	PCB 194 (0.032)	PCB 12 (0.037)	PCB 99 (0.042)
6	PCB 207 (0.034)	PCB 180/193 (0.029)	PCB 180/193 (0.035)	PCB 95 (0.037)
7	PCB 183 (0.034)	PCB 99 (0.028)	PCB 118/106 (0.028)	PCB 180/193 (0.029)
8	PCB 180/193 (0.028)	PCB 209 (0.023)	PCB 52 (0.019)	PCB 44 (0.016)
9	PCB 153 (0.020)	PCB 101/90/89 (0.023)	PCB 66 (0.013)	
10	PCB 154 (0.012)	PCB 183 (0.022)	PCB 202 (0.012)	

were different from both NC and SC as well ($p<0.0001$). NC and SC were not significantly different ($p=0.999$). Sediments from BR and SI shared 6 of the 10 most influential congeners, and there were no congeners among the 10 highest rank-ordered congeners that were shared among all four sediment datasets (Table 2). For tissues, 8 of 10 rank-ordered congeners were shared between BR and SI tissues and two congeners (PCB 153 and 180/193) were identified in each of the four regional datasets (although the ranks differed; Table 4).

Discussion

Sediment PCB_t concentrations in the SI NERR (0.015–3.84 ng/g dw) did not exceed the published ERL or ERM (Long et al. 1995) at any station, and concentrations were similar to other coastal assessments along the NC and SC coasts (Bergquist et al. 2011; Cooksey et al. 2008; Sanger et al. 2008; Van Dolah et al. 2013). Sediment PCB_t concentrations reported along the South Carolina coast over a 10-year (2000–2010) period ranged from not detectable (nd)–30.5 ng/g dw (annual

Table 5 Descriptive statistics for PCB_t (ng/g ww) in fish fillets collected in the SI NERR and the greater Brunswick, GA, estuary; no significant differences for lipid fraction were identified between locations and between species

Species	Count	Arithmetic mean lipid fraction (standard deviation)	Arithmetic mean (standard error) concentration (ng/g ww)	Concentration range (ng/g ww)
Sapelo Island				
Silver perch	3	0.0042 (0.0013)	1.34 (1.96)	0.604–18.8
Spotted seatrout	3	0.0115 (0.0036)	8.14 (0.38)	4.44–18.5
Striped mullet	9	0.0216 (0.0149)	3.32 (0.17)	1.61–7.08
Atlantic croaker	3	0.0249 (0.0165)	5.16 (0.47)	5.84–11.0
Whiting	1	0.0218	25.2	
Southern flounder	1	0.0013	0.873	
Red drum	2	0.0111 (0.0087)	2.17 (1.20)	0.877–13.3
Brunswick				
Silver perch	4	0.0320 (0.0252)	146 (0.51)	107–478
Spotted seatrout	1		42.3	
Spot	6	0.0253 (0.0327)	69.1 (0.56)	33.3–770
Striped mullet	9	0.0141 (0.0030)	207 (0.23)	32.0–838
Atlantic croaker	8	0.0482 (0.0425)	150 (0.27)	70.3–779
Whiting	1	0.0187	188	

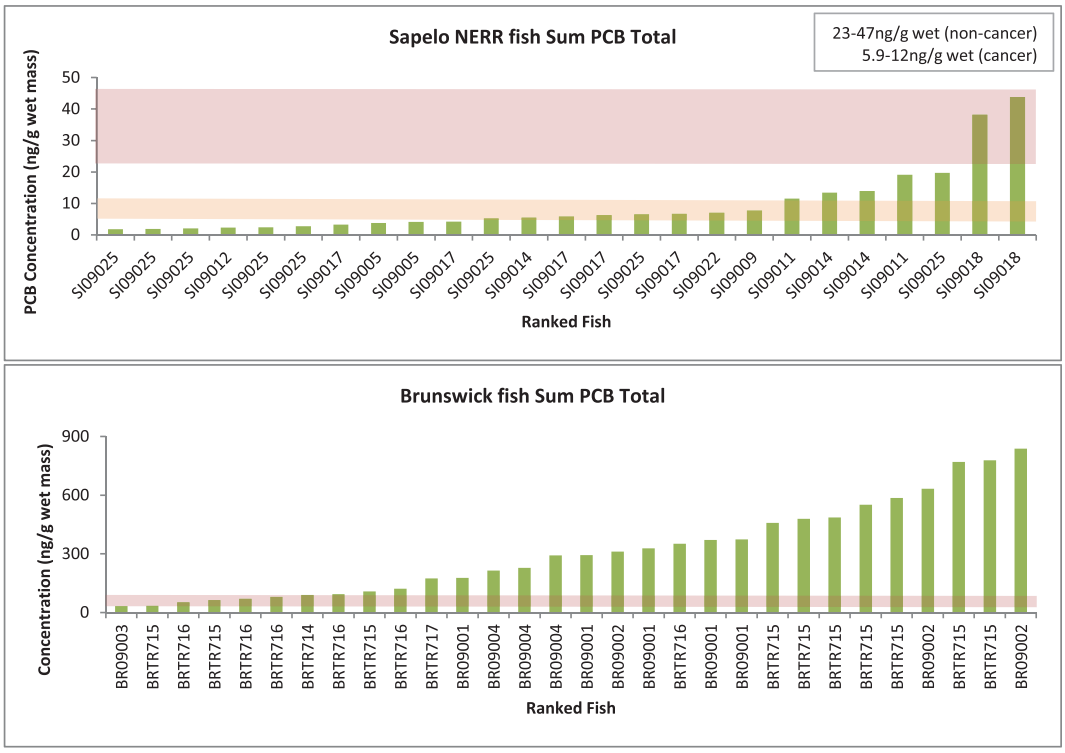

Fig. 2 Rank-ordered arithmetic mean fillet PCB_t concentrations from SI and BR fish plotted in relation to the US EPA cancer and non-cancer fish consumption limits estimating four meals per month (U.S. EPA 2000)

mean 0. 750 ng/g dw) (Bergquist et al. 2009; Van Dolah et al. 2013; VanDolah et al. 2004, 2006). The dominant congeners reported for SC sediments were PCBs 138/163/164, 44, 52, and 153 (Bergquist et al. 2009; VanDolah et al. 2004, 2006). The mean PCB_t sediment concentration reported for NC NERR was 0.240 ng/g dw (range, nd–1.24 ng/g dw), dominated by PCB 206, but there were very few congener detections reported (Cooksey et al. 2008) (Table 2). PCBs were not detected in sediment from the Grays Reef National Marine Sanctuary, 32 km off the coast of Sapelo Island, GA (Balthis et al. 2007).

Several publications have highlighted the need for information on the trophic transfer of PCBs from sediments and prey species to apex and sentinel species such as coastal dolphins (Balmer et al. 2011; Kucklick et al. 2011; Pulster et al. 2005). Prey species from the Brunswick, GA, area had relatively high levels of PCBs (32.0 to 838, mean 141 ng/g ww), in agreement with other reports from the Brunswick area (Balmer et al. 2011; Pulster et al. 2005). Concentrations of PCB_t recently reported in SC fish range from 1.49 to 15.1 (mean 5.06)ng/g ww (Van Dolah et al. 2013), and the dominant congeners expressed in these fish were PCBs 153, 99, and 15. Reported PCB_t concentrations in fish from NC NEER ranged from 0.29 to 4.03 (mean of 1.36)ng/g ww and were primarily driven by PCBs 187, 101/90/89, and 206 (Cooksey et al. 2008). Concentrations reported in fish from SI NERR ranged from 0.604 to 41.0 (mean 3.90)ng/g ww (current study). The congener patterns from SI NERR were more similar to the pattern found in samples from Brunswick estuaries and dominated by congeners PCBs 206, 187, and 202 (Table 4). The rank order of the Aroclor 1268 specific congeners for sediment and tissues follows the typical Aroclor 1268 pattern described by Kannan et al. (1998) and Maruya and Lee (1998).

The similar congener patterns in both sediment and tissues and the expected decrease in PCB concentration in SI relative to BR strongly indicate that PCB transport into SI NERR has occurred and could be attributed to several environmental routes, although the question of how Aroclor 1268 came to occur in SI cannot be defined in this experimental design. It is well documented that PCB transport occurs via downstream sediment transport (Feng et al. 1998). Feng et al. (1998) described a

10-fold decrease over an approximately 80-km stream transect along the Hudson River. In the case of transport from BR to SI, our data seem to indicate a 100-fold decrease over a similar spatial scale. Another possible route of PCB movement is through the migration of fish populations, realizing that fish migration is species and season dependent. There are subtle differences in PCB homolog patterns in fish from SI and BR (Table 4). Congener patterns appear to be relatively similar for the more highly chlorinated congeners (homolog groups 7, 8, 9, and 10), though congeners in homolog groups 4, 5, and 6 are enhanced in SI fish compared with BR. It is interesting to note that several congeners found in SI tissue were not often detected in SI sediment samples. For example, PCBs 105, 110, 177, 188, and 195 were detected in tissues but not detected in SI sediments. It seems that the PCB profiles between SI and BR are more similar for tissues than sediments and may indicate that tissues are a more likely source of transport, thus identifying fish as an influential vector for PCBs to be passed onto predators found in the SI NERR. Balmer et al. (2011) reported distinct dolphin populations that are resident in SI and distinct from dolphin populations found in the BR estuary; yet both populations exhibited clear Aroclor 1268-type congener patterns in blubber samples. Understanding the presence of an Aroclor 1268-type pattern in SI as observed in this study implies an influence from the likely source (BR) and helps define needed research into predator/prey associations and Aroclor 1268 movement mechanisms into this protected estuary.

US EPA consumption guidelines (U.S. EPA 2000) were used in an attempt to understand potential risks associated with the levels of PCB found in fish from Sapelo Island, NERR. Total PCB levels in some SI NERR fish exceeded US EPA lower and upper endpoints for cancer risks (48 %>5.9 ng/g ww and 16 % >12 ng/g ww, respectively) and the lower endpoint for non-cancer/systemic-health risks (6.5 %>23 ng/g ww) based on predictions associated with consumption of four 8-oz meals per month (U.S. EPA 2000); none exceeded the upper non-cancer endpoint of 47 ng/g ww. Due to the restricted access to the SI NERR (boat only), the extent of recreational or subsistence fishing that occurs in these waters is unclear. All fish from BR exceeded both the lower and upper endpoints for cancer risks and the lower endpoint for non-cancer risks; most (73 %) also exceeded the upper non-cancer endpoint. Mullet and croaker from Purvis Creek (adjacent to the LCP site in Brunswick, GA) are identified in Georgia EPD publications as "do not eat," and red drum and flounder are listed as "1 meal per month" due to PCB contamination (Guidelines for Eating Fish from Georgia Waters 2010).

While SI PCB levels in both sediment and fish were considerably lower than the PCB levels found in Brunswick, GA, the congener patterns strongly suggest transport of Aroclor 1268 away from the LCP site and into the SI NERR (Tables 1, 2, 3, and 4). The rank order for the first four congeners (based on proportion) is identical in both SI and BR sediment samples from 1994 that were reanalyzed for this study (PCB 206>199>203/196>208), and 8 of the 10 most abundant congeners are similar between BR and SI sediments. Congeners 153 and 52 are among the 10 most abundant congeners from SI and are not associated with published Aroclor 1268 patterns (Maruya and Lee 1998; Kucklick et al. 2011), and this signal likely indicates ambient background PCBs (Hoekstra et al. 2003). Kucklick et al. (2011) showed a high correlation of PCB153 with coastal human population supporting the assertion of PCB 153 as an indicator of general urban PCB contamination (non-Aroclor 1268). Congener profiles follow a similar pattern of agreement in tissues (Table 4). Congener ranks are identical for PCB 199>206>203/196>202>187 and 8 of the 10 most abundant congeners are again the same in both SI and BR tissues.

An earlier study examined dolphin prey species from three coastal regions including Brunswick, GA; Jacksonville, FL, to the south; and Savannah, GA, to the north of the LCP site (Pulster et al. 2005). Using discriminant analysis, these authors reported that the Aroclor 1268 patterns (using congeners 194, 138, 180, and 196) were recognizable to the south (in samples from Jacksonville, FL) but not in PCB profiles from Savannah. This apparent pattern movement is not specific to fish, as Aroclor 1268 specific signatures in turtles were reported as far south as Port Canaveral, FL (Ragland et al. 2011). Our data clearly indicated that the SC and NC datasets were distinct and different from SI and BR data for both sediments and tissues.

In closing, while the magnitude of PCB contamination at the SI NERR is much lower than that in the Brunswick, GA, area near the LCP site, the similarity of congener profiles suggests that much of the PCB contamination at the SI NERRS is likely due to transport from the LCP site. Sediment advection may account for the PCB transport into SI as only a small proportion of

highly contaminated BR sediment could explain the PCB levels found in SI. Additionally, PCB transport could also be a result of fish migration from BR into SI. The more similar PCB patterns were found between tissue PCB profiles. Fish tissue concentrations occasionally exceed US EPA human-health guidelines for caner and non-cancer health endpoints (based on consumption of four 8-oz meals per month). Without better understanding of the amount of prey dolphins consume, it may be difficult to gauge if consumption of SI resident fish is enough to explain the high levels of PCB reported in SI resident dolphin populations. Generally, the Aroclor 1268 signature around BR and SI appears to be closely bounded to the north. Future research includes similar estuary wide assessments in northern Florida and southern South Carolina to help better understand the extent of the movement of Aroclor 1268 along the southeastern coast and especially among coastal-protected research areas (NERRs).

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Satilla RIVERKEEPER®

Galo Jackson
Environmental Protection Agency
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March 9, 2105

Dear Mr. Jackson,

Please see the comments below from Satilla Riverkeeper regarding the LCP Chemicals Superfund site proposed cleanup plan.

1. Area of Contamination vs. Area Designated for Remediation

- EPA's chosen cleanup plan for the LCP Chemicals site is inadequate identifying only 24 acres of marsh to be remediated. This is a problem because 81 acres of the march is heavily contaminated and should be removed for the good of public and environmental health. If this cleanup plan proceeds as planned the responsible parties would leave behind 57 acres of contaminated marsh with high levels of mercury and polychlorinated biphenyls (PCBs). These leads us to numerous questions…

- How is it known that only 81 acres of the 670+ acres of marshland at the LCP site is in need of remediation?
- Is it true that 33 of these target 81 acres were not chosen for remediation because of concern over temporary damage to restorable marshland?
- If these 33 acres were included despite the damage to the marsh that might result, how would the amount and time frame of damage to the marsh compare to the risk to people that remains from leaving LCP-contaminated sediments in those 33 acres?
- Has this comparison of risk been the subject of a scientific risk assessment?

Recommendations: The EPA should reevaluate their original cleanup plan and add the additional 57 acres of contaminated marsh, originally left out of the proposal, for cleanup.

2. Sediment Removal vs. Capping

- Capping and thin-cover placement methods are not an acceptable means of cleaning up a heavily contaminated tidal salt marsh. Both of these methods cover up contaminated soils rather than removing them forever. How can the EPA claim that thin-cover placement or caps is well studied method for site cleanup when there are less than ten thin layer caps at contaminated sites in the United States and these are mostly in lakes or bays? The thin-layer capping examples in the plan include estuarine, river, and tidal flats, of which are all systems with different hydrologies and cannot be adequately compared with salt marsh ecosystems. With this information it is obvious that the proposed capping plans are not applicable to the LCP site and is, at best, a science experiment in the field. This plan also does not seem very logical as natural storm events like hurricanes and sea level rise will bring an increased risk that the contaminated sediments will once again be disturbed and the capping work will ultimately fail.

- Thin-cover placement or enhanced natural recovery is not a sustainable recovery method. This thin layer of sediment, six inches or less will not be adequate to contain any contaminants in the marsh bed. Storm surge, the bottom of a boat passing by, and benthic infaunal invertebrates will disturb the layer. *Spartina* can also accumulate these pollutants and will continue to release them into the food web.

- Because of the high toxicity levels of the contaminated area in question and the proposed thin covering layer offered by the engineered cap, this plan, would be at best, just experimental when one considers an 8 or 9 foot tide and a meandering intertidal creek that is always present and on the move.

- What assurances can be given that capping contaminated sediments in place (rather than removing them) can withstand storm intensities at least comparable to that required for coastal construction?
- Does storm preparedness for coastal construction require structures to withstand FEMA-determined flood levels, and 120 mph wind speed?
- What similar storm preparedness standards will be required for the capping project?
- Even with capping, might a storm with upland flooding and 120 mph winds suspend contaminated sediments in the LCP-contaminated sediments and spread them over the upland landscape into residential neighborhoods and businesses?
- During a flooding storm, would contaminated sediments settle onto roadways, where they could be further spread on the tires of roadway traffic, and suspended as dust into the air?
- Will construction criteria for a contaminant cap include even stricter minimum storm standards (based on higher flood levels and more powerful winds) in order to address the public risk of contaminant exposure during and after a storm?
- If a storm penetrates the cap, would contaminants spread far and wide once a bolus of contaminated sediments is suspended in coastal waters?
- Could any and all of the contaminants be spread by a storm, including mercury, lead, Aroclor 1268, PCBs, PAHs, dangerous dioxins, and others? If not, which would not be spread by a storm?
- Did the EPA consider containment of the contaminated areas with a coffer dam and complete removal as one of the remedies in the Feasibility Study? If not, why not? Would a coffer dam or other containment structure facilitate removal without reintroducing the contaminated sediments in to the estuary?)
- Did the EPA model reintroduction of contaminants into the marsh via benthic organisms and the Spartina life cycle? If not, why not?

Recommendations: Do not waste time and money on capping projects that don't remove the contaminants from the environment. Please consider sediment removal to keep these contaminants from further entering the food web over the next century.

3. Restoring Vegetative Communities after Cleanup

- The proposed cleanup plan proposed by the EPA will include the removal of native marsh vegetation, which is critical for the health of the ecosystem as well as the neighboring estuarine systems. The proposed cleanup plan relies heavily on the assumption that marsh vegetation will re-grow on its own within two years. While it is possible that vegetation will begin to regrow, it is unlikely that the marsh will be fully restored in just two growing seasons.

- Have marsh vegetative restoration efforts been conducted at the LCP Site? If so, were they successful and should be repeated?

Recommendations: The EPA should modify their proposed cleanup plan to include a re-planting program in order to speed up recovery of the ecosystem post-remediation. We recommend focusing on natives such as *Spartina*, which is native to the salt marshes of coastal Georgia. *Spartina* will attractive native wildlife which will help speed up the ecosystem recovery process.

4. Human Health Assessment

- The human health assessment in the proposed plan does not adequately account for the risks posed by the contaminants to humans around the estuary. The two most harmful chemicals are mercury and Arclor 1268. Defined in the plan are high quantity fish consumers, adults that eat 40 fish meals per year for 20 years, and a recreational fish consumer as someone who eats 26 meals per year for 30 years. The differences between the two consumer categories are too small. The EPA should make more realistic assumptions like the Sapelo Island Study presented to the EPA Remedial Project Managers and Stakeholder Agencies for the LCP Site on September 3, 2014, which suggests a more appropriate number if meals in between 100 and 150 per year.

- Will the EPA increase the high quantity fish consumer number to 150 meals per year to reflect the actual consumption level observed in coastal Georgia populations?

-The posted fish consumption signs and public information on this subject is not an adequate source of information to alert the fishing and our seafood consuming public living in the contaminated areas where people rely heavily on seafood for their sustenance.

- How many signs has the EPA posted in the 20 years since the serious threat to human health was identified?
- Where are the EPA posted signs located?
- What is the EPA budget to maintain the signs over the past 20 years, and for sign placement and maintenance required until seafood is safe to eat?

- Over four thousand people live within a one mile radius of the LCP Superfund site. Over 400 of these citizens are 6 years or under and over 800 of these are women of child bearing age. In considering the many components of this major problem to one of our important coastal cities, the EPA must revise their fish consumption estimates and be cognizant of the health of those citizens that have already become affected with these

toxins. This will take a voluntary testing program to learn about the human cost from this timely exposure to highly toxic contaminants now lurking in our marshes, soil, creeks, rivers, and now our coastal ocean bottom.

- What warning signs have been posted in the estuary and at boat ramps to keep people from to keep boaters and swimmers from coming into contact with contaminated sediments?
- Who is responsible for these signs now and into the future?
- Are contaminated crabs still entering the public food supply?
- Are the sets of floats that are sometimes visible in waters adjacent to the LCP site from commercial or residential crab traps?
- Have the people most likely to have been contaminated by LCP-tainted seafood been tested? Have sufficient numbers of people been tested for LCP contaminants?
- Has testing included those who eat large amounts of fish and shellfish from St Andrew Sound, Jekyll Sound, Jointer Creek, Christmas Creek, and the Satilla River estuary?
- How many people have consumed large quantities of fish and shellfish from those waters during the decades of contamination at the LCP site?
- Has an effort been made to warn those people and to suggest that they be tested?
- Among the contaminants allowed to remain in sediments at the LCP site, are any mutagenic or teratogenic, as well as carcinogenic? If so, what will be the risk of mutations and birth defects from human exposure to LCP-contaminated sediments, water, or seafood collected from impacted waters?
- Did the EPA consider three congeners, PCBs 138, 153, and 180, were particularly higher in women with endometriosis? If not, why not?

Recommendations: The fish consumption numbers should be increased based on detailed surveys of local fishermen. In this area 40 fish meals a year is an underestimate. Some residents eat fish every day and depend on it for their survival. A more appropriate number would be 150 meals per year, and this number is obtained from people actually consuming seafood in coastal Georgia.

5. Ecological Risk Assessment

- One of the sites used to compare the levels of sediment chemicals at LCP is only four miles from the LCP site at Troup Creek and has shown to be contaminated with the same chemicals.

Recommendations: The EPA should use a cleaner site for comparison. Choose a proper control site that has low to no levels of these contaminants. The available data from the US National Park Service sampling and analysis at Cumberland Island and Fort Pulaski would fulfill this need. Unlike the LCP data, this data is not of questionable quality.

6. Contamination in the Satilla River

- The dangerous spread of the contamination beyond the salt marsh is obvious proof that the so called site boundaries established by the EPA are far from being trustworthy.

These site boundaries could never be reliable when they only include the local marsh, the peripheral soil and the local groundwater. Sapelo is far offshore and the Satilla River has also been demonstrated to be contaminated with PCB 206 (most abundant congener in Aroclor 1268; ≥ 5.0 ppb) produced and dumped by the LCP plant (Backer and Mellard 2014). We now know that the data on Aroclor 1268 which is considered to have come from the LCP plant is showing up in our dolphin population, *Tursiops truncatus*, the ocean bottom sediments and in the blood of residents 25 miles offshore in Sapelo Island.

- Does the spin of the Earth (Coriolis effect) tend to turn local river discharges southward, which over the decades could have put contaminated sediments suspended at the LCP site into these areas, and along the beaches of Cumberland Island and into Christmas Creek?

Recommendations: The site boundaries must be rewritten and extend to all areas where these LCP toxins can be sampled and demonstrated with assurance.

Other Questions for Consideration

- What lasting risks to human health will remain after remediation? Who will be responsible for these and what remedies or recourse will they have?
- How safe will the environment be?
- Will children be safely able to swim and boat in Purvis Creek or in the nearby open waters of Gibson Creek and Turtle River?
- Will people be able to safely eat fish and shellfish caught in the vicinity?
- Will warning signs be needed, and if so, who will be responsible for the warnings?

Documents used for preparation:

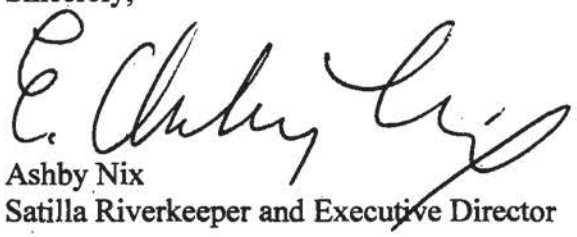
1) U.S. ENVIRONMENTAL PROTECTION AGENCY SUPERFUND PROPOSED PLAN, LCP CHEMICALS SUPERFUND SITE. OPERABLE UNIT 1
2) BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE ESTUARY AT THE LCP
CHEMICAL SITE IN BRUNSWICK, GEORGIA
3) OSHA Resource conservation and recovery act. Management of PCB.
4) Fisherman of Sapelo Island David Goldman AP
5) 2010 US Census Bureau
6) Polychlorinated Biphenyls USEPA Hazardous Waste 2014
7) Glynn county Health Department Seafood Consumption
8) US Department of Health and Human Services Toxic substances 2012
9) US Environmental Protection Agency 2014 Superfund site
10) POLYCHLORINATED BIPHENYLS (PCBs) IN GEORGIA COASTAL ENVIRONMETS AND POPULATIONS (Backer and Mellard 2014)

We would like to thank you and the EPA for hosting an EPA Public Comment meeting back in December of 2014 at the Brunswick public library. Though this event was well attended, it was poorly planned and did not serve the people of the community informatively, simply due to venue size and the lack of good communication on the part of the EPA. The EPA released its Administrative Record only 26 hours before the public comment meeting took place. The people of Brunswick who have been directly impacted

by the LCP Chemicals Superfund site for decades deserve the EPA's upmost effort with communication and the flow of information to the public. We request that the EPA grant the communities of Brunswick a proper EPA Public Comment meeting that is well advertised to potentially interested parties and nearby residents.

If there are any questions you may have about our comments, please contact us at 912-510-9500 or riverkeeper@satillariverkeeper.org

Sincerely,



Ashby Nix
Satilla Riverkeeper and Executive Director

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Public Safety and Homeland Security – Secretary
Juvenile Justice – Vice Chairman
Appropriations – Chairman Public Safety Sub Committee

January 20, 2015

Mr. Galo Jackson
US Environmental Protection Agency, Region 4
Superfund Remedial Branch
Waste Management Division
61 Forsyth Street, SW
Atlanta, GA 30303

Dear Mr. Jackson,

I write regarding the LCP Chemicals Superfund Site in the City of Brunswick, Georgia, and the Proposed Plan issued by the U.S. Environmental Protection Agency (US EPA) and the GA Environmental Protection Division (GA EPD) on December 4, 2014. Specifically, on behalf of my constituents in Georgia District 179, which includes the superfund site, I request that the period for submitting public comment be extended at least sixty (60) days.

Since 1996, the LCP Chemicals Superfund site has been on the National Priorities List, ranking among the highest priorities among sites of known releases of toxic and hazardous substances. The citizens within my district and interested parties need more time to review and assess the decades of collected data and the alternatives assessments that have informed the US EPA's Proposed Plan. This information was only just compiled and made available to the public on December 3, 2014. While I appreciate the initial extension of time for public review (to February 2, 2015), the review period is still not sufficient.

I respectfully request that the US EPA extend the public comment period by 60 more days for interested parties to have adequate time to respond with their written comments. This would create a new deadline for public comment of March 31, 2015. I would appreciate a prompt response to this request.

Sincerely,

J. Alexander Atwood

Representative Alex Atwood

cc: Jeff Cown, Chief - GA EPD Land Protection Branch

BRUNSWICK-GOLDEN ISLES CHAMBER OF COMMERCE

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March 10, 2015

To: Mr. Galo Jackson, EPA Project Manager, LCP Project

Subject: EPA Region IV Proposed Plan to Remediate LCP Chemicals Marsh in Brunswick, Georgia

The Brunswick-Golden Isles Chamber of Commerce appreciates the opportunity to submit comments regarding the proposed marsh remedy for the former LCP Chemicals site in Brunswick. The Chamber has been following the activities at this site since LCP's shutdown in the 1990's. We understand that it is a complex site that required extensive studies. However, we also believe that the site has now been thoroughly investigated.

We don't purport to comprehend the technical details of EPA's proposed plan, but we understand from the EPA public meeting and the Honeywell presentations to the Chamber's Board of Directors, the Brunswick City Commission and the Brunswick Rotary Club, that it is based on scientifically sound principals and will be environmentally protective. We support the approval and implementation of your recommended remedy as soon as possible. It is in the best interest of Glynn County and the City of Brunswick to advance the cleanup and to redevelop the site, safely and expeditiously.

Sincerely,

M. H. Woodside
President

FROM: Norman Meade, National Oceanic and Atmospheric Administration

TO: Galo Jackson, USEPA RPM

CC: Jim Brown, Georgia Department of Natural Resources
Spud Woodward, Georgia Department of Natural Resources
Strant Colwell, US Fish & Wildlife Service
Tom Dillon, Dillon Environmental Consulting

SUBJECT: LCP Natural Resource Trustees Comments on the OU1 (Marsh) Proposed Plan for the LCP Superfund Site, Brunswick, GA

DATE: January 29, 2015

On behalf of the LCP Natural Resource Trustees ("Trustees"), we would like to take this opportunity to provide comments on the subject Proposed Plan (PP) from a natural resource damage assessment (NRDA) perspective. Please contact me with any questions or concerns.

1. The subject PP concludes that Alternative 6 is the preferred alternative for remedial action in the LCP Marsh. The three major components of this alternative are: 1) dredging 7 acres of the LCP Ditch and Eastern Creek, 2) installation of armored caps in 6 acres of tidal creeks, 3) application of a thin layer sand cap (6-9 inches) over 11 acres of marsh largely along either side of the Eastern Creek. For reasons given below, the Trustees believe this remedial action may not restore the injured natural resources as quickly as the other alternatives that were considered. Moreover, Alternative 6 may not represent a permanent solution to environmental contamination at the LCP Marsh and the larger Turtle-Brunswick River Estuary.

a. The LCP Ditch and Eastern Creek were dredged in 1998-1999 along with approximately 13 acres of saltmarsh in Domain 1. Now, 15 years later, the LCP Ditch and Eastern Creek must be dredged again. Without a more comprehensive remedial action (i.e., Alternative 2 in the PP), the Trustees are concerned that re-dredging these tidal creeks now may not restore the marsh to its baseline condition.

b. The PP describes armoring material for the capped tidal creek areas as "coarse sand and/or gravel". This appears to be inconsistent with the descriptions in Appendix H of the 2013 Feasibility Study which specify an "armor stone layer for erosion protection" (§3.3.1) or an "armor stone cap" (Table H-4). Furthermore, the placement of an armored stone layer (or any hard substrate) on top of 6 acres of capped tidal creek areas, will likely result in the development of oyster reef communities similar to those currently found on large pieces of concrete that line

the LCP Ditch. While oyster reef communities can provide important ecological services, in this particular case, a 6-acre attractive nuisance will likely be created if Alternative 6 is implemented. This is because oysters efficiently bioaccumulate site contaminants such as mercury, lead and Aroclor 1268 thus making these contaminants available to higher trophic level organisms; e.g., blue crabs, black drum. As a result, capping 6 acres of tidal creeks under Alternative 6 may actually ***enhance*** entry of site contaminants into the marsh food web. This possibility must be studied as part of the post-remedial monitoring plan.

c. The arguments presented in support of installing a thin layer (6-9 inches) sand cap over 11 acres of LCP salt marsh as a method of reducing the risk to the benthic community are unconvincing. At the very least, placing sand over silty vegetated marsh surface may alter the benthic community and hydrology in ways not foreseen by the modeling that was performed.

d. The PP (page 29) provides a justification for the thin layer cap saying, "Thin-cover placement is best suited for wetlands or marsh environments where tidal energy and potential erosion is at a minimum.". This minimal tidal energy requirement seems inconsistent with the LCP marsh's 7-10 foot semi-diurnal tidal range and periodic high energy storm events. EPA's National Remedy Review Board expressed a similar view in their March 28, 2014 Memo saying, "The Board is concerned about the long-term permanence aspects of the proposed thin cover placement" (page 5, March 28, 2014 Memo). "Long-term effectiveness and permanence" is the first Primary Balancing Criteria that EPA is required to use when evaluating remedial alternatives. Dredging certainly meets this criterion especially when compared to the more questionable thin layer (≈6-9 inches) capping in a system experiencing large daily tidal fluctuations and periodic high energy storm events. EPA's National Remedy Review Board echoed this same concerns when they recommended to EPA Region 4 that they "consider a contingent remedy approach due to the uncertainty regarding the long-term permanence aspect of the proposed thin cover and capping components of alternative 6" (page 5, March 28, 2014 Memo). The permanence and effectiveness of the thin layer capping will need to be studied as part of the post-remedial monitoring.

e. It is not exactly clear in the PP how Preliminary Remedial Goals (PRGs) and Cleanup Levels (CULs) were derived and whether they are protective of human health and the environment. For example, the ranges of PRGs for the protection of the Benthic Community (page 22 of the PP) are greater than the ecologically protective Remedial Goal Objectives (RGOs) initially developed in the Baseline Ecological Risk Assessment (BERA) (see page 92 of the BERA and the values below). The recommended CULs in the PP are higher still (page 42 of the PP and below). These CULs represent the highest value in the range of PRGs in the PP. The PP does not clearly explain how these PRGs and CULs can drift ever higher, yet still be protective of the benthic community. Further, the PP does not explain whether a similar progressive relaxation of PRGs and CULs was allowed for fish and wildlife receptors.

COC	BERA RGOs →	PP PRGs →	PP CULs
Mercury	1.4-3.2 ppm	4-11 ppm	11 ppm
Aroclor 1268	3.2-12.8 ppm	6-16 ppm	16 ppm
tPAH	0.8-1.5 ppm	4 ppm	4 ppm
Lead	41-60 ppm	90-177 ppm	177 ppm

2. As noted above, approximately 13 acres of saltmarsh were excavated and backfilled with clean material in 1998-1999. Visual observations afterwards suggested very rapid recovery of the saltmarsh vegetation (see 2-year post-removal photo in Figure 2-10 of the 2013 OU1 Feasibility Study). Despite this site-specific experience of rapid recovery, the subject PP opts for other less permanent methods of remediation. The PP also repeatedly states that additional dredging and excavation would create unnecessary "destruction", "unwarranted harm" and "significant damage", which is not supported by the evidence. EPA's National Remedy Review Board reached a similar conclusion stating, "The PRPs do not provide any site-specific information to indicate that marsh restoration at this site is particularly difficult and, in fact, earlier removal actions have excavated and restored wetlands at the site already." (pages 6-7, March 28, 2014 Memo). In their Memo, the Remedy Review Board recommended dredging the 6 acres of tidal creek currently slated for capping under Alternative 6.

3. The above comments are offered from the perspective of the LCP NRDA Trustees, which differs slightly from that of EPA. At Superfund sites, the Trustees are charged with: 1) restoring ecological services back to baseline (if possible) and 2) compensating the public for interim losses through restoration projects. As a general rule, more thorough cleanups at a Superfund site translate into smaller interim losses and a more rapid return to baseline. Consequently, the LCP NRDA Trustees would rather see implementation of a more aggressive remedial action. However, the NRDA Trustees also recognize that important uncertainties are always present in ecological risk assessments and evaluations of remedial alternatives. Therefore, if Alternative 6 is implemented, the Trustees strongly urge that a comprehensive, science-based monitoring plan be designed and implemented. The plan should be capable of quantifying the rate of recovery (return to baseline) soon after the remedial action. Additionally, the plan should incorporate specific numerical "triggers" for further clean up action as described in §8.0 of the PP. The importance of post-remedial monitoring was also cited in EPA's National Remedy Review Board's March 28, 2014 memo. The Trustees concur with the Board's recommendation to develop a fish tissue monitoring plan using extant EPA guidance; i.e., Sediment Assessment and Monitoring Sheet (SAMS) #1 " Using Fish Tissue Data to Monitor Remedy Effectiveness" (2008) which can be found at http://www.epa.gov/superfund/health/conmedia/sediment/documents.htm.

Atlantic Richfield Company

REMEDIATION MANAGEMENT
Atlantic Richfield Company
201 Helios Way
HPL 6th Floor
Houston, TX 77079

Paul F. Taylor
Strategy Manager – OB&C
Office (281) 366-6920
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Mobile (713) 751-9439
paul.taylor2@bp.com

March 16, 2015

Mr. Galo Jackson
U.S. Environmental Protection Agency – Region IV
61 Forsyth Street
Atlanta, GA 30303

Sent Electronically

RE: LCP Chemical Site
Glynn County
Brunswick, GA

Dear Mr. Jackson:

On behalf of the Atlantic Richfield Company, attached are comments provided to EPA in response to the Agency's request for public comment on its Proposed Remedial Action Plan for the Marsh (OU1) at the LCP Brunswick Chemical Site. Please include Atlantic Richfield's comments in the administrative record for the Site.

Atlantic Richfield appreciates this opportunity to provide input into the administrative process.

If you have any questions, please let me know.

Respectfully,

Paul Taylor

Paul Taylor
Strategy Manager – OB&C Portfolio

Attachment

March 16, 2015

Atlantic Richfield Company Comments

United States Environmental Protection Agency (USEPA) Region 4

Superfund Proposed Plan

LCP Chemicals Superfund Site Operable Unit 1

City of Brunswick, Glynn County, Georgia

Atlantic Richfield Company (AR) offers the following comments for the Administrative Record on the USEPA Region 4's Superfund Proposed Plan for the LCP Chemicals Superfund Site (Site), Operable Unit (OU) 1, located in the City of Brunswick, Glynn County, Georgia. OU1 includes the 670+ acre tidal marsh and Purvis Creek system adjacent to the LCP property.

AR has been identified as one of the remaining, viable Potentially Responsible Parties (PRPs) at the Site, along with Honeywell International and the Georgia Power Company. AR's involvement as a PRP arose from one of its corporate predecessor's ownership and operation of an oil refinery and terminal on the LCP property between 1919 and 1955. As a PRP, AR has been involved in the thorough and lengthy remedial investigation/feasibility study (RI/FS) that has culminated in USEPA's Proposed Plan.

1. Disagreement on USEPA's Assertions Regarding Potential Benthic Invertebrate Risks

The USEPA includes an assertion in the Proposed Plan that there are risks to benthic invertebrate communities from the 4 designated chemicals of concern (COCs) in OU1. To that end, one of the Remedial Action Objectives established by USEPA for OU1 is to:

> *"Reduce risks to benthic organisms exposed to contaminated sediment to levels that will result in self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas."*

This is based on flawed and highly uncertain conclusions in USEPA's Baseline Ecological Risk Assessment (BERA) for OU1 that do not comport with the results of site-specific studies that have been conducted to address potential risks to these organisms. These studies, which include both measures of sediment toxicity in laboratory assays, as well as benthic community surveys (i.e., collection, identification and counts of the organisms in sediments from various sampling locations), clearly demonstrate that there is no difference between the OU1 results

and those from a reference/background study site in the Brunswick Estuary (facts that are acknowledged by USEPA both in the BERA and the Proposed Plan). Therefore, the "*..self-sustaining benthic communities with diversity and structure comparable to that in appropriate reference areas.*" identified as an RAO by USEPA has already been met within OU1 under current conditions and should be recognized as such.

In addition, statistical analyses of the sediment chemistry and toxicity data for OU1 in the BERA clearly showed that there are no demonstrable relationships between these factors for the identified COCs. As such, the USEPA's conclusion of risk to benthic communities within OU1 is incorrect, and the calculation of Preliminary Remediation Goals (PRGs) for benthic invertebrate communities was inappropriate. In fact, the OU1 BERA notes that the development of PRGs for the protection of benthic invertebrates is "highly uncertain with poor accuracies" and that "only conservative assumptions were used" for this purpose. The resultant PRGs were equivalent to the conservative sediment screening benchmarks. This conservatism and dismissal of the actual risk findings for the site is inappropriate in a baseline risk assessment under USEPA risk assessment guidance. AR recommends USEPA modify the administrative record to correctly reflect the lack of relationship between sediment chemistry and toxicity for the identified COCs when commenting on the current understanding of the actual risk associated with OU1.

2. <u>Disagreement with the Inclusion of PAHs and Pb as Risk Management Issues for OU1 in the Proposed Plan</u>

The USEPA clearly acknowledges that there are no findings of unacceptable risk to human health, fish or wildlife from PAHs or Pb in OU1 of the Site. These chemicals only remain as identified COCs due to the assertion by USEPA that they could possibly cause risk to benthic invertebrate communities, as discussed above.

AR believes that PAHs and Pb are very minor issues for OU1, as they do not pose a bio-accumulative (food web) unacceptable risk to humans, fish or wildlife of any kind or by any means of exposure, and their concentrations in the majority of the hundreds of sediment samples that have been collected within OU1 do not exceed either the conservative sediment benchmarks that are used by regulatory agencies as a means to rule out potential risk, or the respective PRGs that were established by USEPA from the BERA. While a low number of sediment samples collected in OU1 contained concentrations of PAHs and/or Pb that exceeded such screening benchmarks, that does not demonstrate risk. Instead, it suggest that further assessment of potential risk was warranted. That assessment came in the form of extensive sediment toxicity and benthic community measures (as described in comment 1 above). These site-specific measures showed toxicity levels and communities metrics that were comparable with the reference/background area studied. In the absence of the remedy being proposed to manage exposure to PCBs and Hg, AR believes that the distribution and concentrations of PAHs

and Pb in the OU1 marsh/creek system would not warrant any further response action. As such, any reduction of exposure to PAHs and Pb achieved by the Proposed Plan is simply a minor added benefit of the remedy developed to address PCBs and Hg.

3. Agreement with the Superfund Recommended Alternative

AR believes that the recommended alternative within the USEPA's proposed plan is appropriate, sustainable, and protective of human health and the environment. The remedial action recommended in the proposed plan has been developed through a careful evaluation process that takes into account the extensive data and information collected at the Site over more than two decades including: conservative human health and ecological risk assessments performed by the USEPA; a previous large-scale (i.e., 13 acre) removal response action for the marsh (completed in 1999); and a detailed RI/FS that evaluates the range of potential remedial alternatives for OU1 all pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) and utilizing evaluation criteria set forth in the National Contingency Plan (NCP). USEPA's proposed remedy will substantially reduce exposure to polychlorinated biphenyls (PCBs) and mercury (Hg) that have been determined by USEPA to pose an unacceptable risk to humans, fish and wildlife within OU1. It will also serve to reduce exposure to other chemicals that exist in sediments in portions of the marsh and creek (i.e., other metals and polycyclic aromatic hydrocarbons [PAHs]) that do not pose unacceptable risks to humans or fish/wildlife, but exceed conservative sediment screening levels in limited areas of OU1). A follow-up monitoring plan and Superfund Five Year Review process will be included as part of the Record of Decision (ROD) and serve to ensure remedy effectiveness post-implementation.

4. Agreement Regarding Primary Remedial Risk Management Drivers

The USEPA clearly and appropriately acknowledges in the Proposed Plan that the remedy is primarily based on management of potential risks from PCBs and Hg to humans, fish and wildlife (i.e., the primary risk drivers for the site), and that there are no findings of unacceptable risk to human health, fish or wildlife from other chemicals in OU1. AR agrees with this approach and focus.

AR appreciates USEPA's consideration of these comments and looks forward to USEPA's response and the final Record of Decision.

Aquafine
CORPORATION

3963 DARIEN HIGHWAY
BRUNSWICK, GEORGIA 31525

PROCESSING EQUIPMENT AND CHEMICALS

TELEPHONE: 912-265-2000
TELEFAX: 912-265-3000

To: U.S. Environmental Protection Agency

Superfund Proposed Plan

LCP Superfund Site

PLS RETURN

Gentlemen- in accordance with your public comment solicitation dated November 16, 2015 current deadline extended to March 16, 2015, I have reviewed your six alternative plans for remediation of the LCP superfund site and respectfully offer comments and another alternative (7).

WE strongly agree that your proposed alternative 6 is preferred choice for the excellent reasons recited in your superfund proposed plan dated November 2014 as it minimizes sediment removal ,sediment capping, and thin cover placement lost. The least transfer of contaminated soil and least importation of good soil is the best overall outcome for the environment. All efforts should be made to avoid transfer and internment of toxic contaminants to other sites even with good safeguards in place. This avoids any risk of transferring pollution to another site regardless of how well protected the new repository is.

email: iannicelli@aquafinecorp.com

To: U.S. Environmental Protection Agency

Alternate Proposal 7 (AZorb™)

The best of all worlds would be to separate the pollutants in the most secure form that advanced technology can offer. We wish to propose a new, efficient low cost method for accomplishing this objective.

During the past ten years our company, has devised, reduced to practice and published a new breakthrough in pollution control technology that(AZorb™) combines the following advantages.

1) Broad spectrum sorption of heavy metals, organic pollutants, sanitary waste, and noxous gases.

2) High capacity

3) Low cost

4) Produced by economic remediation of a world wide waste and trial (red mud)

5) Stable after sorption (TCLP results)

Our pollution control reagent is prepared by the simple step of sulfidizing red mud, the waste by product of the Bayer process for extracting alumina from bauxite. Because of its broad range of sorbtive properties, our reagent has been trade named AZorb™.

Testing by an independent environmental laboratory has shown that AZorb does not release any of its sulfidized red mud pollutants (TCLP tests). It has also been shown that AZorb is equal to or better than ion exchange resins and avoids the expense for resin regeneration. Regeneration of resin merely transfers sorbed contaminants to another facility! With reference to use of AZorb at the LCP site, one preferred application would be to berm the LCP Domain near South Purvis Creek and install a HiFlo type thickener and ancillary filter as shown in the attached flow sheet(to recover AZorb™).

Installation of a thickener using AZorb™ would eliminate the cost of sediment removal, capping, the LCP Domains, and need to transfer polluted soil to a secure land fill!

We can produce and supply AZorb at our cost, probably less than twenty five cents per pound FOB Brunswick, GA.

Joseph Iannicchi Ph.D.
M.I.T.

Attachments: 2012 Seattle paper, CEN Article, Resume, and WestTech thickener installation

Cc: Governor- Nathan Deal

State Representative- Earl Carter

State Senator - William Ligon, Jr

U.S. senator- Johnny Isakson

U.S. Senator- David Perdue

Mr. Milton Woodside- Glynn Chamber of Commerce

Bcc: Mr. Dan Parshley- Glynn Environmental Coalition

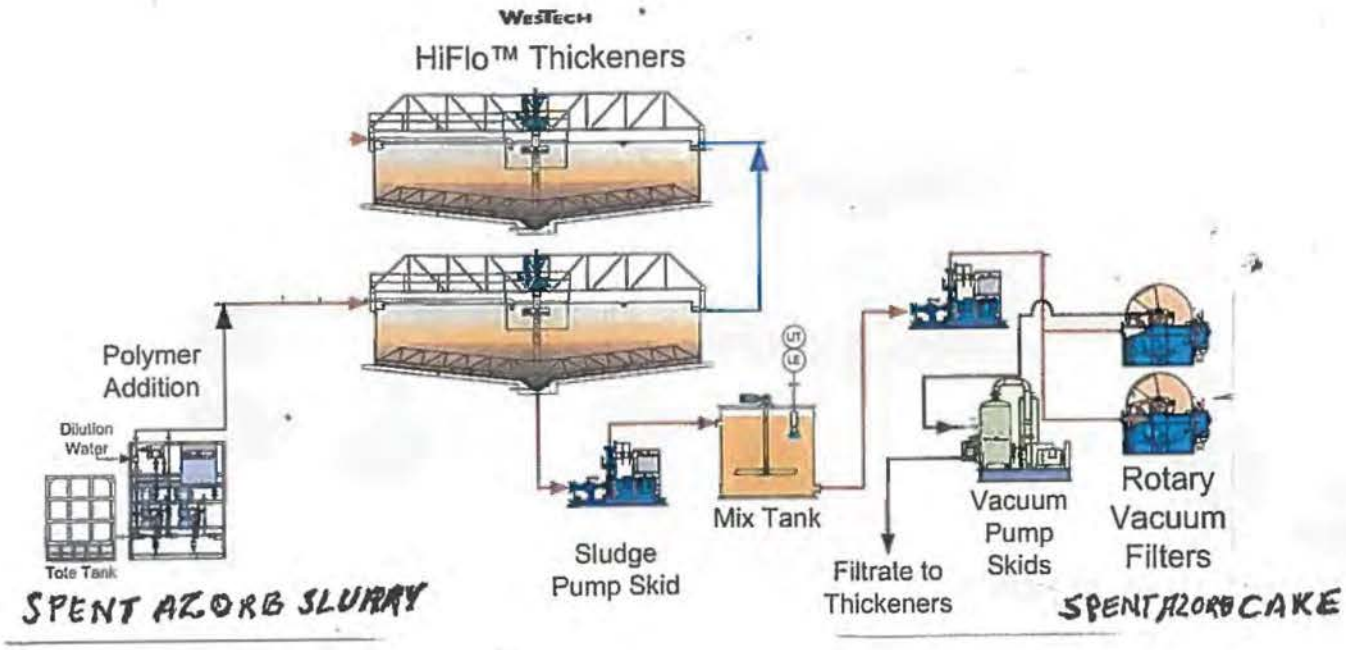
WesTech
HiFlo™ Thickeners
Polymer Addition
Dilution Water
Tote Tank
SPENT AZORB SLURRY
Sludge Pump Skid
Mix Tank
Filtrate to Thickeners
Vacuum Pump Skids
Rotary Vacuum Filters
SPENT AZORB CAKE

Figure 9 – Sediment Remedy Alternative 4: Sediment Removal – 18 Acres

IANNICELLI, JOSEPH

EDUCATION

1951	S.B., Massachusetts Institute of Technology, Chemistry
1955	Ph.D., Massachusetts Institute of Technology, Organic Chemistry, minor in Patent Law.

EXPERIENCE

1987 – Present	Founder of Aero-Instant Spray Drying Services, Brunswick, Georgia, which conducts toll or custom spray drying of non-hazardous materials on ten Niro dryers. One of the leading custom spray drying firms in the U.S.
1986 – Present	Co-founder with John Williamson and vice president of IMPEX (Industrial Minerals Process Equipment Corporation), a distributor of proprietary and major lines of wet process equipment used in mineral processing including: blungers, vibrating screens, clarifiers, filters, and calciners. Carry out test work and process development for domestic and international clients. Produce up to truckload quantities of processed industrial minerals from new deposits. Plan and design complete turnkey industrial minerals plants for U.S. and overseas clients. Projects include $16 million turnkey calciner for Thiele Kaolin and $18 million turnkey kaolin plant in Zhanjiang, China.
1971 – Present	Founder and chief executive officer of Aquafine Corporation, 3963 Darien Highway, Brunswick, Georgia. Distributor and manufacturer's representative for major lines of wet processing equipment used in kaolin and industrial minerals industries. Founded and operated Culligan of Georgia, Inc.
1971 – 1996	Exclusive world-wide representative for Pacific Electric Motor Company, Oakland, California. Product: magnetic separators. Sold thirty (30) large industrial magnetic separators (about 75% of total sold) and a number of smaller units to customers in the U.S., England, Germany, Finland, China, and Australia. Maintains the most complete high intensity magnetic separation laboratory and pilot plant in the U.S.
1971 – 1996	Niro Atomizer, Inc., Columbia, Maryland, and Copenhagen, Denmark. Products: spray dryers, evaporators, fluid bed dryers. Represented Niro in Georgia, which has the highest concentration of large dryers in the world. Sold 95% of spray dryers acquired by kaolin firms in the U.S. Maintains laboratory, pilot plant, and small industrial dryers (Aero-Instant).
1969 – 1971	Technical Director, Clay Division, J.M. Huber Corporation, Huber, Georgia. In charge of new process and product development in kaolin beneficiation and mineral modification. Head of a group of sixty-five (65) technical and non-technical personnel, which serviced a $20-million per year division (1970) having four plants in Georgia and South Carolina. Inventor of approximately one hundred (100) U.S. and foreign patents. Responsible for first commercial use of

high gradient magnetic separation, now in use throughout the kaolin industry worldwide.

1963 – 1968 Assistant Technical Director, Research Manager, and, previous to that, Research Supervisor, Clay Division, J.M. Huber Corporation, Huber, Georgia. Developed novel mineral beneficiation processes and equipment for high extraction magnetic separation, high shear leaching of iron minerals in clay, high-pressure comminution of clay slurries, selective anatase froth floatation, and fine media milling, spearheaded all phases of commercial development of surface modified specialty clays (Nulok, Nucap, Nupak, and Polyfil) from inception to pilot plant to commercial production and sales.

1960 – 1963 Research Supervisor, Central Research Division, J.M. Huber Corporation, Borger, Texas. Supervised research on clays, synthetic silicates and on production of carbon black by catalytic pyrolysis of hydrocarbons, reinforcement of elastomers and plastics with various natural, synthetic, and modified pigments.

1955 – 1960 Research Chemist, E.I. DuPont de Nemours & Company, Dacron Research Laboratory, Kinston, North Carolina. Headed special development projects at:

Pioneering Research Laboratory
Textile Fibers Department
Wilmington, Delaware 1958 – 1960

Carothers Research Laboratory (nylon)
Textile Fibers Department
Wilmington, Delaware 1957 – 1958

Technical Laboratory (dyes)
Organic Chemicals Department
Deepwater, New Jersey 1956

Member of the team that developed
T-62 and T-64 dyeable, anti-pilling Dacron

1951 – 1955 Teaching Assistant, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Summer projects in M.I.T. Metallurgy Department (corrosion of chromium/molybdenum/alloys) and at the Explosives Division of E.I. DuPont de Nemours & Company, Gibbstown, New Jersey.

AWARDS

2012 Recipient SME-AIME Robert Earll McConnell Award for "Invention, development, and commercialization of high gradient magnetic separator".

AFFILIATIONS

New York Academy of Science
Technical Association of the Pulp & Paper Industry
(Chairman, Pigments Committee 1970 – 1971)
American Institute of Mining, Metallurgical, and Petroleum Engineers
Member since 1974
Specialty Minerals Co-Chairman 1982
Surface Treated Minerals Chairman 1989
Robert Earll McConnell Award Committee 1993
Robert Earll McConnell Committee Chairman 1995 & 1996
American Institute of Chemists (Fellow)
American Chemical Society
Clay Minerals Society
M.I.T. Educational Council
American Society for Testing and Materials
American Ceramic Society
Canadian Pulp & Paper Industry
Pilots International Association
American Management Association

BIOGRAPHIES

Who's Who in America
Who's Who in the World
American Men of Science
Who's Who in Science and Engineering
Who's Who in Commerce and Industry
Who's Who in the South and Southwest
Dictionary of International Biography

CIVIC ACTIVITIES

Chairman, Glynn Union of Taxpayers 1995 – 1996
President, Jekyll Island Citizens Association 1993 – 1995
President, Georgia Tidewater Conservation Association 1991 – 1992
Foreman, Glynn County Grand Jury 1989
Member, M.I.T. Educational Council 1963 – 1971
Member, Glynn County Board of Education 1998 – 2002, chairman 2002

Patents

Magnetic Separation of Clays

4,424,124	Method and Magnetic Separator for Removing Weakly Magnetic Particles from Slurries of Minute Mineral Particles
3,471,011	Process for Improving the Brightness of Clays (U.S.)
3,667,689	Method for Producing Mineral Products (U.S.)
423,983	Australian Patent
269,729	Austrian Patent
1,122,523	British Patent
22,382	Chilean Patent
15,464	Columbian Patent
1,490,027	French Patent
1,571,552	German Patent
32,475	Greek Patent
106,550	Indian Patent
93,981	Mexican Patent
146,075	New Zealand Patent
46,253	Portuguese Patent
664,718	South African Patent
330,184	Spanish Patent
14,084	Turkish Patent
19,725	Venezuelan Patent

High Extraction Magnetic Separator

1,347,396	British Patent
935,126	Canadian Patent
2,111,986	German Patent
163,020	New Zealand Patent
55,388	Portuguese Patent
389,169	Spanish Patent

Other U.S. Patents

3,052,653	Metallic Phosphonate Containing Polyester
3,068,207	Process for Increasing the Dyeability of Linear Condensation Polymer Esters with Chelatable Dyes
3,193,344	Process for Bleaching Clay
3,193,398	Mastic Compositions
3,201,200	Modified Carbon Black Production
3,203,765	Production of Carbon Black
3,224,582	Kaolin Clay Beneficiation
3,290,165	Surface Modified Pigments
3,320,027	Clay Bleaching Under Non-Oxidizing Atmospheres

3,323,932	Antioxidant Carbon Black
3,335,020	Modified Carbon Blacks
3,390,120	Polyurethanes Containing Amino Organosilane Modified Clay
3,414,422	Chemically Treated Clays
3,442,677	Chemically Treated Clays
3,561,999	Metallic Stearate Coated Clays and the Process of Producing Same
3,556,416	Apparatus for Shearing Solids in a Solids-Liquid Suspension
3,567,680	Surface Modified Pigments and Methods for Producing Same and Elastomers Containing Same
3,661,515	Method of Brightening Kaolin Clay by Removing Organic Contaminants
3,667,688	Method for Shearing Solids in a Solids-Liquid Suspension
3,667,689	Methods for Producing Mineral Products

Patents Unassigned

3,984,309	Magnetic Separator
3,999,958	Coal Beneficiation

Assigned to Aquafine Corporation

1,104,066	Canadian Patent, Thin-Section-Matrix Magnetic Separation Apparatus and Method
1,215,821	Canadian Patent, Removing Total Reduced Sulfur Compounds from Industrial Gases
1,216,732	Canadian Patent, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
1,576,158	UK Patent, Apparatus for Separating Particles from a Fluid-Particle Mixture
2,149,389A	UK Patent Application, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
2,149,389B	UK Patent Application, Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
2,346,822B	UK Patent, Continuous Filament Matrix for Magnetic Separator
4,079,002	Thin-Section-Matrix Magnetic Separation Apparatus and Method
4,552,734	Fluidization Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
4,552,735	Process for Removing Total Reduced Sulfur Compounds from Industrial Gases Using Manganese Dioxide
4,713,225	Method for Removing Organic Reduced Sulfur Compounds
4,923,688	Wet Scrubber Process for Removing Total Reduced Sulfur Compounds from Industrial Gases
5,112,796	Manganese Dioxide Impregnated Filter
5,128,027	Method for Removing Mineral Slimes from Kaolin Clay
5,376,605	Process for Beneficiating Minnesota Kaolin
5,397,754	Method of Brightening Kaolin Clay by Thermal Oxidative Decarboxylation of Organic Contaminants
6,180,005	Continuous Filament Matrix for Magnetic Separator
6,224,777	Continuous Filament Matrix for Magnetic Separator
7,601,319B2	Process for the Manufacture of Monobasic Potassium Phosphate
7,686,401B1	Method for Sub-Glacial Mineral Reconnaissance and Recovery

Sulfidized Red Mud Sorbent for Toxic Substances

7,763,566B2 Method and Composition for Sorbing Toxic Substances
7,807,058B2 Method and Composition for Sorbing Toxic Substances (CIP-1)
8,080,172B2 Method and Composition for Controlled Heat Release And Disposable Chemical Heater Utilizing Same
8,231,711B2 Sorption Processes - FGS
8,236,185B2 Methods for Using Sulfidized Red Mud – Sedimentation
8,377,310 B2 Method and Composition For Sorbing Toxic Substances – SRM + RM
8,382,991 B2 Method of Sorbing Discolored Organic Compounds from Water

Foreign Filings Pending

Sulfidized Red Mud - Europe, China, Canada

Publications and Presentations

Iannicelli, J. "SRM – A New Sorbent for Toxic Substances" Paper Presented at the 2012 SME/AIME Annual Meeting, Seattle, WA, February 19th – 23rd, 2012.

Iannicelli, J. "Evolution of High Gradient Magnetic Separation" Paper Presented at the 2010 SME/AIME Annual Meeting, Haydn Murray Symposium, February 28th – March 3rd, 2010.

Iannicelli, J. and J. Pechin, M. Ueyama, K. Ohkura, K. Hayashi, and K. Sato, A. Lauder and C. Rey, "Magnetic Separation of Kaolin Clay Using a High Temperature Superconducting Magnet System". Paper presented at the Applied Superconductivity Conference, August 29, 1996, Pittsburgh, PA.

Iannicelli, J., "High Tech Pigments by Novel Processing Methods". Paper presented at the AIME/SME Annual Meeting, February, 1990, Salt Lake City, UT.

Iannicelli, J., "Polymer Reinforcement with Amino and Mercaptosilane Grafted Kaolin". Paper presented at the AIME/SME Annual Meeting, February, 1990; Salt Lake City, UT.

Iannicelli, J., "The Iannicelli TRS Scrubber". Paper presented at the TAPPI Environmental Conference, April, 1986, New Orleans, LA.

Iannicelli, J., "New Trends in World-Wide Exploration of Kaolin Resources". International Clay Minerals Conference, 1985, Denver, CO.

Iannicelli, J., "Role of Kaolin Tailings Ponds in Conservation". Paper presented at the Society of Mining Engineers of AIME Fall Meeting, October 16-18, 1985, Albuquerque, NM; Preprint No. 85-395.

Iannicelli, J., "Kaolin Review 1985"; Engineering & Mining Journal 1986.

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Iannicelli, J., "Advances in Large Spray Dryers". Paper presented at the Society of Mining Engineers of SME-AIME Annual Meeting, February 14-18, 1982, Dallas, TX; Preprint No. 82-38.

Iannicelli, J., "Evaluation of Comparison of Cross Field and Solenoid Field Magnetic Filters". Prepared for the Electric Power Research Institute, Inc., Research Project S106-1, 1981, Palo Alto, CA;.

Iannicelli, J., "Developments in the Kaolin Industry and Opportunities for Technology Transfer". Presented at the Niro Atomizer Kaolin Seminar, 1981, Hilton Head, SC.

Iannicelli, J., "Expansion and Soft Market Squeeze Profits in 1981"; Engineering & Mining Journal; March, 1981.

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Murray, H.H. and J. Iannicelli, "High Intensity Magnetic Beneficiation of Industrial Minerals—A Survey". Study supported by The National Science Foundation (RANN); Project #GY 44129.

Iannicelli, J., "New Developments in the High Extraction Magnetic Filtration of Kaolin Clay". Paper presented at XIII International Mineral Processing Congress, June, 1979, Warsaw, Poland.

Iannicelli, J., "Record Year in 1979 Spurs Industry Expansion"; Engineering & Mining Journal; March, 1980.

Iannicelli, J., "High Intensity, High Gradient Magnetic Separation as a New Process Tool". Paper presented at the National Science Foundation Workshop, November, 1978, Columbia University, Sterling Forest, NY.

Iannicelli, J., "Kaolin—Record 1978 Output and Sales Promise a Bright Future"; Engineering & Mining Journal; March, 1979, pp. 121-122.

Halaka, N.J., J. Iannicelli, and J.A. Negrych, "Upgrading Ione Refractory Kaolins by High Extraction Magnetic/Filtration". Paper presented at the Society of Mining Engineers of AIME Fall Meeting and Exhibit, October 19-21, 1977, St. Louis, MO; Preprint No. 77-H-400.

Iannicelli, J., "High Intensity, High Gradient Magnetic Separation as a New Process Tool". Paper presented at the Joint Meeting of the American Institute of Chemical Engineers, Central Florida and Peninsular Florida Sections, May 20-22, 1977, Clearwater Beach, FL.

Iannicelli, J., "Kaolin; Production Reaches New High in '77"; Engineering & Mining Journal; March, 1978; pp. 188-192.

Iannicelli, J., "New Developments in Magnetic Separation". IEEE Transactions on Magnetics, Vol. MAG-12, No. 5; September, 1976; pp. 436-443. Paper presented at the Magnetic Desulfurization Symposium, March 23-25, 1976, Auburn University, Auburn, AL.

Iannicelli, J., "Development of High Extraction Magnetic Filtration by the Kaolin Industry of Georgia". IEEE Transactions on Magnetics, Vol. MAG-12, No. 5; September, 1976. Paper presented at the Magnetic Desulfurization Symposium, March 23-25, 1976, Auburn University, Auburn, AL.

Iannicelli, J., "High Extraction Magnetic Filtration Applications in Kaolin and Paper Making". Paper presented at the TAPPI Coating Conference, May 17-18, 1976, Boston, MA.

Iannicelli, J., "Development of High Extraction Magnetic Filtration by the Kaolin Industry of Georgia". Georgia Geologic Survey, Information Circular No. 49, published Atlanta; 1978; pp. 44-52. Paper presented at the Twelfth Forum on Geology of Industry of Industrial Minerals, April 22-24, 1976, Atlanta, GA.

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Iannicelli, J., "High Extraction Magnetic Filtration of Kaolin Clay and Mineral Slimes". Filtration & Separation, January/February, 1976; pp. 15-18. Paper presented at the Magnetics Conference, April 14-17, 1975, London, England.

Iannicelli, J., "Extraction Magnetic Filtration of Kaolin Clay"; Clays and Clay Minerals, Vol. 24, Pergamon Press 1976; pp. 64-68. Paper presented at the International Clay Conference, July 16-23, 1975, Mexico City, Mexico.

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SULFIDIZED RED MUD
A NEW SORBENT FOR TOXIC SUBSTANCES

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ABSTRACT

A powerful improved sorbent is produced by sulfidizing red mud, a noxious by-product from the Bayer extraction of alumina from bauxite. Sulfidized red mud (SRM) sorbed 90 to 100% of the following metals from laboratory solutions of Cr, Co, Ni, Cu, Zn, Se, Ag, Cd, Hg, Pb, Th, U. Discolored organic compounds (DOC) are also sorbed (90%). Sulfidization of red mud is accomplished under ambient or relatively mild conditions using exemplary compounds such as H_2S, Na_2S, K_2S, $(NH_4)_2S$, and CaS_x. Sulfur content ranges from 0.2% to 10% above the residual sulfur in red mud. The sulfidization reaction blocks leaching of metals naturally present in red mud. In some cases, (As, Mn, Sr), mixtures of sulfidized red mud plus red mud are more effective than sulfidized red mud alone. Sulfidized red mud has applications for cleaning raw industrial process water as well as effluent wastewater (and gases) for the entire range of industrial processes.

BACKGROUND

Red mud is a noxious by-product and pollutant of the production of alumina from bauxite by the process invented by Karl Bayer in 1887. This process relies on the selective solubility of aluminous minerals in hot (125 - 250°C) sodium hydroxide solution and the insolubility of the remaining minerals (iron, titanium, and silica) which are either insoluble or react and re-precipitate. The insoluble, iron rich residue can contain 17.4 to 37.5% (Fe). Red mud is a complex mixture of finely divided hydrated iron oxides and a wide range of lesser minerals containing Al, Na, Ti, Si, Ca, Mg plus traces of over a score of other elements including Cr, Ni, Cu, Pb, Se, Hg, As, Th, etc.

The resulting red mud has strong sorptive and complexing properties and is the subject of scores of publications. Because of its preparation, red mud is intensely alkaline, with pH values of 13 and above, but also may contain and leach toxic metals. This creates serious problems with its storage in tailings impounds which poses a toxic hazard for wildlife and personnel, and creates widespread contamination of ground water. Reduction of pH below 10 is necessary for safe storage and many sorptive applications.

It is estimated that 150 million tonnes of red mud is produced and impounded per year and that about 2.5 billion tonnes is currently stored worldwide.

Hazards of storing highly caustic and toxic red mud has been brought into focus by the bursting of a red mud impound at Ajka, Hungary on October 4th, 2010 which released 700,000 tonnes of red mud over 40 square kilometers, killing ten people and hospitalizing 120 others. Neutralization of red mud can be accomplished with waste acid, or by washing red mud with large amounts of sea water (typically 12 to 18 times the volume of red mud). This requires seaside location, large settling basins, and of course the ability to discharge waste water back to the sea.

Red mud has been proposed as a sorbent for heavy metals, cyanides, phosphates, and the like. However, the sorptive and release properties of red mud are not always compatible.

Depending on the source of a particular red mud, it can leach out significant amounts of toxic pollutants such as radioactive thorium, uranium, chromium, barium, arsenic, copper, zinc, cobalt, as well as lead, cadmium, beryllium, and fluorides.

Red mud is a very hydrophilic high pH slime which is difficult to dewater by filtration or sedimentation means. This also complicates and limits its utility as a sorbent in aqueous systems.

The potential problems involved with use of red mud to control pollution are highlighted in an e-newsletter article entitled "The Great Red Mud Experiment that Went Radioactive". This experiment conducted by the Western Australian Agricultural Department involved placing 20 tonnes of Alcoa red mud per hectare on pastureland in order to stop unwanted phosphorous from entering waterways. An unintended result of this experiment was that runoff waters showed excessive quantities of copper, lead, mercury, arsenic, and selenium. Emaciated cattle grazing on treated land exhibited high chromium, cadmium, and fluoride levels. Furthermore, each hectare contained up to 30 kilograms of radioactive thorium. The disastrous red mud application test was abruptly terminated after five years.

It is evident that extreme caution must be exercised in selecting, treating, and testing red mud before attempting to use it to sorb toxic compounds.

Furthermore, the capacity of red mud to capture and hold toxic substances such as mercury and related metals often is not adequate to eliminate traces of these metals in leachate. The possibility also exists that sorption of one toxic pollutant may release other pollutants. Therefore, use of red mud as a sorbent to purify water is problematic.

As a result of intensive investigations on methods for neutralizing and using red mud, an Australian based company, Virotec, has developed a line of red mud based products covering a wide range of pollution control applications. Virotec uses a variety of methods to neutralize red mud. These involve use of natural sea water (up to 13 washings), evaporatively concentrated sea water, saline or hard groundwater brines, salt lake brines, industrial waste brines and even solid salts.

APPLICATIONS FOR SULFIDIZED RED MUD

Heavy metal contaminated liquids and flue gases from various sources (ground, stream, runoff, mines, petroleum, industrial waste) are among the most dangerous and difficult environmental problems facing the world today. Among these metals are mercury, chromium, cobalt, nickel, copper, zinc, silver, gold, cadmium, lead, selenium, and transuranic elements. Mercury contamination of the environment is the subject of increasing attention because it eventually accumulates at high levels in bodies of large predatory fish such as tuna, swordfish, and shark. A major concern is the atmospheric release of mercury from coal fired power plants, currently estimated at 46 tons per year in the United States. The Environmental Protection Agency (EPA) has identified women of childbearing age as especially threatened because of possible neurological damage to unborn children. It is estimated that 8% of women in this category have a methyl mercury blood level above 5.8 ppb.

On Dec. 14, 2000, the EPA issued a determination that their agency must propose new regulations under the Clean Air Act to control mercury emissions from coal and oil fired power plants by Dec. 15, 2003. One proposal was to reduce mercury emissions from power plants 90% by 2007. According to an article in Forbes, such regulation "could cost the power industry at

least 8.58 billion dollars per year." More recent proposals such as the Clear Skies Act call for a 70% reduction in mercury emissions over 15 years. Now decision in 2018.

Sulfidized red mud is a powerful sorbent for remediating polluted sources such as groundwater, wastewater, mine runoff, petroleum streams, and industrial waste. Of particular interest is sorbing heavy metals such as mercury (Hg), chromium (Cr), lead (Pb), copper (Cu), zinc (Zn), silver (Ag), cadmium (Cd), selenium (Se), thorium (Th), and uranium (U) from such sources. The metals may be present as free elements, ions, or in compounds with other elements.

Of special interest is remediation of over 30,000 mine drainage streams where the alkalinity of sulfidized red mud would be useful.

PREPARATION OF SULFIDIZED RED MUD

The sorbent is prepared by the sulfidation of red mud, which contains hydrated ferro ferric oxides derived from the Bayer processing of bauxite ores. Sulfidation can be achieved by reacting red mud with one or more sulfidizing compounds such as H_2S, Na_2S, K_2S, $(NH_4)_2S$, and CaS_x. Unlike red mud, which is very hydrophilic, sulfidized red mud is lyophobic. As a result, sulfidized red mud has much faster dewatering rates than red mud.

The relative amount of sulfidizing agent is selected so that the sulfur content of the reaction product is from about 0.2 to about 10% above the residual sulfur content of the red mud. The weight ratio of sulfidizing compound to red mud will vary with the type of sulfidizing compound used and the desired level of sulfidation for a particular end use. Most often, the sulfidizing compound and red mud are combined at a weight ratio usually from about 1:25 to about 1:6. Conditions under which red mud can be sulfidized depend on such factors as the type of sulfidizing compound(s) and the intended use of the resulting sorbent. In some cases, sulfidation can be accomplished by mixing red mud and the sulfidizing compound at ambient temperature and atmospheric pressure. In general, higher sulfur contents can be obtained when the reaction is carried out at slightly elevated temperatures and/or elevated pressures. Sulfur content in the reaction product is affected by sulfur content of the sulfidizing agent. For example, compounds such as calcium polysulfide, usually yield products having higher sulfur contents.

When using gaseous sulfidizing compounds, such as hydrogen sulfide (H_2S), it is often preferred to conduct the reaction at slightly elevated temperature and/or elevated pressure to increase the rate of reaction and the sulfur content of the resulting sorbent. Suitable reaction temperatures range from about 40 to 200°C., often from about 80 to 120°C. The reaction pressure typically ranges from about 30 to about 70 psi (absolute).

USE OF SULFIDIZED RED MUD

In a typical application, the sorbent is slurried with a medium containing the contaminant(s) to be extracted. The sorbent, which forms a complex with the contaminant(s), can then be separated from the slurry using one or more conventional techniques such as filtration, sedimentation, or centrifugation.

In an alternative application, sulfidized red mud sorbent is processed into pellets using conventional pelletizing or extrusion equipment. The pellets can be used in filters of

conventional construction in a variety of industrial or consumer filtration applications, including filters for preparing potable water.

It has been found that sulfidized red mud sorbent is effective for sorbing various contaminants, such as mercury, which are not effectively sorbed by red mud. On the other hand, red mud itself is effective for sorbing other contaminants, such as arsenic, which are not efficiently sorbed by sulfidized red mud. For treatment of media having contaminants in both categories, use of red mud and sulfidized red mud in tandem, either in the same sorbent composition or in sequential treatment stages (e.g., red mud followed by sulfidized red mud) can be more advantageous than using either sorbent alone.

RM 1. Preparation of Red Mud. A 1kg sample of red mud received from Sherwin Alumina Company of Corpus Christi, TX was slurried at 15% solids in demineralized water and filtered on a Buchner funnel. The resulting filter cake was re-slurried with demineralized water, re-filtered, and used as the starting material in Example 2.

SRM 2. Preparation of Sulfidized Red Mud Using Hydrogen Sulfide (H_2S). Washed red mud (100g) from Example 1 was slurried in demineralized water at 15% solids and the stirred slurry was saturated with hydrogen sulfide for 30 minutes at ambient temperature. The sample was dried overnight at 100°C. and the resulting cake was pulverized.

SRM 3. Preparation of Sulfidized Red Mud Using H_2S Under Pressure in a Parr Bomb. The sulfidation procedure of Example 2 was repeated using a Laboratory Parr Bomb. After saturation of the slurry with hydrogen sulfide gas, the bomb was sealed and heated four hours at 100°C., while stirred. The bomb was then cooled, depressurized and the contents filtered, dried, and pulverized.

SRM 4. Preparation of Sulfidized Red Mud Using Ammonium Sulfide $(NH_4)_2S$. Red mud (200g) was dispersed in 600 grams of deionized (DI) water in a Waring Blender for 5 minutes. Ammonium sulfide (10g) was added and the slurry was heated with stirring on a hot plate for 1 hour at 60°C. It was then filtered and dried at 90°C.

SRM 5. Preparation of Sulfidized Red Mud Using Sodium Sulfide (Na_2S). The procedure of Example 2 was repeated using sodium sulfide instead of ammonium sulfide.

SRM 6. Preparation of Sulfidized Red Mud Using Calcium Polysulfide (CaS_x). The procedure of Example 2 was repeated using 33.5g of 30% solution of Cascade, calcium polysulfide.

Table 1. Sulfur Content of RM-1 and SRM (2-6)

CODE	DESCRIPTION	EXAMPLE	S (wt%)
RM-1	Red Mud	1	0.19
SRM-2	Sulfidized Red Mud H_2S	2	0.48
SRM-3	Sulfidized Red Mud H_2S with Pressure	3	0.90
SRM-4	Sulfidized Red Mud $(NH_4)_2S$	4	0.46
SRM-5	Sulfidized Red Mud Na_2S	5	0.62
SRM-6	Sulfidized Red Mud CaS_x	6	1.19

A more complete analysis of RM-1, SRM (3-6) is given in Table 2. The analysis reveals that filtration and washing during preparation of sulfidized red mud extracts sodium chloride (except for SRM-5) and increases concentration of Fe_2O_3 in red mud. It is significant that very small amounts of reacted sulfur have such a strong effect on the chemical and physical properties of red mud.

Table 2. Analysis of RM-1, SRM (3 -6).

		Weight %						PPM		
CODE	DESCRIPTION	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	Fe_2O_3	Cr	Pb	Cu
RM-1	Control	4.73	0.12	17.1	8.23	1.14	39.9	1258	144	119
SRM-3	H_2S (b)	3.94	0.14	14.6	9.14	1.38	46.2	1506	180	138
SRM-4	$(NH_4)_2S$	4.39	0.13	17.9	9.24	1.26	42.3	1379	176	146
SRM-5	Na_2S	5.20	0.11	17.2	8.41	1.29	41.5	1272	159	130
SRM-6	CaS_x	4.44	0.09	16.2	8.41	1.29	41.2	1364	165	138

Leaching of RM-1 vs. SRM-2. In part (a), a slurry of red mud (50g) and demineralized water (450ml) was prepared, mixed for 30 minutes, and filtered. The filtrate was acidified with 2ml concentrated nitric acid and analyzed by ICP using EPA3050 and EPA6010 methods. In part (b), the procedure of part (a) was repeated using sulfidized red mud (SRM-2). Results are given in Table 3 and show that leachate from sulfidized red mud (SRM-2) gave a much reduced content of heavy metals (low parts per billion) than leachate from the red mud (RM-1) in every case, except Cd, where the difference was insignificant.

Table 3. Metal Concentration in Leachate (ppm)

	Hg	As	Cd	Cr	Pb	Se
SRM-2	0.0026	ND*	0.0013	0.0044	ND	ND
RM-1	0.0032	0.096	ND	0.0510	0.0064	0.017

*ND – Not detectable, below limits.

Mercuric Solution (3.5ppm) Sorption by SRM-3. Ten grams of sulfidized red mud SRM-3 was slurried 30 minutes with 1kg demineralized water containing 3.5ppm mercury (5.66ppm mercuric nitrate). The slurry was filtered and analyzed for mercury (Hg^{++}) by ICP (Method EOA 245.1).

The procedure was repeated using 22.0 ppm and 41.0 ppm mercury solutions (11-12), (13-14).

Results of tests 9-14 are summarized in Table 4 and demonstrate the superior performance of sulfidized red mud compared to red mud for sorption of mercuric ion from aqueous solutions.

Table 4. SRM-3 vs RM Mercuric Ion Sorption from Aqueous Solutions

Example	Mercuric Concentration in Filtrate	% Sorbed
Control Solution	3.5 ppm	
9 RM-1	0.56 ppm	84
10 SRM-3	0.2 ppm	94.3
Control Solution	22.0 ppm	
11 RM-1	8.0 ppm	64

12 SRM-3	0.22 ppm	99
Control Solution	41.0 ppm	
13 RM-1	23.4 ppm	43
14 SRM-3	0.04 ppm	99.9

Example 15 Mercury (metal) Sorption from Vapor Phase by SRM-3 and RM-1 (Spray Absorbed). In part (a), one gram of mercury metal was placed in a two necked round bottom (RB) flask on a supported heating mantle. One neck of the flask was open and the second neck was connected with a Teflon® tube to an aperture in the inlet duct of a spray dryer. The mercury was heated to 300°C. A slurry of 580g SRM-3 in 450ml demineralized water was sprayed by a rotary atomizer operating at 30,000 rpm. The feed rate of SRM-3 was regulated to produce an outlet temperature of 100°C from the dryer.

In part (b), the procedure of part (a) was repeated using RM-1 instead of SRM-3. The mercury content of the spray dried SRM from part (a) and the RM from part (b) are tabulated in Table 5 and show that the SRM had a significantly improved sorption of mercury.

Table 5. Mercury Sorption by Spray Dried SRM-3 and RM-1.

	Sorbed Hg Concentration (ppm)
15 (a) SRM-3	61.0
15 (b) RM-1	8.1

SRM-3 absorbed 7.5 times more mercury as RM-1 when spray dried at 300°C inlet and 100°C outlet in the presence of an air stream containing mercury heated to 250°C. Sulfidized red mud is significantly superior to red mud as a sorbent for elemental mercury metal vapor.

Example 16 Mercury (metal) Sorption from Vapor Phase by SRM-3 and RM-1 (Spray Absorbed). Example 15 was repeated except that a slurry of 100g SRM-3(a) and also 100g of RM-1 in 900ml demineralized water were spray dried (b). Samples 16a and 16b were analyzed for mercury.

This experiment was then repeated using 100g RM-1 and also 100g SRM-3 to furnish samples 16c and 16d, which were analyzed. The results of tests 16(a) – (d) are shown in Table 6 below.

Table 6. Mercury Sorption from Vapor Phase

		Sorbed Hg Concentration (ppm)
16 (a) SRM-3	1st pass	95
16 (b) SRM-3	2nd pass	340
16 (c) RM-1	1st pass	43
16 (d) RM-1	2nd pass	48

As evident from Table 6, SRM-3 is about twice as efficient as RM-1 on the 1st pass and about seven times as efficient as RM-1 on the second pass. The results show that the affinity of SRM-3 for mercury vapor improves with increased exposure to mercury, indicating an induction effect.

Sorption of mercury by scrubbing gases with sulfidized red mud has important potential for reducing mercury contamination of both freshwater and saltwater bodies.

Table 7 below summarizes the results of Examples 19 – 28 using the general procedure of Example 9. The last column indicates the amount (in wt %) of the target ion that was removed by SRM. The results with thorium are especially significant.

Table 7. Summary of Examples 19-28 SRM-3 vs. RM-1

Example	Element	Control Solution Ppm	RM-1 Filtrate ppm	SRM-3 Filtrate ppm	% Removed by SRM-3
19	Chromium III	2.240	0.018	0.005	99.8
20	Copper II	1.550	0.028	<0.004	99.99
	Copper II	6.250	0.054	0.038	99.4
	Copper II	30.50	0.073	0.040	99.9
21	Zinc II	1.850	0.035	0.009	99.5
	Zinc II	2.380	0.103	0.022	99.1
22	Silver I	3.15	ND*	ND**	99.99
23	Gold I	0.703	ND	0.227	67.7
24	Cadmium II	1.850	0.035	0.009	99.5
25	Lead II	2.0	0.058	0.007	99.7
26	Selenium	2.5	2.1	0.24	90.4
27	Thorium IV	0.956	0.054	ND	99.99
	Thorium IV	4.93	0.260	ND	99.99
	Thorium IV	10.50	0.564	ND	99.99
	Thorium IV	19.40	0.921	ND	99.99
28	Uranium II	1.13	0.074	0.04	96.5
	Uranium II	10.1	2.45	0.494	95.1
	Uranium II	38.0	6.90	3.95	89.6

***ND: Not detectable.**

****ND: Essentially quantitative removal of Thorium was obtained by SRM-4.**

Example 29 Comparison of SRM and RM for Sorption of As, Co, Mn, and Sr. The procedure of Example 9 was repeated using solutions of arsenic (III), arsenic (V), cobalt II, manganese (II), and strontium (I), with results summarized in Table 21.

Table 8. Comparison of SRM-3 and RM-1 sorption

Element	Control Solution ppm	RM-1 Filtrate ppm	% Removed	SRM-3 Filtrate Ppm	% Removed
Arsenic III	0.60	0.11	81.6	0.36	40
Arsenic V	1.60	0.21	86.9	1.15	28
Cobalt II	2.75	0.013	99.5	0.046	98.3
Manganese II	1.63	0.135	91.7	0.548	66.4
	2.10	0.72	65.7	0.792	62.3
Strontium II	1.90	0.10	94.7	1.10	42.1
	9.0	0.08	99.1	4.60	48.9
	27.0	0.19	99.3	11.0	59.3

These experiments reveal that sorption of red mud (RM-1) is significantly better than SRM-3 in the case of As (III), AS (V), Mn (II), and Sr (II). However, the use of red mud as a sorbent is restricted by leaching of undesirable elements which can cause serious problems. Use of sulfidized red mud in combination with red mud is useful because sulfidized red mud prevents undesirable leaching of toxic metals from red mud itself.

Example 30 Sorption of Hg (II) by Various SRMs. Summarized in Table 9 below.

Table 9. Sorption of Hg(II) by SRM (3-6)

	Concentration of Hg(II) in Original Solution (ppm)	Concentration After Treatment With SRM (ppm)	% Removed
SRM 4	4.5	0.001	100
5% $(NH_4)_2S$	19.6	0.0229	99.9
SRM 5	4.5	0.449	90.0
5% Na_2S	19.6	3.68	81.2
SRM 6	4.5	0.005	99.9
5% CaS,	19.6	3.16	83.8
SRM 3	4.5	0.004	99.9
H_2S pressure	19.6	0.02	99.9

SRM-3, 4, and 6 gave excellent sorption results from solutions of Hg(II) at two concentrations (4.5 ppm and 19.6 ppm). It is significant that SRM-4 reduced Hg to 1 ppb, thus meeting current drinking water standards (3 ppb maximum).

Ammonium sulfide treatment red mud (SRM-4) was the most effective sorbent despite the fact it had the lowest S content. SRM-5 prepared by treatment of red mud with Na_2S was much less effective than SRM-4.

Example 35 Sedimentation Rates of SRM-4 and RM-1. In the course of tests on metal sorption from aqueous solutions by sulfidized red mud and red mud, it was found that in all cases, sulfidized red mud exhibited significantly faster filtration rates than red mud. Red mud is very hydrophilic but conversion of red mud to sulfidized red mud transforms it to a lyophobic sorbent which is more readily dewatered. The unexpected improvement of dewatering behavior is shown in the following experiment.

A dispersion of 50 grams of RM-1 in 500ml demineralized water was prepared by rapid mixing in a Waring Blender for 10 minutes. The experiment was repeated using 50 grams of SRM-3 in 500ml demineralized water.

Both freshly prepared slurries were allowed to settle undisturbed at ambient temperature (25°C) for a period of 23 hours. After 23 hours, the RM-1 dispersions had settled to give a clear supernatant layer of only 1cm. The remaining slurry consisted of dispersed RM-1 with no visible sediment.

During a 23 hour period, the SRM-3 slurry settled to furnish a sedimentary layer about 3cm deep and a clear supernatant layer 11.5cm above the sediment.

These results clearly show the significant alteration of surface chemistry and dewatering characteristics of red mud by relatively small degrees of sulfidation.

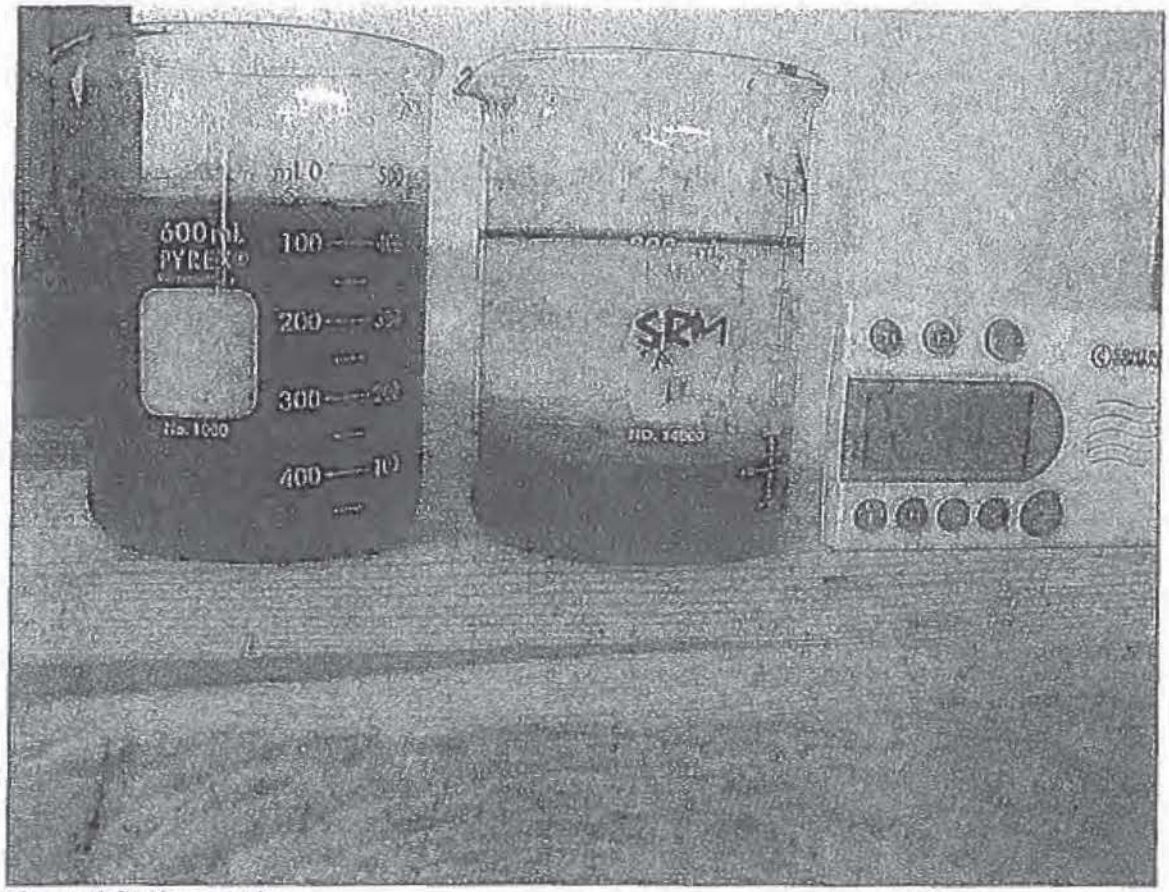

Figure 1 Sedimentation.

Example 36 Clarification of Okefenokee Swamp Water with SRM-4. 500ml of Okefenokee Swamp water (Sample I) was adjusted to pH7 with dilute NaOH and mixed with 10 grams of SRM-410 (made with 10% ammonium sulfide) in a Waring Blender at high speed for 5 minutes. The mixture was transferred to a beaker and allowed to stir an additional hour using a magnetic stirrer.

The suspension was filtered and the color value of the filtrate was determined with a LaMotte TC-3000e colorimeter. Another 10 grams of SRM-410 was then added and the procedure was repeated a second time (2nd Pass). The filtrate was again evaluated for color. Results are given in Table 26 and showed that the treated sample was nearly colorless (over 90% reduction in absorbance).

Table 26. Absorbance Testing of Okefenokee "Black" Water (Sample I)

Sample Designation	Color Value (CV) (375nm)
Control Untreated	247
1st Pass SRM-410	38.9
2nd Pass SRM-410	18.8

Another sample of Okefenokee "Black" Water (Sample II) was treated with sulfidized red mud according to the above procedure. The absorbance was reduced 90% to nearly colorless as shown in Table 27 (2 passes) and Figure 2.

Table 27. Okefenokee "Black" Water (Sample II)

Sample Designation	Absorbance
Control Untreated	0.063
Sample II	0.0063

*Fisher Genesys5 Spectrophotometer 500nm

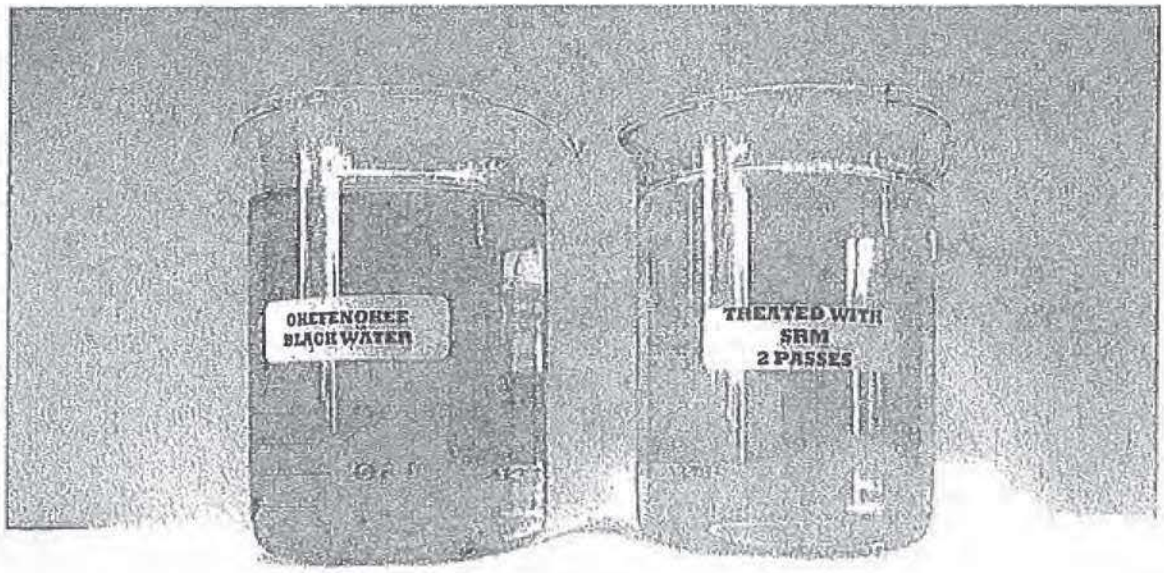

Figure 2 Okefenokee "Black" Water DOC Removal.

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AQUAFINE

MUD MAN Iannicelli poses with a sample of his sulfidized red mud sorbent, called Azorb.

MAKING THE MOST OF RED MUD

An octogenarian chemist's latest invention turns hazardous aluminum mining waste into a material for **CLEANING UP WATER**

STEPHEN K. RITTER, C&EN WASHINGTON

JOSEPH IANNICELLI is an inventor unlike any other you might have met. He is the 84-year-old president of Aquafine Corp., a Brunswick, Ga., company that supplies spray-drying and magnetic separation equipment and provides laboratory services for industrial mineral processing. Iannicelli holds dozens of patents for technologies used to purify kaolin, a white aluminum silicate mineral that is essential to making paper, cosmetics, paint, and sorbents for water treatment.

Iannicelli has amassed a small fortune since he graduated from Massachusetts Institute of Technology with a Ph.D. in organic chemistry back in 1955, when he helped develop a biosynthetic method to make penicillin. After working for DuPont on textile fiber polymers and for J. M. Huber Corp. on kaolin, he launched Aquafine in 1971.

In conversations, Iannicelli spontaneously recalls the details of his diverse inventions. His firm baritone leaves the listener hanging on his every word as he weaves a tale to explain how he lately came to be interested in playing with red mud.

Known formally as bauxite residue, red mud is the noxious by-product of the Bayer process for extracting aluminum from bauxite ore. Aluminum mining leaves behind a staggering 120 million metric tons per year of the salty, highly alkaline, heavy-metal-laden material, according to the International Aluminium Institute, a London-based trade organization. The aluminum industry has long tried to find ways to recycle the environmentally problematic red mud. But so far there have been few safe and economical large-scale applications.

"Red mud is a curse," Iannicelli observes. "There is no shortage of simple, ingenious solutions for dealing with most categories of environmental pollution, including red mud. The deciding factors on implementation are cost and safety."

Iannicelli's solution for red mud is to treat the abundant material with cheap sulfur compounds. Doing so locks in trace metals and improves the material's sorbent properties, he says, so it can be used for cost-effective wastewater treatment and in other environmental remediation applications. He calls the sulfidized red mud Azorb.

In the Bayer process, strip-mined bauxite is treated with hot caustic soda (sodium hydroxide), which selectively dissolves aluminum from an array of other mineralized metals. The end product is alumina, Al_2O_3, which is the feedstock for producing aluminum metal.

But for every ton of alumina extracted, more than a ton of red mud is produced. Bauxite processors recycle the caustic soda and pump the residual red sludge into huge settling ponds. When as much water is removed as possible, the material can be chemically treated to lower the pH and planted over with vegetation.

The scourge of red mud burst into the public's eye in October 2010 when a settling pond in Hungary ruptured. A flash flood of red sludge gushed through several small towns, killing 10 people by drowning and injuring more than 100 others by burning their skin and irritating their eyes and lungs.

Iannicelli isn't the first person to think about getting his hands dirty with red mud to help prevent such disasters. Australia-based industrial waste management firm Virotec has developed a process to neutralize red mud with copious amounts of seawater or brine. The resulting material is generally used to remediate mining sites, but it is also used as filler to make bricks and as a sorbent to trap metals and phosphorus in wastewater.

Aluminum producer Alcoa has a process to carbonate red mud using CO_2 from industrial gas streams. The resulting "red sand" is used to make cement and in road construction. Others have developed processes to recover iron and rare-earth metals from red mud. But so far, only 2 million metric tons of red mud is being repurposed annually—less than 2% of the amount being generated.

ONCE ALUMINUM is extracted from bauxite, the remains are a porous matrix of metals—a mineral skeleton, Iannicelli explains. As much as half of red mud is iron oxide, from which it gets its rusty color. Other major components include aluminum, silicon, titanium, calcium, and sodium oxides. The material includes trace amounts of other metals, including radioactive uranium.

With a high surface area, red mud is a natural sorbent capable of grabbing heavy metals and organic contaminants and sequestering them. But red mud can also leach toxic heavy metals, which is an environmental concern.

Iannicelli's sulfidation process involves treating red mud with sulfur compounds under ambient conditions or with mild heating. Any of a number of sulfur compounds will do the job, he says, including Na_2S, $(NH_4)_2S$, and H_2S. In the sulfidation reaction, sulfur atoms bind to vacant spots on metals throughout the skeletal network, locking the metals into place and preventing them from leaching.

Sulfidation also tunes the red mud so

that it has significantly higher sorbent capacity than untreated red mud, Iannicelli says. He has been testing Azorb's sorbent capabilities in side-by-side tests with untreated red mud using solutions of different metal salts.

Azorb removes better than 90% of most metals from aqueous solutions, Iannicelli says. His team has achieved better than 99% removal rates for metals of concern such as cadmium, chromium, lead, and mercury. The sulfidized red mud is not as efficient at removing arsenic, manganese, and strontium as red mud itself, Iannicelli says. But he suggests mixtures of red mud and sulfidized red mud might be an option for some applications. Once used, the material would be placed in a landfill.

"This work is certainly a very interesting study to detail the removal of a wide range of different species," says Justin Hargreaves, a chemist at the University of Glasgow, in Scotland. "Particularly interesting is that consideration has been given to the possibility of the red mud systems being sources of contaminants themselves and the application of sulfided and nonsulfided red mud combinations to optimize removal efficacies."

Hargreaves and his colleagues have been treating red mud with methane, a readily available by-product of oil refining and landfills. Red mud catalytically decomposes methane to form hydrogen and an iron-carbon composite. The Glasgow researchers think the inexpensive magnetic composite material could be used to remove impurities such as arsenic and chromate from drinking water in developing countries.

BY COMPARISON As a rule of thumb, 4 metric tons of bauxite yields 2 tons each of alumina and red mud, and in turn 1 ton of aluminum metal.

Global production in 2012, metric tons

Bauxite production	Alumina production	Red mud
258 million	101 million	120 million

1 ton of aluminum ≈ 70,000 cans

SOURCE: International Aluminium Institute

INTERNATIONAL ALUMINIUM INSTITUTE (BAUXITE, ALUMINA); SHUTTERSTOCK (CAN, RED MUD)

Iannicelli has also tested Azorb to clean up water discolored with natural dissolved organic compounds, such as tannins and lignin. This is a problem encountered when the effluent of pulp and paper mills is discharged into rivers. Although such water isn't always considered polluted, when water clarity is unnaturally impacted the effluent is in violation of the intent of clean water laws.

With that in mind, Iannicelli has shown that Azorb readily traps and removes discolored compounds from Okefenokee Swamp water. Iannicelli also has been working with Altamaha Riverkeeper, a nonprofit environmental stewardship organization that is concerned with discolored water in the Altamaha River, which drains central Georgia. The discolored water there mostly comes from a Rayonier wood pulp mill that manufactures cellulose fibers used in plastics and as an absorbent material in products such as diapers. In preliminary tests on the river water, Azorb removed the discolored compounds, Iannicelli says.

Iannicelli also owns a colonial-era rice plantation in Georgia. The plantation is no longer farmed, but it is home to a mobile home park that has its own wastewater treatment facility. As a licensed wastewater engineer, Iannicelli has carried out water treatment tests using Azorb. His team found that Azorb removes phosphorus and fecal coliform bacteria, the major contaminants of concern in wastewater, to below detection levels.

Not content to stop there, Iannicelli had technicians with the Jekyll Island State Park Authority in Georgia test Azorb on municipal wastewater. They obtained similar results, providing an independent confirmation of phosphorus and bacteria removal.

Iannicelli has also talked with scientists at a large coal-fired power plant about the prospects of using Azorb to remove mercury and selenium, the two metals of greatest concern in scrubber gas wastewater.

"There is a long history of attempts to

"Red mud is a curse."

reformat red mud for beneficial use, with none to my knowledge having proved successful on a large scale," says Ian T. Burke, an environmental scientist at the University of Leeds, in England. Burke remains skeptical that the abundant red mud can safely be used.

Last year, Burke led a team that took a look at three of the most hazardous trace metals in the Hungarian red mud: arsenic, chromium, and vanadium. The researchers found that arsenic and chromium are not in bioavailable states and posed low risk. But vanadium is in the bioavailable V^{5+} state and could be a long-term problem.

"MANY STUDIES that deal with red mud as an absorbent focus on the uptake of metals or nutrients," Burke continues. "But they do not give enough consideration to the quality of the treated water—that is, is it suitable for discharge to rivers?"

Burke also has questions about the long-term stability of new mineral phases in the sulfidized material and how it will hold up when used as a sorbent. "Much more detailed work seems to be required before this material could actually be used," Burke believes.

Futility has been the name of the game with red mud, adds geologist Katy Tsesmelis, a communications manager at the International Aluminium Institute. "We receive lots of project proposals that may have a sound scientific basis but could never be scaled up," Tsesmelis notes. She says there are also lots of attempts made to reuse red mud that never come to light. It's possible someone already tried sulfidized red mud.

But Tsesmelis emphasizes that the industry continues to invest in research. "The industry as a whole is working hard to remediate and reuse bauxite residue."

Iannicelli isn't discouraged by the lack of success so far in using red mud. He now has multiple patents for the sulfidation process and is eager to make commercial quantities of Azorb. He expects the cost to be as little as 10 cents per lb, less than half the cost of similar sorbents. And the first major application might be this year, cleaning up discolored pulp and paper mill effluent.

"I think the time is ripe to turn cheap red mud into an inexpensive material that can help solve some serious environmental problems," Iannicelli says. "I don't have all the answers yet. But as a chemist, I want to do good for the chemical industry," ■

Jackson, Galo

From: Jimmie Ann Abner [redacted]
Sent: Saturday, March 07, 2015 10:01 PM
To: Jackson, Galo
Subject: LCP CHEMICALS SUPERFUND SITE PROPOSED FOR THE MARSH

Dear Mr. Jackson,

I have lived on St. Simons Island, GA for over 30 years, which is only a few miles from the cleanup site, so I feel that I can speak as a "local" when it comes to writing to you about my concerns with the proposed cleanup plan of the LCP chemicals site.
I'll try to be brief.

1. What are your goals with the cleanup? Is it possible to have healthy wildlife, fish, and dolphins once you've finished with this work?

2. What happens with the site once you all have finished cleaning up your proposed area? Will you come back and test the area for the dangerous chemicals as long as there is still contaminants present?
This needs to be clearly stated in the proposal. If it's there, I haven't found it. You need to monitor this site; it's not fair to any of us who live here for it to be a one-time job. We desperately need this entire place cleaned up; not just a small area.

3. It is my understanding that the marsh around the site is contaminated with mercury and PCBs. If this is true, then all the marsh should be removed,

4. What is the medical risks to women as far as the continued contamination that you will NOT be cleaning up?

Please ask yourself if you would be willing to live anywhere near this site.

Regards,

Jimmie Ann Abner
[redacted]

Jackson, Galo

From: Albonanova [redacted]
Sent: Monday, March 16, 2015 12:14 PM
To: Jackson, Galo
Subject: GA

Dear Mr. Jackson,
Please make sure the EPA takes measures to thoroughly clean up the toxic chemical sites around Brunswick/Saint Simons Island that affect our rivers, Saint Simons Sound, the soil and ground/drinking water which spreads like underground rivers, and of course seriously affects our health and all children in the area.
Sincerely,
Virginia Balbona
Sent from my iPhone

Jackson, Galo

From: Janice Browning <[redacted]
Sent: Saturday, March 07, 2015 10:21 PM
To: Jackson, Galo
Subject: LCP Chemical site cleanup

Dear Mr. Jackson,

There are some concerns I have with the proposed cleanup at the contaminated LCP Chemical site.

I can't understand the longterm goals of your work.

> Are you only going to cleanup a small area within the poisoned, contaminated site?
> What is the point of only doing this area? The whole contaminated area needs to be cleaned up.
> I haven't seen where you will be back to monitor your work. You need to monitor this entire site for years.

I want to see healthy fish, dolphins, turtles, and animals freely roam this marsh and water. That is my goal and it should be EPA's goal also.

I am sincerely asking for long-term site monitoring; don't leave us high and dry with acres of still contaminated marsh and water.

As far as the thin layer cover, I think that's just a trick. Have you seen our strong tides? How could this possibly work for any length of time?

I have been a resident of St. Simons Island for a long time and consider myself as a very concerned citizen. Please reconsider your proposal and ask yourself is this really a credible cleanup of one of the most contaminated sites in the United States!

Regards,

[redacted]

Jackson, Galo

From: Janice Browning [redacted]
Sent: Sunday, March 08, 2015 8:40 PM
To: Jackson, Galo
Subject: more thoughts and concerns about the superfund cleanup site

Dear Mr. Jackson,

Yesterday evening I sent an email to you about LCP Chemicals contamination cleanup in Brunswick, Georgia. I have some additional thoughts and concerns.

Will the EPA require annual monitoring for mercury and PCBs in all the fish (whole fish and fillets) that people eat and also that dolphins, mink, raccoons, otters, estuarine turtles, snails, and fiddler crabs eat? If not, why not?

My next questions are:

What monitoring has the EPA conducted on a regular basis for the past 20 years?

What monitoring data is the EPA using to compare before and after the cleanup and coverup of the contamination?

When will the EPA evaluate the cleanup (dates for evaluation, and how frequent will the EPA evaluate), what will be the specific evaluation factors (numerical goals) and specifically what will be done if the numerical goals are not reached?

What will fiddler crabs do to the thin layer cap?

Thank you in advance for your time; I look forward to hearing from you with answers to all my thoughts and concerns.

Regards,

Janice Browning

30303893199

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the LCP Chemicals Superfund Site is important in helping EPA select a remedy for the site. Please use the space below to write your comments. Then fold and mail. A response to your comments will be included in the Responsiveness Summary, an Appendix to the Record of Decision.

Note: In order to permit the community ample time to review and comment on this Proposed Plan, a 30 day extension to the initial 30 day comment period has been allowed for, concluding the comment period on February 2, 2015.

Your 53 page proposal for long term monitoring "Chemical measurements in tissues of fish and shellfish" with nothing about monitoring dolphins! Putting a thin layer of sand was tried in Seattle Bay, Wash. & failed. After 20 years why are you giving such a short time period for the community to respond?

1/26/15 **NAME:** Penn Clarke

ADDRESS: PENN CLARKE
[redacted]

PENN CLARKE
Name [redacted]
Address [redacted]
City [redacted] State [redacted] Zip [redacted]

N METRO
GA 301
21 JAN '15
PM 1 1

UNIT POST.

FROM
CARR
USPS
TRK#: 70121010000071992936
RCVD: 01/23/2015 15:22

TO: JACKSON-VELASCO , GALO
BR: REMEDIAL
CUB: WEST
PCS: 1

,2 1010 0000 7199 2936

PLACE STICKER AT TOP OF ENVELOPE TO THE RIGHT OF THE RETURN ADDRESS. FOLD AT DOTTED LINE
CERTIFIED MAIL™

7012 1010 0000 7199 2936

Galo Jackson
Superfund Remedial Branch
Waste Management Division
61 Forsyth St., SW
Atlanta, GA 30303

FLR: 11 MSC: 1
JACKSON-VELASCO , G

Jackson, Galo

From: PATTI CLAUSON [redacted]
Sent: Monday, March 16, 2015 6:22 PM
To: Jackson, Galo
Subject: Clean up Brunswick/St. Simons please

Dear Mr. Jackson,
As a citizen and a resident of Georgia I urge to please clean up the toxic wetlands, rivers, waterways and surrounding land in the Brunswick area.
It is crucial to health of our children. We know that they are the most at risk for all of the obvious reasons. But the wildlife that you and I both admire and adore is not expendable.
Please commit yourself to reestablishing a healthy, clean environment.
Respectfully submitted,
Patricia Clauson

Sent from my iPhone

Jackson, Galo

From: WILLIAM D CORSON [redacted]
Sent: Tuesday, March 03, 2015 6:59 PM
To: Jackson, Galo
Cc: Glynn Environmental Coalition
Subject: Please make sure my homeland is protected

I was born in Brunswick in 1950. I lived in Glynn County until 1975. My parents bought waterfront property on the west shore of Blythe Island in the late 1950s. My wife and I now own the "old place" on Blythe. We vacation there often and look forward to flshing and crabbing. Growing up in a "Paper Mill" family, I am aware of the great contribution industry can make to a community. As a geologist for the US Army Corps of Engineers for 30 years, I have experience to know, industry has a responsibility to leave a community as clean as possible. Glynn county marshes were not polluted in the area LCP built before LCP and LCP should clean up to an acceptable, livable level before clean up efforts are stopped.

We are all stewards of this plant. Let us be good stewards.
Sam Corson
[redacted]
Brunswick, GA[redacted]
[redacted]

Jane Fraser
[redacted]

March 16, 2015

Galo Jackson
U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960
Jackson.galo@epa.gov

Mr. Jackson,

I am very concerned about the LCP Superfund Site documents NOT addressing the risks to a woman's health from the chemicals in the seafood. How these chemicals hurt the health of men and women is quite different, and it appears the EPA is using a "one size fits all" approach to human health and the cleanup at the LCP Chemicals Superfund Site.

At a minimum, the Human Health Baseline Risk Assessment should acknowledge polychlorinated biphenyls, also known as PCBs, and dioxin and furan chemicals are associated with women contracting endometriosis, a very painful disease. Very often, doctors perform a hysterectomy to prevent further instances of endometriosis along with removal of these growths in the abdomen.

The EPA extensively quotes a study conducted in the Brunswick, Glynn County area (DHHS, 1999), which found over 50% of the women surveyed had already had a hysterectomy. When considering the wide age range of women surveyed, this is a shocking statistic.

Will the EPA include information about how the chemicals at the LCP Chemicals Superfund Site can hurt a woman's health?

Will the EPA plan a cleanup that will reduce these chemicals to levels that will not cause endometriosis in women?

Will the EPA call in experts to assist the EPA in finding the level to clean up to that will end the risk of endometriosis from the LCP Chemicals Superfund Site?

The LCP Chemicals Superfund Site documenters do not appear to have any information about how the chemicals hurt woman's health. I have provided several references below for use in the EPA decision-making process and plan for cleaning up the marsh.

Will the EPA include these studies in the LCP Chemicals Superfund Site documents?

Will the EPA use these documents to plan a cleanup that not only protects men, but women, too?

Potera, C. Women's Health: Endometriosis and PCB Exposure. Environ Health Perspect. Jul 2006; 114(7): A404.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513298/
Toxicologist Elena De Felip of the Istituto Superiore di Sanità in Rome and her colleagues measured 11 PCB congeners that are most abundant in human tissue. In 80 women aged 20 to 40, the sum of all congeners was 1.6 times higher in the 40 women diagnosed with endometriosis than in controls. Three congeners, PCBs 138, 153, and 180, were particularly higher in women with endometriosis. These three congeners have been reported to have estrogenic activity and to interfere with hormone-regulated processes.
Bruner-Tran, K.L., Kevin G. Osteen, K.G., Dioxin-like PCBs and Endometriosis. Syst Biol Reprod Med. 2010 Apr; 56(2): 132–146.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2867352/
Specifically, if the majority of PCBs and other toxicants have limited activity, the TEQ may not correlate with disease status since a weak AhR agonist could limit the actions of a more potent compound. For example, using primary rat hepatocytes Chen and Bunce (2004) demonstrated that PCB 153, which binds the aryl hydrocarbon receptor (AhR) without inducing CYP1A1 transcription, has no impact on TCDD-mediated CYP1A1 induction when TCDD is present at low levels, but antagonizes the effects of a high dose treatment. Since PCB 153 binds the AhR, this ligand will compete with TCDD for available binding sites, resulting in antagonism when all sites are bound. If more binding sites are present than can be occupied by all ligands, no competition exists; thus, depending on the activity of all ligands, there may be an additive, synergistic or no change in effect.
Louis G.M., Weiner JM, et al. Environmental PCB exposure and risk of endometriosis. Hum Reprod. 2005 Jan;20(1):279-85. Epub 2004 Oct 28.
http://www.ncbi.nlm.nih.gov/pubmed/15513976

Conclusion - These data suggest that anti-estrogenic PCBs may be associated with the development of endometriosis.

Thank you for your consideration of these comments on the Proposed Plan for the LCP Chemicals Superfund Site marsh.

Sincerely,

Jane Fraser
[redacted]

Jackson, Galo

From: Jane Frase[redacted]
Sent: Monday, March 16, 2015 10:50 AM
To: Jackson, Galo
Subject: LCP Superfund-Women's Concerns

March 16, 2015

Galo Jackson U.S EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960
Jackson.galo@epa.gov

Mr. Jackson,

I am very concerned about the LCP Superfund Site documents NOT addressing the risks to a woman's health from the chemicals in the seafood. How these chemicals hurt the health of men and women is quite different, and it appears the EPA is using a "one size fits all" approach to human health and the cleanup at the LCP Chemicals Superfund Site.

At a minimum, the Human Health Baseline Risk Assessment should acknowledge polychlorinated biphenyls, also known as PCBs, and dioxin and furan chemicals are associated with women contracting endometriosis, a very painful disease. Very often, doctors perform a hysterectomy to prevent further instances of endometriosis along with removal of these growths in the abdomen.

The EPA extensively quotes a study conducted in the Brunswick, Glynn County area (DHHS, 1999), which found over 50% of the women surveyed had already had a hysterectomy. When considering the wide age range of women surveyed, this is a shocking statistic.

Will the EPA include information about how the chemicals at the LCP Chemicals Superfund Site can hurt a woman's health?

Will the EPA plan a cleanup that will reduce these chemicals to levels that will not cause endometriosis in women?

Will the EPA call in experts to assist the EPA in finding the level to clean up to that will end the risk of endometriosis from the LCP Chemicals Superfund Site?

The LCP Chemicals Superfund Site documenters do not appear to have any information about how the chemicals hurt woman's health. I have provided several references below for use in the EPA decision-making process and plan for cleaning up the marsh.

Will the EPA include these studies in the LCP Chemicals Superfund Site documents?

Will the EPA use these documents to plan a cleanup that not only protects men, but women, too?

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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1513298/

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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2867352/

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Louis G.M., Weiner JM, et al. Environmental PCB exposure and risk of endometriosis. Hum Reprod. 2005 Jan;20(1):279-85. Epub 2004 Oct 28.
http://www.ncbi.nlm.nih.gov/pubmed/15513976

Conclusion - These data suggest that anti-estrogenic PCBs may be associated with the development of endometriosis.

Thank you for your consideration of these comments on the Proposed Plan for the LCP Chemicals Superfund Site marsh.

Sincerely,

[redacted]

January 21, 2015

Mr. Galo Jackson
US Environmental Protection Agency, Region 4
Superfund Remedial Branch
Waste Management Division
61 Forsyth Street, SW
Atlanta, GA 30303

Good afternoon Mr. Jackson,

I'm writing on behalf of myself, my family, and our business, SouthEast Adventure Outfitters regarding the LCP Chemicals Superfund Site in the City of Brunswick, Georgia, and the Proposed Plan issued by the U.S. Environmental Protection Agency (US EPA) and the GA Environmental Protection Division (GA EPD) on December 4, 2014. Specifically, I'm requesting that the period for submitting public comment be extended at least sixty days.

Since 1996, this site has ranked as a high priority in terms of toxicity, and after so many years an increase in 60 days hopefully is not an unreasonable request. We'd really appreciate more time to review and assess the decades of collected data and the alternatives assessments that have informed the US EPA's Proposed Plan. I was raised in Coastal GA only miles from this site and am raising our two kids not too far away on St. Simons. For these and future generations we do appreciate your consideration.

Respectfully, please consider extending the public comment period by 60 more days for interested parties to have adequate time to respond with their written comments. This would create a new deadline for public comment of March 31, 2015.

Sincerely,

Michael Gowen

[redacted]

Copy:
Jeff Cown, Chief - GA EPD Land Protection Branch

Jackson, Galo

From: Marla Henderson [redacted]
Sent: Friday, March 13, 2015 5:33 PM
To: Jackson, Galo
Subject: Apologies....

My apologies Mr. Jackson, I meant to address you by your last name instead of addressing it to Mr.Galo (I do my best).
Thanks in advance for taking the time to read this letter. I think it will give you a clearer picture of what is happening in Glynn County.

Begin forwarded message:

From: Marla Henderson [redacted]
Subject: Brunswick Superfund sites
Date: March 13, 2015 4:22:57 PM CDT
To: Jackson.galo@epa.gov

Mr.Galo,

I want to thank you for turning your attention to such a serious situation that many have ignored for decades. I won't go into my entire personal history regarding being poisoned by these toxins because it would take pages, but will share a few of the highlights. I grew up near many of the SuperFund sites, and have been very sick from about the age of five on, and in my life I have had eighteen bouts of serious pneumonia, chronic leukemia, neurological issues due to chemical toxins in my brain, and many other serious diagnoses. I was in and out of hospitals…once having wires drilled into my head while awake (at the teaching hospital in Augusta, Georgia) because they were trying to find out why I was having seizures that started at twenty (I do not have epilepsy), their next step was to shave my head and insert a metal plate. An angel of a nurse came in and told me I should leave b/c they didn't know what was wrong with me and I was being used as a guinea pig! All the nurses worse suits like people wear at contamination sites because it was when AIDS was just coming to light, and they were concerned that is what i had, but of course I didn't thank goodness. Can you imagine the fear and grief I felt? I was the age of a college kid and my life was just supposed to be taking off. Then I ended up at the Boston Children's Hospital under the care of a John Hopkins trained doctor who was smart enough to realize I had chemical poisoning, so at the age of 20 (I had had to leave college because of being so sick) he sent my blood work to a lab specializing in chemical poisoning. They wrote him a personal note saying they had never seen such high levels of dioxin and mercury in a living human being, and it was a miracle I was alive. They didn't even know to test for toxaphene or other chemicals. I have been told the same by many doctors, even recently, that they were expecting me to pass at any time. I am a fighter, and although there have been many times I was so sick I wanted to die, I kept on for my family (who also have many health problems related to this situation) and for my Godchildren (one of whom grew up on Saint Simons Island and had leukemia at four, his Mother has had breast cancer, his Grandfather liver cancer, and Grandmother died from cancer that had spread all over her body. So this isn't an issue that just affects the poor or the African American community which many believe, it reaches even the wealthy on Saint Simons Island/Sea Island many of whom are unaware. I grew

up in Glynn County so I know all about racism/elitism and it disgusts me. I know that this is in part is what has stalled a thorough clean up.

I like everyone from the community do not want this issue to affect tourism, jobs or embarrass my hometown. Having said that, I care more about keeping people healthy, especially the children who have no voice. But if something is not done about this local scenario, it will eventually make its way into the larger public. I had a friend who was a producer on Oprah's show, she approached me and got us into the final five potential shows that would be airing before Ms.Winfrey retired from that job. The show was to be on the effect of chemical toxicity in the environment and its link to health. I have also been approached by 60 minute producers etc. I have spoken with Erin Brockovich. It is like a volcano that is waiting to blow. While some might not pay attention to sick humans, they do pay attention to tv, and also a place that has the most toxic dolphins in the world.
I would rather see this cleaned up quietly, I know many would prefer that as well. Before that time, there should be signs all around the rivers, land, buildings and notices should be sent to residents about the contaminated ground water until outside, knowledgeable and unbiased parties agree that the danger has been eliminated.

My paternal Grandmother worked in the shipyards during WWII as a way to help her country. I am sure she was exposed to God knows what and she died of cancer. My father has struggled with cancer as well.- He fished every weekend, often in Turtle River, while we played, packing the mud on our bodies like kids do, not knowing we were releasing poison into our systems. We had an entire freezer filled with fish, shrimp and crab that we ate on almost a daily basis. Because I had so many health problems, I tried to eat right/live healthy, exercise (when I was strong enough), and instead of drinking coca cola like most good Southerners, I drank water. Unbeknownst to me, I was drinking poison. We swam in the creeks, and took baths in this contaminated ground water. I also attended Altama Elementary school where it took thirty years after I had left for them to shut the school down because of the high levels of toxaphene STILL in the soil/water. To say this situation has affected my life adversely would be a gross understatement. It has kept me from having children which was my greatest dream, the financial stress was largely responsible for the dissolution of my first and only marriage, and I have spent just about every penny I have ever earned keeping myself alive. My insurance dropped me when I was in my twenties because the doctors could not figure out what was wrong until it was too late. It ruined my credit. That makes things very hard. I have spent years in and out of bed, often in a semi comatose state with all kinds of issues that I know relate directly back to a compromised immune system due to early childhood chemical poisoning, a time when my brain and body and many systems were still forming. I have tried to chelate the toxins out but they are so deeply embedded in my organs (I have been told by doctors) that I become deathly ill when an attempt is made (I tried anyway). I lost my business and all belongings recently which was devastating because I like to work, it is all I have in my life in many ways. As my body ages, it gets harder to stay well. This living nightmare has cost me almost everything, and while it is too late for me in many ways, it isn't too late to clean it up so that other local children won't suffer the way I have for 40+ years. Do you have children or grandchildren Mr.Jackson? I am sure you are someone who has a heart and compassion. If you can't do it for strangers, please think about the children you love and how you would want this to be handled to protect them from harm.

I am asking/pleading for you to help make this right. I have read over many comments that are being submitted, as well as the important questions you are being asked, that need to be answered honestly. I will not go there as surely this has been made very clear by others. I wanted to show you a personal side of this disastrous matter, in the hopes it will inspire you to do

what needs to be done to thoroughly clean this mess up, to not do it half way. I pray that the team of lawyers and PR people that the corporations have hired do not win this battle. It is wrong for them to even try. Money means nothing if you don't have your health. I learned that first hand. They would feel differently if it were their sister, mother, father, child who was sick. I will continue to follow what I hope is positive progress in this matter because besides me, there are many who have been affected.

Most Sincerely,
Marla Henderson

Jackson, Galo

From: Marla Henderson [redacted]
Sent: Friday, March 13, 2015 5:23 PM
To: Jackson, Galo
Subject: Brunswick Superfund sites

Mr.Galo,

I want to thank you for turning your attention to such a serious situation that many have ignored for decades. I won't go into my entire personal history regarding being poisoned by these toxins because it would take pages, but will share a few of the highlights. I grew up near many of the SuperFund sites, and have been very sick from about the age of five on, and in my life I have had eighteen bouts of serious pneumonia, chronic leukemia, neurological issues due to chemical toxins in my brain, and many other serious diagnoses. I was in and out of hospitals...once having wires drilled into my head while awake (at the teaching hospital in Augusta, Georgia) because they were trying to find out why I was having seizures that started at twenty (I do not have epilepsy), their next step was to shave my head and insert a metal plate. An angel of a nurse came in and told me I should leave b/c they didn't know what was wrong with me and I was being used as a guinea pig! All the nurses worse suits like people wear at contamination sites because it was when AIDS was just coming to light, and they were concerned that is what i had, but of course I didn't thank goodness. Can you imagine the fear and grief I felt? I was the age of a college kid and my life was just supposed to be taking off. Then I ended up at the Boston Children's Hospital under the care of a John Hopkins trained doctor who was smart enough to realize I had chemical poisoning, so at the age of 20 (I had had to leave college because of being so sick) he sent my blood work to a lab specializing in chemical poisoning. They wrote him a personal note saying they had never seen such high levels of dioxin and mercury in a living human being, and it was a miracle I was alive. They didn't even know to test for toxaphene or other chemicals. I have been told the same by many doctors, even recently, that they were expecting me to pass at any time. I am a fighter, and although there have been many times I was so sick I wanted to die, I kept on for my family (who also have many health problems related to this situation) and for my Godchildren (one of whom grew up on Saint Simons Island and had leukemia at four, his Mother has had breast cancer, his Grandfather liver cancer, and Grandmother died from cancer that had spread all over her body. So this isn't an issue that just affects the poor or the African American community which many believe, it reaches even the wealthy on Saint Simons Island/Sea Island many of whom are unaware. I grew up in Glynn County so I know all about racism/elitism and it disgusts me. I know that this is in part is what has stalled a thorough clean up.

I like everyone from the community do not want this issue to affect tourism, jobs or embarrass my hometown. Having said that, I care more about keeping people healthy, especially the children who have no voice. But if something is not done about this local scenario, it will eventually make its way into the larger public. I had a friend who was a producer on Oprah's show, she approached me and got us into the final five potential shows that would be airing before Ms.Winfrey retired from that job. The show was to be on the effect of chemical toxicity in the environment and its link to health. I have also been approached by 60 minute producers etc. I have spoken with Erin Brockovich. It is like a volcano that is waiting to blow. While some might not pay attention to sick humans, they do pay attention to tv, and also a place that has the most toxic dolphins in the world.
I would rather see this cleaned up quietly, I know many would prefer that as well. Before that time, there should be signs all around the rivers, land, buildings and notices should be sent to residents about the contaminated ground water until outside, knowledgeable and unbiased parties agree that the danger has been eliminated.

My paternal Grandmother worked in the shipyards during WWII as a way to help her country. I am sure she was exposed to God knows what and she died of cancer. My father has struggled with cancer as well. He fished every weekend, often in Turtle River, while we played, packing the mud on our bodies like kids do, not knowing we were releasing poison into our systems. We had an entire freezer filled with fish, shrimp and crab that we ate on almost a daily basis. Because I had so many health problems, I tried to eat right/live healthy, exercise (when I was strong enough), and instead of drinking coca cola like most good Southerners, I drank water. Unbeknownst to me, I was drinking poison. We swam in the creeks, and took baths in this contaminated ground water. I also attended Altama

Elementary school where it took thirty years after I had left for them to shut the school down because of the high levels of toxaphene STILL in the soil/water. To say this situation has affected my life adversely would be a gross understatement. It has kept me from having children which was my greatest dream, the financial stress was largely responsible for the dissolution of my first and only marriage, and I have spent just about every penny I have ever earned keeping myself alive. My insurance dropped me when I was in my twenties because the doctors could not figure out what was wrong until it was too late. It ruined my credit. That makes things very hard. I have spent years in and out of bed, often in a semi comatose state with all kinds of issues that I know relate directly back to a compromised immune system due to early childhood chemical poisoning, a time when my brain and body and many systems were still forming. I have tried to chelate the toxins out but they are so deeply embedded in my organs (I have been told by doctors) that I become deathly ill when an attempt is made (I tried anyway). I lost my business and all belongings recently which was devastating because I like to work, it is all I have in my life in many ways. As my body ages, it gets harder to stay well. This living nightmare has cost me almost everything, and while it is too late for me in many ways, it isn't too late to clean it up so that other local children won't suffer the way I have for 40+ years. Do you have children or grandchildren Mr.Jackson? I am sure you are someone who has a heart and compassion. If you can't do it for strangers, please think about the children you love and how you would want this to be handled to protect them from harm.

I am asking/pleading for you to help make this right. I have read over many comments that are being submitted, as well as the important questions you are being asked, that need to be answered honestly. I will not go there as surely this has been made very clear by others. I wanted to show you a personal side of this disastrous matter, in the hopes it will inspire you to do what needs to be done to thoroughly clean this mess up, to not do it half way. I pray that the team of lawyers and PR people that the corporations have hired do not win this battle. It is wrong for them to even try. Money means nothing if you don't have your health. I learned that first hand. They would feel differently if it were their sister, mother, father, child who was sick. I will continue to follow what I hope is positive progress in this matter because besides me, there are many who have been affected.

Most Sincerely,
Marla Henderson

Jackson, Galo

From: Jill Jennings-McElheney [redacted]
Sent: Monday, March 16, 2015 11:57 PM
To: Jackson, Galo
Cc: Mccarthy, Gina
Subject: Comments on LCP CleanUp

Dear Galo:

I am submitting these comments based on a newspaper article I read in January 2015:

http://america.aljazeera.com/articles/2015/1/12/georgia-pollutionlcpsuperfund.html

I am a Georgia native and reside in the Northeast part of the state. After my family and neighbors became victims of exposure from industrial waste that EPA egregiously and flagrantly misrepresented in HRS scoring in the 1990s, my 4 year old son was diagnosed with leukemia in 1998.

AFTER botched HRS scoring as an accepted pattern, and the negotiating of lives by EPA notated with "low target populations" justifying false scores to not trigger enforcement, my toxic residency in Athens, GA, and in other places like Asheville, NC/CTS are not cleaned up until victims come forth with their tragic stories. Then begins the behind closed doors remedial delays strategized and instigated by the perpetrators. The results are the same revictimizing of those who were violated by the agencies and poisoned by the industries. I doubt any rights through environmental regulatory have been afforded to victims of this nature in EPA Region IV.

At this time, I would like to submit my support for the clean up plan proposed by the Glynn Environmental Coalition.

I would also like to submit that victims' rights no longer be denied to families who have suffered at the hands of EPA botched HRS scoring followed by behind the scenes manipulation to delay site clean up. This unprofessional and unethical treatment of victims should cease immediately, and victims be afforded the rights to be fully disclosed and protected from deep pockets. The perpetrators should not be allowed to revictimize those they have externalized their waste upon.

Here is a list of victims' rights from the Department of Justice which should immediately be modified for the families who have tested for PCBs on Sapelo connected to this tragic two decade old violation of their human and civil rights.

http://www.justice.gov/usao/resources/crime-victims-rights-ombudsman/victims-rights-act

Thank you.

Sincerely,

Jill Jennings-McElheney

[redacted]

Jackson, Galo

From: Luanne [redacted]
Sent: Sunday, March 08, 2015 1:57 PM
To: Jackson, Galo
Subject: LCP Chemicals Superfund Site Proposed Plan for the Marsh

As citizens of Brunswick GA and a board members of Glynn Environmental Coalition we would like to ask for your attention to the subject project please. We are concerned that there are no measurable goals, timelines to reach goals or alternative plans to implement if goals are not reached. Goals should include seafood safe to eat, mink once again living at the LCP site and dolphins health improving.
Additionally, cleanup was based on a study with only 4 percent African American participants despite the indisputable fact that 70 percent of the population for 1.5 miles around the LCP site is/was African American.
The plan completely ignores the marsh grass that accumulated PCBs in the root, rhizome, stem, leaf and detritus and excretes Mercury.
The Plan ignores Dioxin/Furan contamination and all the past data in fish and sediments and argues it is not needed based upon observations from a lake 1,000 miles away in Syracuse NY!
Protection of people has been ignored for over twenty years. Totally ignored. Cleanup of all PCBs and Mercury is most necessary since the EPA has failed to show competence to implement recommendations issued by health agencies for the past twenty years.
We are confident that if you give this issue your consideration you will see that there is only way this project should progress if the interests and health of all living things are to be protected in a fair and just way.

Very truly yours,
Frank Lea
Luanne Lea
[redacted]

John R. McQuown
[redacted]

March 16, 2015

Mr. Galo Jackson, Remedial Project Manager
South Superfund Remedial Branch
U.S. EPA Region 4
61 Forsyth Street, SW
Atlanta, GA 30303-8960

Dear Mr. Jackson

The purposes of this letter are to request information, submit questions, and offer comments on the Propose Plan for the LCP Chemicals Superfund Site. I expect these and any responses to be included in the official records of the Plan.

My wife and I are residents of St. Simons Is. We look out our back window onto a marsh that protects our house from the Atlantic Ocean about a half mile to the east. I am retired from IT consulting that included many projects for clinical trials of drugs. In a previous part of my career, I helped lead the founding of the Illinois EPA. I later prepared and presented testimony on several issues before the Illinois Pollution Control Board. I don't have the expertise that you and your staff do but I am an informed citizen on many issues involved in the LCP Site Plan.

I attended the first Public Comments session you held in Brunswick last November. I have studied the Proposed Plan documents as well as the materials submitted to you by Daniel Parshley for the Glynn Environmental Coalition (GEC). I have three topical areas to cover in this communication:

- The GEC's responses to the Plan;
- The hydrodynamic model(s) used in the Plan;
- The economic issues raised by the Alternatives in the Plan.

The GEC Submissions

I full-heartedly endorse the submissions of the GEC and Mr. Parshley. They are supported by years of experience in the field, the area, and the specific LCP Site. They reflect current and well gathered data and applicable published research. They provide important, even critical, considerations and corrections to the Proposed Plan. With these inputs, you should be able to make needed amends to the Proposed Plan. The pollutants involved will outlast you and I by several generations. Therefore, we should be working together to protect this environment.

The Hydrodynamic Model (HDM)

In the initial version of the Proposed Plan, there were a couple of off-hand mentions of such a model. In the Public Comments meeting, both you and one of your staff present indicated that you used a hydrodynamic model to test the proposed and recommended remediation design. I questioned this

model and you indicated it was standard for EPA. I expected that the follow-up from the meeting would provide details but, so far, nothing has shown up.

The EPA Region IV website provides only two such models. Both are supposed downloadable from the site. One is one dimensional, according to the site. The other is supposed to be one, two, or three dimensioned according to the model user's selection. One model is validated by two western Georgia rivers while the other is validated by a North Carolina river that flows into the Atlantic Ocean without any indication of a mediating tidal Spartina marsh. It appears, therefore, that the hydrodynamic models available to EPA are of little or no applicability to the LCP site. ***Is this the correct situation?***

In my career, I have used many and written some quantitative, statistical models. To use a model, it is necessary to identify the model's authorship, ownership, and the revision level used. ***What is the pedigree and version of the HDM(s) used in the Proposed Plan?***

Whenever I've used a model formally, including in court testimony and published research reports, I have always taken pains to itemize the parameter settings and the data fed into produce the reported results. For example, you might have set minimum and maximum air temperature parameters and used a set of Weather Bureau temperature data to run the HDM for the Plan. ***What were the parameters used and what was the data set(s) used in the HDM to test the recommendations?***

The Proposed Plan shows several maps of the LCP site and its surroundings to show where core samples for different pollutants were taken. I believe that sample sites numbered in excess of 80. ***Were the sample sites predicted by the HDM's estimate of where pollutants spread since the initial remediation? Is this why the sampling was performed at the LCP site? If so, how well did the HDM predict the spreading? If not, why not?***

The remediation for the LCP site will need to address the long run effects, likely for century or more. ***What does the HDM predict into the long future? What time horizons have been tested on the HDM? Will the results be reported in the Final Plan document?***

Based on the HDM modeling, how complex and how frequent will future sampling be required?

While the Glynn coast has tended to be missed by many hurricanes, sooner or later it will be hit. When it is, it could get hit by a "perfect storm" – a nor'easter and a hurricane. The storm surge could be awesome. If such a surge coincides with high tide, there will be major effects deep inland. ***What does the HDM predict will be the pollution outcomes of such a storm? How will the capping and anchoring of the Proposed Plan hold up?***

The Economic Considerations

The Proposed Plan offers six Alternative remediation scenarios and recommends #6. Yet, it appears that, ignoring #2 – the all-out costly option, the highest cost is only a quarter more than #6 ($28M → $34M). This appears to provide remediation of three times more polluted area, up to 48 acres. ***Why was the cheaper Alternative selected when a cheaper per acre option would provide more remediation?***

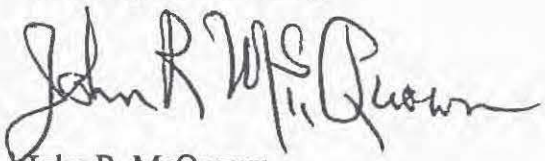
The Proposed Plan does not seem to address the social and governmental issues to sustain coping with the continued effects of polluting sediment at the LCP site. The only mentions of social adaptation are a) to put signs around the capped area and b) to put Do-Not-Eat warnings on the fishing website. ***Who is going to check and maintain the signage? Who is going to remind DNR to keep warning fishermen?***

Proactive steps should be provided for, as well. For example, EPA address the Brunswick City Council and the Glynn County Commission after each general election that the LCP site is hazardous and not used for recreation or development. Likewise, police and game wardens need to be regularly reminded of the dangers. Perhaps, these could be done on a two year cycle.

Sampling needs to be done to check that the remediation is working. This could be on a four or five year cycle. Superfund money should be allocated but it would be more sustaining if the State carried out the sampling. In any case, the results should be reported to the public with each cycle.

To conclude, thank you for your attention to these points. And thank you in advance for your responses to my questions and your follow thru to perfect the Plan. It is sad that earlier generations so abused the rich resources and beauty of this environment. Together, we can do better.

Sincerely and cordially,



John R. McQuown

cc: D.Parshley, GEC

Jackson, Galo

From: Clay Montagu[redacted]
Sent: Sunday, March 15, 2015 4:37 PM
To: Jackson, Galo
Cc: Satilla Riverkeeper; gec@glynnenvironmental.org
Subject: Questions Pertaining to the Proposed LCP Superfund Cleanup

08 March 2015

Mr. Galo Jackson, Project Manager
Environmental Protection Agency
61 Forsyth Street
Atlanta, GA 30303

Dear Mr. Jackson:

I have a number of questions listed below that pertain to the planned cleanup of the LCP Superfund Site in Brunswick, Georgia. I live on the nearby Satilla River estuary. I am an estuarine scientist and university professor, and I have substantial concerns about impacts of the LCP site on the people that live with the contamination. Moreover, it is apparent to me that contaminants from the LCP site can connect widely through hydrology, sediment transport, and fishery resources.

Earlier I shared the questions below with the Satilla Riverkeeper and the Glynn Environmental Coalition, two environmental groups with a history of involvement with the LCP site. However, I now understand that you are the correct "point person" for the EPA, so I'm submitting them directly to you during the ongoing public comment period scheduled to end on March 16th.

I have reviewed the following two documents pertaining to the EPA's plan to address contamination at the LCP Superfund site in Brunswick, Georgia:
1) U.S. ENVIRONMENTAL PROTECTION AGENCY SUPERFUND PROPOSED PLAN, LCP CHEMICALS SUPERFUND SITE. OPERABLE UNIT 1
2) BASELINE ECOLOGICAL RISK ASSESSMENT FOR THE ESTUARY AT THE LCP CHEMICAL SITE IN BRUNSWICK, GEORGIA

Listed below are eight sets of related questions from me. I hope you can help with the answers.

1) What assurances can be given that capping contaminated sediments in place (rather than removing them) can withstand storm intensities at least comparable to that required for coastal construction? Does storm preparedness for coastal construction require structures to withstand FEMA-determined flood levels, and 120 mph wind speed? What similar storm preparedness standards will be required for the capping project?
Even with capping, might a storm with upland flooding and 120 mph winds suspend contaminated sediments in the LCP-contaminated sediments and spread them over the upland landscape into residential neighborhoods and businesses? During a flooding storm, would contaminated sediments settle onto roadways, where they could be further spread on the tires of roadway traffic, and suspended as dust into the air? Will construction criteria for a contaminant cap include even stricter minimum storm standards (based on higher flood levels and more powerful winds) in order to address the public risk of contaminant exposure during and after a storm? If a storm penetrates the cap, would contaminants spread far and wide once a bolus of contaminated sediments is suspended in coastal waters? Could any and all of the contaminants be spread by a storm, including mercury, lead, Aroclor 1268, PCBs, PAHs, dangerous dioxins, and others? If not, which would not be spread by a storm?

2) What warning signs have been posted in the estuary and at boat ramps to keep people from consuming fish and shellfish in the vicinity of the LCP site, and to keep boaters and swimmers from coming into contact with contaminated sediments? Who is responsible for these signs?

3) Are contaminated crabs still entering the public food supply? Are the sets of floats that are sometimes visible in waters adjacent to the LCP site from commercial or residential crab traps?

4) Have the people most likely to have been contaminated by LCP-tainted seafood been tested? Have sufficient numbers of people been tested for LCP contaminants? Has testing included those who eat large amounts of fish and shellfish from St Andrew Sound, Jekyll Sound, Jointer Creek, Christmas Creek, and the Satilla River estuary? Does the spin of the Earth (Coriolis effect) tend to turn local river discharges southward, which over the decades could have put contaminated sediments suspended at the LCP site into these areas, and along the beaches of Cumberland Island and into Christmas Creek? How many people have consumed large quantities of fish and shellfish from those waters during the decades of contamination at the LCP site? Has an effort been made to warn those people and to suggest that they be tested?

5) How is it known that only 81 acres of the 670+ acres of marshland at the LCP site is in need of remediation?

6) Is it true that 33 of these target 81 acres were not chosen for remediation because of concern over temporary damage to restorable marshland? If these 33 acres were included despite the damage to the marsh that might result, how would the amount and time frame of damage to the marsh compare to the risk to people that remains from leaving LCP-contaminated sediments in those 33 acres? Has this comparison of risk been the subject of a scientific risk assessment?

7) Among the contaminants allowed to remain in sediments at the LCP site, are any mutagenic or teratogenic, as well as carcinogenic? If so, what will be the risk of mutations and birth defects from human exposure to LCP-contaminated sediments, water, or seafood collected from impacted waters?

8) After the selected remediation process, what lasting risks to human health will remain? Who will be responsible for these and what remedies or recourse will they have? How safe will the environment be?
Will children be safely able to swim and boat in Purvis Creek or in the nearby open waters of Gibson Creek and Turtle River? Will people be able to safely eat fish and shellfish caught in the vicinity? Will warning signs be needed, and if so, who will be responsible for the warnings?

Please feel free to share these questions among those at EPA who might be able to answer them. I look forward to your reply.

Yours sincerely,

Clay L. Montague

--

Clay L Montague, PhD
Associate Professor Emeritus (Systems Ecology, Coastal Ecology) Howard T. Odum Center for Wetlands Department of Environmental Engineering Sciences University of Florida, Gainesville

Mailing Address: [redacted]

Jackson, Galo

From: Kyle O'Keefe [redacted]
Sent: Monday, February 09, 2015 11:03 AM
To: Jackson, Galo
Subject: Glynn County

I urge you to take every measure to clean up the toxic mess that has been made of my beautiful childhood home. It is disgraceful what companies like LCP have done. I will be keeping an eye on the situation and spreading the word reporting your success in this matter. Thank you

Jackson, Galo

From: Carolyn Rader [redacted]>
Sent: Thursday, December 04, 2014 5:43 PM
To: Jackson, Galo
Cc: Carolyn Rader ([redacted])
Subject: Comments on the EPA proposal to clean up the Brunswick Superfund Site

Dear Mr. Galo,

I will not be able to attend tonight's hearing in Brunswick but I would like to submit comments in lieu of attendance in person. For many years I have been aware, through various organizations such as the Georgia Environmental Project led by Dr. Olin Ivey, in uncovering this toxic mess, and I am shocked to learn that the harmful impacts of this illegal and immoral dumping of toxic waste extends far beyond what was previously known or understood.

I have not had time to perform my own research or delve into the details but I would like to look up the work of the scientists at the Marine Institute because I recall that several papers were published on the heavy metal contamination in the salt marshes and estuaries around the Sapelo and the effects on oysters and other sea and marsh life. Their research on industrial and man-made pollution into the coastal water bodies led to the formation of the Marshlands Protection Act and other important legislation protecting Georgia's coastal resources. I lived on Sapelo in the 60s and early 70s so I am also concerned as to what extent I or my siblings were exposed to these chemicals at an early age in our development.

The Center for a Sustainable Coast is the premiere, scientifically backed environmental advocacy and policy organization for the Georgia Coast. My father, Dr. Jim Henry, the former director of the Marine Institute on Sapelo, and professor emeritus University system and Skidaway Island, was a founding member. I highly recommend that the comments you receive from David Kyler, the Center's director, on EPA's proposal for the Superfund site clean-up are taken very seriously and followed closely.

Thank you,

Carolyn Henry Rader

[redacted]

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Please consider expanding the current effort to clean up the Site of the former LCP Plant in Brunswick, GA.

We believe the area of contamination is far beyond your existing plan.

Joan + Charles Shellito

[redacted]

Brunswick, GA [redacted]

USE THIS SPACE TO WRITE YOUR COMMENTS

Your input on the Proposed Plan for the LCP Chemicals marsh important to EPA. Comments provided by the public are valuable in helping EPA select a final cleanup remedy for Operable Unit 1 of the Site.

You may use the space below to write your comments, then fold and mail. Comments must be postmarked for receipt by EPA no later than February 2, 2015. If you have questions about the comment period, please contact Mr. Galo Jackson, 404-562-8827. Those with electronic communications may submit their comments to EPA at the following email address: jackson.galo@epa.gov on or before February 2, 2015. **Note: In order to permit the community ample time to review and comment on this Proposed Plan, a 30 day extension to the initial 30 day comment period has been allowed for, concluding the comment period on February 2, 2015.**

One would think that an agency of the Federal Government has the resources and capacity to update public communications. The failure to do so is indicative of the general disregard exhibited towards the public by the regulatory agencies. This is not new. If the general welfare of the people and the health of the environment had been properly valued long ago we would not now be dealing with accumulations of toxic wastes and a poisoned atmosphere.

That the fish are not fit to eat, the waters are not clean enough to drink and the air to breathe is unconscionable. Issuing advisories to the public that they should stop eating, drinking and breathing is unacceptable as unacceptable as the Republican health care plan to "die quickly."

A society which permits its members to die in the prime of life will not long survive.

Also, since mobility is one of the essential characteristics of organic existence, precluding human access to a particular terrain is not "protective."

The LCP Chemical site is contaminated. The contamination needs to be removed.

Name MONICA SMITH

Address [redacted]

City [redacted]

State GA

Zip [redacted]

10989553

Introduction

I am a former employee of the Environmental Protection Agency Headquarters and worked in the Office of General Counsel as a secretary between January 1977 and June 1978. My boss was Joseph Zorc who was an Assistant General Counsel responsible for the grant appeal process re Wastewater Treatment Plants. This is where I learned about the Superfund process. When I told him I was moving to Brunswick, Georgia he recommended I seek employment with Bishop & Bishop law firm. The only thing I recall him sharing with me about the Brunswick area was that they wanted to build a causeway from the North end of St. Simons Island through protected marshland (Jimmy Carter from Georgia served from 1977 to 1981 and the marshlands were being protected.) I gathered from what he said that it was never going to happen.

History

When I told my father, Richard L. Strong, Command Sergeant Major, U. S. Army that I was moving to Brunswick, Georgia he said "Isn't that the place that stinks?" I didn't know at the time, but it turns out he was right. Even so, I had just been working for the Environmental Protection Agency and knew there were laws in place to protect the citizens so I didn't worry about it.

Subconsciously I must have worried. When my husband, Donald Parkhurst, who worked for the Federal Law Enforcement Training Center (FLETC), and I looked for a house we told the realtor that we wanted to live far enough away from Hercules that we didn't have to smell it. We ended up on the north end of Glynn County just before the Altamaha River. The area north of us is the marshland that Mr. Zorc was referring to where they wanted to build a causeway.

My first child, Jody Rae Parkhurst, was born February 18, 1980. She was over a month overdue, but I didn't have any warning ahead of time that she would be born with birth defects so severe that the doctors at Shands Hospital in Gainesville, FL would later tell me that there had only been about thirty babies in history with similar conditions that had lived . . . the doctor in Brunswick said that she should have been a miscarriage. She died when she was eleven days old on February 29, 1980 from renal failure. About three days after her funeral the EPA shutdown the Hercules 009 Superfund site. I started following and clipping articles about toxic sites in Glynn County. What really surprised me at the time was that I could live in Brunswick, Georgia for a year and a half and never hear anything about polluted sites from friends, at college or at work.

In August of 1981 I was at the movies at Lanier Plaza next to the Hercules plant when I passed out. An ambulance was called; the emergency medical technician who checked me out said that I had probably just cut off my circulation from sitting too long – I was nine months pregnant and was not transported. I should have realized when I left, and there was a young boy in the lobby having a seizure, that I had been exposed to something through the ventilation system. It wasn't until that child's permanent molars came through without enamel, and I was told that it was probably something that happened right before she was born or when she was

very young that caused it, that I thought I had been exposed to something through the ventilation system. In those days our only two theaters in Glynn County were the one at Lanier Plaza and the Drive-in next to LCP, which I also went to.

I encountered a lady in the Kroger's grocery store. Who asked me what stunk. I told her what I believed at the time – Hercules, but it could have been the pulp mill. She was from up North and wanted to know what the community was doing about it. I started listing out all the reasons I had heard over the last couple of years about why nothing was ever done about it . . . jobs, retaliation, etc... And, then she asked me why I wasn't doing anything about it and I didn't have an answer. I of all people, have a reason to do something about it. And, so I have tried.

I attended what I believe was the first public hearing on the 009 site and was surprised when the EPA would not accept the autopsy report on my daughter, Jody, because it would violate her privacy. I remember saying to the audience that now we know why EPA doesn't have any reports of problems associated with the site because they won't accept them when people try to hand them to them. I wanted to give the report to her because I did not think they would associate her condition with the site because my address at the time was north Glynn County. But, when she was conceived I lived in an apartment on Altama Avenue less than a mile from the site; and, met a carpool at Lanier Plaza next to Hercules to commute to Kings Bay to work. The next speaker after me was an instructor at the Federal Law Enforcement Training Center, where I worked at the time, who had recently had a baby born without kidneys and had died. Apparently I forgot to identify myself when I spoke, so she identified me for EPA (and I had signed in). But, on the transcript my name was spelt wrong [it was Deborah Parkhurst at the time]. This meeting was the first time I had encountered Dr. Pegg who was the technical advisor for the Glynn Environmental Coalition. I already knew who Daniel Parshley was because I worked for the Deputy Director of the Federal Law Enforcement Training Center and recognized his name as a role player working for a contractor at FLETC.

By the time I attended the 009 Superfund Site hearing I had, had three more daughters who appeared healthy based on prenatal screening and at birth. They were bused to Burroughs-Molette Elementary School at 1900 Lee Street, Brunswick, Georgia 31520 which is less than a mile from the Hercules plant. Other than the fact that my first daughter had to be at the bus stop at 7:00 a.m.; and, had to ride through the Marshes of McKay neighborhood before heading to Burroughs-Molette; and, that she typically threw up on the bus when she passed the Hercules plant; and, often arrived at school late after 8:00 a.m. Besides all that she basically adjusted well. Not long after she started school my third daughter started a pre-school nursery program at Brunswick High School which I think was less than a mile from the LCP site and Georgia Pacific Pulp Mill (as the crow flies). It wasn't until my children started school that I realized how sick our community was. By the time the third child started at Burroughs-Molette there was a kindergarten teacher, Johnny Falstrom [from memory], who died of cancer. And, the fourth daughter was starting at the Brunswick High nursery school where the teacher, Mrs. Vaughn, had cancer. When she started high school there years later her social studies teacher who was the Georgia teacher of the year two years in a row had cancer.

Around this time there was an Office of Civil Rights (OCR) Complaint filed by a group I was a member of – Positive Action for Children and Teachers (PACT). The complaint was alleging racism regarding busing and how handicapped students were being served. The OCR agreed to investigate. One of the leaders who signed the initial complaint, Sandy Rumanek, told me that she was contacted and told that they had a limited budget and she should select one or the other for them to investigate. She told me they dropped the part about the handicapped students. The investigation was enlightening. At that time, St. Simons Elementary School on the island had televisions in the classroom (Which we thought was an advantage because they were not teaching reading phonetically so it helped to see the words of what was being said on closed caption.) ; Burroughs-Molette did not have televisions until right before the investigation; and then they weren't hooked up. At any rate, one of the investigators called Sandy to say that the report he submitted was not the one that she would be receiving and that he had resigned. The OCR did not find racism.

Like so many of the people in Glynn County who try to make a difference and can't, she moved. We had been attending school board meetings for a while and one of us had to run, so I did and won. The night before the election my dad called me to tell me he had cancer. I had been putting together what I had learned about the schools and their bussing and what I knew about the environmental hazards in the community and I concluded that there was environmental racism going on. I didn't want to file a complaint at that time because I didn't want to be tied up with that when my dad was dying. He died on April 1, 1993 from Agent Orange; something he was exposed to in the Vietnam War. I hear it was produced at Hercules in Glynn County. I filed a complaint with the OCR in Atlanta, but they selected not to investigate. So I filed a complaint with the Department of Justice alleging environmental racism and they did investigate. They intervened in the bankruptcy hearing which prevented LCP from being able to sell the plant which lead to their shut down. The Department of Justice never came back and told me that they found environmental racism, but the Atlanta Constitution Journal ran a story on Tuesday, December 28, 1993 by David Pace of the Associated Press entitled *Toxic hazards found worse near homes of blacks, poor* where he wrote:

> In Georgia's most polluted community, encompassed by the Brunswick ZIP code 31520, five plants spewed out 6.3 million pounds of 27 toxic chemicals in 1991. A little more than 21,000 people live in the area, half of them black and nearly a quarter below the poverty line.
>
> Among the chemicals released into the air, land and water in 1991 were 922,000 pounds of acetone and 523,390 pounds of chloroform, both known carcinogens, and 213,500 pounds of xylene and 52,000 pounds of methylethyl ketone, both of which are suspected of causing birth defects.

Over the years, I have followed the toxic sites in Glynn County and attended the public hearings that I was aware of. I served on the Glynn Environmental Coalition for four years after I got off the school board. I didn't always agree with Daniel Parshley and was very disappointed when Dr. Pegg told me in July 2009 that Daniel had fired him for not being responsive to emails. He said Daniel was sending emails to his old fccj.edu address, but the college name had changed

and he had told him that it was now fscj.edu. I could not imagine how a new technical advisor could ever get up to speed with everything that had happened over the past ten years or more. I attended one of the meetings where the new technical advisor was introduced and was surprised to see so many in attendance. Several introduced themselves as being with the role players at FLETC.

I attended the December 4, 2014 public hearing about the proposed plan for Operable Unit 1; there was a meeting prior to the EPA hearing for the Glynn Environmental Coalition which I attended. At that point, it was hard to judge how effective the new technical advisor was, but once in the hearing the audience was bringing up things that Dr. Pegg could have spoken to because he attended the meetings with ASTDR, but the new technical advisor was not able to speak to. I left the meeting happy about the attendance and the fact that Mr. Killian had spoken up on behalf of our future grandchildren, but bewildered. After all in the beginning when people brought up wildlife that would be affected they talked about wood storks not dolphins. There is a big difference. One was protected at the time the plant was closed down and the other wasn't. It's bad enough that the federal judge dropped the wood stork charges in the federal hearing, but does the EPA have to forget about them too?

Conclusion

I read all 50 pages of the proposed plan and I believe the EPA did an excellent job explaining the process and explaining their rational for the preferred selection. But, I have also participated in decisions regarding contaminated school grounds and the other toxic sites in Glynn County and it seems like we never get a cleanup, we get a cover up. I thought just this one time we could actually get a cleanup. I prefer Alternative 2. I agree with Mr. Killian who cited concerns for future generations. I have read a book called *Now That You Know* by McGregor Smith, Jr. that talks about *The Seventh Generation Test* in Chapter 1, page 3:

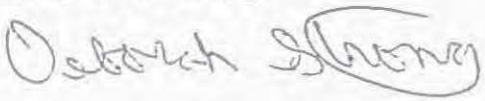
> The Council reviewed decisions made by the chiefs. The old women sat in a circle and applied what they called "the Seventh Generation Test." They did not debate. They sat in silence and pondered the issue presented to them. Their question was simple: **"How will the decisions made by our chief affect our children seven generations into the future?"**

I'm asking you to review your decision and ask yourself the same question. Why should you do that? Because I believe the public participation component of the process has been compromised by the multiple changes in site manager for the LCP superfund site and the replacement of our technical advisor ten years into the process. I also believe that the whole purpose of the technical assistance grants in the superfund process is so that the community can be represented between industry and government. In this case, the government hasn't helped us. The federal judge dropped the woodstork charges in the LCP conspiracy prosecution [which I believe he did because if they prosecuted LCP for it they would have to prosecute all the other industries in Glynn County that were violating it.]. The Georgia EPD was responsible for enforcing the environmental laws in Georgia when these violations occurred. Of course they will go along with what EPA wants. Some of the lead we are talking about cleaning up

might actually have come from the Glynn County Firing Range next to the site. The Navy had permits at Glynco to pollute the Altamaha-Brunswick Canal, an historic site which has not been considered in the cleanup.

Another way I believe the community has suffered and will continue to suffer with the proposed cleanup is with health insurance. When we apply for insurance we are asked three questions: 1) how old are you, 2) do you smoke or have you smoked within the last however may months or years, and 3) where do live. The last question factors in to how much we are charged for insurance and one of the things insurance companies take into consideration is the health status of the community. If the poison remains at LCP we will likely be charged more money to be insured. Which is just wrong since we paid for state and federal regulators to administer the environmental laws; and, we are punished by being sick or having babies with birth defects and we are punished again in attempt to stay healthy.

Deborah Ann Strong



Jackson, Galo

From: Wilson [redacted]
Sent: Sunday, March 15, 2015 9:22 PM
To: Jackson, Galo
Subject: Brunswick/St.Simons Isl. River Clean Up

Mr. Jackson, please make sure the EPA takes measures to thoroughly clean up the toxic chemical sites around Brunswick/Saint Simons Island Georgia that affect our rivers, Saint Simons Sound, the soil and ground/drinking water which spreads like underground rivers, and of course seriously affects our health and all children in the area.

Sincerely,
James Wilson Patrick

#1

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,
[redacted]
[redacted] Rd
Brunswick, Ga
31523

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

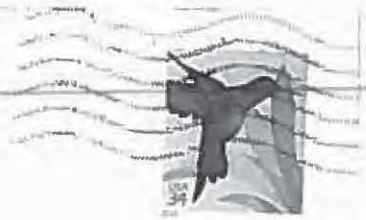
Signed,
[redacted]
Brunswick, GA 31520

TO:
Galo Jackson
Environmenl
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

10989551

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,
Jeremy Cook
BWK GA
3520



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,
Alice Vick
[redacted]
Brunswick GA
31523

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,

Wesley Deverger

[redacted]

Townsend, GA 31331

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

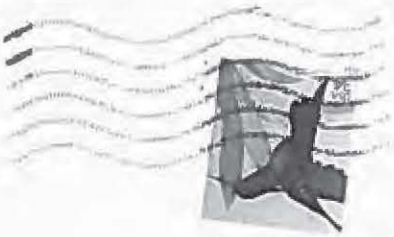
Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,

Helen Jackson

[redacted]

Brunswick, GA 31520



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

08893193

Cleanup of the LCP site will not be complete until toxins from the contaminated marsh are removed from our food chain.
I want to know that the seafood and the water in my community are safe for my family and me.

Signed,

Tavan Sage

[redacted]

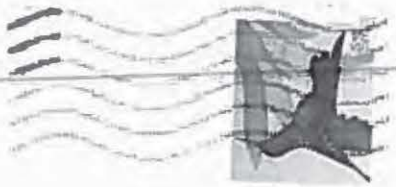
Brunswick, GA
31520

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

#2

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Chuck Latham
[redacted]
Brunswick, Ga. 31520



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Scott Smith
[redacted]
Brunswick GA 31520

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

10989552

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Valerie Ann Cook
BWK GA 31520

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Cheri Knight
[redacted]
Brunswick, GA 31520

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

03893199

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,

[redacted]

BWK, GA 31520

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,

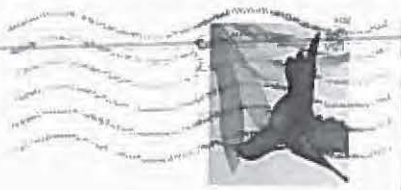
Linda Cook

BWK GA 31520

Galo Jackson
Environmental
Protection Agenc
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Shirleen Thomas
[redacted]
BWK. GA 31525



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

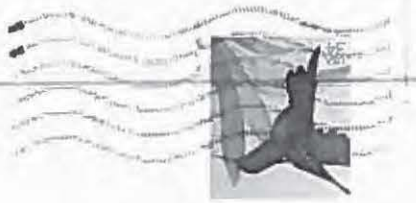
Signed,
Debra Patterson
[redacted]
Brunswick, GA. 31523

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

10989199

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

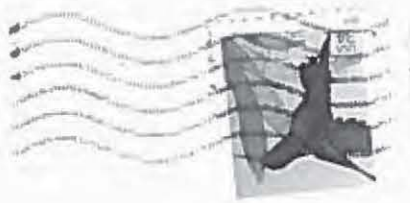
Signed,
Mishaynda Wooten
[redacted]
Brunswick GA 31520.



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
[redacted]
Brunswick, GA 31520



TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

10389199

The proposed remedy to cleanup the LCP site is not enough to remove toxins from the contaminated marsh.
I want a remedy that cleans up our food chain and ensures the health of my children.

Signed,
Barbara Miller
[redacted]
Brunswick, GA 31523

TO:
Galo Jackson
Environmental
Protection Agency
61 Forsyth Street
Atlanta, GA 30303

TO: GALO JACKSON
ENVIRONMENTAL PROTECTION AGENCY
61 FORSYTH ST
ATLANTA GA 30303

CLEANUP OF THE LCP SITE WILL NOT BE COMPLETE UNTIL TOXINS FROM THE CONTAMINATED MARSH ARE REMOVED FROM OUR FOOD CHAIN.
I WANT TO KNOW THAT THE SEAFOOD AND THE WATER IN MY COMMUNITY ARE SAFE FOR MY FAMILY AND ME.

NAME	ADDRESS
Margaret Wheet	
Madeline Smith	
Sarah McInnis	
Amanda Kline	
Beth Barber	
Drew Weldon	
Becca Bartlomek	
Rachel Brand	
John Mahas	
Jeremy [illegible]	

RESPONSIVENESS SUMMARY

ATTACHMENT 3

Transcript of the December 4, 2014 public meeting

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4

LCP CHEMICALS SUPERFUND SITE *
*
PROPOSED PLAN PUBLIC MEETING *
*

Brunswick Glynn County Library
208 Gloucester Street
Brunswick, Georgia

Thursday, December 4, 2014
6:02 p.m. - 8:00 p.m.

P R E S E N T:

ANGELA R. MILLER
EPA Community Involvement Coordinator

GALO JACKSON
EPA South Superfund Remedial Project Manager

MARK SPRINGER
EPA Environmental Response Team

KEVIN P. KOPOREC
EPA Human Health Risk Assessor

SHARON R. THOMS
EPA Ecological Risk Assessor

DERECK MATORY
EPA Region 4 Section Chief

STACEY A. HAIRE
EPA Site Attorney

Gilbert & Jones
Certified Court Reporters

P.O. Box 1894 (31521)
1607 Norwich Street
Brunswick, Georgia 31520
(912) 264-1670

gilbertandjones1@bellsouth.net

P. O. Box 14515 (31416)
7505 Waters Avenue, F3
Savannah, Georgia 31406
(912) 355-0320

P R O C E E D I N G S

* * *

MS. MILLER: Good evening. For the sake of time we're going to go ahead and get started. I know people are still signing in, but we have to be out of here at 8 o'clock. So, we want to go ahead and get started.

My name is Angela Miller. I'm with the Environmental Protection Agency. I'm a Community Involvement Coordinator working on the LCP site. Tonight we're here to present a proposed plan that we have to clean up the LCP Chemicals' marsh. The comment period for the proposed plan actually started today. Our normal comment period is 30 days, but Glynn Environmental Coalition asked for an extension, so we've granted 60 days.

So, your comments can be submitted tonight, or you can mail them to Galo's office back in Atlanta, or you can e-mail them to Galo as long as we receive them by February 2nd, so from today to February 2nd.

We have documents in the administrative record here at the library if you need to review some of the materials that helped us get

to the decision where we're at today. Galo's going to give a presentation. He's going to try to keep it to about 30 minutes, so then we can open it up to questions and answers. I do have a court reporter here that's transcribing everything, so when we get to the questions and answers if you can stand up, say your name, and spell any unusual names for the report.

Again, if you don't get a comment in or if you have a question after we leave today you can still submit that up until February the 2nd. I have some cards. You can contact me, and I'll be glad to get that information to Galo.

With that I'm going to turn it over to Galo, and if you have any questions if you could just hold them until the question-and-answer period that would be great so we can get done and have plenty of time for questions and answers. Thank you, so much. Galo?

MR. JACKSON: Welcome. My name is Galo Jackson. I'm the RPM for the LCP site -- or one of the RPMs -- remedial project managers -- for the LCP site. In this

presentation I'll be introducing the site team, briefly, go over the site history, summarize the risk assessments, go over the cleanup objectives, a description of the cleanup alternatives, the alternatives evaluated, and present EPA's and the state of Georgia's preferred remedy.

The people that have been working on the LCP site for a number of years are Mark Springer with EPA's ERT, Environmental Response Team, in New Jersey; Kevin Koporec, Human Health Risk Assessor; Sharon Thoms, Ecological Risk Assessor; Derek Matory my Section Chief; and Stacey Haire, the site attorney.

The LCP site was listed on the National Priorities List in 1994. This sketch shows a Superfund process. Recently we have concluded the remedial investigation and feasibility study for the LCP Chemicals' marsh. We're here at the proposed plan stage on the verge of selecting a remedy for the marsh. In the next couple of years the remedy will have to be designed to be implemented.

The site had soon after the listing a removal -- that I'll go into in some detail--

performed. Just to remind everybody EPA'S mandate under Superfund is site characterization to determine the nature and extent of the contamination, conduct baseline risk assessments to establish whether unacceptable risk exists or not, remedy selection, and remedy implementation. Those are the constraints that we have to work under.

The LCP marsh was divided into four domains during development of one of the risk assessments. This slide has a mistake in that this should be Domain 2 here and that 3. This slide shows the four domains with the site's uplands to the east or to the right. These are the uplands.

The physical separation of the LCP marsh by drainage features lead to the designation of domains which are mostly marsh areas of similar physical setting and contamination characterizations. The smallest domain is Domain 1. It lies east -- west of the uplands and east of the Eastern Creek.

Domain 2 lies -- this is the error I mentioned. Domain 2 lies west of Eastern Creek and east of Purvis Creek. Domain 3 lies east of

the causeway which is an extension of the entrance road and east of Purvis Creek. Domain 3 is shown in purple. This is Domain 3. It's showing in purple on this slide, and it's north of the LCP Ditch. Domain 4 which is about 417 acres is located west of Purvis Creek and is the largest domain.

This slide shows that the site for most of its history has been industrial. It began being used at a refinery starting in 1919 and has continued to be industrial through the years that Georgia Power operated a refinery. There was a paint and varnish operation there, and in 1955 Allied Chemical constructed a chlor-alkali plant there, and in 1979 LCP Chemicals purchased most of the site and continued to operate the chlor-alkali facility.

As you may recall during the late 1990s there was a removal undertaken overseen by EPA. This figure shows in yellow the extent of some of the uplands removal and all of the marsh removal completed in late 1990s. About 142,000 cubic yards of upland waste which is equivalent to about 39,000 tons of sediment were removed as well as associated contaminated soil.

In addition 13 acres of former landfill, which is what's shown in orange -- located in the marsh and shown in orange as well as 2,650 linear feet of creek and ditch shown in green and purple were also removed. The color codes for the marsh show removal of the upper one foot and up to, in a limited number of cases, two feet.

This next slide shows the conditions of mercury before the removal and after the removal. The take-home message from these slides is that -- the graph on the left shows that before the late 1990s removal about 75 percent of the mercury samples were above ten parts per million.

The graph on the right shows that -- the current situation shows that 30 percent of the mercury concentrations are greater than ten parts per million.

This is a similar slide for Aroclor-1268. Note the difference in the vertical scale on these slides by the way. The graph on the left shows the distribution of Aroclor-1268 which is a PCB in the sediment. It shows that before the removal about 70 percent of the PCB

concentrations were above ten parts per million.

The graph on the right shows that 10 percent of the PCB concentrations are currently above 10 parts per million.

Relying on the chemical data collected since the mid-1990s over the past couple of years the remedial investigation for the marsh and both baseline human health and ecological risk assessments have been completed. The objective of the remedial investigation was to determine where the contamination is located and what it is.

The goal of the human health and ecological risk assessments were to estimate the risk posed by the contaminants to humans and organisms living in the marsh and exposed to the contaminants.

The risk assessment looked at all media. The major contaminants of concern for the marsh were mercury including methylmercury, the PCB Aroclor-1268, lead, and total PAHs. The latter are constituents of petroleum.

This slide -- I want to point out this is -- on this slide I'll refer to it as the Eastern Creek, the LCP Ditch. This is Purvis

Creek here, and this is what I'll refer to as the Western Creek Complex. This slide shows mercury concentrations in the upper 12 inches of the sediment.

Mercury concentrations of over 12 parts per million are shown in red. Green shows those mercury concentrations less than one part per million. Generally the higher concentrations of mercury remain in the Eastern Creek and former LCP Ditch.

This makes sense because the mercury-contaminated waste was piped from the uplands to the outfall pond which flowed into the LCP Ditch which in turn joins the Eastern Creek. There is some elevated mercury present outside the creeks and channel banks particularly on the flanks of the Eastern Creek. Only a very small fraction of the mercury is in the methylated form which is the more toxic form.

This is a similar slide for the PCB Aroclor-1268. Aroclor-1268 over 18 parts per million is shown in red, and it appears to be much better confined to the creek and ditch, much more so than mercury which appears to have

spilled over the banks.

There exists a few isolated detections of Aroclor-1268 in Domains 2 and 3. Note also the absence of red in the areas that were removed in the late 1990s.

This is a similar slide for lead. The higher lead concentrations are found in the Domain 3 Creek. They're shown in concentrations. Concentrations over 90 parts per million are in red. Lead is a contaminant of concern of ecological risk not to humans. Lead in Domain 3 north of the causeway -- this is the causeway, and I'm talking about this red here -- may be due to some of the refinery operations.

The PAHs or polynuclear aromatic hydrocarbons are associated also with the Domain 3 Creek up here. There exists a couple of samples over four parts per million in the Eastern Creek and the LCP Ditch, but PAHs are contaminants of concern for ecological risk but not for humans.

Superfund requires that EPA determine whether an unacceptable risk exists at the site. The baseline human health risk assessment's

estimated risk, both cancer and noncancer. The acceptable excess cancer risk ranges between one in a million and one in 10,000. EPA is directed to reduce excess cancer risk to less than one in 10,000.

For noncancer risk EPA's goal is to reduce the hazard to less than one. In a few slides I'll show the cancer and noncancer estimates for the LCP marsh.

The baseline human health risk assessment examined the following exposure scenarios. Direct contact with the sediment by a hypothetical marsh trespasser, the eating of finfish and shellfish based on area-specific ingestion rates for each fish species, eating the game bird the clapper rail, and note also that the fish consumption rates used in the human health risk assessment make conservative assumptions that the consumption advisories are not observed.

This slide shows the cancer and noncancer risk calculated by the human health risk assessment. The unacceptable excess cancer risk and noncancer hazards are shown in red. The slide also shows that the human health risk

assessment concluded that only the high-quantity fish consumer showed unacceptable cancer due to Aroclor-1268 and mercury.

The marsh trespasser coming into contact with the marsh sediments did not show unacceptable cancer risk and noncancer hazard. Noncancer hazards due to mercury and Aroclor-1268 were unacceptable for all the high-quantity and recreational finfish consumers and most of the shellfish and clapper rail consumer age groups.

It should be noted that the risk and hazard indices shown here for fish consumption are likely conservative due to the established consumption advisors. The exact consumption rate of clapper rail is not known for certain. The estimates are believed to be conservative.

This summarizes the baseline ecological risk assessment conclusions. The Benthic Community or the small organisms that live in the sediment appear to be affected by the contaminants particularly in the Eastern Creek and LCP Ditch. Modeling and fish tissue data suggest long-term effects to fish that live in the marsh.

This summary of the ecological risk assessment indicates that lead and PAHs do not present unacceptable risk to wildlife receptors, but methylmercury is a risk to birds while the PCB Aroclor-1268 presents a risk to mammals.

Since none of the lowest-observed hazard quotients -- which is this column right here -- for the red-winged blackbird, marsh rabbit, raccoon and river otter are above one, this is just minimal risk to these. The green heron was most at risk. The hazard quotient here is a range of about 3.5 to 10.6. Only the green heron has a hazard quotient above one. Note that the areas of concern are primarily the LCP Ditch and the Eastern Creek.

The remedial action objectives will come up in a moment. They are to -- they're all up now -- reduce releases of hazardous substance from the smaller contaminated creeks to Purvis Creek, reduce contaminate exposures to fish-eating birds and animals in the marsh, reduce risk to contaminated sediments -- from contaminated sediments to bottom-living organisms, reduce finfish exposure from ingestion of contaminated prey, and prevent

human exposure through ingestion of finfish, shellfish contaminated above protected levels, and finally to restore surface water quality. That's the objective of the remedial action proposed.

Since the risk assessment showed unacceptable risk under some scenarios the objectives of the feasibility study was to identify the technologies to clean up the marsh sediment.

The identified technologies were further screened and evaluated. This process ended up with a detailed evaluation of the remedial alternatives.

The six alternatives, other than the no action alternative -- the five alternatives other than the no action alternative were retained in the feasibility study ranging from complete removal of the contaminated sediments to a combination of sediment removal, capping, and thin-layer covering.

This side shows all six retained alternatives. Alternatives 2 and 3 are based on remediation of the lower end of the Benthic cleanup goals. The larger remediation deals

with the lower end of the cleanup goals for the mud-living organisms. Alternatives 4 and 5 are based on the higher end of the Benthic cleanup goals.

Alternative 6 is based on remediation of the 24 acres which are the higher end of the goals of the Benthic cleanup goals plus segments of Purvis Creek and the marsh flats in Domain 1.

All alternatives will include long-term monitoring and fish and -- monitoring of sediment and fish and institutional controls.

Nine criteria were used to evaluate the cleanup alternatives and select the preferred remedy. Of the nine protection of human health and the environment and in compliance with the laws and regulations are threshold requirements which must be met by the remedial alternatives.

EPA then evaluates the alternatives for long-term effectiveness and permanence; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; cost and then compares and balances them.

State and community concerns are modified criteria that may cause EPA to modify the

preferred alternative or select another alternative. There currently exists a limited number of technologies available for the cleanup of contaminated sediment sites. Included among them is dredging.

This slide shows one of the types of dredging for removal of contained sediments. The main advantages with dredging are one, less uncertainty about the long-term cleanup; two, no need to predict cap stability; three, quicker reduction of risk.

The disadvantages are one, implementation and effectiveness may be a challenge due to the narrowness of the creek; two, the recontamination of the marsh through the resuspension of sediment in dredging; three, the traffic created by the need to transport the contaminated sediment; and four, disruption to the marsh ecosystem.

This next slide shows another -- a graphic that shows the resuspension and release of contaminants in the water and to the sediment as a result of dredging.

A couple of caps are shown on this slide. The main advantage of caps is that one, they

quickly reduce exposure to fish or other organisms with less material handling; two, the potential for recontaminate suspension is minimized; three, no need to ship sediment to a landfill.

The main disadvantage is that the contaminants could once again be exposed if the cap is disturbed, and this next slide is an example of probably a large-scale dredging -- I mean cap operation.

As far as thin-layer cover is concerned the main advantage is accelerated natural recovery by mixing of sediment of relatively low concentrations of contaminants with clean sediment. The disadvantage is that there's currently limited demonstration at other sites.

This is just a site that we are required to compare it against, the no-action alternative which is if things are left as they are now.

Alternative 2 addresses the lower end of the range of contaminates for protection of the bottom-living organisms in 48 acres, and by the way the cost and time to implement are shown on each of the following slides at 48 acres.

This alternative combines sediment removal

with institutional controls and long-term monitoring. The estimated in-place sediment removal is about 153,000 cubic yards. Following removal the sediment -- the remedial areas would be backfilled with clean material to establish a clean sediment surface.

Alternative 3 addresses the same 48 acres as Alternative 2 by combining sediment removal plus backfill, sediment capping, and thin-cover placement with institutional control and long-term monitoring. The estimated in-place sediment volume targeted for removal in Alternative 2 is approximately 27,000 cubic yards. Alternative 3 also includes 16 acres of capping and 23 acres of thin-cover placement.

Alternative 4 addresses the higher end of the range for protection of the bottom-living organisms in 18 acres by combining sediment removal plus backfill with institutional controls and long-term monitoring. The estimated sediment volume targeted for removal in Alternative 4 is approximately 57,000 cubic yards.

Similar to Alternative 2 following removal the remedial areas would be backfilled with

clean material to manage risks associated with post-removal residuals and accelerate the natural recovery process and establish a clean sediment surface.

Alternative 5 addresses the same 18 acres as Alternative 2 by combining sediment removal plus backfill, sediment capping, and thin-cover placement along with institutional controls and long-term monitoring.

The estimated sediment volume targeted for removal in Alternative 5 amounts to approximately 22,000 cubic yards. Alternative 5 also includes three acres of capping and eight acres of thin-cover placement.

Alternative 6 addresses 24 acres of remediation area by combining sediment removal plus backfill, sediment capping, and thin-cover placement along with institutional controls and long-term monitoring. The estimated sediment volume targeted for removal in this Alternative 6 is approximately 22,000 cubic yards.

Alternative 6 also includes six acres of capping and 11 acres of thin-cover placement.

EPA's preferred alternative in this proposed plan and open to comment is Alternative

6. It involves dredging of seven acres of the LCP Ditch and Eastern Creek to a depth of 18 inches and backfilling, capping of six acres of Domain 3 Creek and Purvis Creek, thin-layer capping of Dillon Duck -- what's called the Dillon Duck in Domain 1 and Domain 2; long-term monitoring including biological monitoring; and institutional controls.

At this point I conclude the technical portion of this presentation and move to schedule. Actually before that these are the cleanup levels proposed for protection of human health; two parts per million for mercury, three parts per million for the PCB Aroclor-1268, and for protection of the Benthic organisms or the bottom-living organisms that form the base of the food web 11 parts per million for mercury, 16 parts per million for the PCB Aroclor-1268, 177 parts per million for lead, and 4 for PAHs.

Now this is the tentative timeline. We're here at the -- on December 4th, the proposed plan public meeting. As Angela mentioned, the comment period runs through February 2nd of next year. The estimated time to conclude a record of decision is March of next year, about a

year's worth of working with the Department of Justice and the responsible parties in negotiating a consent decree, having the courts lodge it and enter it, and then from that -- from March of '16 to March of '17 going into design and actual construction beginning in March of 2017.

The next slide is -- I'll leave this up. These are the contact people. That concludes my portion.

UNKNOWN SPEAKER: It's a public document. There's a lot of information for everyone, and I think it would really be helpful.

MR. JACKSON: I can e-mail it.

MS. MILLER: For those that are interested if you can see me after the meeting I'll be glad to take your name, or you can just e-mail Galo and say I'd like a copy of the presentation.

UNKNOWN SPEAKER: Can you post it on your website?

MR. JACKSON: I can put it in the Reading Room. Yeah, I can put it in the Reading Room. I've never done a PowerPoint, but I can turn it into Adobe and then -- yeah, yeah.

MS. MILLER: We can do that, and we can

get it put in the Reading Room. Okay, let's go ahead and open for questions and answers. Now remember if you would stand up, say your name, and spell any unusual -- and speak up so my court reporter can hear.

DR. LLOYD: Dr. Roger Lloyd. My question is do you have any reproducible data on the thin-cover cap in a nine to ten-foot diurnal tide situation like we have here?

MR. JACKSON: Well, the thin-cover cap, we put that through hydrodynamic modeling, and in the feasibility study there's an appendix that has the results of the modeling that was performed to establish the thin-cover cap should work.

Now keep in mind that once the thin-cover cap is applied there will be long-term monitoring going on -- periodic monitoring to see that it, indeed, is intact.

DR. LLOYD: But previous to now it's just modeling?

MR. JACKSON: Modeling and experience with other sites. There's a sediment site -- EPA website that has a number of sites where thin-cover placement has been applied. However

what I notice from that website is the feedback has not been received yet as to its effectiveness.

DR. LLOYD: Thank you.

MS. MILLER: For the second time, if you have several questions if you could just ask one since there's so many people here, and then we'll just come back. Yes, sir.

MR. DRESSEL: I'm Floyd Dressel. I live on Purvis Creek with my family, and I've been concerned through all of this. On this picture you have a cap across Purvis Creek. Why is that cap off there by itself?

MR. JACKSON: The design in the feasibility area is where they detected elevated Aroclor-1268. I think Purvis Creek is primarily conditions of elevated -- the PCB Aroclor-1268.

MR. DRESSEL: I live above this cap. What is that going to do to the flow above the cap in Purvis Creek?

MR. JACKSON: I might prevail on Mr. Rhon (phonetic) to -- I don't think the flow should affect it at all. He did the modeling -- the hydrodynamic modeling.

MR. RHON: The flow will not change

significantly.

MR. DRESSEL: Is it going to kill any of the marsh grass?

MR. JACKSON: The cap might, but to a fairly limited extent.

MR. DRESSEL: I'm at a loss. I see where others are, but there's just one cap, right? That would block or dam Purvis Creek, and I live up here.

MR. JACKSON: These caps are not going to be interfering with flow at all.

MS. MILLER: He was going to speak to the flow.

MR. RHON: What we did was we modeled the system with a hydrodynamic model, and we look at the scenario before we do any action -- you know, how would the system react today and how would it react -- you know, after we place a cap, and there's no significant change with respect to flow or the health and the behavior of the marsh following.

MS. MILLER: Yes, sir.

MR. HUGHES: Van Hughes. I live here in Brunswick. How thin is this thin cap, or to put it another way, how thick is it?

MR. JACKSON: The thin-layer cover is about six inches.

MR. HUGHES: So, it's only a six-inch cap, and it will stay there?

MR. JACKSON: It's to restrict the -- it's on the flats, not in the creeks. In the creeks they're going to be armoring to make it stay. That's where your velocities are. That's where the modeling indicated the velocities are that might erode. That's where the cap will be armored.

MR. HUGHES: You'll change the elevation of the marsh by only six inches?

MR. JACKSON: Correct, in the flats. In the flats, not the creeks.

MS. MILLER: Yes, ma'am, in the back.

MS. HUBBARD: My name is Peach Hubbard. I'm the president of the Dolphin Project. We're a nonprofit organization. There's studies of bottle-nosed dolphins in estuaries in Georgia. Dolphins are a species in their environment. We humans share this environment.

Dolphins eat fish, shrimp, and crab. We humans eat fish, shrimp, and crab. Dolphin Project did a study a few years ago where

they're found to have the highest level of the PCBs in the world, in Brunswick. The highest levels of PCBs in the world here.

It is documented that dolphins that live here are sick from their toxic environment. It follows that humans who eat the same food and share the same environment are also at risk. Shrimp, shellfish, and fish live in the marsh sediment absorbing these toxic chemicals. Capping the marsh will not eliminate toxic contaminates in the shrimp, shellfish, and fish, and dolphins, and if a hurricane comes and moves all those rocks and those armaments you've wasted your money.

UNKNOWN SPEAKER: Amen.

(Applause.)

MR. JACKSON: That's a comment we'll take.

MS. MILLER: Yes.

MS. BROWN: My name is Wendy Brown. I'm a mammal and a mother, and I agree with her because we're eating that shrimp. My question is you said institutional controls every time with the different alternatives. What does it mean? Give us an example of institutional controls.

MR. JACKSON: Well, one example is fish consumption advisories that are already in place. Another one is the restrictions on the use of the marsh in perpetuity. Those are the two examples that come more readily to mind.

MS. BROWN: Well, I assume that that has never been done yet? You said it is, but I don't see something like this visible in marshes.

MR. JACKSON: You're right. That's something that has to be worked on, and a record of decision will develop that.

MS. MILLER: Yes.

MS. CROOMS: My name's Lisa Crooms, and I want to know where these advisories are posted.

MR. JACKSON: They're state advisories. It's the State's responsibility -- they're under the state of Georgia, and they're on their web sites I believe. I've seen them myself.

MS. CROOMS: What web site specifically, please?

MR. JACKSON: I don't know off the top of my head, but I have looked at them.

MS. MILLER: Yes, sir.

MR. KYLER: I'm David Kyler with the

Center for a Sustainable Coast, a non-profit organization. We've been around for about 18 years promoting responsible decisions that support a sustainable environment, and we're located on St. Simons but serve the entire Georgia coast.

I became aware of the work that the Glynn Environmental Coalition -- a study done for toxic substances and disease registry which you may now be aware of through your interactions with the coalition. I'm not sure.

But it's obvious from the report that the plan -- that the assessment of human health risk had a fish consumption rate that is a fraction of the rate that people have revealed through this sample commonly exhibited. So, whereas you estimated 40 meals a year, they're eating twice or three times a week which would be 100 to 150 meals a year.

So, that being the case won't you have to completely re-evaluate the human health assessment because of the much higher rate of consumption? And other very disturbing finding of this study was an extremely high presence of PCBs in the bloodstreams of those who were

sampled and those who have the fish consumption characteristics.

MR. JACKSON: So, what -- your question was?

MR. KYLER: Actual consumption being two and a half to three times the rates you assumed in your health assessment.

MR. JACKSON: The human health risk assessment was based on -- the consumption rate was based on a study done some years ago that was site specific, and that's -- Kevin, you might be able to --

MR. KOPOREC: Yeah. The human health risk assessment assumed fish consumption rates based on a survey of people in this area, how much fish in the area they said they would eat if there was not a consumption advisory in place, and those were the assumptions used in the health risk assessment. It amounted to -- for the recreational fish consumption that we saw it was 26 meals per year for the adult and a corresponding number of meals -- based on each meal being about half a pound of fish per meal.

And then for the high-quantity fish consumer that assumed about 43 meals per year.

I mean, there could be people eating more fish than that but --

(Laughter.)

MR. KOPOREC: What we would say to that is there are fish consumption advisories in place because we know contaminate levels are above where we would like them to be. We all acknowledge that. So, we would recommend you follow the fish consumption advisories.

MR. KYLER: That doesn't answer my question. What my point was -- my question was given the consumption is at least two and a half to three times the rate you assumed, and there are already fish consumption advisories in place of certain types -- I'm not sure exactly how much they correspond with those in your study, but advisories are in place and plenty of them thanks to DNR, but will you now have to reassess human health risks because we know for a fact that consumption is two and a half to three times what you assume?

MR. KOPOREC: We've already triggered the need for remedial action. That was the function of the human health risk assessment. It's already been triggered.

UNKNOWN SPEAKER: What does trigger mean?

MR. JACKSON: We have already got -- we have -- EPA has legal license now to require a cleanup. It won't change anything.

MR. KOPOREC: That means the levels of the fish are high enough that we know there's an unacceptable risk for people that eat the fish. We already know that. The goal is to get those levels in the fish down, and the target is to hope to do that by reducing the -- you can't clean up the fish directly, of course, but if we clean up the sediment the assumption is that that will reduce the levels in the fish over time.

MR. KYLER: The higher risk revealed by the higher consumption does not alter the remedy or the amount of money being spent to implement a more comprehensive remedy?

MR. KOPOREC: Well, we'll be following -- I mean, the State has fish consumption guidelines based on number of meals per week or per month, or they have a graduated approach of looking at fish consumption guidelines.

So, those numbers are going to stay in place, and the State, based on what data they

have from what they collect and from what others give them, they will adjust those guidelines to say if the levels go up or down in the fish. The levels go up and down in the fish over time whether that's shellfish or finfish or whatever, but as Galo mentioned it's already triggered the need for action, and monitoring is a very important part of the remedy -- of any remedy that ends up being selected here.

So, we will continue to monitor both the sediment levels as well as the fish levels and talking to people, that's part of -- the State's job is to talk to people about how much fish they eat or how much fish they would eat if there weren't consumption guidelines or whatever -- or how much fish they eat even with consumption guidelines.

MR. KYLER: I'm looking for a succinct answer. In other words, the level of risk revealed by actual testing of human consumption is far higher than the assumed level of consumption in your human health assessment does not alter the proposed remedy which means the amount you're willing to invest and the comprehensiveness and intensity of the remedy;

is that correct?

MR. KOPOREC: Well, I'm not selecting the remedy, but if you have that comment that comment is on the record now, and that will be considered in the remedy selection as well.

MR. KYLER: So, it could?

MR. KOPOREC: Yeah, it could, it could.

MS. MILLER: Let's get the gentleman back there, and then you, ma'am.

MR. KILLIAN: I'm Bob Killian. It sounds like you're saying that the fish advisory will continue in perpetuity because DNR on behalf of assisting the State will not require Allied Chemicals and Honeywell to clean up the levels for the fish advisories; is that correct?

MR. JACKSON: Fish advisories --

MR. KILLIAN: It's just a yes or no.

MR. JACKSON: It probably will last many years realistically.

MR. KILLIAN: Why do we not clean up --

MR. JACKSON: Even if it were removed today -- all of it were removed today.

MR. KILLIAN: Sure, but why don't we start removing it all so we no longer have a fish advisory as quick as possible? I don't want

fish advisories to still be here when my great grandchildren are alive. I want the fish advisories to be three years, five years, ten years, but it looks like that's not even a goal.

(Applause.)

MR. KILLIAN: My question was why not? Please answer.

UNKNOWN SPEAKER: Why not?

UNKNOWN SPEAKER: Why not?

MR. JACKSON: Why not --

MR. KILLIAN: Why not clean it up? Why not clean it up so we have no more fish advisories?

MR. JACKSON: Keep in mind the PCBs are being removed from the majority of -- in the creeks are being removed. They're being dredged out of there.

MR. KILLIAN: You know that's not true. You know how widespread they are. You know that they spread out into the ocean. Why tell us something that's not true, or do you not know the truth?

MR. JACKSON: We can't clean up the ocean.

MR. KILLIAN: I understand that, but we can clean up as much of the source as possible,

48 acres of upland.

(Applause.)

MS. MILLER: Yes, ma'am.

MR. KILLIAN: Just cleaning the 48 acres does not accomplish the goal.

UNKNOWN SPEAKER: And it's a lot deeper than 18 inches too. We know that. It was in 1990.

MR. JACKSON: We've got -- the remedial investigation -- the Appendix A has some vertical profiles, and the contamination drops off significantly after the first couple of inches, and it's Appendix A of the remedial investigation which is in the Reading Room.

MS. MILLER: Yes, ma'am.

MS. PURVIS: Hi. My name is Kim Purvis. I grew up here in Brunswick, Georgia and spent my teenage years in Ellis Point which is located, if you Google Map, about midway between where the creeks feed out from LCP and the Brunswick Wood Preserving Plant.

In that area of Ellis Point -- and this was without research, just the people that I know. Two ladies before the age of 30 diagnosed with breast cancer, myself and another young

lady diagnosed at the age of 40 with breast cancer, and another woman 50 years old with breast cancer on the same road in Ellis Point. These are just people that I know personally, not doing research in the area.

I don't recall seeing any type of public survey or invitation to come be part of the testing that took place with the residents of Sapelo Island. Is there a way for people to volunteer to be tested for these levels of PCBs and such other carcinogenic agents?

MR. JACKSON: As I mentioned in the early slides we -- EPA is restricted to determining nature and extent of contamination and cleanups. That's the -- what you're asking about is something that is the responsibility of the Agency for Toxic Substances and Disease Registry, and I believe they've done studies here and, in fact, a couple years ago when I first became involved with this site with LCP they were consulted through the County and ultimately the State to look for cancer clusters, and my recollection is they didn't find anything.

(Laughter.)

UNKNOWN SPEAKER: They did a study on Sapelo Island in the year 2009, and they tested several people that come up with chemical in their blood. My parents live on Sapelo. They eat seafood every other day. My family catch fish every single day. So, we're trying to figure out why weren't everyone on Sapelo aware of this study because my parents didn't know. Not only Sapelo, but Glynn County and the surrounding area.

MS. PURVIS: I didn't hear the answer to my -- is there a way to volunteer to be tested?

MR. JACKSON: I can pass that on. Now that we've got your name I can pass it on. You've got my contact information to the Agency for Toxic Substances and Disease Registry.

MS. MILLER: Yes, the guy in the back.

MR. RENNER: Jim Renner from St. Simons. I'm sure you've got a big matrix where you store the alternatives for the effectiveness of remediation meeting your goal. You haven't done any explanations here tonight. A lot of these questions are related to that. Why is the preferred alternative Alternative 6?

MR. JACKSON: It's explained in the

proposed plan summary, and there's a link to the full proposed plan which is on the web.

MR. RENNER: How about in a nutshell; other than low cost was the long-term effectiveness weighted heavily or --

MR. JACKSON: It was a matter of balancing -- balancing the marsh disturbance and removal of contaminates. We have to balance those things.

MR. RENNER: Minimally invasive?

MR. JACKSON: Well, not minimally invasive, but not taking out 48 acres which may or may not come back.

MS. MILLER: Yes, sir.

MR. LAWRENCE: First I wonder if you could --

MS. MILLER: Could you state your name?

MR. LAWRENCE: -- turn the fans down so that everybody can hear.

MS. MILLER: I was told earlier that it's controlled by the County, and it's after 5:00.

MR. LAWRENCE: Another thing --

MS. MILLER: Could you state your name, please?

MR. LAWRENCE: Larry Lawrence. I don't

understand these people that would feed on Sapelo -- eight, ten, whatever it was -- had the high readings of PVC.

MS. MILLER: PCBs.

MR. LAWRENCE: That water flowing from the LCP plant and all surrounding areas goes from there to Sapelo Island. That means it passes through St. Simons, Sea Island, every island you can think of between here and there. What are these people or their property going to do with a situation like this? Are they going to correct it or not?

In Step 3, you've got -- what is your environmental people up in Atlanta that have to do with taking care of the -- I'm sorry -- the people -- CDC or whatever it is -- disease control, are these people working on it? Are they being made aware of -- are they following step-by-step what you're doing down here to see if it's correct and at a correct enough speed.

MR. JACKSON: You know, we've seen very little -- other than a PowerPoint we've seen very little of the CDC, and I don't think it's been scrutinized yet. It's just been made available.

MR. LAWRENCE: Don't we think it should be?

MR. JACKSON: That's a question for CDC.

UNKNOWN SPEAKER: I have a question on the --

MS. MILLER: State your name, please.

MR. DRESSEL: Floyd Dressel. My question on the dredging, where will the dredge spoils go?

MR. JACKSON: They'll be taken -- depending on the concentration of the contaminate they'll be taken to hazardous or nonhazardous landfills.

MR. DRESSEL: Well, that's the dry material.

MR. JACKSON: Right.

MR. DRESSEL: I understand dredging.

MR. JACKSON: Yes.

MR. DRESSEL: What's going to happen to all the water running all --

MR. JACKSON: The liquids will be treated, and that's in the proposed plan. I encourage everybody to use the link on the proposed plan summary. There's a link that takes you to the 50-page proposed plan with all the details.

MR. DRESSEL: None of the water will run back into there?

MR. JACKSON: No. It will be treated and it will be monitored.

UNKNOWN SPEAKER: The whole ocean.

MS. MILLER: Yes, ma'am.

MS. KEYES: My name is Alice Keyes spelled K-e-y-e-s, and I'm associate director of One Hundred Miles. We're a conservation organization located just across the street here in Brunswick. We serve to protect and promote the Georgia coast. We really appreciate the number of people that are here, our friends and our supporters.

We know that there are a lot of concerns about what y'all have proposed. We also appreciate you being here. So, thank you so much for coming and starting this process of hearing our concerns and getting the LCP site cleaned up.

It has been way too long that this egregious violation of wildlife health, of human health has been going on. It is time we clean up the LCP Superfund site.

Again our office is located just across

the street on Gloucester. I live in Windsor Park not a mile away. This is our home. This is our community, and we have a lot of concerns for what y'all have proposed.

I have read the 50-page detailed summary of what you've proposed. Number one, the federal agency should provide more than 24 hours notice of information so that we as citizens can engage with you and talk to you from an informed standpoint about what you're proposing.

I know that you've located the material here at the Brunswick Library 24 hours ago. That's not enough time for us to absorb and inspect and get back to you guys.

MR. JACKSON: You've got two months actually. The public comment runs to the beginning of February.

MS. MILLER: Sixty days.

MS. KEYES: We really appreciate the extension, however we have to be able to engage with you to come up with a solution that's good for our community. Number 2, the long-term monitoring that you described in every single one of the alternatives does not include marine mammals or include terrestrial animals.

We have to look at things beyond water, shellfish, and fish to determine the extent of contamination and the remedy that you propose.

Number 3, additional studies should be conducted to determine the extent of the contamination. The Sapelo study, I understand it's beyond your purview but for public record I would like to get it in that we need additional studies to determine the extent of the contamination.

My last step specific to the alternative that you have proposed -- that you've selected as EPA --

MR. JACKSON: It's not a selected alternative yet.

MS. KEYES: The alternative that is preferred. Thank you for correcting my terminology. The contaminates of concern on this site will exist in the environment for a long time, and they're more harmful for wildlife and human life than many of us know. The infertility, the birth defects, the cancer, the learning disabilities, it's just a scary situation.

What you have proposed in Alternative 6 is

not enough. Capping these contaminates will not clean up the LCP Superfund site. We propose the development of another alternative that removes more sediment, cleans it up, and looks at additional treatments such a bioremediation. It doesn't have to return to its existing site. We just want the stuff cleaned out of there.

We would like for EPA and our potential responsible parties to work with us as citizens of this community to come up with a better solution. We know there's a better solution out there that can clean this up. It's dependant on our health, our children's health, and our health as a community in coming up with a better alternative.

So, we look forward to continuing this conversation with you. Again, we appreciate the extension to the public comment period, but before I sit down I want to submit for the public record a report that was released earlier this year. It's called the Dirty Dozen. It was developed by the Georgia Water Coalition, a group of over 250 organizations and businesses who identify the most outrageous situations throughout our state, the most egregious

pollution problems throughout our state waters.

The Turtle River is located in this report as one of the 12 most polluted sites in the state, and it's because of the LCP contamination. So, I'd like to submit that for public record. Again thank you so much for being here. We appreciate y'all.

(Applause.)

MS. MILLER: Yes, sir.

MR. BROWN: My name's Tommy Brown. I'm a wholesale crab and shrimp dealer. Can I make a fair assumption that because this is in the Sapelo area -- or Island that these things are found in Sapelo Sound as well as the other sounds, right? Would that be fair?

MR. JACKSON: The Sapelo was -- you know -- are you talking about sediment or fish?

MR. BROWN: Sediment.

MR. JACKSON: I don't know enough about the sediment quality in Sapelo.

MR. BROWN: Well, what I've seen over the last 20 years is a decline in the crabs, a decline in the fish. We built fisheries -- DNR built fisheries out there, and you can't buy fish. Crabs are no longer down there because

your crab will eat around the septic tank, but he won't eat in it.

What I propose to -- just now propose -- I got a letter back from the commissioner -- was that we open the sounds to a limited amount of trawling. He didn't like that idea. I've talked to shrimpers that said we'll take our nets off. We'll just drag drag-lines through there and get the crap out of our sounds, move it out. Like the gentleman said earlier, the 43 acres ain't going to fix this. We got a major problem, I think, in all of our estuaries, and the shrimpers if y'all would call on them, they would be willing to help y'all.

Sure they'd like to drag the sounds for shrimp but they'll take -- they're willing -- a lot of them are willing to take the nets off and just drag the stuff out of here, and it needs to go. It really needs to go I think.

(Applause.)

MS. MILLER: Yes, sir.

MR. CLARK: My name is Penn Clark. I have worked with the dolphins that were in this study since 2009. I'm a volunteer. I've worked many, many weeks with NOAA, mainly Brian Palmer, and

as we know part of the reason we're here tonight is because of that study.

Now that the Government has cut back the 15 percent on spending, which I agree with actually, but dolphin money has stopped. So, when you're doing your proposal on some type of long-term understanding if this is being solved or not will there be money in that proposal to have NOAA out of Charleston continue this study so that we know we're actually getting results in the fish -- because they're the ones that are testing the fish -- in the dolphins -- because they're the ones that are testing the dolphins. They're taking them out of the water. They're doing health assessments. They're spending all of their money.

That money is gone now. BP pays for the study of the dolphins in the Gulf of Mexico. That's it. So, if you don't propose some money for this cleanup we won't know in a year or two whether it's working or not.

(Applause.)

MS. MILLER: Yes, sir.

JAMES PAULIN: Good evening. My name is James Paulin. I'm a retired crabber. I just

heard a person in this room complain about the reduction of funds and then talk about needing more funds and asking for funds to do this with.

The problem is ours. We're sending these people to Washington, and they're cutting the rug right out from under us. We can't even have education. This is not right. I appreciate what y'all are doing. I too -- 48 acres don't cut it.

Andrews Island down here is probably chock full of this stuff because it went all the way out in that river and they dredged it and dumped it over in there, and we turned right around and poured it right back in here.

Have y'all looked at Andrews Island down in the depths of that of what's there? I know what leachates out of there. There's metals coming out of Andrews Island through the leachate, and 48 acres -- you better look at this whole darn thing.

I've crabbed this river. I've fished this river for 30 years or more, and I don't think y'all can do what you're trying to even say you're going to do. How did we come up with these alternatives? You're talking about

Alternative 6 is best. Who decided that?

MR. JACKSON: Well, that's what -- we're proposing that, and we explain the reasoning in the long version of the proposed plan fact sheet.

MR. PAULIN: Quite frankly -- you know, I don't personally have zillions of dollars, but I wish that we would extend this program out and look a little bit further because how did people up on Sapelo Island get sick from what we did down here in Brunswick? That's a long ways -- you know.

I agree that fish travel but we've got fish -- crabs in our traps. They generally just kind of maintain themselves in this sound and these beaches. They don't like to go up to Sapelo. How do they get up there?

UNKNOWN SPEAKER: And all the islands in between.

(Laughter.)

MR. PAULIN: Thank you. I appreciate it.

(Applause.)

UNKNOWN SPEAKER: Instead of asking you were's the money come from let me ask you this --

MS. MILLER: Will you state your name, please?

MR. DAY: Steven Day. I live in Washington, D.C. and Jacksonville, Florida.

MR. JACKSON: We've been in touch, yeah.

MR. DAY: You and I had a conversation. I have an environmental remediation company and in partners with Golder Associates that's an 11,000 person remediation company, and we're doing the Trans Canada Pipeline cleanup on PCBs right now. We know a little tiny bit about this stuff.

Here's a question for you. Who is here from Honeywell? Sir, you asked the question about money. This really shouldn't be taxpayer money.

UNKNOWN SPEAKER: That's right.

MR. DAY: EPA should be fining Honeywell and getting that money from Honeywell. It shouldn't be a question.

(Applause.)

MR. DAY: Sir, how much did Honeywell earn last year, fiscal year 2013?

MR. JACKSON: I have no idea.

MR. DAY: You should. It's $3.9 billion net revenue. $3.9 billion in gross sales. I

can tell you this. $3.9 billion and you're talking about $28 million, I would say that their attorneys in Washington are better than your attorneys because they're getting up in front of -- and their lobbyists, and where does the plan come from? Does it come from Washington, or does it come from Region 4? Did it really come from you guys, or did it come from higher up?

MR. JACKSON: This went to the National Remedy Review Board because it went over the $25 million threshold which meant Washington and others in the country.

MR. DAY: So, they sought input from the stakeholders, in this case Honeywell.

MR. JACKSON: And the Glynn Environmental Coalition.

MR. DAY: If anybody's got a calculator we're talking about $28 million and $3.9 billion for the revenue of 2013. That works out to .0078. That's 78-thousandths percent, okay? I mean, come on guys. You know someone ought to be talking to Honeywell, and is there no one here that works for Honeywell, and if you are do you have enough gumption to stand up and say you

do?

Come on, there has to be someone here from Honeywell. If there's no one here why are they not here?

UNKNOWN SPEAKER: They're not responsible.

MR. DAY: Can you answer that question? Why are they not here? I'm not the one should be asking the question. Can you answer that question, why are they not here.

UNKNOWN SPEAKER: They are here. They just don't want to be recognized.

MR. DAY: Can somebody from Honeywell stand up and at least tell us who you are?

MR. MORRIS: I'm with Honeywell.

MR. DAY: Are you a lawyer?

MR. MORRIS: I'm not a lawyer. I'm with Honeywell.

MR. DAY: Can you tell us why you're only willing to spend $28 million and work with the EPA for $28 million versus doing a complete cleanup?

MR. MORRIS: We have worked with EPA as have the other responsible parties. Honeywell's not the only responsible party.

MR. DAY: Who are the majority?

MR. MORRIS: And we've been working with the Agency in a cooperative manner without attorneys to follow a Superfund process in a way that Galo has described, and we're standing here ready based on 20 year's worth of scientific studies.

MR. DAY: Is Honeywell willing to stand up to the plate and really commit to really doing a complete cleanup rather than just piecemeal?

Look, I'm familiar with GE. I'm familiar with Monsanto. We know how it works, and I also live in the Washington, D.C. area. I've been there since Jimmy Carter. That tells my age, right? I went with Jimmy Carter. I had an important job. I parked people's cars and carried their briefcases.

So, we really understand how this happens and how influence can be gained by a quiet word in the right person's ear and a quiet word in -- you know, and certain kind of government support.

Honeywell is a bigger power than everyone in this collective room. We need you guys to stand up and stand tall as opposed to linking and slinking in the background.

MR. MORRIS: We're not slinking in the background.

MR. DAY: Then why aren't you --

MR. JACKSON: This is our meeting.

MR. MORRIS: This is the process that is followed. I am not here to answer questions. This is not my public meeting. This is the EPA's public meeting. If you would please honor that and direct your questions to the people who are here to answer them.

MR. DAY: Okay.

UNKNOWN SPEAKER: What is your name?

MR. MORRIS: My name is John Morris.

UNKNOWN SPEAKER: Where do you live, Mr. Morris? Are you a resident of this community or in town for this meeting?

MR. MORRIS: No. I am in town. I come from the corporate office, and I am here because this site is important to Honeywell. We want to get this site cleaned up. We are cooperating with the Agency. We are not fighting with the Agency.

We are here to say that this plan is based upon sound science, and it has evaluated the risks, and we are here ready to implement the

plan.

UNKNOWN SPEAKER: Would you object to taking it to a higher level assuming that the community doesn't feel like capping is a complete answer? Would you be willing to go back to your board and say we need more revenue to get this done properly and be good corporate citizens?

MR. MORRIS: We are ready to encourage the public to put your comments on the record, and the process requires EPA to evaluate those comments and respond, and that's what's going to occur here, and we support that process.

MS. MILLER: Yes, ma'am.

MR. PARSHLEY: I've already been recognized. First of all I do not recognize this as a public hearing. This is a question/answer session. There's people who have prepared for a public hearing who are not participating tonight because they know the difference between a public hearing and a question and answer session.

At a public hearing the public comes and they put their questions on the record, and the EPA responds to them in a responsiveness

summary. I've got my questions in my back pocket, and that's where they're staying, in my back pocket because this is a farce.

You do not put an administrative record in the library -- the repository 36 hours before you come in with a court recorder and expect the public to be ready for what they've worked on for 34 years, 4 months, and 4 days.

UNKNOWN SPEAKER: Amen.

(Applause.)

MR. PARSHLEY: Let's end the farce and let's end what this is tonight. This is a question and answer session.

UNKNOWN SPEAKER: There you go.

MR. PARSHLEY: You need to write to our representatives and say we came to what was represented to be a public hearing and had a question and answer session. Thank you, very much.

(Applause.)

MS. MILLER: Yes, ma'am.

MS. CIDAR: I just have a question. My name is Kate Cidar, C-i-d-a-r. I'm a new resident to Brunswick. I'm unfortunately not new to the Superfund process. I've lived in

Superfund communities and have been involved with potentially responsible parties and the government as well.

What's interesting about this site to me and what I haven't really seen in any of the alternatives is an interim measure to break the cycle of contaminates getting into the food web. I think that even with a little bit of public health assessment that's happened and the newer information that we have about the insufficientness [sic] of that reporting and the new extent -- the scope and the scale of these impacts in the human health population it should really be, I think, both in the private and the public sector a central focus of the remediation to stabilize that aspect of the contamination going out through those pathways and affecting wildlife and human health.

That's something that's going to go on for a very long time, and it's something that's been going on. Why is there not a management plan in place right now? If this was a site on land there'd be a fence around it.

It's in the marsh, and I understand that's more tricky, but there are Superfund sites that

are water bodies that are settling under active water bodies under tens if not dozens of feet of water.

In an intertidal zone -- I mean, we live in an area with tons of historic impoundments. We see water being managed for waterfowl, for agriculture, and this site needs to be maintained similarly to keep in those contaminates from getting into the next generation of people who live here.

So, where has that been? In what alternative does that management step occur?

MR. JACKSON: Well, the removal did remove 39,000 tons of contaminated sediment, and as we saw in a couple of slides it has dropped. It has brought the concentrations down dramatically, but as far as isolating this, yeah, you're right. There is no alternative for something like that. That would be a good comment.

MS. CIDAR: My decision would be as an environmental planner to introduce, and hopefully stabilizing the site in that way will allow you to actually do more removal and less capping.

Of course with the ultimate -- I'm standing next to One Hundred Miles, so I have to say with the ultimate goal of fully restored ecological salt marsh, but it's not functioning right now. It's functioning as a vector for negative health impacts, so an interim step.

MR. JACKSON: Right.

(Applause.)

MS. MILLER: Yes, sir.

UNKNOWN SPEAKER: I'm curious about mercury. Can you quantify how much mercury was discharged, where and when, how much has been recovered? I ran across an article in the Atlanta Constitution a couple days ago. Back in 1993 they reported 35 pounds of mercury that was released over a five-day period.

We know mercury is a real heavy metal. It likes to sink down low. So, it's probably not going to be sitting on the top 18 inches of marsh. It's probably sunk down deep. What types of mercury were discharged? Was it solid metal --

MR. JACKSON: It was methyl mercury.

UNKNOWN SPEAKER: Is that soluble form or what?

MR. JACKSON: The discharge was elemental mercury, but in the marsh it methylates, but only -- I may have mentioned too quickly that only a tiny fraction has methylated. As far as volume and mass of mercury there are estimates that I have in the record. I know I can come up with those.

UNKNOWN SPEAKER: Can you estimate how much mercury is left in the 28 acres that you want to dredge given the concentrations that you said, 12 milligrams per kilogram?

MR. JACKSON: Yeah, you probably could.

UNKNOWN SPEAKER: Can we get a figure on how much was emitted, how much was left, how much was recovered, and where else the rest of the mercury might have gone? I'm just curious because it didn't go anywhere. It didn't disappear. It's out there.

MR. JACKSON: I agree with you.

UNKNOWN SPEAKER: Thank you.

MS. MILLER: Yes, sir.

MR. MCEWEN: My name is John Mcewen. You in your 54-page report -- of which 20 percent is forms and pictures -- you do make extreme use of a hydrodynamic model. It's not footnoted. Its

design, its authorship, or anything else is nowhere referenced in that report. Googling produces no result. That report needs to be there. That model needs to be challenged.

MR. JACKSON: Again I would remind you that you we have set up an electronic -- EPA has set up an electronic Reading Room. All you have to do is Google LCP Chemicals Electronic Reading Room, and the report you're looking for is there -- a couple of drafts and, in fact, those drafts have all -- the risk assessments have been there for multiple years now. Starting shortly after I got involved with the site --

MR. MCEWEN: I'm asking about the model.

MR. JACKSON: I'll get there. You look there, and that modeling is there in the feasibility study. Look for feasibility study. It's there.

MR. MCEWEN: As I understand it the feasibility study wasn't delivered until 36 hours ago.

MR. JACKSON: There are drafts of it there with substantially the same thing. Remember you've got two months left.

MS. MILLER: Yes.

WENDY BROWN: Coffin Park is right next to the marsh. Are you familiar where Coffin Park is? Are you?

UNKNOWN SPEAKER: Howard Coffin Park?

WENDY BROWN: Yes. My son was playing soccer. A lot of sports are taking place in that area, and all of a sudden a fence came up. It was lead or chemicals there. It was in the paper. The fence went up. The fence came down. What was there? Was that residual from the marsh?

MR. JACKSON: I really don't know.

WENDY BROWN: Okay. Well it's on public record that kids were playing in that contaminated environment and my son was one. I want us to be able to be tested, and that's what I request as a citizen.

MR. JACKSON: Okay.

MS. MILLER: I just wanted to make one statement in regard to what this gentleman said. The documents were placed in the administrative record. We did not expect anybody to totally dissect it and be able to come here tonight and know it.

The proposed plan is so technical that EPA

is required to come out for a public meeting to discuss the preferred remedy, and then we have the comment period -- the 60-day comment period for you guys to digest tonight, look at the documents, and be able to comment within that 60 days.

MR. DEFUR: Peter deFur. Did I hear you say at the beginning you would have a time for official public comment, or is just now?

MS. MILLER: You're talking about tonight? Yes. This is questions and comments, but the comment period does not -- I wanted to make that clear -- doesn't stop tonight. It's through February 2nd. Everything that comes in will be noted.

MR. DEFUR: I understand.

MS. MILLER: Yes, sir.

MR. DEFUR: My name is Peter deFur. I live in Henrico County, Virginia. I'm the president of Environmental Stewardship Concepts, a consulting firm that's been hired under a Technical Assistance Grant Program to work with the Glynn County Environmental Coalition.

The EPA program provides technical assistance to communities around the country so

that they have their own technical experts to work in this process. Essentially I work for the community. I do this work around the country for approximately 20 sites in 5 different EPA regions. So, I'm very familiar with the process.

I appreciate the opportunity to make public comments here. I have comments on two different aspects of the proposed plan at this time. I will be working and listening to the citizens, the community, and working with GEC to determine the specific nature and manner of how my technical comments will be made public and delivered to the EPA, so that will come out in the future.

I have comments about the process and about the substance. The comments about the process do reflect some of the things that we've already discussed and that Daniel Parshley has mentioned. The document here is incredibly important for the community to understand how the rest of their lives will be affected by the future of this site.

The specific details do matter, and they will alter the outcome of how we use the river

and how the river continues to serve as a resource. It's a large and technical document and traditionally EPA releases the public proposed plan with enough time for the citizens to digest it before taking public comments.

Twenty-six hours is a fairly short time period for the public to read and digest. I would hope and expect that EPA Region 4 would follow the example and lead of their sister agency Region 10 which they are familiar with.

EPA in Region 10 for a very important site in the Seattle area held a series of six meetings over a period of five months including three different public meetings, one of which was officially held in Spanish.

I would encourage the EPA to consider that alternative, and my understanding is that when the community -- not I -- makes a request of an extension of the public comment period EPA has an obligation to honor that commitment.

Now as to the substance. The higher actual fish consumption rate does, in fact, affect the cleanup because if lower cleanup numbers are needed in order to accommodate a higher fish consumption rate then the remedy

must accommodate lower concentrations of the contaminants in the site cleanup.

That's just simple math, and it's a calculation that is done throughout the nation. The boundaries of the site are not clearly established as evidenced by two pieces of data. Number 1 is the dolphin data indicating that PCB-1268 -- which we know originates from the LCP site -- is found in dolphins that are both residents of the river and residents of the nearby area.

Second of all, the other set of data are the Sapelo Island data that we've seen indicating that again PCB-1268 is not restricted to the narrow marsh area, so I think it's incumbent upon evaluation to do a broader consideration of samples farther afield. Hence the boundaries have not been clearly established.

The other limitation or problem that I see with the evaluation of the site is the evaluation of the salt marsh grass itself. Salt marsh grass has multiple components, and in order to accurately understand how the contaminates are separated between the plants

and the sediment they have to measure all the different parts of the plants including not just the leaves but the stems and the roots as well as the rhizomes of those roots. So, those data have not been collected.

In addition, even though the report indicates that dioxin is a known co-contaminate and a known product of the process that occurred at the LCP site I don't find dioxin data in any of the reports. So, those data are needed.

It's not obvious or necessary that the dioxide is all and exclusively collocated with PCBs or mercury or PAHs or lead. The dioxins may occur in other places, and we don't know about that.

As to the remedies there are a couple of comments that I think need to be made, and I will elaborate on these at great detail and length. The thin-layer cap is a problem because of a couple of things, one of which was already noted here, and that is that we don't have a long experience with thin-layer caps. That is we don't have 30, 40, or 50 years. We do have a longer experience with some other remedies.

Second of all, we do have evidence, that

EPA has collected, indicating that when we remove contaminates such as PCBs from a system then the result is that the PCP contamination in the trophic system, in fish, and consequently in other animals does go down.

The monitoring program can go a great deal towards demonstrating that, and so the monitoring program can measure not only, quote, "fish", but also young-of-the-year fish that will be exposed to the most recent conditions, new conditions. So, they should be the first to pick up any improvement.

And then there are the animals that live in the sediment that also have to be monitored in multiple ways. So, these are just several of the substantive issues, and I look forward to providing detailed written comments to the EPA in the future before the end of the public comment period. I look forward to further interaction with the people of Brunswick for whom I work. Thank you, very much.

(Applause.)

MS. MILLER: Yes, sir.

ROGER MURRAY: Roger Murray. Just as a humble conclusion here listening to this last

gentlemen I think these people would be a lot more comfortable if you identified the hot spots and hauled the stuff off.

MR. PARSHLEY: I'm going to enter some questions into the record. DEP has to answer questions. That's what the public hearing is all about. The first question is how were the chemicals released? I know it's a proposed plan that concentrates on water and sediments. It ignores air transport.

My question is, is the gradient being observed across the Brunswick peninsula a result of air transport of the PCBs? We see a PCB gradient. This same gradient that we observe across the Brunswick peninsula extends toward Sapelo Island, and that is why we are seeing PCBs in seafood and people and sediments towards Sapelo Island.

We also see the same distribution across tidal modes going in other directions down to the Sapelo River, and so it makes -- it appears from the sediment data that has been issued with the Sapelo Island Report that there's a strong indication of air deposition. If you go into the library, Volume Number 38 goes into

extensive detail concerning the air releases from the plant.

I'd be interested if the remedial project managers have included the well-documented air releases into their calculations of aerial distribution of PCPs across the Brunswick peninsula and the surrounding marshes.

My next question is how many pounds of each chemical were released, and that would be again to the soils, to the marsh, and to the air. Please identify how many pounds to the marsh will be removed of those that you've identified.

This is called a mass calculation. Please provide the mass calculations for the site. I could not find them in any document.

I'd like to reinforce Dr. deFur's comment concerning the lack of testing of the root, rhizome, and stem of the marsh grass in the LCP Marsh. Literature has documented that these bio-accumulate. A significant amount of biomass PCBs could be located in the spartina ecosystem.

This could greatly change the calculations and ecological risk assessment and the human health risk assessment if these were brought

into the calculation. Furthermore spartina genus has also been associated with the detritus of accumulating PCBs. We see no data for the detritus PCB levels. The biological matter has been ignored. This is a huge hole that we'd like the EPA to fill.

Who determined the physical damage for the proposed toxins in the feasibility study? What projects have the authors of the proposed options in the feasibility study completed in spartina marsh ecosystems?

How many companies who have been working in estuaries and marshes were consulted for the estimates presented for remedial options in the feasibility study and proposed plans?

Please provide a list of the projects they have done and the success of those projects. What institutional controls has the EPA implemented over the past 20 years? Who conducted these institutional controls? What is the budget for these institutional controls, and what institutional controls does the EPA anticipate implementing as far as the proposed plan?

As part of that please describe the

institutional controls in detail. Who will be implementing the institutional controls, and please provide an evaluation of your last 20 years of institutional controls since you've been aware of the problem for the past 20 years. I'm sure since you're going to depend on that to protect human health and welfare and to meet your regulatory-required protection of human health and the environment that's going to be very important.

The proposed plan lacks any monitoring plan. In particular mink are not found within the area. Mink is an apex species, and it's indigenous. So, the only conclusion can be that the dead zone for mink around the LCP site extends to where the mink population has been established.

Please explain in the response to the study the work that the EPA has done to identify the mink habitat and the area of reproductive failure. Please describe the frequency of testing the EPA is proposing for the marine mammal population and for the mink population, and also for the individual fish species.

The EPA does mention goals, but the goals

do not have any timeline for evaluation. It mentions evaluation, but it doesn't state what the evaluation criteria are. Please clearly state in your response to the summary what are the evaluation goals, at what date and time would those evaluations take place?

What are the action items the evaluation will use to determine if additional action is needed, and what will the additional actions be to meet those goals?

Please make those specific dates, specific goal criteria, specific evaluation criteria so we'll know how it's going to be evaluated. I will submit the rest of my comments and the peer review journal studies in support of my comments here this evening at a later date.

(Applause.)

MS. MILLER: Yes, sir.

MR. LAWRENCE: I moved --

MS. MILLER: Larry Lawrence?

MR. LAWRENCE: I lived out there, like, 30 years. Purvis Creek was just like my back yard. I and other personnel have tested 24 hours a day, 7 days a week the contaminates going out of Purvis Creek. Allied Chemical did a wonderful

job while they were there.

I retired 25 years ago. I don't know what's happened since then, but as far as -- I'm 83 years old. I have trouble. I haven't heard anybody with EPA -- as far as EPA is concerned -- when I worked for that laboratory they were on the spot all the time. They came every month, and so I told people it was probably -- I worked about two hours a day making out reports to EPA and EPD, and -- but as far as I was concerned they did a really good job.

That was 45 years ago. I haven't been back since then. Anyway, you'd excuse me, my age. That's where I am.

MS. MILLER: Thank you for your comment. Yes, ma'am.

LINDA STRONG: Linda Strong. Can you tell me how this plan protects the aquifer?

MR. JACKSON: Right now there's -- they were doing work on the caustic prime pool which is out there, and they're bringing that mix from a pH of about 11 or 12 to neutral, and it's working quite well.

That will immobilize the mercury because

at high pHs mercury becomes much more volatile as well as other heavy metals.

MS. MILLER: Yes, sir.

BOB KILLIAN: Does it give concern to DNR that Honeywell is so happy with your plan?

(Laughter.)

MR. JACKSON: I don't know how to answer that.

MR. KILLIAN: Does anybody from DNR have any concern about how happy Honeywell is?

MR. JACKSON: Not that I'm aware of.

MR. KILLIAN: Thank you.

MR. CLICK: My name is Damon Click. I guess the question I heard from a couple people is if Honeywell is putting up any of their own money to help the community, or is just government funds?

MR. JACKSON: Honeywell funded the removal that occurred in the 1990s. There were two on-scene coordinators here overseeing it. In fact, all the uplands removal was overseen by -- the funding was done by not just Honeywell but the other responsible parties as well.

MR. CLICK: And for the additional remediation?

MR. JACKSON: It's exactly the same.

MR. CLICK: Also, does anyone know if there's any of our local representatives here tonight?

UNKNOWN SPEAKER: We can't hear you.

MR. CLICK: Does anyone know if there's any of our local representatives here tonight?

UNKNOWN SPEAKER: One city commissioner, and he's right back there.

MR. CLICK: One city commissioner? What's his name?

UNKNOWN SPEAKER: Johnny Cason.

MR. CLICK: Johnny Cason is here. Thank you.

MS. MILLER: Yes, sir.

MR. WOOTEN: Joel Wooten. What do you mean by long-term monitoring; 50 years, 100 years, 200 years?

MR. JACKSON: Long term, decades, until it's determined to have met the goals.

MR. WOOTEN: What are the goals?

MR. JACKSON: There are goals for sediment concentration as well as fish tissue concentrations also, and those are prescribed by the state of Georgia regulations.

MR. WOOTEN: Do you know how much mercury was discharged at the Allied Chemical plant, Honeywell plant?

MR. JACKSON: Do I know?

MR. WOOTEN: Yes.

MR. JACKSON: I have run recent estimates, but they're -- I know the records are incomplete, but there are some records that we've been looking at.

MR. WOOTEN: What records are those?

MR. JACKSON: Generally depositions from some of the former people.

MR. WOOTEN: Plant manager?

MR. JACKSON: Correct.

MR. WOOTEN: Didn't he testify that over one million pounds of mercury was unaccounted for and potentially discharged?

MR. JACKSON: I have not read the deposition recently so I --

MR. WOOTEN: The one that was taken up in Jesup?

MR. JACKSON: Correct.

MR. WOOTEN: You've done testing on fish. You've done testing on herons. You've done testing on mammals, but there's been no testing

whatsoever on humans or substantive fishermen in the Turtle River area, the Blythe Island area, St. Simons, correct?

MR. JACKSON: There was an ATSDR health study done more than ten years ago. It's kind of vague in my memory.

MR. WOOTEN: Haven't you been working on this? That's a fairly significant --

MR. JACKSON: Your question is what?

MR. WOOTEN: Isn't this -- shouldn't this be a --

MR. JACKSON: Yes.

MR. WOOTEN: -- meeting?

MR. JACKSON: Yes.

MR. WOOTEN: Are you the person that's most informed about what's been going on?

MR. JACKSON: This has decades of history. I don't recall every nuance immediately.

MR. WOOTEN: Do you recall any testing of PCB levels and mercury levels in residents of Glynn County to see what the PCB levels or the mercury levels were that were --

MR. JACKSON: No, I don't. No, I don't recall.

MR. WOOTEN: -- in the Turtle River area?

MR. JACKSON: No, I don't recall.

MR. WOOTEN: Wouldn't that be the gold standard; to find out whether or not there's mercury in residents in that area?

MR. JACKSON: I would imagine so.

UNKNOWN SPEAKER: Agreed.

UNKNOWN SPEAKER: It needs to be done tomorrow.

MS. MILLER: I'm sorry, she had her hand up first.

MS. FREUND: My name is Mary Freund, F-r-e-u-n-d. In all of your removal alternatives none of them actually have any bioremediation methods, and I was just curious why you guys aren't looking at any especially to remove the PCBs.

We were informed at the earlier session that there might be a powder that could be applied to the sediment that would actually remove the PCBs from the environment.

So, my question is why is there no bioremediation being explored?

MR. JACKSON: Mercury does not --

MS. FREUND: I'm talking about PCBs.

MR. JACKSON: PCBs -- I think to

bioremediate would create difficulty.

MS. FREUND: So, that's your answer?

MR. JACKSON: Actually Mark is the sediment expert.

MR. SPRINGER: PCB degradation and bioremediation, people have been working on it for 20-plus years starting with the Hudson River. The primary researcher from Rensselaer is at the point where she can degrade in the laboratory some of the higher chlorinated compounds.

The problem, especially with 1268, is it's primarily higher chlorinated content. It's a slow process, and quite frankly we're not at the point where we can do it as a treatability.

We can do it in the laboratory. If you want to follow it actually Tierra Solution which is a conglomerate or coalition of responsible parties on the Passaic River site in New Jersey which is PCBs and dioxins from the Diamond Shamrock site, they proposed to do an in situ project to evaluate whether or not they could do it. That's in the works. It's being addressed. I do bioremediation of contaminates. Doing PCBs as a treatment technology, as far as I know

we're not there yet.

MS. FREUND: Thank you.

MR. DAY: NASA developed something for Kennedy Space Center, and we had a very special relationship -- I was in southwest Mississippi two weeks ago, and they've asked us to commercialize what they developed for caulk and paint as well and other surface PCBs. Remember most paints and caulks before 1978 had PCBs laced with chips and other things. It was kind of a miracle product really. I mean everybody thought it was a miracle. It wouldn't overheat. It wouldn't burn. It was great for transformers and other metals.

The only problem is Monsanto -- and I won't get into the whole history. Monsanto knew about the problems years and years and years ago back in the thirties. They didn't bother to tell anybody oops, we also made a small little problem that they didn't mention to anybody. They didn't mention it to Honeywell.

So, what this does, this doesn't use a bio approach. This is using something quite similar to a tree root. It's spikes that are loaded with ethenol. The spikes are sealed, driven

into the soil, into the marsh, into sediment, and then in the area that surrounds the spike it's like tree roots.

Tree roots are the most wonderful filtering system. They never get clogged, do they? Your filter at homes gets clogged. Tree roots don't have that happen.

What happens is that the sugars in the tree root attract nutrients. It's very simple. The ethenol inside the spike attracts PCBs and absorbs PCBs. So, we take the PCB spike out and put it in a container, and off it goes for an EPA-approved disposal location.

We put some more spikes down and keep doing that until there are no PCBs left or they're down to an acceptable level. The reason you don't know about this is that it's new. It's been researched, and it's been working in Kennedy Space Center and other locations in NASA for a while.

We're now working with the Trans Canada pipeline, 500 sites around the country. There's some good technologies every day. We looked at all the biologicals. I agree with you, sir. There is not really a great biological solution.

There is not really a great oxidizer solution.

You have to change the molecule of the chlorine that's in the PCB to change it to make it more inert. It's not as easy as it sounds because PCBs are very complicated compounds, but we actually remove the PCBs rather than trying to change them.

We have some other things that are being developed now. They kind of have to be removed to do that. It's not something we can just sprinkle on the earth and expect it to work. It really has to be concentrated, and then we can remove it.

I hope that answers your question. This is something new that's been developed by NASA, but they're scientists. They're pretty smart. I'm not a scientist. I'm just a non-achiever.

Anyway I do respect what they've done, and we're very excited about what they're doing and what they've developed for us. Thank you.

MS. MILLER: Let me ask you something. We've got about five minutes left. If you had a magic wand -- and maybe it's not a fair question to ask tonight. If you had a magic wand what would you want to be done?

UNKNOWN SPEAKER: Clean up the entire area.

UNKNOWN SPEAKER: Completely.

MS. MILLER: For the record.

UNKNOWN SPEAKER: You'd have to determine the extent of the contamination for the area and see more testing of the human population. I think a lot of people raised that point tonight. I don't want to say EPA was insensitive, but in that regard I think it was insensitive -- you know, when we're talking about people's health.

MS. MILLER: Right, and we need ATSDR for that too.

UNKNOWN SPEAKER: I guess that leads me to a question. How much contamination would have to be present for the EPA then to decide to get another agency involved on their own instead of having the people in the community be the one that drives that?

It's not that we shouldn't drive it, but when does the EPA decide to drive it?

MR. JACKSON: I've not been confronted with that.

MS. MILLER: Yes, ma'am.

UNKNOWN SPEAKER: With my magic wand I

would waive it and y'all would have -- y'all would work with Honeywell and the other potential responsible parties to come up with a management plan as a short-term solution to stop the pollutants from continuing to get out into our system and spreading through however far, and then during that time the funds come in and you actually remove the contaminated sediment as much as possible -- as much as financially can be done, and then after that you actually put in the plants and restore the system to the best extent possible, but I do think you have to have a management plan.

It's 20 years and you don't have a management plan that's cutting off the pollutants from entering the system continually. I think we've got to have that.

MS. MILLER: Thank you for your comment. Mr. deFur?

MR. DEFUR: Peter deFur again. I have a process question, what Steve commented on and a comment that I made -- and I will be making -- that has to do with alternative methods, technologies, or equipment that is not in the proposed plan and has to be considered in the

feasibility study.

This method was not available at the time the feasibility study was begun. I know that EPA will always take every serious comment into consideration. So, I'm confirming that you will take these suggestions into consideration and upon demonstration with empirical data that they work will EPA be able to include them in the record of decision and how does that happen?

Will you have to go back out for a public comment period with a new component of the remedy that includes, for example, Steve's method or the one that Joe has talked about, or one that I'm going to explain to you? Do you have to start over? Can you include that even though it's not been part of the feasibility study.

MS. MILLER: From what I understand if there is a significant change to the remedy we have to start over.

MR. DEFUR: All over or do you simply have to take it out to public hearing?

MR. JACKSON: I have not thought that through. I'm not sure. I'd have to get back to you on it.

MS. MILLER: We would have to go --

MR. DEFUR: I know you'd have to have another public component to it.

MR. JACKSON: It's starting another feasibility study.

MS. MILLER: Okay, one more question or comment. Yes, ma'am.

UNKNOWN SPEAKER: I would just like to comment that I think there should more health risk assessment and testing of the residents in the area -- all of the area, and I think that the fish consumption advisories should be more prevalent. I bought a fishing license this year. No one said a word to me about what I should and shouldn't eat or how much and how often I should and should not eat that fish.

(Applause.)

MS. MILLER: Yes, sir.

MR. BROWN: Carl Brown. Dealing with the PCBs, the type that we're dealing with where's the toxicity level? Is this something that is more toxic than some of the other types, or is it less?

MR. JACKSON: Kevin, do you want to address that?

MR. KOPOREC: Yeah. The Arclor-1268 is the PCB compound that -- or mixture that's prevalent here that we're worried about. The testing that's been done showed it to be less -- somewhat less toxic than the most toxic one that we have well-established toxicity information on -- and that's Aroclor-1254 -- and so, we used the toxicity information from 1254 to evaluate 1268.

Even though we think it's probably less toxic we don't have enough information for its own toxicity value, but basically it's an EPA database. It's a probable human carcinogen.

We have some information about causing cancer, not enough human information about it causing cancer to be a known carcinogen like other compounds are, and from a non-carcinogenic toxicity standpoint at higher exposure levels it's been shown to cause immune system problems and other effects on the blood system, effects on the central nervous system sometimes.

So, things like that could happen at higher exposure levels. That's where we're at with that.

MS. MILLER: We're going go have to wrap

it up tonight. Again the comment period is extended to February the 2nd. You can e-mail it. You can mail it. You can call me. I'll type it up. I'll submit it, but I want to thank you personally for coming out tonight to the meeting. I understand this is your community, and you know it best. So, thank you so much for coming.

(Meeting concluded at 8:00 p.m.)

CERTIFICATE OF COURT REPORTER

STATE OF GEORGIA:

COUNTY OF GLYNN:

I, hereby certify that the foregoing transcript was reported as stated in the caption and was reduced to writing by me; that the foregoing 89 pages represent a true, correct, and complete transcript of the proceeding held on Thursday, December 4, 2014.

I certify that I am not disqualified for a relationship of interest under O.C.G.A. 9-11-28(c); I am a Georgia Certified Court Reporter here as a representative of Gilbert & Jones, Inc., who was contacted by United States Environmental Protection Agency to provide court reporting services for the proceedings; I will not be taking these proceedings under any contract that is prohibited by O.C.G.A. 15-14-37(a) and (b) or Article 7.C. of the Rules and Regulations of the Board; and by the attached disclosure form I confirm that neither I nor Gilbert & Jones, Inc., are a party to a contract prohibited by O.C.G.A. 15-14-37(a) and (b) or Article 7.C. of the Rules and Regulations of the Board.

This 10th day of December, 2014.

Barbara J Prindle

BARBARA J. PRINDLE, Certified Court Reporter, 2471

DISCLOSURE OF NO CONTRACT

I, Debbie Gilbert, do hereby disclose pursuant to Article 10.B of the Rules and Regulations of the Board of Court Reporting of the Judicial Council of Georgia that Gilbert & Jones, Inc., was contacted by United States Environmental Protection Agency to provide court reporting services for these proceedings, and there is no contract that is prohibited by O.C.G.A. 15-14-37(a) and (b) or Article 7.C. of the Rules and Regulations of the Board for the taking of these proceedings.

There is no contract to provide reporting services between Gilbert & Jones, Inc., or any person with whom Gilbert & Jones, Inc., has a principal and agency relationship nor any attorney at law in this action, party to this action, party having a financial interest in this action, or agent for an attorney at law in this action, party to this action, or party having a financial interest in this action. Any and all financial arrangements beyond our usual and customary rates have been disclosed and offered to all parties.

This 19th day of December, 2014

Debbie Gilbert
FIRM REPRESENTATIVE
Gilbert & Jones, Inc.