Risk Assessment for Air Monitoring Results
Hopewell, Virginia

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Risk Assessment Program

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1.0 Introduction

Air toxics information was collected in the Hopewell, VA area from late 2006 through 2008 by the VDEQ Office of Air Quality Monitoring. The project was funded by a Community Air Toxics grant from the U. S. EPA Office of Air Quality Planning and Standards. There were three monitoring locations in the study plan: Spruance Street (Spruance), G. Carter Woodson Middle School (Woodson) and the Virginia Commonwealth University (VCU) Rice Center (Rice). The details of the sampling locations and the data collection program can be found in the following document: "Quality Assurance Project Plan for the Hopewell Air Toxics Monitoring Project, 2006", Office of Air Quality Monitoring (AQM, 2006). The purpose of this paper is to analyze and discuss the implications of the collected air toxics information with respect to potential human health risk.

The information from the study was analyzed using the National Academy of Sciences (NAS) Risk Assessment Paradigm. This paradigm was first presented in "Risk Assessment in the Federal Government: Managing the Process", (NAS, 1983). The four steps of this paradigm are:

- ***Hazard identification****: The determination of whether a particular chemical is or is not causally linked to particular health effects.*
- ***Dose-response assessment:*** *The determination of the relation between the magnitude of exposure and the probability of occurrence of the health effects in question.*
- ***Exposure assessment****: The determination of the extent of human exposure before or after application of regulatory controls.*
- ***Risk characterization****: The description of the nature and often the magnitude of human risk, including attendant uncertainty.*

This paradigm purposely omits discussion of risk management in order to prevent the science-based process from being influenced by management objectives.

The paradigm was further developed in "Science and Judgment in Risk Assessment", (NAS, 1994) to show the relationship between risk assessment and risk management. Figure 1 is a diagram of the paradigm recommended by NAS. There are three distinct phases of analysis within this paradigm: risk assessment, risk characterization and risk management. This paper will focus on risk assessment only. However, the results of this risk assessment will be used by DEQ to assess management options for addressing Air Toxics in Virginia.

In practice, environmental regulatory programs implement the risk assessment paradigm in the following 4 steps:

1. Data collection and evaluation (including risk-based screening).
2. Exposure Assessment
3. Toxicity Assessment (including hazard identification and dose-response assessment)
4. Risk Characterization (including uncertainty analysis)

This report follows these four steps as they apply to the Hopewell Air Toxics Monitoring Project.

2.0 Data Collection and Evaluation

2.1 Analyte List

The U.S. Congress passed the Clean Air Act Amendments of 1990. Within those amendments a specific list of Hazardous Air Pollutants (HAPs) was established. The HAPs, also known as air toxics, are chemicals that were determined by EPA to have the potential to cause serious health effects. Appendix A of this report is a table of the HAPs as presently utilized by the U.S. Environmental Protection Agency (EPA). Appendix B of this report is a listing of the HAPs that were analyzed for this study. These represent most of the HAPs identified in EPA's Integrated Urban Air Toxics Strategy (UATS) (EPA, 1999). They are a subset of the 187 HAPs and are recommended by the EPA for air monitoring programs.

2.2 Sampling and Analytical Methods

The sampling procedures and analytical methods used in this project are described in the "Preliminary Data Report, Ambient Air Monitoring Project, Hopewell, VA, 2006-2008." (DEQ, 2008.) In addition to the samples described in that report, the risk assessment included other available data. The data sets used in this risk assessment covered the following dates:

Volatile Organic Compounds (VOCs)

Woodson:	November 19, 2006 through November 14, 2008
Spruance:	November 16, 2006 through June 30, 2009
Rice:	February 5, 2007 through September 27, 2008

Additional samples were available from the Woodson station from 11/20/08-12/26/08. These samples were not included in the quantitative risk assessment because they were analyzed by a different laboratory. It would not be appropriate to statistically combine the two data sets since the laboratories had different MDLs. The results of these samples are included on Table 2.4 for information purposes.

Carbonyls

Woodson:	December 1, 2006 through December 26, 2008
Spruance:	December 1, 2006 through September 27, 2008
Rice:	February 5, 2007 through September 27, 2008

PM_{10} Metals

Woodson: November 19, 2006 through September 27, 2008
Spruance: November 1, 2006 through September 27, 2008
Rice: February 5, 2007 through September 27, 2008

Hexavalent Chromium

Woodson: January 12, 2007 through September 27, 2008
Spruance: January 12, 2007 through September 27, 2008
Rice: February 5, 2007 through September 27, 2008

Although it is not on the original HAPs list, VDEQ is aware that hydrogen sulfide (H_2S) is a particular concern to residents of Hopewell. Therefore this risk assessment also includes the H_2S samples collected by the Air Monitoring Program in Hopewell from December 2008 to July 2009 at the Spruance site. However, because the sampling method for H_2S is different from the other chemicals, H_2S is addressed separately. A description of the sampling method is included in Appendix C.

2.3 QA/QC

All data sets were reviewed by the Office of Air Quality Monitoring (OAQM) to insure that they met the data quality objectives described in the "Quality Assurance Project Plan for the Hopewell Air Toxics Monitoring Project, 2006." A description of the review process is available in the Quality Assurance Report and may be obtained from the OAQM upon request.

2.4 Screening for Contaminants of Potential Concern

2.4.1 Risk-Based Screening

The risk-based screening process involves comparing the maximum detected concentration in each data set with a screening level derived from conservative exposure factors and target risks and hazards. Detected contaminants that are below the screening levels may be dropped from consideration in the risk assessment since they do not contribute significantly to the overall risk. Detected chemicals that are above the screening levels are carried through a more detailed quantitative assessment. The purpose of the screening process is to focus limited resources on chemicals that drive risk.

The risk-based screening levels used in this risk assessment were developed in part from the reference values developed from the Virginia Inhalation Toxicology Advisory Group (VINTAG) recommendations. The recommendations of this group are discussed in further detail in

Section 4.0 of this report. The screening levels are based on a target cancer risk of 1×10^{-6} and a target non-cancer hazard quotient (HQ) of 0.1. Cancer risk and non-cancer hazard quotients will be discussed in further detail in Section 5.0 of this report. It should be noted that the VINTAG recommendations and the target risks and HQs have not yet been reviewed by DEQ management. Therefore, they should not be interpreted as DEQ policy at this time. RAP staff chose these targets in order to present a conservative assessment of the air monitoring results in Hopewell.

Tables 2.1, 2.2, and 2.3 present the maximum detected concentrations detected at the Spruance, Woodson and Rice stations respectively, compared to the screening levels. Concentrations that exceed the screening value are further evaluated to determine how frequently they were detected. Chemicals that exceed the screening level and that are detected at a frequency of greater than 10% of the total number of samples are considered Chemicals of Potential Concern (COPC) and are evaluated quantitatively in this risk assessment. Chemicals that were not detected are noted as "ND". In addition, as noted above, the maximum concentrations of the VOCs detected at the Woodson stations from 11/20/08-12/26/08 are also presented in Table 2.4.

2.4.2 Regulatory Screening

Since the screening levels discussed in the previous section are not the current Virginia Significant Ambient Air Concentrations (SAACs) by regulation, this report also presents a comparison of the maximum detected concentrations at each station to the current SAAC. The comparison to the current SAACs are presented in Tables 2.5, 2.6, 2.7 and 2.8.

The SAACs were developed by DEQ in the mid 1980's (SAPCB, 1985). The scientific field of toxicology with respect to air toxics inhalation has advanced significantly in the interim. Therefore these regulatory values do not represent the most current toxicological information and do not take into consideration carcinogenic effects.

3.0 Exposure Assessment

Exposure assessment is the estimation or determination of the magnitude, frequency, duration, and route of exposure. The exposure assessment for the Hopewell risk assessment is fairly straightforward since DEQ is evaluating only one exposure medium (air) and one exposure route (inhalation).

3.1 Exposure Pathways and Assumptions

In this risk assessment DEQ is evaluating a general residential population exposed to the ambient air. The general equation for estimating exposure to contaminants in air is:

EC=CA x EF x ED/AT

where:

Variable	Definition	Units	Value
EC	Exposure Concentration	ug/m^3	Calculated
CA	Concentration in Air	ug/m^3	Chemical and station specific
EF	Exposure Frequency	Days per year	365
ED	Exposure Duration	years	70
AT	Averaging Time	days	70 years x 365 days/yr =25550

Note that under a residential scenario using 70 years, 365 days/year the equation reduces to EC=CA.

3.2 Determining Exposure Point Concentrations in Air

There are two general methods for estimating concentrations in air for risk assessment: 1) ambient air monitoring and 2) modeling from an emissions source to a point of exposure. For this risk assessment DEQ is using the results of the air monitoring conducted in Hopewell to estimate the CA variable in the equation above. No modeling was performed to predict concentrations at actual exposure points.

The reported concentrations for the HAPs were analyzed statistically via the calculation of percentiles. The concentration percentile approach was selected because some of the HAPs had a significant number of non-detects. The degree of non-detection can bias the selection of a statistical distribution. In the percentile calculations, one half the method detection limit (MDL) was substituted for the non-detected results. The percentiles selected for further analysis in the risk characterization section are the 50^{th} and 90^{th}. A percentile is a value below which a defined percentage or fraction of the variable values lie. The 50^{th} percentile is the value below which one half of the values lie. The 90^{th} percentile is the value below which 90% of the values lie. The 50^{th} percentile gives an estimate of a central tendency exposure while the 90^{th} percentile results in a more conservative, upper bound estimate of exposure.

Tables 3.1, 3.2, and 3.3 provide a summary of the exposure information for the Spruance, Woodson and Rice station, respectively, for the chemicals of potential concern. Minimum and maximum concentrations, frequency of detection, the 50^{th} and 90^{th} percentile values and the distribution for each data set are presented.

4.0 Toxicity Assessment

The toxicity assessment step of the risk assessment process consists of two parts: hazard identification and dose-response evaluation. The first step, hazard identification, is the process of determining whether exposure to a chemical can cause an increase in the incidence of a particular adverse effect and whether the adverse effect is likely to occur in humans. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. (EPA, 1989b) In simpler terms, hazard identification is the determination of whether a chemical can cause harm. Dose-response assessment is the determination of how much of a chemical it takes to cause the harmful effect.

As noted above in Section 2.4.2 the current SAACs in DEQ Air Toxics Regulations were established in the mid 1980s. Since that time the field of toxicology with respect to air toxics inhalation has advanced and new toxicological information has become available from various sources. These sources include the U. S. EPA Integrated Risk Information System (IRIS), the Agency for Toxic Substances and Disease Registry (ATSDR) and the California EPA Office of Environmental Health Hazard Assessment (OEHHA). Because there are often differences in the toxicity information provided by each of these agencies, DEQ established the Virginia Inhalation Toxicology Advisory Group (VINTAG) in late 2008. The charge of this advisory group was to advise the RAP staff on the selection or development of reference values for potential use in risk assessments performed by the Air Division and in the development of updated SAACs. A summary of the results of the VINTAG process is as follows:

"For cancer and chronic non-cancer effects, the VINTAG recommended that VDEQ compare the reference values developed by the US EPA and the California EPA (CalEPA). When the differences between the US EPA and CalEPA values are not significantly different, the VINTAG recommended that VDEQ use the value based upon the most recent agency review. When differences are significant (greater than 3 times for non-cancer and ten times for cancer), the VINTAG recommended doing a more in-depth chemical-specific review."

A copy of the VINTAG recommendations report is available from the VDEQ Risk Assessment Program upon request. (DEQ, 2009)

Table 4 presents the toxicity values resulting from the VINTAG recommendations. The toxicity values for cancer and non-cancer are described in the next two sections.

4.1 Toxicity Assessment for Carcinogenic Effects

The reference value used to express dose-response for carcinogens is called the Inhalation Unit Risk (IUR) and is defined as follows:

The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent via inhalation per µg/m^3 over a lifetime. The interpretation of the IUR would be as follows: if IUR = 2×10^{-6} per µg/m^3, not more than 2 excess tumors (above background levels) are expected to develop per 1,000,000 people if exposed continuously for a lifetime to 1 µg of the chemical per cubic meter of inhaled air. (U. S. EPA, 2004)

IURs are developed from either human epidemiological studies or laboratory animal studies. When animal studies are used, models are applied to extrapolate from the high concentrations to which the animals are exposed to the concentrations that humans may be exposed to in the environment.

Both CalEPA and U. S. EPA recommend that the IURs be adjusted to account for early life stage (infants and children) susceptibility to carcinogens in risk assessments that include early life exposure. U. S. EPA recommends these adjustments for carcinogens that act by a mutagenic mode of action while CalEPA recommends the adjustment for all carcinogens. The VINTAG recommended that DEQ adopt the CalEPA approach and adjust the IUR for all carcinogens. This risk assessment includes this adjustment. Note, however, that this approach has not been reviewed and approved by DEQ management and therefore does not at the time of the writing of this report represent official agency policy.

4.2 Toxicity Assessment for Non-Carcinogenic Effects

The reference value used to express noncancer dose-response is called the Reference Concentration (RfC) and is defined by U. S. EPA as follows:

An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious noncancer health effects during a lifetime. The inhalation reference concentration applies to continuous inhalation exposures and is appropriately expressed in units of mg/m^3 (EPA, 1994). Note that in this report units have been converted to ug/m^3.

Reference concentrations are determined by evaluating the levels that cause adverse effects in either human epidemiology studies or laboratory animal studies. Uncertainty factors are applied to these effects levels to account for factors such as differences between animals and humans, different sensitivities among the human population, and duration of the study compared to a human lifetime.

4.3 Additional Information

Appendix C presents ATSDR summaries of toxicological information for the chemicals of concern for Hopewell, called ToxFAQs. ToxFAQs for additional

chemicals or more detailed Toxicological Profiles may be found on the ATSDR website http://www.atsdr.cdc.gov/toxprofiles/index.asp.

5.0 Risk Characterization

The last step in the risk assessment process is risk characterization. The risk characterization step combines the information collected during the exposure assessment and the toxicity assessment to produce a quantitative estimate of risk for both cancer and non-cancer effects. Quantitative risk estimates are accompanied by text describing the uncertainty inherent in each step of the process. Risk characterization is also the bridge between risk assessment and risk management.

Cancer Risk Characterization

For cancer, risk is expressed as a probability of an individual developing cancer over a lifetime due to exposures from the contaminants included in the study. The risk represents the incremental risk above background cancer risk. For individual contaminants risk is calculated by:

Risk =EC x IUR

EC	Exposure concentration	ug/m^3
IUR	Inhalation Unit Risk	$(ug/m^3)^{-1}$

Cancer risk is usually expressed in scientific notation. For example, a 1 in a million cancer risk is expressed as 1×10^{-6} or 1e-6.

Cancer risks are assumed to be additive. Therefore, for multiple contaminants

$Risk_{total} = Risk_1 + Risk_2 + \ldots + Risk_i$

Use of additivity assumes that the actions of the carcinogens are independent (i.e. that there are no synergistic or antagonistic interactions between any of the chemicals being evaluated). Synergism means that the effect of the combined exposure to two or more chemicals is greater than that suggested by adding the toxic effects from each chemical. Antagonism means that the effect of the combined exposure to two or more chemicals is less than that suggested by adding the toxic effects from each chemical. In most cases there is not enough information to determine whether there are synergistic or antagonistic interactions. Therefore, the default assumption is that cancer risks from multiple chemicals are additive.

Non-cancer Risk Characterization

Non-cancer risks are calculated as a hazard quotient.

Hazard quotient (HQ) = EC/RfC

EC	Exposure concentration	ug/m3
RfC	Reference concentration	ug/m3

In a screening assessment HQs are assumed to be additive. The sum of HQs for multiple contaminants is referred to as the Hazard Index (HI).

$HI=HQ_1 + HQ_2 + ….. + HQ_i$

In reality hazard quotients would only be additive for contaminants with the same target organ, effect, and mechanism of toxicity. Because an evaluation of additivity or interaction based on effects and mechanisms of toxicity are quite complex, the most common method is to assume additivity for contaminants that act on the same target organ. Therefore hazard indices may be refined by calculating a separate HI for each target organ.

5.1 Risk Characterization Results

Tables 5.1, 5.2, and 5.3 present the quantitative risk and hazard estimates for the three monitoring sites. The top portion of each table represents the risk resulting from exposure at the 50^{th} percentile concentration. The bottom portion presents the risk resulting from a 90^{th} percentile concentration. Risks and hazard quotients are presented for individual chemicals. These results are then summed to provide a total risk and hazard index at each station. The respiratory system was the only target organ with an HI greater than one. Therefore the respiratory HI is calculated separately.

5.2 Risk Characterization Discussion

Table 5.4 contains a comparison of the excess cancer risks and the hazard quotients for each site. With respect to excess cancer risk, the three sites range from 1.2e-04 for the 50^{th} percentile at all of the sites to 2.3e-04 for the 90^{th} percentile at Spruance and Rice. With respect to non-cancer hazard, the three sites range from 1.2 for the 50^{th} percentile at Woodson to 3.6 for the 90^{th} percentile at Woodson. Note that these results do not currently have any regulatory implications for DEQ. Therefore, a summary of the chemicals that exceed the current regulatory standards (SAACs) is presented for reference in Table 5.5.

To put these results into perspective, the cancer risk that is considered acceptable for most environmental regulatory programs is within the range of 1×10^{-4} and 1×10^{-6}. With respect to Air Toxics, the Clean Air Act directs that emission sources be set at levels that "provide an ample margin of safety to protect the public health." The preamble to the National Emission Standards for Hazardous Air Pollutants (NESHAP) rulemaking for benzene states that EPA should strive to:

1) Protect the greatest number of persons possible to an individual lifetime risk level no higher than 1 x 10^{-6}.

2) Limit to no higher than approximately 1 x 10^{-4} the estimated risk that a person living near a source would have if exposed to the maximum pollutant concentration for 70 years.
(EPA, 1989a)

These are also the goals incorporated by Congress for EPA's residual risk program under the Clean Air Act (CAA) section 112(f).

In other words, neither Congress, via the Clean Air Act Amendments of 1990, nor EPA via a regulatory route has established clear guidelines for the protection of human health with respect to air toxics. EPA, however, has generally followed as guidance the 1989 Benzene NESHAP.

For the Hopewell project the excess cancer risks for each of the sites exceed the 1 x 10^{-4} benchmark at both the 50^{th} and 90^{th} percentile concentrations.

Neither Congress nor EPA has provided any intent language with respect to non-cancer inhalation hazards similar to the proceeding language for carcinogens. As noted above, the non-cancer RfC is defined as a concentration below which humans could be exposed over a lifetime without appreciable risk of non-cancer effects. Therefore when a hazard quotient (or hazard index) exceeds one, non-cancer effects cannot be ruled out. Accordingly, most environmental programs have set either an HQ or an HI of one as the target for non-cancer effects. (Exceedance of an HI of one does not mean, however, that non-cancer risks will necessarily be observed.)

For the Hopewell project the hazard indices exceed 1.0 for each of the sites at both the 50^{th} and 90^{th} percentile concentrations.

To further put these risks into perspective, Table 5.6 presents the concentrations at each of the Hopewell stations in comparison to cancer risk and hazard targets along with the 2008 results for DEQ's three Air Toxics Monitoring stations in Northern Virginia, Richmond, and Norfolk. This comparison shows that the concentrations detected and risks from Air Toxics in Hopewell are very similar to other urban areas in Virginia.

5.3 Chemicals of Concern

Cancer

As noted above, cancer risk estimates above 1 x 10^{-4} are generally considered to be unacceptable. Chemicals that contribute to cancer risks above this level are

referred to as chemicals of concern (COC). At each of the sites the most important COCs are carbon tetrachloride and formaldehyde. Benzene and arsenic also contribute to the cancer risk but to a lesser degree at the Spruance site.

Non Cancer

As noted above, hazard indices above 1 are generally considered to be an acceptable. Compounds that contribute to a hazard index greater than one are considered COCs. At all the sites, the non-cancer COCs are acrolein and formaldehyde.

The ToxFAQs documents referenced above in Section 4 also provide information on potential sources of the chemicals of concern.

5.4 Hydrogen Sulfide (H_2S)

Although H_2S is not a COPC by the definition in this assessment, VDEQ is aware that H_2S is a particular concern to some residents of Hopewell. Therefore, VDEQ ran the HQ calculations for H_2S separately. Since H_2S was detected so infrequently, both the 50^{th} and the 90^{th} percentiles are represented by one half of the MDL. Using 0.71 ug/m^3 (0.5 times the MDL of 1.42 ug/m^3) and an RfC of 2 ug/m^3 (EPA, 2003) the hazard quotient for hydrogen sulfide would be 0.36.

5.5 Uncertainty Assessment:

Each step of the risk assessment process includes uncertainties that should be considered when evaluating the results.

Data collection and Evaluation Uncertainties

The standard list of analytes for Air Monitoring projects addresses only a portion of the 188 HAPs. If additional HAPs had been analyzed the excess cancer risk and hazard values could be higher.

Although the maximum concentration of H_2S exceeded the risk-based screening value, H_2S did not meet the definition of a COPC because it was detected in less than 10% of the collected samples. The frequency distribution in Figure 2 indicates that 92% of the readings were below the detection limit of one ppb (1.42 ug/m^3) or 0.001 ppm (0.00142 mg/m^3). There was one 1-hour period when the H_2S concentration was between 16 and 20 ppb (23-28 ug/m^3)and one reading where the concentration was greater than 25 ppb (36 ug/m^3). Both these readings occurred during a structure fire that occurred at an apartment building located within a block of the Spruance monitoring station. It is likely that the fire caused these extreme readings and that they are not representative of exposures to H_2S. Figure 3 shows the concentrations of H_2S at the Spruance station by date.

Exposure Assessment Uncertainties

The data set for each parameter analyzed was of sufficient size so that variability could be addressed with each parameter. Because samples were collected every six days over a one to two year time frame, variations over seasons and days of the week are captured.

Some data sets included a large number of non-detected values. One half of the detection limit was used in calculating the exposure concentrations for these data sets. Although this is a generally accepted method, it may introduce considerable uncertainty into the assessment. When a chemical is not detected by the analytical method, the concentration could actually be anywhere from zero to just below the detection limit. Therefore the use of one-half the detection limit could result in either an over-estimate or under-estimate of the risk. None of the COPCs included in the quantitative risk assessment were highly influenced by the use of one-half the detection limit. The separate HQ calculation for H_2S at the Spruance site was based on one-half the MDL.

Another uncertainty related to the exposure assessment is the fact that the assessment relies on concentrations detected at the three monitoring stations and therefore spatial variability in concentrations may not be adequately captured. Without the inclusion of air dispersion modeling of the emissions from the Hopewell sources a spatial risk assessment is not possible at this point in time. In other words the risk characterization is only applicable to the concentrations detected at the three monitoring sites and may not be representative of concentrations at actual exposure points. However, the fact that concentrations of the major COCs were similar across the sites indicates that this variability would not likely be significant.

Toxicity Assessment Uncertainties

The toxicity values used for this risk assessment were taken from recognized sources and were based on the process developed by the VINTAG. There is always uncertainty inherent in the development of toxicity values for chemicals. For carcinogens, the major uncertainty lies in the extrapolation from the high exposures used in animal or human occupational studies to the lower levels representative of environmental exposures. For the two major risk drivers in this assessment, formaldehyde and carbon tetrachloride, the IURs used to estimate carcinogenic risk were based on animal studies. The IURs are upper bound estimates of the probability of a response. Therefore the resulting risk estimates are likely to be overestimated rather than underestimated.

As noted in Section 4.1 above, the IURs for this risk assessment have been adjusted to account for early life stage exposure. This results in risk estimates approximately two times higher (more protective) than estimates without the adjustment.

Also note that the IUR for formaldehyde is currently under review and U. S. EPA has issued a draft report for review. (EPA, 2010) If the proposed IUR is eventually adopted the risk estimates for formaldehyde would be about five times higher. It should also be noted that other models, including one developed by the Chemical Industry Institute of Toxicology (CIIT, 2000, 2001a, 2001b, 2003), indicate that formaldehyde is much less likely to cause cancer. If an IUR based on the CIIT model were used, risk estimates for formaldehyde would be about one thousand times lower.

For non-carcinogens, uncertainty factors are used to account for factors such as study length, differences between animals and humans, variability among humans, and a limited toxicological data base. For non-carcinogens, the uncertainty also tends to lead to a more conservative (protective) risk result.

The acrolein RfC was based on a value derived by the CalEPA OEHHA in 2008 (OEHHA, 2008). The fact that this value was reviewed and updated recently lends confidence to the value. The value is based on a rat study and the uncertainty relating to the extrapolation to humans is accounted for by an uncertainty factor of 6. OEHHA determined that acrolein has the potential to exacerbate asthma in children. This is accounted for by an uncertainty factor of 10. An additional uncertainty factor of 3 was added to account for the extrapolation from a subchronic study to chronic exposures. These three uncertainty factors result in an overall uncertainty factor of 200 being applied to the no observable adverse effects level (NOAEL).

The formaldehyde RfC was also based on a value derived by OEHHA in 2008 (OEHHA, 2008). Again, the update is recent which increases the confidence in the value. The RfC was based on a study of human chemical plant workers. The use of a good quality human study has the advantage of not having to account for the differences between animals and humans. OEHHA determined that formaldehyde has the potential to exacerbate asthma in children and therefore applied an uncertainty factor of 10 to the NOAEL. Note that the U. S. EPA is also currently re-evaluating the RfC for formaldehyde. The draft report presents a range of RfCs for consideration. If any of these RfCs are eventually adopted, the hazard quotients for formaldehyde could go up from about 2 to 10 times.

Risk Characterization Uncertainties

Cancer Risk Characterization

Because each slope factor is a 95th percentile estimate of potency, and probability distributions are not strictly additive, adding risks from multiple chemicals may overestimate the risk. However, when the risk is due primarily to one or two chemicals, as is the case with Hopewell, the overestimation is minimal.

Non-Cancer Risk Characterization

The assumption of additivity of non-cancer effects from all chemicals affecting the same target organ generally overestimates the HI. In the case of formaldehyde and acrolein, however, it is not clear whether this is the case. There is some indication that acrolein and formaldehyde do interact. However, some studies indicate that the interaction is synergistic while others indicate that the interaction is antagonistic. (ATSDR 1999, ATSDR 2007)

There is also uncertainty involved with the assessment of H_2S. The HQ for H_2S was below one and therefore H_2S by itself would not be expected to cause harmful effects. However, because H_2S affects the respiratory system, it could contribute to respiratory effects in combination with other respiratory COCs. On the other hand, it is important to remember that this hazard quotient is based on ½ the MDL and not on detected concentrations. Therefore it is not likely that H_2S would contribute to these effects.

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Table 2.1
Ambient Air Risk-Based Screening: Spruance

				Screening Levels (SL)							
				cancer	**noncancer**	**Final**		Maximum	Exceedance	Frequency of	Frequency	Contaminant
HAP	HAP #	CHEMICAL	CASRN	SL at 1e-6 risk	SL at 0.1 HQ	**SL**		Air Conc.	of Screening	of Detection	of Detection	of Potential
				ug/m^3	ug/m^3	ug/m^3		ug/m^3	Level?		%	Concern?
*	1	acetaldehyde	75-07-0	2.19E-01	1.40E+01	2.19E-01	c	3.51E+00	yes	109/110	99%	yes
*	6	acrolein	107-02-8		3.50E-02	3.50E-02	nc	2.02E+00	yes	73/97	75%	yes
*	9	acrylonitrile	107-13-1	2.04E-03	5.00E-01	2.04E-03	c	NA				
*	15	benzene	71-43-2	7.57E-02	3.00E+00	7.57E-02	c	4.15E+01	yes	130/160	81%	yes
*	18	benzyl chloride	7440-41-7	1.21E-02		1.21E-02	c	NA				
*	22	bromoform	75-25-2	5.37E-01		5.37E-01	c	ND				
*	23	1,3-butadiene	106-99-0	1.97E-02	2.00E-01	1.97E-02	c	ND				
*	28	carbon disulfide	75-15-0		8.00E+01	8.00E+01	nc	NA				
*	29	carbon tetrachloride	56-23-5	1.39E-02	1.90E+01	1.39E-02	c	4.34E+00	yes	117/160	73%	yes
*	37	chlorobenzene	108-90-7		1.00E+02	1.00E+02	nc	ND				
*	39	chloroform	67-66-3	1.11E-01	3.00E+01	1.11E-01	c	ND				
*	53	p-dichlorobenzene	106-47-7	5.37E-02	8.00E+01	5.37E-02	c	2.40E+00	yes	14/160	9%	no
*	56	1,3-dichloropropene	542-75-6	1.48E-01	2.00E+00	1.48E-01	c	ND				
*	77	ethyl benzene	100-41-4		2.00E+02	2.00E+02	nc	7.37E-01				
*	79	ethyl chloride	75-00-3		3.00E+03	3.00E+03	nc	4.48E-01				
*	80	ethylene dibromide	106-93-4	9.85E-04	8.00E-02	9.85E-04	c	ND				
*	81	ethylene dichloride	107-06-2	2.27E-02	4.00E+01	2.27E-02	c	ND				
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	3.69E-01	5.00E+01	3.69E-01	c	ND				
*	87	formaldehyde	50-00-0	4.54E-02	9.00E-01	4.54E-02	c	8.33E+00	yes	110/110	100%	yes
*	90	hexachlorobutadiene	87-68-3	2.69E-02		2.69E-02	c	1.49E+00	yes	1/160	1%	no
*	95	n-hexane	110-54-3		7.00E+01	7.00E+01	nc	4.12E+00				
	999	hydrogen sulfide (daily average)	2148-87-8		2.00E-01	2.00E-01	nc	3.64E+00	yes	101/196	52%	yes
*	105	methyl bromide	74-83-9		5.00E-01	5.00E-01	nc	ND				
*	106	methyl chloride	74-87-3		9.00E+00	9.00E+00	nc	1.65E+00				
*	113	methyl methacrylate	80-62-6		7.00E+01	7.00E+01	nc	ND				
*	114	methyl tert-butyl ether	1634-04-4	2.27E+00	3.00E+02	2.27E+00	c	ND				
*	116	methylene chloride	75-09-2	5.91E-01	1.00E+02	5.91E-01	c	1.84E+00	yes	103/160	64%	yes
*	139	propionaldehyde	123-38-6					2.80E+00				
*	146	styrene	100-42-5		9.00E+01	9.00E+01	nc	ND				
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.02E-02		1.02E-02	c	ND				
*	150	tetrachloroethylene	127-18-4	1.00E-01	2.70E+01	1.00E-01	c	4.54E+00	yes	8/160	5%	no
*	152	toluene	108-88-3		5.00E+02	5.00E+02	nc	5.27E+00				
*	157	1,2,4-trichlorobenzene	120-82-1		2.00E+01	2.00E+01	nc	3.85E+00				
*	158	1,1,2-trichloroethane	79-00-5	3.69E-02		3.69E-02	c	8.18E-01	yes	1/160	1%	no
*	159	trichloroethylene	79-01-6	2.95E-01	6.00E+01	2.95E-01	c	1.02E+00	yes	1/160	1%	no
*	167	vinyl chloride	75-01-4	6.71E-02	1.00E+01	6.71E-02	c	ND				
*	169	xylenes (mixed)	1330-20-7		1.00E+01	1.00E+01	nc	3.34E+00				
**	174	arsenic compounds	7440-38-2	1.37E-04	1.50E-03	1.37E-04	c	2.74E-03	yes	99/99	100%	yes
**	174	arsenic and compounds (inorganic)	7440-38-2	1.79E-03		1.79E-03	c	2.74E-03	yes	99/99	100%	yes
**	175	beryllium compounds	7440-41-7	2.46E-04	7.00E-04	2.46E-04	c	2.84E-04	yes	54/99	55%	yes
**	176	cadmium compounds	7440-43-9	1.41E-04	2.00E-03	1.41E-04	c	9.72E-04	yes	97/99	98%	yes
**	177	chromium (VI) compounds	18540-29-9	4.92E-05	2.00E-02	4.92E-05	c	6.00E-04	yes	71/97	73%	yes
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	3.94E-06	8.00E-04	3.94E-06	c	6.00E-04	yes	71/97	73%	yes
**	182	lead compounds	7439-92-1		1.50E-01	1.50E-01	nc	6.91E-03				
**	183	managanese compounds	7439-96-5		9.00E-03	9.00E-03	nc	1.12E-02	yes	99/99	100%	yes
**	186	nickel compounds (soluble)	7440-02-0		9.00E-03	9.00E-03	nc	4.47E-03				
**	186	nickel compounds (insoluble)	1313-99-1		9.00E-03	9.00E-03	nc	4.47E-03				

NA=Not Analyzed
ND=Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.2
Ambient Air Risk-Based Screening: Woodson

				Screening Levels (SL)							
				cancer	**noncancer**	**Final**		Maximum	Exceedance	Frequency of	Frequency	Contaminant
HAP	HAP #	CHEMICAL	CASRN	SL at 1e-6 risk	SL at 0.1 HQ	**SL**		Air Conc.	of Screening	of Detection	of Detection	of Potential
				ug/m^3	ug/m^3	ug/m^3		ug/m^3	Level?		%	Concern?
*	1	acetaldehyde	75-07-0	2.19E-01	1.40E+01	2.19E-01	c	3.40E+00	yes	109/110	99%	yes
*	6	acrolein	107-02-8		3.50E-02	3.50E-02	nc	1.56E+00	yes	35/60	58%	yes
*	9	acrylonitrile	107-13-1	2.04E-03	5.00E-01	2.04E-03	c	NA				
*	15	benzene	71-43-2	7.57E-02	3.00E+00	7.57E-02	c	2.30E+00	yes	86/117	74%	yes
*	18	benzyl chloride	7440-41-7	1.21E-02		1.21E-02	c	NA				
*	22	bromoform	75-25-2	5.37E-01		5.37E-01	c	1.76E+00	yes	1/117	1%	no
*	23	1,3-butadiene	106-99-0	1.97E-02	2.00E-01	1.97E-02	c	ND				
*	28	carbon disulfide	75-15-0		8.00E+01	8.00E+01	nc	NA				
*	29	carbon tetrachloride	56-23-5	1.39E-02	1.90E+01	1.39E-02	c	4.03E+00	yes	81/117	69%	yes
*	37	chlorobenzene	108-90-7		1.00E+02	1.00E+02	nc	ND				
*	39	chloroform	67-66-3	1.11E-01	3.00E+01	1.11E-01	c	ND				
*	53	p-dichlorobenzene	106-47-7	5.37E-02	8.00E+01	5.37E-02	c	2.04E+00	yes	10/117	9%	no
*	56	1,3-dichloropropene	542-75-6	1.48E-01	2.00E+00	1.48E-01	c	ND				
*	77	ethyl benzene	100-41-4		2.00E+02	2.00E+02	nc	9.57E-01				
*	79	ethyl chloride	75-00-3		3.00E+03	3.00E+03	nc	4.70E-01				
*	80	ethylene dibromide	106-93-4	9.85E-04	8.00E-02	9.85E-04	c	ND				
*	81	ethylene dichloride	107-06-2	2.27E-02	4.00E+01	2.27E-02	c	ND				
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	3.69E-01	5.00E+01	3.69E-01	c	ND				
*	87	formaldehyde	50-00-0	4.54E-02	9.00E-01	4.54E-02	c	9.19E+00	yes	110/110	100%	yes
*	90	hexachlorobutadiene	87-68-3	2.69E-02		2.69E-02	c	ND				
*	95	n-hexane	110-54-3		7.00E+01	7.00E+01	nc	1.73E+00				
*	105	methyl bromide	74-83-9		5.00E-01	5.00E-01	nc	ND				
*	106	methyl chloride	74-87-3		9.00E+00	9.00E+00	nc	1.75E+00				
*	113	methyl methacrylate	80-62-6		7.00E+01	7.00E+01	nc	ND				
*	114	methyl tert-butyl ether	1634-04-4	2.27E+00	3.00E+02	2.27E+00	c	ND				
*	116	methylene chloride	75-09-2	5.91E-01	1.00E+02	5.91E-01	c	3.78E+00	yes	73/117	62%	yes
*	139	propionaldehyde	123-38-6					2.74E+00				
*	146	styrene	100-42-5		9.00E+01	9.00E+01	nc	5.54E-01				
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.02E-02		1.02E-02	c	ND				
*	150	tetrachloroethylene	127-18-4	1.00E-01	2.70E+01	1.00E-01	c	6.10E-01	yes	3/117	3%	no
*	152	toluene	108-88-3		5.00E+02	5.00E+02	nc	6.89E+00				
*	157	1,2,4-trichlorobenzene	120-82-1		2.00E+01	2.00E+01	nc	ND				
*	158	1,1,2-trichloroethane	79-00-5	3.69E-02		3.69E-02	c	ND				
*	159	trichloroethylene	79-01-6	2.95E-01	6.00E+01	2.95E-01	c	ND				
*	167	vinyl chloride	75-01-4	6.71E-02	1.00E+01	6.71E-02	c	ND				
*	169	xylenes (mixed)	1330-20-7		1.00E+01	1.00E+01	nc	4.03E+00				
**	174	arsenic compounds	7440-38-2	1.37E-04	1.50E-03	1.37E-04	c	4.12E-03	yes	105/105	100%	yes
**	174	arsenic and compounds (inorganic)	7440-38-2	1.79E-03		1.79E-03	c	4.12E-03	yes	105/105	100%	yes
**	175	beryllium compounds	7440-41-7	2.46E-04	7.00E-04	2.46E-04	c	2.87E-04	yes	58/105	55%	yes
**	176	cadmium compounds	7440-43-9	1.41E-04	2.00E-03	1.41E-04	c	7.00E-04	yes	100/105	95%	yes
**	177	chromium (VI) compounds	18540-29-9	4.92E-05	2.00E-02	4.92E-05	c	1.13E-03	yes	72/98	73%	yes
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	3.94E-06	8.00E-04	3.94E-06	c	1.13E-03	yes	72/98	73%	yes
**	182	lead compounds	7439-92-1		1.50E-01	1.50E-01	nc	8.11E-03				
**	183	managanese compounds	7439-96-5		9.00E-03	9.00E-03	nc	1.02E-02	yes	105/105	100%	yes
**	186	nickel compounds (soluble)	7440-02-0		9.00E-03	9.00E-03	nc	2.05E-02	yes	97/105	92%	yes
**	186	nickel compounds (insoluble)	1313-99-1		9.00E-03	9.00E-03	nc	2.05E-02	yes			

NA=Not Analyzed
ND=Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.3
Ambient Air Risk-Based Screening: Rice Center

				Screening Levels (SL)							
				cancer	**noncancer**	**Final**		Maximum	Exceedance	Frequency of	Frequency	Contaminant
HAP	HAP #	CHEMICAL	CASRN	SL at 1e-6 risk	SL at 0.1 HQ	**SL**		Air Conc.	of Screening	of Detection	of Detection	of Potential
				ug/m^3	ug/m^3	ug/m^3		ug/m^3	Level?		%	Concern?
*	1	acetaldehyde	75-07-0	2.19E-01	1.40E+01	2.19E-01	c	2.55E+00	yes	95/95	100%	yes
*	6	acrolein	107-02-8		3.50E-02	3.50E-02	nc	2.43E+00	yes	95/95	100%	yes
*	9	acrylonitrile	107-13-1	2.04E-03	5.00E-01	2.04E-03	c	NA				
*	15	benzene	71-43-2	7.57E-02	3.00E+00	7.57E-02	c	8.00E-01	yes	50/94	53%	yes
*	18	benzyl chloride	7440-41-7	1.21E-02		1.21E-02	c	NA				
*	22	bromoform	75-25-2	5.37E-01		5.37E-01	c	ND				
*	23	1,3-butadiene	106-99-0	1.97E-02	2.00E-01	1.97E-02	c	ND				
*	28	carbon disulfide	75-15-0		8.00E+01	8.00E+01	nc	NA				
*	29	carbon tetrachloride	56-23-5	1.39E-02	1.90E+01	1.39E-02	c	4.02E+00	yes	72/94	77%	yes
*	37	chlorobenzene	108-90-7		1.00E+02	1.00E+02	nc	ND				
*	39	chloroform	67-66-3	1.11E-01	3.00E+01	1.11E-01	c	ND				
*	53	p-dichlorobenzene	106-47-7	5.37E-02	8.00E+01	5.37E-02	c	6.00E-01	yes	1/94	1%	no
*	56	1,3-dichloropropene	542-75-6	1.48E-01	2.00E+00	1.48E-01	c	ND				
*	77	ethyl benzene	100-41-4		2.00E+02	2.00E+02	nc	ND				
*	79	ethyl chloride	75-00-3		3.00E+03	3.00E+03	nc	ND				
*	80	ethylene dibromide	106-93-4	9.85E-04	8.00E-02	9.85E-04	c	ND				
*	81	ethylene dichloride	107-06-2	2.27E-02	4.00E+01	2.27E-02	c	ND				
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	3.69E-01	5.00E+01	3.69E-01	c	ND				
*	87	formaldehyde	50-00-0	4.54E-02	9.00E-01	4.54E-02	c	1.06E+01	yes	95/95	100%	yes
*	90	hexachlorobutadiene	87-68-3	2.69E-02		2.69E-02	c	ND				
*	95	n-hexane	110-54-3		7.00E+01	7.00E+01	nc	5.30E-01				
*	105	methyl bromide	74-83-9		5.00E-01	5.00E-01	nc	ND				
*	106	methyl chloride	74-87-3		9.00E+00	9.00E+00	nc	1.71E+00				
*	113	methyl methacrylate	80-62-6		7.00E+01	7.00E+01	nc	ND				
*	114	methyl tert-butyl ether	1634-04-4	2.27E+00	3.00E+02	2.27E+00	c	ND				
*	116	methylene chloride	75-09-2	5.91E-01	1.00E+02	5.91E-01	c	1.73E+00	yes	45/94	48%	yes
*	139	propionaldehyde	123-38-6					2.55E+00				
*	146	styrene	100-42-5		9.00E+01	9.00E+01	nc	6.00E-01				
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.02E-02		1.02E-02	c	ND				
*	150	tetrachloroethylene	127-18-4	1.00E-01	2.70E+01	1.00E-01	c	ND				
*	152	toluene	108-88-3		5.00E+02	5.00E+02	nc	1.32E+00				
*	157	1,2,4-trichlorobenzene	120-82-1		2.00E+01	2.00E+01	nc	ND				
*	158	1,1,2-trichloroethane	79-00-5	3.69E-02		3.69E-02	c	ND				
*	159	trichloroethylene	79-01-6	2.95E-01	6.00E+01	2.95E-01	c	ND				
*	167	vinyl chloride	75-01-4	6.71E-02	1.00E+01	6.71E-02	c	ND				
*	169	xylenes (mixed)	1330-20-7		1.00E+01	1.00E+01	nc	5.60E-01				
**	174	arsenic compounds	7440-38-2	1.37E-04	1.50E-03	1.37E-04	c	2.55E-03	yes	99/99	100%	yes
**	174	arsenic and compounds (inorganic)	7440-38-2	1.79E-03		1.79E-03	c	2.55E-03	yes	99/99	100%	yes
**	175	beryllium compounds	7440-41-7	2.46E-04	7.00E-04	2.46E-04	c	2.84E-04	yes	54/99	55%	yes
**	176	cadmium compounds	7440-43-9	1.41E-04	2.00E-03	1.41E-04	c	4.54E-04	yes	97/99	98%	yes
**	177	chromium (VI) compounds	18540-29-9	4.92E-05	2.00E-02	4.92E-05	c	3.00E-04	yes	71/97	73%	yes
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	3.94E-06	8.00E-04	3.94E-06	c	3.00E-04	yes	71/97	73%	yes
**	182	lead compounds	7439-92-1		1.50E-01	1.50E-01	nc	5.81E-03				
**	183	managanese compounds	7439-96-5		9.00E-03	9.00E-03	nc	1.74E-02	yes	99/99	100%	yes
**	186	nickel compounds (soluble)	7440-02-0		9.00E-03	9.00E-03	nc	2.56E-03				
**	186	nickel compounds (insoluble)	1313-99-1		9.00E-03	9.00E-03	nc	2.56E-03				

NA=Not Analyzed
ND=Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.4
Ambient Air Risk-Based Screening: Woodson VOCs 11/20/08-12/26/08

				Screening Levels (SL)					
				cancer	**noncancer**	**Final**		Maximum	Exceedance
HAP	HAP #	CHEMICAL	CASRN	SL at 1e-6 risk	SL at 0.1 HQ	**SL**		Air Conc.	of Screening
				ug/m^3	ug/m^3	ug/m^3		ug/m^3	Level?
*	6	acrolein	107-02-8		3.50E-02	3.50E-02	nc	6.64E-01	yes
*	9	acrylonitrile	107-13-1	2.04E-03	5.00E-01	2.04E-03	c	1.30E-01	yes
*	15	benzene	71-43-2	7.57E-02	3.00E+00	7.57E-02	c	1.49E+00	yes
*	18	benzyl chloride	7440-41-7	1.21E-02		1.21E-02	c	1.05E-01	yes
*	22	bromoform	75-25-2	5.37E-01		5.37E-01	c	ND	
*	23	1,3-butadiene	106-99-0	1.97E-02	2.00E-01	1.97E-02	c	3.98E-01	yes
*	28	carbon disulfide	75-15-0		8.00E+01	8.00E+01	nc	6.22E-02	
*	29	carbon tetrachloride	56-23-5	1.39E-02	1.90E+01	1.39E-02	c	6.92E-01	yes
*	37	chlorobenzene	108-90-7		1.00E+02	1.00E+02	nc	ND	
*	39	chloroform	67-66-3	1.11E-01	3.00E+01	1.11E-01	c	1.47E-01	yes
*	53	p-dichlorobenzene	106-47-7	5.37E-02	8.00E+01	5.37E-02	c	6.01E-02	yes
*	56	1,3-dichloropropene	542-75-6	1.48E-01	2.00E+00	1.48E-01	c	ND	
*	77	ethyl benzene	100-41-4		2.00E+02	2.00E+02	nc	2.61E-01	
*	79	ethyl chloride	75-00-3		3.00E+03	3.00E+03	nc	1.05E-01	
*	80	ethylene dibromide	106-93-4	9.85E-04	8.00E-02	9.85E-04	c	ND	
*	81	ethylene dichloride	107-06-2	2.27E-02	4.00E+01	2.27E-02	c	8.10E-02	yes
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	3.69E-01	5.00E+01	3.69E-01	c	ND	
*	90	hexachlorobutadiene	87-68-3	2.69E-02		2.69E-02	c	1.07E-01	yes
*	95	n-hexane	110-54-3		7.00E+01	7.00E+01	nc	1.27E+00	
*	105	methyl bromide	74-83-9		5.00E-01	5.00E-01	nc	3.88E-02	
*	106	methyl chloride	74-87-3		9.00E+00	9.00E+00	nc	1.46E+00	
*	113	methyl methacrylate	80-62-6		7.00E+01	7.00E+01	nc	ND	
*	114	methyl tert-butyl ether	1634-04-4	2.27E+00	3.00E+02	2.27E+00	c	7.22E-02	
*	116	methylene chloride	75-09-2	5.91E-01	1.00E+02	5.91E-01	c	7.29E-01	yes
*	146	styrene	100-42-5		9.00E+01	9.00E+01	nc	8.52E-02	
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.02E-02		1.02E-02	c	ND	
*	150	tetrachloroethylene	127-18-4	1.00E-01	2.70E+01	1.00E-01	c	2.03E-01	yes
*	152	toluene	108-88-3		5.00E+02	5.00E+02	nc	2.11E+00	
*	157	1,2,4-trichlorobenzene	120-82-1		2.00E+01	2.00E+01	nc	7.41E-02	
*	158	1,1,2-trichloroethane	79-00-5	3.69E-02		3.69E-02	c	ND	
*	159	trichloroethylene	79-01-6	2.95E-01	6.00E+01	2.95E-01	c	5.37E-02	
*	167	vinyl chloride	75-01-4	6.71E-02	1.00E+01	6.71E-02	c	ND	
*	169	xylenes (mixed)	1330-20-7		1.00E+01	1.00E+01	nc	8.67E-01	

NA=Not Analyzed
ND=Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.5
Ambient Air Regulatory Screening: Spruance

HAP	HAP #	CHEMICAL	CASRN	Current SAAC ug/m^3	Maximum Air Conc. ug/m^3	Contaminant of Potential Concern?
*	1	acetaldehyde	75-07-0	3.60E+02	3.51E+00	
*	6	acrolein	107-02-8	4.60E-01	2.02E+00	yes
*	9	acrylonitrile	107-13-1	8.60E+00	NA	
*	15	benzene	71-43-2	6.40E+01	4.15E+01	
*	18	benzyl chloride	7440-41-7	1.04E+01	NA	
*	22	bromoform	75-25-2	1.04E+01	ND	
*	23	1,3-butadiene	106-99-0	4.40E+01	ND	
*	28	carbon disulfide	75-15-0	6.20E+01	NA	
*	29	carbon tetrachloride	56-23-5	6.20E+01	4.34E+00	
*	37	chlorobenzene	108-90-7	9.20E+01	ND	
*	39	chloroform	67-66-3	9.80E+01	ND	
*	53	p-dichlorobenzene	106-47-7	9.02E+01	2.40E+00	
*	56	1,3-dichloropropene	542-75-6	9.00E+00	ND	
*	77	ethyl benzene	100-41-4	8.68E+02	7.37E-01	
*	79	ethyl chloride	75-00-3	5.28E+03	4.48E-01	
*	80	ethylene dibromide	106-93-4	6.92E-01	ND	
*	81	ethylene dichloride	107-06-2	8.00E+01	ND	
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	1.62E+03	ND	
*	87	formaldehyde	50-00-0	2.40E+00	8.33E+00	yes
*	90	hexachlorobutadiene	87-68-3	4.20E-01	1.49E+00	yes
*	95	n-hexane	110-54-3	3.52E+02	4.12E+00	
	999	hydrogen sulfide (daily average)	2148-87-8		3.64E+00	
*	105	methyl bromide	74-83-9	3.80E+01	ND	
*	106	methyl chloride	74-87-3	2.06E+02	1.65E+00	
*	113	methyl methacrylate	80-62-6	8.20E+02	ND	
*	114	methyl tert-butyl ether	1634-04-4	3.60E+02	ND	
*	116	methylene chloride	75-09-2	3.48E+02	1.84E+00	
*	139	propionaldehyde	123-38-6		2.80E+00	
*	146	styrene	100-42-5	4.26E+02	ND	
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.38E+01	ND	
*	150	tetrachloroethylene	127-18-4	6.78E+02	4.54E+00	
*	152	toluene	108-88-3	7.54E+02	5.27E+00	
*	157	1,2,4-trichlorobenzene	120-82-1		3.85E+00	
*	158	1,1,2-trichloroethane	79-00-5	1.10E+02	8.18E-01	
*	159	trichloroethylene	79-01-6	5.38E+02	1.02E+00	
*	167	vinyl chloride	75-01-4	2.60E+01	ND	
*	169	xylenes (mixed)	1330-20-7	8.68E+02	3.34E+00	
**	174	arsenic compounds	7440-38-2	4.00E-01	2.74E-03	
**	174	arsenic and compounds (inorganic)	7440-38-2		2.74E-03	
**	175	beryllium compounds	7440-41-7	4.00E-03	2.84E-04	
**	176	cadmium compounds	7440-43-9	1.00E-01	9.72E-04	
**	177	chromium (VI) compounds	18540-29-9	1.00E-01	6.00E-04	
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	1.00E-01	6.00E-04	
**	182	lead compounds	7439-92-1	3.00E-01	6.91E-03	
**	183	managanese compounds	7439-96-5	1.00E+01	1.12E-02	
**	186	nickel compounds (soluble)	7440-02-0	2.00E-01	4.47E-03	
**	186	nickel compounds (insoluble)	1313-99-1	2.00E+00	4.47E-03	

NA Not Analyzed
ND Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.6
Ambient Air Regulatory Screening: Woodson

HAP	HAP #	CHEMICAL	CASRN	Current SAAC ug/m^3		Maximum Air Conc. ug/m^3	Contaminant of Potential Concern?
*	1	acetaldehyde	75-07-0	3.60E+02	c	3.40E+00	
*	6	acrolein	107-02-8	4.60E-01	nc	1.56E+00	yes
*	9	acrylonitrile	107-13-1	8.60E+00	c	NA	
*	15	benzene	71-43-2	6.40E+01	c	2.30E+00	
*	18	benzyl chloride	7440-41-7	1.04E+01	c	NA	
*	22	bromoform	75-25-2	1.04E+01	c	1.76E+00	
*	23	1,3-butadiene	106-99-0	4.40E+01	c	ND	
*	28	carbon disulfide	75-15-0	6.20E+01	nc	NA	
*	29	carbon tetrachloride	56-23-5	6.20E+01	c	4.03E+00	
*	37	chlorobenzene	108-90-7	9.20E+01	nc	ND	
*	39	chloroform	67-66-3	9.80E+01	c	ND	
*	53	p-dichlorobenzene	106-47-7	9.02E+01	c	2.04E+00	
*	56	1,3-dichloropropene	542-75-6	9.00E+00	c	ND	
*	77	ethyl benzene	100-41-4	8.68E+02	nc	9.57E-01	
*	79	ethyl chloride	75-00-3	5.28E+03	nc	4.70E-01	
*	80	ethylene dibromide	106-93-4	6.92E-01	c	ND	
*	81	ethylene dichloride	107-06-2	8.00E+01	c	ND	
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	1.62E+03	c	ND	
*	87	formaldehyde	50-00-0	2.40E+00	c	9.19E+00	yes
*	90	hexachlorobutadiene	87-68-3	4.20E-01	c	ND	
*	95	n-hexane	110-54-3	3.52E+02	nc	1.73E+00	
*	105	methyl bromide	74-83-9	3.80E+01	nc	ND	
*	106	methyl chloride	74-87-3	2.06E+02	nc	1.75E+00	
*	113	methyl methacrylate	80-62-6	8.20E+02	nc	ND	
*	114	methyl tert-butyl ether	1634-04-4	3.60E+02	c	ND	
*	116	methylene chloride	75-09-2	3.48E+02	c	3.78E+00	
*	139	propionaldehyde	123-38-6			2.74E+00	
*	146	styrene	100-42-5	4.26E+02	nc	5.54E-01	
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.38E+01	c	ND	
*	150	tetrachloroethylene	127-18-4	6.78E+02	c	6.10E-01	
*	152	toluene	108-88-3	7.54E+02	nc	6.89E+00	
*	157	1,2,4-trichlorobenzene	120-82-1		nc	ND	
*	158	1,1,2-trichloroethane	79-00-5	1.10E+02	c	ND	
*	159	trichloroethylene	79-01-6	5.38E+02	c	ND	
*	167	vinyl chloride	75-01-4	2.60E+01	c	ND	
*	169	xylenes (mixed)	1330-20-7	8.68E+02	nc	4.03E+00	
**	174	arsenic compounds	7440-38-2	4.00E-01	c	4.12E-03	
**	174	arsenic and compounds (inorganic)	7440-38-2		c	4.12E-03	
**	175	beryllium compounds	7440-41-7	4.00E-03	c	2.87E-04	
**	176	cadmium compounds	7440-43-9	1.00E-01	c	7.00E-04	
**	177	chromium (VI) compounds	18540-29-9	1.00E-01	c	1.30E-03	
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	1.00E-01	c	1.30E-03	
**	182	lead compounds	7439-92-1	3.00E-01	nc	8.11E-03	
**	183	managanese compounds	7439-96-5	1.00E+01	nc	1.02E-02	
**	186	nickel compounds (soluble)	7440-02-0	2.00E-01	nc	2.05E-02	
**	186	nickel compounds (insoluble)	1313-99-1	2.00E+00	nc	2.05E-02	

NA Not Analyzed
ND Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.7
Ambient Air Regulatory Screening: Rice Center

HAP	HAP #	CHEMICAL	CASRN	Final SL ug/m^3		Maximum Air Conc. ug/m^3	Contaminant of Potential Concern?
*	1	acetaldehyde	75-07-0	3.60E+02	c	2.55E+00	
*	6	acrolein	107-02-8	4.60E-01	nc	2.43E+00	yes
*	9	acrylonitrile	107-13-1	8.60E+00	c	NA	
*	15	benzene	71-43-2	6.40E+01	c	8.00E-01	
*	18	benzyl chloride	7440-41-7	1.04E+01	c	NA	
*	22	bromoform	75-25-2	1.04E+01	c	ND	
*	23	1,3-butadiene	106-99-0	4.40E+01	c	ND	
*	28	carbon disulfide	75-15-0	6.20E+01	nc	NA	
*	29	carbon tetrachloride	56-23-5	6.20E+01	c	4.02E+00	
*	37	chlorobenzene	108-90-7	9.20E+01	nc	ND	
*	39	chloroform	67-66-3	9.80E+01	c	ND	
*	53	p-dichlorobenzene	106-47-7	9.02E+01	c	6.00E-01	
*	56	1,3-dichloropropene	542-75-6	9.00E+00	c	ND	
*	77	ethyl benzene	100-41-4	8.68E+02	nc	ND	
*	79	ethyl chloride	75-00-3	5.28E+03	nc	ND	
*	80	ethylene dibromide	106-93-4	6.92E-01	c	ND	
*	81	ethylene dichloride	107-06-2	8.00E+01	c	ND	
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	1.62E+03	c	ND	
*	87	formaldehyde	50-00-0	2.40E+00	c	1.06E+01	yes
*	90	hexachlorobutadiene	87-68-3	4.20E-01	c	ND	
*	95	n-hexane	110-54-3	3.52E+02	nc	5.30E-01	
*	105	methyl bromide	74-83-9	3.80E+01	nc	ND	
*	106	methyl chloride	74-87-3	2.06E+02	nc	1.71E+00	
*	113	methyl methacrylate	80-62-6	8.20E+02	nc	ND	
*	114	methyl tert-butyl ether	1634-04-4	3.60E+02	c	ND	
*	116	methylene chloride	75-09-2	3.48E+02	c	1.73E+00	
*	139	propionaldehyde	123-38-6			2.55E+00	
*	146	styrene	100-42-5	4.26E+02	nc	6.00E-01	
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.38E+01	c	ND	
*	150	tetrachloroethylene	127-18-4	6.78E+02	c	ND	
*	152	toluene	108-88-3	7.54E+02	nc	1.32E+00	
*	157	1,2,4-trichlorobenzene	120-82-1		nc	ND	
*	158	1,1,2-trichloroethane	79-00-5	1.10E+02	c	ND	
*	159	trichloroethylene	79-01-6	5.38E+02	c	ND	
*	167	vinyl chloride	75-01-4	2.60E+01	c	ND	
*	169	xylenes (mixed)	1330-20-7	8.68E+02	nc	5.60E-01	
**	174	arsenic compounds	7440-38-2	4.00E-01	c	2.55E-03	
**	174	arsenic and compounds (inorganic)	7440-38-2		c	2.55E-03	
**	175	beryllium compounds	7440-41-7	4.00E-03	c	2.84E-04	
**	176	cadmium compounds	7440-43-9	1.00E-01	c	4.54E-04	
**	177	chromium (VI) compounds	18540-29-9	1.00E-01	c	3.00E-04	
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5	1.00E-01	c	3.00E-04	
**	182	lead compounds	7439-92-1	3.00E-01	nc	5.81E-03	
**	183	managanese compounds	7439-96-5	1.00E+01	nc	1.74E-02	
**	186	nickel compounds (soluble)	7440-02-0	2.00E-01	nc	2.56E-03	
**	186	nickel compounds (insoluble)	1313-99-1	2.00E+00	nc	2.56E-03	

NA Not Analyzed
ND Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 2.8
Ambient Air Regulatory Screening: Woodson VOCs 11/20/08-12/26/08

HAP	HAP #	CHEMICAL	CASRN	Current SAAC ug/m^3		Maximum Air Conc. ug/m^3	Contaminant of Potential Concern?
*	6	acrolein	107-02-8	4.60E-01	nc	6.64E-01	yes
*	9	acrylonitrile	107-13-1	8.60E+00	c	1.30E-01	
*	15	benzene	71-43-2	6.40E+01	c	1.49E+00	
*	18	benzyl chloride	7440-41-7	1.04E+01	c	1.05E-01	
*	22	bromoform	75-25-2	1.04E+01	c	ND	
*	23	1,3-butadiene	106-99-0	4.40E+01	c	3.98E-01	
*	28	carbon disulfide	75-15-0	6.20E+01	nc	6.22E-02	
*	29	carbon tetrachloride	56-23-5	6.20E+01	c	6.92E-01	
*	37	chlorobenzene	108-90-7	9.20E+01	nc	ND	
*	39	chloroform	67-66-3	9.80E+01	c	1.47E-01	
*	53	p-dichlorobenzene	106-47-7	9.02E+01	c	6.01E-02	
*	56	1,3-dichloropropene	542-75-6	9.00E+00	c	ND	
*	77	ethyl benzene	100-41-4	8.68E+02	nc	2.61E-01	
*	79	ethyl chloride	75-00-3	5.28E+03	nc	1.05E-01	
*	80	ethylene dibromide	106-93-4	6.92E-01	c	ND	
*	81	ethylene dichloride	107-06-2	8.00E+01	c	8.10E-02	
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3	1.62E+03	c	ND	
*	90	hexachlorobutadiene	87-68-3	4.20E-01	c	1.07E-01	
*	95	n-hexane	110-54-3	3.52E+02	nc	1.27E+00	
*	105	methyl bromide	74-83-9	3.80E+01	nc	3.88E-02	
*	106	methyl chloride	74-87-3	2.06E+02	nc	1.46E+00	
*	113	methyl methacrylate	80-62-6	8.20E+02	nc	ND	
*	114	methyl tert-butyl ether	1634-04-4	3.60E+02	c	7.22E-02	
*	116	methylene chloride	75-09-2	3.48E+02	c	7.29E-01	
*	146	styrene	100-42-5	4.26E+02	nc	8.52E-02	
*	149	1,1,2,2-tetrachloroethane	79-34-5	1.38E+01	c	ND	
*	150	tetrachloroethylene	127-18-4	6.78E+02	c	2.03E-01	
*	152	toluene	108-88-3	7.54E+02	nc	2.11E+00	
*	157	1,2,4-trichlorobenzene	120-82-1		nc	7.41E-02	
*	158	1,1,2-trichloroethane	79-00-5	1.10E+02	c	ND	
*	159	trichloroethylene	79-01-6	5.38E+02	c	5.37E-02	
*	167	vinyl chloride	75-01-4	2.60E+01	c	ND	
*	169	xylenes (mixed)	1330-20-7	8.68E+02	nc	8.67E-01	

NA Not Analyzed
ND Not Detected

c=cancer
nc=noncancer

HAP
* original
** subdivided

Table 3.1--EXPOSURE SUMMARY--SPRUANCE

Exposure Medium: Air
Receptor Population:Residential

Chemical of Potential Concern	Units	Minumum Concentration	Maximum Concentration	Detection Frequency	Exposure Point Concentration		Data Distribution
					50th percentile	90th percentile	
acetaldehyde	ug/m^3	7.00E-02	3.51E+00	109/110	1.47E+00	2.04E+00	logistic
acrolein	ug/m^3	ND	2.02E+00	73/97	3.68E-01	8.42E-01	maximum extreme
benzene	ug/m^3	ND	4.15E+01	130/160	4.79E-01	8.29E-01	student's t
carbon tetrachloride	ug/m^3	ND	4.34E+00	117/160	5.67E-01	7.56E-01	logistic
formaldehyde	ug/m^3	9.80E-01	8.33E+00	110/110	2.56E+00	6.20E+00	gamma
methylene chloride	ug/m^3	ND	1.84E+00	103/160	3.50E-01	8.40E-01	student's t
arsenic compounds	ug/m^3	1.11E-04	2.74E-03	99/99	9.60E-04	1.81E-03	maximum extreme
beryllium compounds	ug/m^3	ND	2.84E-04	54/99	3.46E-05	2.19E-04	beta
cadmium compounds	ug/m^3	ND	9.72E-04	97/99	1.30E-04	3.30E-04	maximum extreme
chromium (VI)	ug/m^3	ND	6.00E-04	71/97	1.20E-05	9.60E-05	weibull
managanese	ug/m^3	5.63E-04	1.12E-02	99/99	3.27E-03	6.46E-03	gamma

TABLE 3.2. EXPOSURE SUMMARY--WOODSON

Exposure Medium: Air
Receptor Population:Residential

Chemical of Potential Concern	Units	Minumum Concentration	Maximum Concentration	Detection Frequency	Exposure Point Concentration		Data Distribution
					50th percentile	90th percentile	
acetaldehyde	ug/m^3	0.07	3.40E+00	109/110	1.36E+00	2.10E+00	logistic
acrolein	ug/m^3	ND	1.56E+00	35/60	2.76E-01	9.43E-01	beta
benzene	ug/m^3	ND	2.30E+00	86/117	4.31E-01	9.98E-01	beta
carbon tetrachloride	ug/m^3	ND	4.03E+00	81/117	5.67E-01	8.19E-01	logistic
formaldehyde	ug/m^3	1.06	9.19E+00	110/110	2.43E+00	5.12E+00	gamma
methylene chloride	ug/m^3	ND	3.78E+00	73/117	3.15E-01	7.11E-01	student's t
arsenic compounds	ug/m^3	2.36E-05	4.12E-03	105/105	9.04E-04	1.67E-03	maximum extreme
beryllium compounds	ug/m^3	ND	2.87E-04	58/105	2.05E-05	2.18E-04	gamma
cadmium compounds	ug/m^3	ND	7.00E-04	100/105	1.77E-04	3.71E-04	maximum extreme
chromium (VI) compounds	ug/m^3	ND	1.13E-03	72/98	2.20E-05	1.10E-04	gamma
managanese compounds	ug/m^3	5.05E-04	1.02E-02	105/105	3.04E-03	5.46E-03	maximum extreme
nickel compounds	ug/m^3	ND	2.05E-02	97/105	7.29E-04	1.62E-03	student's t

TABLE 3.3. EXPOSURE SUMMARY--RICE

Exposure Medium: Air
Receptor Population:Residential

Chemical of Potential Concern	Units	Minumum Concentration	Maximum Concentration	Detection Frequency	Exposure Point Concentration		Data Distribution
					50th percentile	90th percentile	
acetaldehyde	ug/m^3	ND	2.55E+00	95/95	1.14E+00	1.80E+00	gamma
acrolein	ug/m^3	ND	2.43E+00	95/95	3.20E-01	8.40E-01	student's t
benzene	ug/m^3	ND	8.00E-01	50/94	2.90E-01	6.10E-01	student's t
carbon tetrachloride	ug/m^3	ND	4.02E+00	72/94	6.30E-01	7.60E-01	logistic
formaldehyde	ug/m^3	ND	1.06E+01	95/95	2.80E+00	7.02E+00	gamma
methylene chloride	ug/m^3	ND	1.73E+00	45/94	1.40E-01	6.50E-01	logistic
arsenic compounds	ug/m^3	1.11E-04	2.55E-03	99/99	7.38E-04	1.25E-04	maximum extreme
beryllium compounds	ug/m^3	ND	2.84E-04	54/99	1.50E-05	2.22E-04	gamma
cadmium compounds	ug/m^3	ND	4.54E-04	97/99	1.17E-04	2.58E-04	maximum extreme
chromium (VI) compounds	ug/m^3	ND	3.00E-04	71/97	3.50E-05	1.46E-04	beta
managanese compounds	ug/m^3	5.63E-04	1.74E-02	99/99	2.48E-03	5.13E-03	lognormal

Table 4: Toxicity Factors for Chemicals of Potential Concern

				Cancer		Non-cancer		
HAP	HAP #	CHEMICAL	CASRN	Inhalation Unit Risk (IUR)	IUR Source	Reference Concentration (RfC)	Target Organ	RfC Source
				$(ug/m^3)^{-1}$		ug/m^3		
*	1	Acetaldehyde	75-07-0	2.70E-06	CalEPA, 1993	1.40E+02	respiratory	CalEPA, 2008
*	6	Acrolein	107-02-8			3.50E-01	respiratory	CalEPA, 2008
*	15	Benzene	71-43-2	7.80E-06	IRIS, 1998	3.00E+01	blood	IRIS, 2003
*	29	Carbon tetrachloride	56-23-5	4.25E-05	CalEPA, 1987	1.90E+02	liver	ATSDR, 2005
*	87	Formaldehyde	50-00-0	1.30E-05	IRIS, 1988	9.00E+00	respiratory	CalEPA, 2008
*	116	Methylene chloride	75-09-2	1.00E-06	CalEPA, 1989	1.00E+03	liver	ATSDR, 2000
**	174	Arsenic compounds	7440-38-2	4.30E-03	IRIS, 1994	1.50E-02	Development; cardiovascular system; nervous system; lung; skin	CalEPA, 2008
**	174	Arsenic and Compounds (Inorganic)	7440-38-2	3.30E-04	CalEPA, 1990			
**	175	Beryllium Compounds	7440-41-7	2.40E-03	IRIS, 1998	7.00E-03	Respiratory system; immune system	CalEPA, 2001
**	176	Cadmium Compounds	7440-43-9	4.20E-03	CalEPA, 1990	2.00E-02	Kidney; respiratory system	CalEPA, 2000
**	177	Chromium (VI) Compounds	18540-29-9	1.20E-02	IRIS, 1998	2.00E-01	respiratory system	CalEPA, 2001
**	183	Managanese compounds	7439-96-5			9.00E-02	nervous system	CalEPA, 2008

HAP
* original
** subdivided

TABLE 5.1 CALCULATION OF EXCESS CANCER RISK AND NON-CANCER HAZARD--SPRUANCE

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
50th percentile

life stage adjustment factor
(((10*(2.25/70))+((3*14/70))+(1*(54/70)))))

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR (Life Stage Adjustment) (ugm/m^3)$^{-1}$	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	1.47E+00	1.47E+00	2.7E-06	4.6E-06	6.72E-06	1.47E+00	1.40E+02	respiratory system	1.05E-02
	acrolein	3.68E-01					3.68E-01	3.50E-01	respiratory system	1.05E+00
	benzene	4.79E-01	4.79E-01	7.8E-06	1.3E-05	6.32E-06	4.79E-01	3.00E+01	blood	1.60E-02
	carbon tetrachloride	5.67E-01	5.67E-01	4.3E-05	7.2E-05	4.08E-05	5.67E-01	1.90E+02	liver	2.98E-03
	formaldehyde	2.56E+00	2.56E+00	1.3E-05	2.2E-05	5.63E-05	2.56E+00	9.00E+00	respiratory system	2.84E-01
	methylene chloride	3.50E-01	3.50E-01	1.0E-06	1.7E-06	5.93E-07	3.50E-01	1.00E+03	liver	3.50E-04
	arsenic compounds	9.60E-04	9.60E-04	4.3E-03	7.3E-03	6.99E-06	9.60E-04	1.50E-02	development, cardiovascular, nervous system, lung, skin	6.40E-02
	beryllium compounds	3.46E-05	3.46E-05	2.4E-03	4.1E-03	1.41E-07	3.46E-05	7.00E-03	respiratory system, immune	4.94E-03
	cadmium compounds	1.30E-04	1.30E-04	4.2E-03	7.1E-03	9.24E-07	1.30E-04	2.00E-02	kidney, respiratory	6.50E-03
	chromium VI compounds	1.20E-05	1.20E-05	1.2E-02	2.0E-02	2.44E-07	1.20E-05	2.00E-01	respiratory system	6.00E-05
	manganese compounds	3.27E-03					3.27E-03	9.00E-02	nervous system	3.63E-02
(Total)						1.2E-04				1.5E+00

respiratory system HI 1.4E+00

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
90th percentile

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR Life Stage Adjustment	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	2.04E+00	2.04E+00	2.7E-06	4.6E-06	9.32E-06	2.04E+00	1.40E+02	respiratory system	1.46E-02
	acrolein	8.42E-01					8.42E-01	3.50E-01	respiratory system	2.41E+00
	benzene	8.29E-01	8.29E-01	7.8E-06	1.3E-05	1.09E-05	8.29E-01	3.00E+01	blood	2.76E-02
	carbon tetrachloride	7.56E-01	7.56E-01	4.3E-05	7.2E-05	5.44E-05	7.56E-01	1.90E+02	liver	3.98E-03
	formaldehyde	6.20E+00	6.20E+00	1.3E-05	2.2E-05	1.36E-04	6.20E+00	9.00E+00	respiratory system	6.89E-01
	methylene chloride	8.40E-01	8.40E-01	1.0E-06	1.7E-06	1.42E-06	8.40E-01	1.00E+03	liver	8.40E-04
	arsenic compounds	1.81E-03	1.81E-03	4.3E-03	7.3E-03	1.32E-05	1.81E-03	1.50E-02	development, cardiovascular, nervous system, lung, skin	1.21E-01
	beryllium compounds	2.20E-04	2.20E-04	2.4E-03	4.1E-03	8.94E-07	2.20E-04	7.00E-03	respiratory system, immune	3.14E-02
	cadmium compounds	3.30E-04	3.30E-04	4.2E-03	7.1E-03	2.35E-06	3.30E-04	2.00E-02	kidney, respiratory	1.65E-02
	chromium VI compounds	9.60E-05	9.60E-05	1.2E-02	2.0E-02	1.95E-06	9.60E-05	2.00E-01	respiratory system	4.80E-04
	manganese compounds	6.50E-03					6.50E-03	9.00E-02	nervous system	7.22E-02
(Total)						2.3E-04				3.4E+00

respiratory system HI 3.3E+00

TABLE 5.2
CALCULATION OF EXCESS CANCER RISK AND NON-CANCER HAZARD--WOODSON

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
50th percentile

life stage adjustment factor
(((10*(2.25/70))+((3*14/70))+(1*(54/70)))))

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR (Life Stage Adjustment) (ugm/m^3)$^{-1}$	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	1.36E+00	1.36E+00	2.7E-06	4.6E-06	6.22E-06	1.36E+00	1.40E+02	respiratory system	9.71E-03
	acrolein	2.76E-01					**2.76E-01**	**3.50E-01**	**respiratory system**	**7.89E-01**
	benzene	4.31E-01	4.31E-01	7.8E-06	1.3E-05	5.69E-06	4.31E-01	3.00E+01	blood	1.44E-02
	carbon tetrachloride	**5.67E-01**	**5.67E-01**	**4.3E-05**	**7.2E-05**	**4.08E-05**	5.67E-01	1.90E+02	liver	2.98E-03
	formaldehyde	**2.43E+00**	**2.43E+00**	**1.3E-05**	**2.2E-05**	**5.35E-05**	**2.43E+00**	**9.00E+00**	**respiratory system**	**2.70E-01**
	methylene chloride	3.15E-01	3.15E-01	1.0E-06	1.7E-06	5.33E-07	3.15E-01	1.00E+03	liver	3.15E-04
	arsenic compounds	9.04E-04	9.04E-04	4.3E-03	7.3E-03	6.58E-06	9.04E-04	1.50E-02	development, cardiovascular, nervous system, lung, skin	6.03E-02
	beryllium compounds	2.05E-05	2.05E-05	2.4E-03	4.1E-03	8.33E-08	2.05E-05	7.00E-03	respiratory system, immune	2.93E-03
	cadmium compounds	1.77E-04	1.77E-04	4.2E-03	7.1E-03	1.26E-06	1.77E-04	2.00E-02	kidney, respiratory	8.85E-03
	chromium VI compounds	2.20E-05	2.20E-05	1.2E-02	2.0E-02	4.47E-07	2.20E-05	2.00E-01	respiratory system	1.10E-04
	manganese compounds	3.04E-03					3.04E-03	9.00E-02	nervous system	3.38E-02
	nickel compounds	7.29E-04					7.29E-04	9.00E-02	respiratory system	8.10E-03
(Total)						**1.2E-04**				**1.2E+00**

respiratory system HI **1.1E+00**

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
90th percentile

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR Life Stage Adjustment	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	2.10E+00	2.10E+00	2.7E-06	4.6E-06	9.60E-06	2.10E+00	1.40E+02	respiratory system	1.50E-02
	acrolein	9.43E-01					**9.43E-01**	**3.50E-01**	**respiratory system**	**2.69E+00**
	benzene	9.98E-01	9.98E-01	7.8E-06	1.3E-05	1.32E-05	9.98E-01	3.00E+01	blood	3.33E-02
	carbon tetrachloride	**8.19E-01**	**8.19E-01**	**4.3E-05**	**7.2E-05**	**5.89E-05**	8.19E-01	1.90E+02	liver	4.31E-03
	formaldehyde	**5.12E+00**	**5.12E+00**	**1.3E-05**	**2.2E-05**	**1.13E-04**	**5.12E+00**	**9.00E+00**	**respiratory system**	**5.69E-01**
	methylene chloride	7.11E-01	7.11E-01	1.0E-06	1.7E-06	1.20E-06	7.11E-01	1.00E+03	liver	7.11E-04
	arsenic compounds	1.67E-03	1.67E-03	4.3E-03	7.3E-03	1.22E-05	1.67E-03	1.50E-02	development, cardiovascular, nervous system, lung, skin	1.11E-01
	beryllium compounds	2.18E-04	2.18E-04	2.4E-03	4.1E-03	8.86E-07	2.18E-04	7.00E-03	respiratory system, immune	3.11E-02
	cadmium compounds	3.71E-04	3.71E-04	4.2E-03	7.1E-03	2.64E-06	3.71E-04	2.00E-02	kidney, respiratory	1.86E-02
	chromium VI compounds	1.10E-04	1.10E-04	1.2E-02	2.0E-02	2.23E-06	1.10E-04	2.00E-01	respiratory system	5.50E-04
	manganese compounds	5.46E-03					5.46E-03	9.00E-02	nervous system	6.07E-02
	nickel compounds	1.62E-03					1.62E-03	9.00E-02	respiratory system	1.80E-02
(Total)						**2.1E-04**				**3.6E+00**

respiratory system HI **3.5E+00**

TABLE 5.3 CALCULATION OF CANCER RISK AND NON CANCER HAZARD--RICE

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
50th percentile

life stage adjustment factor
(((10*(2.25/70))+((3*14/70))+(1*(54/70)))))

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR (Life Stage Adjustment) (ugm/m^3)$^{-1}$	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	1.14E+00	1.14E+00	2.7E-06	4.6E-06	5.21E-06	1.14E+00	1.40E+02	respiratory system	8.14E-03
	acrolein	3.20E-01					**3.20E-01**	**3.50E-01**	**respiratory system**	**9.14E-01**
	benzene	2.90E-01	2.90E-01	7.8E-06	1.3E-05	3.83E-06	2.90E-01	3.00E+01	blood	9.67E-03
	carbon tetrachloride	**6.30E-01**	**6.30E-01**	**4.3E-05**	**7.2E-05**	**4.53E-05**	6.30E-01	1.90E+02	liver	3.32E-03
	formaldehyde	**2.80E+00**	**2.80E+00**	**1.3E-05**	**2.2E-05**	**6.16E-05**	**2.80E+00**	**9.00E+00**	**respiratory system**	**3.11E-01**
	methylene chloride	1.40E-01	1.40E-01	1.0E-06	1.7E-06	2.37E-07	1.40E-01	1.00E+03	liver	1.40E-04
	arsenic compounds	7.38E-04	7.38E-04	4.3E-03	7.3E-03	5.37E-06	7.38E-04	1.50E-02	development; cardiovascular system; nervous system; lung; skin	4.92E-02
	beryllium compounds	1.50E-05	1.50E-05	2.4E-03	4.1E-03	6.09E-08	1.50E-05	7.00E-03	respiratory system, immune system	2.14E-03
	cadmium compounds	1.17E-04	1.17E-04	4.2E-03	7.1E-03	8.32E-07	1.17E-04	2.00E-02	kidney; respiratory system	5.85E-03
	chromium VI compounds	3.50E-05	3.50E-05	1.2E-02	2.0E-02	7.11E-07	3.50E-05	2.00E-01	respiratory system	1.75E-04
	manganese compounds	2.48E-03					2.48E-03	9.00E-02	nervous system	2.76E-02
(Total)						**1.2E-04**				**1.3E+00**

respiratory system HI **1.3E+00**

Medium: Air
Receptor Population: Current/Future Resident
Receptor Age: Lifetime
90th percentile

Exposure Route: Inhalation	Chemical of Potential Concern	Exposure Point Concentration ugm/m^3	Exposure Concentration (Cancer) ugm/m^3	Inhalation Unit Risk (IUR) (ugm/m^3)$^{-1}$	IUR Life Stage Adjustment	Cancer Risk (EC*IUR)	Exposure Concentration (Noncancer) ugm/m^3	Reference Concentration (RfC) ugm/m^3	Primary Target Organ	Hazard Quotient (EC/RfC)
	acetaldehyde	1.80E+00	1.80E+00	2.7E-06	4.6E-06	8.23E-06	1.80E+00	1.40E+02	respiratory system	1.29E-02
	acrolein	8.40E-01					**8.40E-01**	**3.50E-01**	**respiratory system**	**2.40E+00**
	benzene	6.10E-01	6.10E-01	7.8E-06	1.3E-05	8.05E-06	6.10E-01	3.00E+01	blood	2.03E-02
	carbon tetrachloride	**7.60E-01**	**7.60E-01**	**4.3E-05**	**7.2E-05**	**5.47E-05**	7.60E-01	1.90E+02	liver	4.00E-03
	formaldehyde	**7.02E+00**	**7.02E+00**	**1.3E-05**	**2.2E-05**	**1.54E-04**	**7.02E+00**	**9.00E+00**	**respiratory system**	**7.80E-01**
	methylene chloride	6.50E-01	6.50E-01	1.0E-06	1.7E-06	1.10E-06	6.50E-01	1.00E+03	liver	6.50E-04
	arsenic compounds	1.25E-04	1.25E-04	4.3E-03	7.3E-03	9.10E-07	1.25E-04	1.50E-02	development; cardiovascular system; nervous system; lung; skin	8.33E-03
	beryllium compounds	2.22E-04	2.22E-04	2.4E-03	4.1E-03	9.02E-07	2.22E-04	7.00E-03	respiratory system, immune system	3.17E-02
	cadmium compounds	2.58E-04	2.58E-04	4.2E-03	7.1E-03	1.83E-06	2.58E-04	2.00E-02	kidney; respiratory system	1.29E-02
	chromium VI compounds	1.46E-04	1.46E-04	1.2E-02	2.0E-02	2.97E-06	1.46E-04	2.00E-01	respiratory system	7.30E-04
	manganese compounds	5.13E-03					5.13E-03	9.00E-02	nervous system	5.70E-02
(Total)						**2.3E-04**				**3.3E+00**

respiratory system HI **3.2E+00**

TABLE 5.4. COMPARISON OF RISK AND HAZARD RESULTS FOR HOPEWELL MONITORING SITES

	Excess Cancer Risk		Hazard Index	
	50th percentile	90th percentile	50th percentile	90th percentile
Spruance	1.2E-04	2.3E-04	1.5E+00	3.4E+00
Woodson	1.2E-04	2.1E-04	1.2E+00	3.6E+00
Rice	1.2E-04	2.3E-04	1.3E+00	3.3E+00

TABLE 5.5: EXCEEDANCES OF EXISTING CHRONIC SAAC

	50th ug/m3	90th ug/m3	SAAC ug/m3	50th exceed SAAC	90th exceed SAAC
Spruance					
acrolein	0.368	0.842	0.46	no	yes
formaldehyde	2.56	6.2	2.4	yes	yes
hexachlorobutadiene	0.43	0.64	0.42	yes	yes
Woodson					
acrolein	0.276	0.943	0.46	no	yes
formaldehyde	2.43	5.12	2.4	close	yes
chromium VI compounds	2.20E-05	1.10E-04	0.1	no	no
Rice					
acrolein	0.32	0.84	0.46	no	yes
formaldehyde	2.8	7.02	2.4	yes	yes

TABLE 5.6 COMPARISON OF HOPEWELL CONCENTRATIONS WITH 2008 MONITORING SITES

		Hopewell						Statewide Air Toxics Monitoring					
		Spruance		Woodson		Rice		Northern		Central		Tidewater	
	Chronic SAAC	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th
formaldehyde	2.4	**2.56**	**6.20**	2.43	**5.12**	**2.8**	**7.02**	2.18	**5.1**	**2.89**	**6.38**	**3.38**	**5.81**
carbon tetrachloride	62	0.57	0.76	0.57	0.82	0.63	0.76	0.63	0.69	0.57	0.63	0.57	0.63
acrolein	0.46	0.37	**0.84**	0.28	**0.94**	0.32	**0.84**	0.37	**0.55**	0.45	**0.69**	0.34	**0.61**
	Screening Level at 10^{-6} Cancer Risk	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th
formaldehyde	0.045	**2.56**	**6.20**	**2.43**	**5.12**	**2.8**	**7.02**	**2.18**	**5.1**	**2.89**	**6.38**	**3.38**	**5.81**
carbon tetrachloride	0.014	**0.57**	**0.76**	**0.57**	**0.82**	**0.63**	**0.76**	**0.63**	**0.69**	**0.57**	**0.63**	**0.57**	**0.63**
	Screening Level at 10^{-5} Cancer Risk	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th
formaldehyde	0.45	**2.56**	**6.20**	**2.43**	**5.12**	**2.8**	**7.02**	**2.18**	**5.1**	**2.89**	**6.38**	**3.38**	**5.81**
carbon tetrachloride	0.14	**0.57**	**0.76**	**0.57**	**0.82**	**0.63**	**0.76**	**0.63**	**0.69**	**0.57**	**0.63**	**0.57**	**0.63**
	Screening Level at HQ 1	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th
acrolein	0.35	**0.37**	**0.84**	0.28	**0.94**	0.32	**0.84**	**0.37**	**0.55**	**0.45**	**0.69**	0.34	**0.61**
formaldehyde	9	2.56	6.20	2.43	5.12	2.8	7.02	2.18	5.1	2.89	6.38	3.38	5.81
	Screening Level at HQ 0.1	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th	50th	90th
acrolein	0.035	**0.37**	**0.84**	**0.28**	**0.94**	**0.32**	**0.84**	**0.37**	**0.55**	**0.45**	**0.69**	**0.34**	**0.61**
formaldehyde	0.9	**2.56**	**6.20**	**2.43**	**5.12**	**2.8**	**7.02**	**2.18**	**5.1**	**2.89**	**6.38**	**3.38**	**5.81**

all units in ug/m3

Bold values exceed screening levels

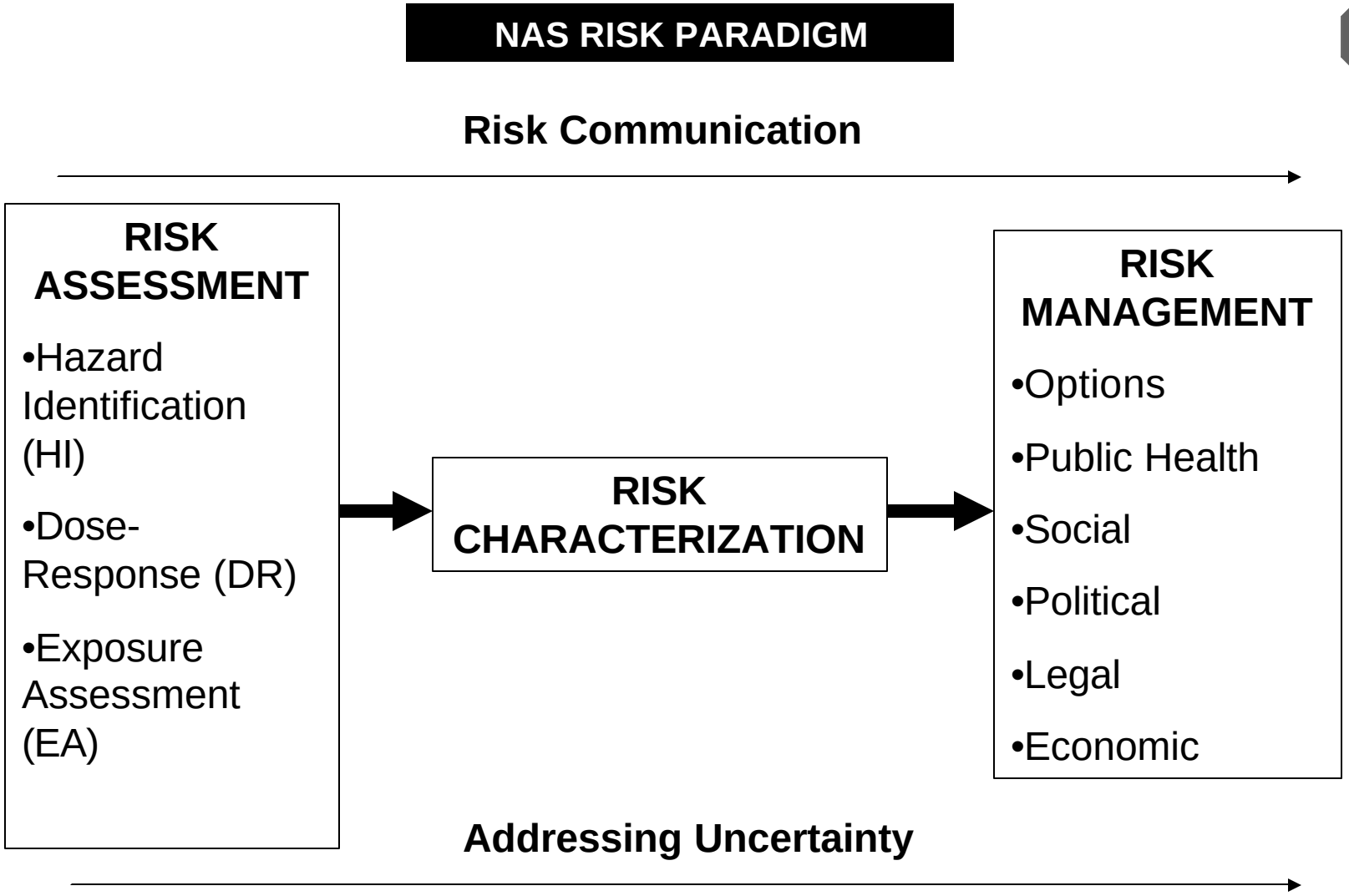

NAS RISK PARADIGM
Risk Communication
RISK ASSESSMENT
•Hazard Identification (HI)
•Dose-Response (DR)
•Exposure Assessment (EA)
RISK CHARACTERIZATION
RISK MANAGEMENT
•Options
•Public Health
•Social
•Political
•Legal
•Economic
Addressing Uncertainty

FIGURE 1

Figure 2
Hopewell H_2S Histogram

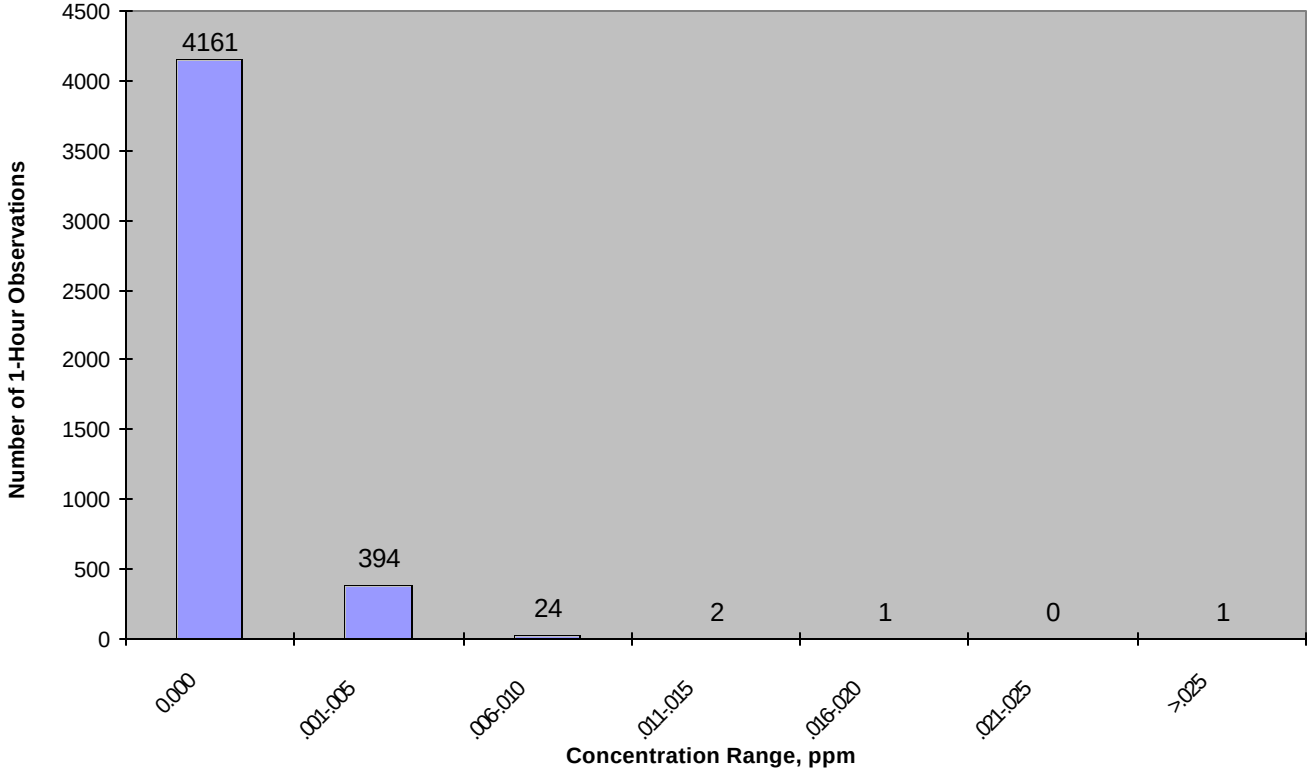
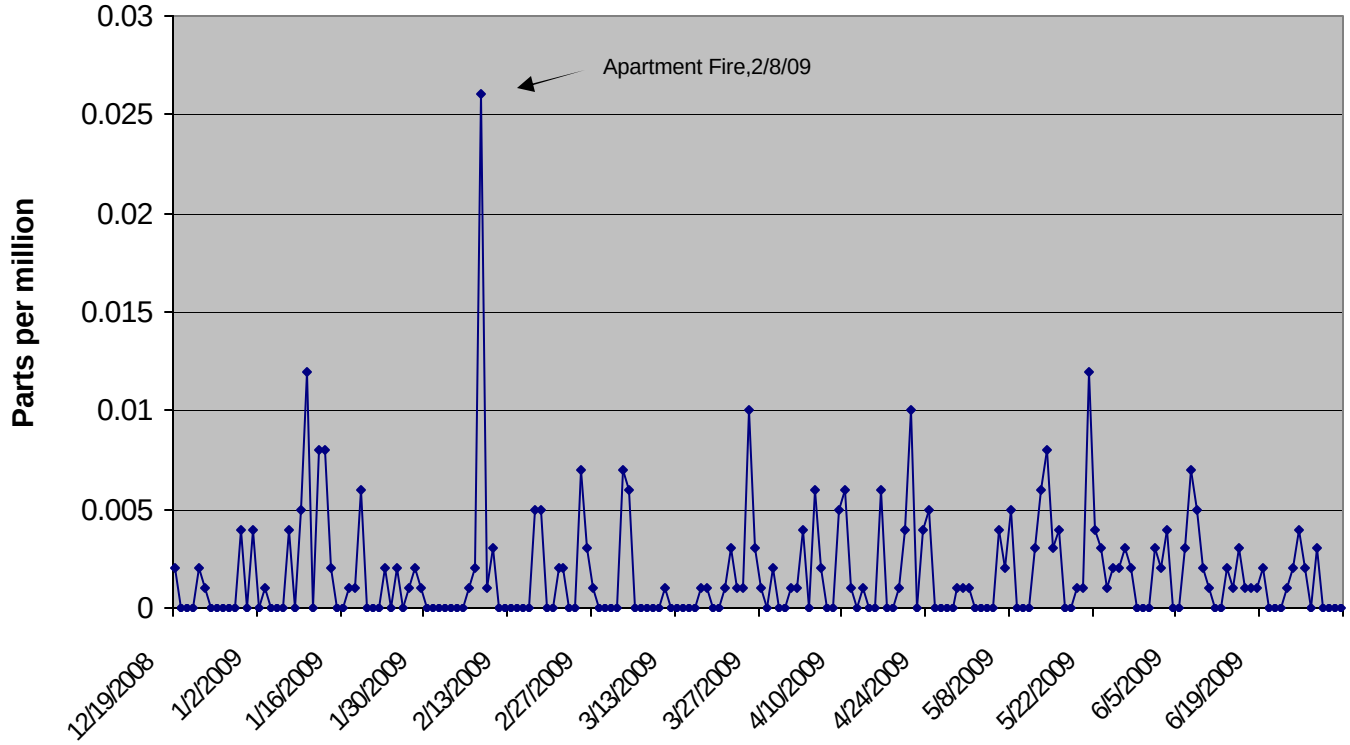


Figure 3
Hopewell H_2S Daily 1-Hour Maximum Values, 12/19/08 to 7/2/09



APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
*	1	acetaldehyde	75-07-0
*	2	acetamide	60-35-5
*	3	acetonitrile	75-05-8
*	4	acetophenone	98-86-2
*	5	2-acetylaminofluorene	53-96-3
*	6	acrolein	107-02-8
*	7	acryrlamide	79-06-1
*	8	acrylic acid	79-10-7
*	9	acrylonitrile	107-13-1
*	10	allyl chloride	107-05-1
*	11	4-aminobiphenyl	92-67-1
*	12	aniline	62-53-3
*	13	anisidine	90-04-0
*	14	asbestos	
*	15	benzene	71-43-2
*	16	benzidine	92-87-5
*	17	benzotrichloride (epa oral conv.)	98-07-7
*	18	benzyl chloride	7440-41-7
*	19	biphenyl	92-52-4
*	20	bis(2-ethylhexyl)phthalate	117-81-7
*	21	bis(chloromethyl)ether	542-88-1
*	22	bromoform	75-25-2
*	23	1,3-butadiene	106-99-0
*	24	calcium cyanamide	156-62-7
*	25	delisted	
*	26	captan (epa oral conv.)	133-06-2
*	27	carbaryl	63-25-2
*	28	carbon disulfide	75-15-0
*	29	carbon tetrachloride	56-23-5
*	30	carbonyl sulfide	463-58-1
*	31	catechol	120-80-9
*	32	chloramben	133-90-4
*	33	chlordane	57-74-9
*	34	chlorine	7782-50-5
*	35	chloroacetic acid	79-11-8
*	36	2-chloroacetophenone	532-27-4
*	37	chlorobenzene	108-90-7
*	38	chlorobenzilate	510-15-6
*	39	chloroform	67-66-3
*	40	chloromethyl methyl ether	107-30-2
*	41	chloroprene	126-99-8
*	42	cresols (mixed)	1319-77-3
*	43	o-cresol	95-48-7
*	44	m-cresol	108-39-4
*	45	p-cresol	106-44-5
*	46	cumene	98-82-8

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
*	47	2,4-D, salts and esters	94-75-7
*	48	DDE (epa oral conv.)	72-55-9
*	49	diazomethane	334-88-3
*	50	dibenzofuran	132-64-9
*	51	1,2-dibromo-3-chloropropane	96-12-8
*	52	dibutylphthalate	84-74-2
*	53	p-dichlorobenzene	106-46-7
*	54	3,3'-dichlorobenzidine	91-94-1
*	55	dichloroethyl ether	111-44-4
*	56	1,3-dichloropropene	542-75-6
*	57	dichlorvos (epa oral conv.)	62-73-7
*	58	diethanolamine	111-42-2
*	59	N,N-dimethylamine	121-69-7
*	60	diethyl sulfate	64-67-5
*	61	3,3'-dimethoxybenzidine (epa oral conv.)	119-90-4
*	62	p-dimethylaminoazobenzene	60-11-7
*	63	3,3'-dimethylbenzidine (epa oral conv.)	119-93-7
*	64	dimethyl carbamoyl chloride	79-44-7
*	65	dimethyl formamide	68-12-2
*	66	1,1-dimethylhydrazine	57-14-7
*	67	dimethyl phthalate	131-11-3
*	68	dimethyl sulfate	77-78-1
*	69	4,6-dinitro-o-cresol	534-52-1
*	70	2,4-dinitrophenol	51-28-5
*	71	2,4-dinitrotoluene	121-14-2
**	71	2,4/2,6-dinitrotoluene mixture (epa oral conv)	25321-14-6
*	72	1,4-dioxane	123-91-1
*	73	1,2-diphenylhydrazine	122-66-7
*	74	epichlorohydrin	106-89-8
*	75	epoxybutane	106-88-7
*	76	ethyl acrylate	140-88-5
*	77	ethyl benzene	100-41-4
*	78	ethyl carbamate	51-79-6
*	79	ethyl chloride	75-00-3
*	80	ethylene dibromide	106-93-4
*	81	ethylene dichloride	107-06-2
*	82	ethylene glycol	107-21-1
*	83	ethylene imine	151-56-4
*	84	ethylene oxide	75-21-8
*	85	ethylene thiourea	96-45-7
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3
*	87	formaldehyde	50-00-0
*	88	heptachlor	76-44-8
*	89	hexachlorobenzene	118-74-1
*	90	hexachlorobutadiene	87-68-3

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
*	91	hexachlorocyclopentadiene	77-47-4
*	92	hexachloroethane	67-72-1
*	93	hexamethylene-1,6-diisocyanate	822-06-0
*	94	hexamethylphosphoramide	680-31-9
*	95	n-hexane	110-54-3
*	96	hydrazine	302-01-2
*	97	hydrochloric acid	7647-01-0
*	98	hydrofluoric acid	7664-39-3
*	999	hydrogen sulfide	2148-87-8
*	99	hydroquinone	123-31-9
*	100	isophorone (epa oral conv.)	78-59-1
**	101	lindane (gamma-HCH)	58-89-9
**	101	alpha-hexachlorocychexane (a-HCH)	319-84-6
**	101	beta-hexachlorocychexane (b-HCH)	319-85-7
**	101	technical hexachlorocychexane (HCH)	608-73-1
*	102	maleic anhydride	108-31-6
*	103	methanol	67-56-1
*	104	methoxychlor	72-43-5
*	105	methyl bromide	74-83-9
*	106	methyl chloride	74-87-3
*	107	methyl chloroform (1,1,1-trichloroethane)	71-55-6
*	108	delisted	
*	109	methyl hydrazine	60-34-4
*	110	methyl iodide	78-88-4
*	111	methyl isobutyl ketone	109-10-1
*	112	methyl isocyanate	624-83-9
*	113	methyl methacrylate	80-62-6
*	114	methyl tert-butyl ether	1634-04-4
*	115	4,4'-methylene bis(2-chloroaniline)	101-14-4
*	116	methylene chloride	75-09-2
*	117	methylene diphenyl diisocyanate	101-68-8
*	118	4,4'-methylenedianiline	101-77-9
*	119	naphthalene	91-20-3
*	120	nitrobenzene	98-95-3
*	121	4-nitrobiphenyl	92-93-3
*	122	2-nitrophenol	100-27-7
*	123	2-nitropropane	79-46-9
*	124	n-nitroso-n-methylurea	684-93-5
*	125	nitrosodimethylamine	62-75-9
*	126	n-nitrosomorpholine	59-89-2
*	127	parathion	56-38-2
*	128	pentachloronitrobenzene (epa oral conv.)	82-68-8
*	129	pentachlorophenol	87-86-5
*	130	phenol	108-95-2
*	131	p-phenylenediamine	106-50-3
*	132	phosgene	75-44-5

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
*	133	phosphine	7803-51-2
*	134	phosporus, white	7723-14-0
*	135	phthalic anhydride	85-44-9
*	137	1,3-propane sultone	1120-71-4
*	138	beta-propioiactone	57-57-8
*	139	propionaldehyde	123-38-6
*	140	propoxur	114-26-1
*	141	propylene dichloride (epa oral conv.)	78-87-5
*	142	propylene oxide	75-56-9
*	143	1,2-propyleneimine	75-55-8
*	144	quinoline	91-22-5
*	145	quinone	106-51-4
*	146	styrene	100-42-5
*	147	styrene oxide	96-09-3
*	148	2,3,7,8-tcdd	1746-01-6
*	149	1,1,2,2-tetrachloroethane	79-34-5
*	150	tetrachloroethylene	127-18-4
*	151	titanium tetrachloride	7550-45-0
*	152	toluene	108-88-3
*	153	2,4-toluene diamine	95-80-7
*	154	2,4/2,6-tdi mixture	26471-62-5
*	155	o-toluidine	95-53-4
*	156	toxaphene	8001-35-2
*	157	1,2,4-trichlorobenzene	120-82-1
*	158	1,1,2-trichloroethane	79-00-5
*	159	trichloroethylene	79-01-6
*	160	2,4,5-trichlorophenol	95-95-4
*	161	2,4,6-trichlorophenol	88-06-2
*	162	triethylamine	121-44-8
*	163	trifluralin (epa oral conv.)	1582-09-8
*	164	2,2,4-trimethylpentane	540-84-1
*	165	vinyl acetate	109-05-4
*	166	vinyl bromide	593-60-2
*	167	vinyl chloride	75-01-4
*	168	vinylidene chloride	75-35-4
*	169	xylenes (mixed)	1330-20-7
*	170	o-xylene	95-47-6
*	171	m-xylene	108-38-3
*	172	p-xylene	106-42-3
		Subdivided chemicals	
		antimony	
**	173	antimony compounds	7440-36-0
**	173	antimony pentoxide	1314-60-9
**	173	antimony potassium tarrate	304-61-0
**	173	antimony tetroxide	1332-81-6

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
**	173	antimony trioxide	1309-64-4
		arsenic	
**	174	arsenic compounds	7440-38-2
**	174	arsenic pentoxide	1303-28-2
**	174	arsine	7784-42-1
**	174	arsenic and compounds (inorganic)	7440-38-2
		beryllium	
**	175	beryllium compounds	7440-41-7
**	175	beryllium oxide	1304-56-9
		cadmium	
**	176	cadmium compounds	7440-43-9
		chromium	
**	177	chromium (III) compounds	16065-83-1
**	177	chromium (VI) compounds	18540-29-9
**	177	chromium (VI) trioxide, chromic acid mist	11115-74-5
**	177	barium chromate	10294-40-3
**	177	calcium chromate	13765-19-0
**	177	lead chromate	7785-97-6
**	177	sodium dichromate	10588-01-9
**	177	strontium chromate	7789062
		cobalt	
**	178	cobalt compounds	7440-48-4
		coke ovens	
	179	coke oven emissions	8007-45-2
		cyanide	
**	180	cyanazine (epa oral conv.)	21725-46-2
**	180	cyanide compounds	57-12-5
**	180	acetone cyanohydrin	75-86-5
**	180	calcium cyanide	592-01-8
**	180	copper cyanide	544-92-3
**	180	cyanogen	460-19-5
**	180	cyanogen bromide	506-68-3
**	180	cyanogen chloride	506-77-4
**	180	ethylene cyanohydrin	109-78-4
**	180	hydrogen cyanide	74-90-8
**	180	potassium cyanide	151-50-8
**	180	potassium silver cyanide	506-16-6
**	180	silver cyanide	506-64-9
**	180	sodium cyanide	143-33-9
**	180	thiocyanic acid	21564-17-0
**	180	zinc cyanide	557-21-1
		diesel	
	999	diesel engine emissions	
		ethers	
**	181	diethlyene glycol monobutyl ether	112-34-5

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
**	181	diethlyene glycol monoethyl ether	111-90-0
**	181	ethylene glycol ethyl ether	110-80-5
**	181	ethylene glycol ethyl ether acetate	111-15-9
**	181	ethylene glycol methyl ether	109-86-4
**	181	ethylene glycol methyl ether acetate	110-49-6
**	181	ethylene glycol monobutyl ether	111-76-2
**	181	isopropoxyethanol	109-59-1
		lead	
**	182	lead compounds	7439-92-1
**	182	tetraethyl lead	78-00-2
**	182	lead acetate	301-04-2
**	182	lead phosphate	7446-27-7
**	182	lead subacetate	1335-32-6
**	182	lead chromate	7758-97-6
		managanese	
**	183	managanese compounds	7439-96-5
		mercury	
**	184	mercuric chloride	7487-94-7
**	184	mercury (elemental)	7439-97-6
**	184	methyl mercury	33967-92-6
**	184	phenylmercuric acetate	62-38-4
	185	fine mineral fibers	
		nickel	
**	186	nickel compounds (soluble)	7440-02-0
**	186	nickel compounds (insoluble)	1313-99-1
**	186	nickel refinery dust	
**	186	nickel oxide	1313-99-1
**	186	nickel subsulfide	12035-72-2
**	186	nickel acetate	373-02-4
**	186	nickel carbonate	3333-67-3
**	186	nickel carbonyl	13463-39-3
**	186	nickel hydroxide	12054-48-7
**	186	nickelocene	1271-28-9
		PCBs	
**	136	polychlorinated biphenyls	1336-36-3
**	136	Aroclor 1016	12674-11-2
**	136	Aroclor 1254	11097-69-1
**	136	pcb unspeciated--lowest risk	1336-36-3
**	136	pcb unspeciated--low risk	1336-36-3
**	136	pcb unspeciated--high risk	1336-36-3
**	136	pcb 77	32598-13-3
**	136	pcb 81	70326-50-4
**	136	pcb 105	32598-14-4
**	136	pcb 114	74472-37-0
**	136	pcb 118	31508-00-6

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
**	136	pcb 123	65510-44-3
**	136	pcb 126	57465-28-8
**	136	pcb 156	38380-08-4
**	136	pcb 157	69782-90-7
**	136	pcb 167	52663-72-6
**	136	pcb 169	32774-16-6
**	136	pcb 189	39635-31-9
		polychlorinated dibenzo-p-dioxins (PCDD)	
**	148	2,3,7,8-tetrachlorodibenzo-p-dioxin	1746-01-6
**	148	1,2,3,7,8-	40321-76-4
**	148	1,2,3,4,7,8-	39227-28-6
**	148	1,2,3,6,7,8-	57653-85-7
**	148	1,2,3,7,8,9-	19408-75-3
**	148	1,2,3,4,6,7,8-	35833-46-9
**	148	1,2,3,4,6,7,8,9-	3268-87-9
		polychlorinated dibenzofurans (PCDF)	
**	148	polychlorinated dibenzofurans (PCDF)	
**	148	2,3,7,8-	5120-73-12
**	148	1,2,3,7,8-	57117-41-6
**	148	2,3,4,7,8-	57117-31-4
**	148	1,2,3,4,7,8-	70648-26-9
**	148	1,2,3,6,7,8-	57117-44-9
**	148	1,2,3,7,8,9-	72981-21-9
**	148	2,3,4,6,7,8-	60851-34-5
**	148	1,2,3,4,6,7,8-	67562-39-4
**	148	1,2,3,4,7,8,9-	55673-89-7
**	148	1,2,3,4,6,7,8,9-	39001-02-0
		PPB	
**	187	polybrominated biphenyl (epa oral conv.)	59536-65-1
		PAHs/PNAs	
**	187	acenaphthene	83-32-9
**	187	acenaphthylene	206-96-8
**	187	2-aminoanthraquinone	117-79-3
**	187	anthracene	120-12-7
**	187	benzo(a)anthracene	56-55-3
**	187	benzo(b)fluoranthene	205-99-2
**	187	benzo(j)fluoranthene	205-82-3
**	187	benzo(k)fluoranthene	207-08-9
**	187	benzo(g,h,i)perylene	191-24-2
**	187	benzo(a)pyrene	50-32-8
**	187	benzo(e)pyrene	192-97-2
**	187	carbazole (epa oral conv.)	86-74-8
**	187	beta-chloronaphthalene	91-58-7
**	187	chrysene	218-01-9
**	187	dibenz(a,h)acridine	226-36-8

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX A--HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
**	187	dibenz(a,j)acridine	224-42-0
**	187	dibenz(a,h)anthracene	53-70-3
**	187	7h-dibenzo(c,g)carbazole	194-59-2
**	187	dibenzo(a,e)pyrene	192-65-4
**	187	dibenzo(a,h)pyrene	189-64-0
**	187	dibenzo(a,i)pyrene	189-55-9
**	187	dibenzo(a,l)pyrene	191-30-0
**	187	7,12-dimethylbenz(a)anthracene	57-97-6
**	187	1,6-dinitropyrene	42397-64-8
**	187	1,8-dinitropyrene	42397-65-9
**	187	fluoranthene	206-44-0
**	187	fluorene	86-73-7
**	187	indeno(1,2,3-cd)pyrene	193-39-5
**	187	3-methylcholanthrene	56-49-5
**	187	5-methylchrysene	3697-24-3
**	187	1-methylnapthalene	90-12-0
**	187	2-methylnapthalene	91-57-6
**	187	5-nitroacenaphthalene	602-87-9
**	187	6-nitrochrysene	749602-8
**	187	2-nitrofluorene	607-57-8
**	187	1-nitropyrene	5522-43-0
**	187	4-nitropyrene	57835-92-4
**	187	phenanthrene	85-01-8
**	187	pyrene	129-00-0
		bromodiphenyl ether	
	187	octabromodiphenyl ether	32536-52-0
		selenium	
**	189	selenium compounds	7782-49-2
**	189	hydrogen selenide	7746084
**	189	selenous acid	7783-00-8
**	189	selenium dioxide	7446084
**	189	selenium disulfide	7488564
**	189	selenium sulfide	7446346
**	189	selenourea	630-10-4
		uranium	
**	188	uranium compounds	7440-61-1
**	188	uranium, soluble salts	

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

APPENDIX B--HOPEWELL HAPs LISTING

HAP	HAP #	CHEMICAL	CASRN
*	1	acetaldehyde	75-07-0
*	6	acrolein	107-02-8
*	15	benzene	71-43-2
*	22	bromoform	75-25-2
*	23	1,3-butadiene	106-99-0
*	29	carbon tetrachloride	56-23-5
*	37	chlorobenzene	108-90-7
*	39	chloroform	67-66-3
*	53	p-dichlorobenzene	106-46-7
*	56	1,3-dichloropropene	542-75-6
*	77	ethyl benzene	100-41-4
*	79	ethyl chloride	75-00-3
*	81	ethylene dichloride	107-06-2
*	86	ethylidene dichloride (1,1-dichloroethane)	75-34-3
*	87	formaldehyde	50-00-0
*	90	hexachlorobutadiene	87-68-3
*	95	n-hexane	110-54-3
*	105	methyl bromide	74-83-9
*	106	methyl chloride	74-87-3
*	107	methyl chloroform (1,1,1-trichloroethane)	71-55-6
*	116	methylene chloride	75-09-2
*	146	styrene	100-42-5
*	149	1,1,2,2-tetrachloroethane	79-34-5
*	150	tetrachloroethylene	127-18-4
*	152	toluene	108-88-3
*	157	1,2,4-trichlorobenzene	120-82-1
*	158	1,1,2-trichloroethane	79-00-5
*	159	trichloroethylene	79-01-6
*	167	vinyl chloride	75-01-4
*	169	xylenes (mixed)	1330-20-7
**	174	arsenic compounds	7440-38-2
**	175	beryllium compounds	7440-41-7
**	176	cadmium compounds	7440-43-9
**	177	chromium (III) compounds	16065-83-1
**	177	chromium (VI) compounds	18540-29-9
**	182	lead compounds	7439-92-1
**	183	managanese compounds	7439-96-5
**	186	nickel compounds (insoluble)	1313-99-1

HAP
* original
** subdivided

CASRN:
Chemical Abstract Service
Registry Number

Appendix C

Hydrogen Sulfide Sampling

As part of the follow-up monitoring performed after the majority of the toxics monitoring was concluded, the Office of Air Quality Monitoring installed a continuous Hydrogen Sulfide (H_2S) monitor at the Spruance site from December 19, 2008 to July 1, 2009. The monitoring assembly included the following instruments:

- Thermo Environmental Instruments (TEI) Pulsed Fluorescence AO2 Analyzer Model 43-C
- Thermo Environmental Instruments (TEI) Hydrogen Sulfide Converter model 340
- Omniscribe strip-chart recorder model 5000 and/or ESC model 8816 data-logger
- ESC data-logger

The TEI 340 H_2S Converter quantitatively oxidizes all H_2S in the collected ambient air sample to SO_2, which will be measured by the TEI SO_2 analyzer. The TEI 340 converter operates at a moderate temperature (200-400 deg. C) which means that it mainly converts a quantitative measurement of H_2S in the sampled air. The operating temperature is not high enough to oxidize the more complex gaseous sulfur compounds to SO_2. In addition, any SO_2 present in the sampled air will be removed by a scrubber prior to analysis. The continuous measurement of H_2S (as SO_2) was recorded on a strip chart recorder and stored as hourly averages in the ESC data-logger.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ACROLEIN

CAS # 107-02-8

Division of Toxicology and Environmental Medicine ToxFAQs™ **August 2007**

This fact sheet answers the most frequently asked health questions (FAQs) about acrolein. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to acrolein occurs mostly from breathing it in air. Cigarette smoke and automobile exhaust contain acrolein. Acrolein causes burning of the nose and throat and can damage the lungs. Acrolein has been found in at least 32 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is acrolein?

Acrolein is a colorless or yellow liquid with a disagreeable odor. It dissolves in water very easily and quickly changes to a vapor when heated. It also burns easily. Small amounts of acrolein can be formed and can enter the air when trees, tobacco, other plants, gasoline, and oil are burned.

Acrolein is used as a pesticide to control algae, weeds, bacteria, and mollusks. It is also used to make other chemicals.

What happens to acrolein when it enters the environment?

- ❏ Acrolein may be found in soil, water, or air.
- ❏ It breaks down fairly rapidly in the air (about half will disappear within 1 day) by reacting with other chemicals and sunlight.
- ❏ Acrolein evaporates rapidly from soil and water.

How might I be exposed to acrolein?

- ❏ Smoking tobacco or breathing air containing tobacco smoke or automobile exhaust.
- ❏ Working in or living near industries where acrolein is manufactured or used to make other chemicals.
- ❏ Inhaling vapors from overheated cooking oil or grease.

How can acrolein affect my health?

There is very little information about how exposure to acrolein affects people's health. The information we have indicates that breathing large amounts damages the lungs and could cause death. Breathing lower amounts may cause eye watering and burning of the nose and throat and a decreased breathing rate; these effects usually disappear after exposure stops.

Animal studies show that breathing acrolein causes irritation to the nasal cavity, lowered breathing rate, and damage to the lining of the lungs.

We do not know if eating food or drinking water containing acrolein affects your health. However, animals that swallowed acrolein had stomach irritation, vomiting, stomach ulcers and bleeding.

How likely is acrolein to cause cancer?

The Department of Health and Human Services (DHHS) has not classified acrolein as to its carcinogenicity. The International Agency for Research on Cancer (IARC) has determined that acrolein is not classifiable as to carcinogenicity in humans. The EPA has stated that the potential carcinogenicity of acrolein cannot be determined based on an inadequate database.

How can acrolein affect children?

In general, children are not likely to be affected by acrolein more than adults. However, children who are sensitive to irritants in the air (such as children with asthma) may be more sensitive to lung irritation from acrolein.

In animal studies, ingestion of very large amounts of acrolein during pregnancy caused reduced birth weights and skeletal deformities in newborns. However, the levels causing these effects were often fatal to the mother.

How can families reduce the risks of exposure to acrolein?

You can reduce your family's exposure to acrolein by reducing their exposure to tobacco smoke, smoke from burning wood products or cooking oils and grease, and exhaust from diesel or gasoline vehicles.

Is there a medical test to determine whether I've been exposed to acrolein?

There are tests to detect acrolein or breakdown products of acrolein in blood or urine; however, these tests are not available in a doctor's office because they require special equipment. These tests also cannot be used to determine if you were exposed to acrolein because acrolein can be produced by the breakdown of other chemicals in the body.

Has the federal government made recommendations to protect human health?

The Food and Drug Administration (FDA) has determined that the amount of acrolein used to prepare modified food starch must not be more than 0.6%.

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.1 parts of acrolein per million parts of workplace air (0.1 ppm) for 8 hour shifts and 40 hour work weeks.

The EPA has restricted the use of all pesticides containing acrolein.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Acrolein (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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CARBON TETRACHLORIDE

CAS # 56-23-5

Division of Toxicology ToxFAQs™ **August 2005**

This fact sheet answers the most frequently asked health questions (FAQs) about carbon tetrachloride. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Carbon tetrachloride does not occur naturally. Exposure to this substance results mostly from breathing air, drinking water, or coming in contact with soil that is contaminated with it. Exposure to very high amounts of carbon tetrachloride can damage the liver, kidneys, and nervous system. Carbon tetrachloride can cause cancer in animals. Carbon tetrachloride has been found in at least 425 of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is carbon tetrachloride?

Carbon tetrachloride is a manufactured chemical that does not occur naturally. It is a clear liquid with a sweet smell that can be detected at low levels. It is also called carbon chloride, methane tetrachloride, perchloromethane, tetrachloroethane, or benziform.

Carbon tetrachloride is most often found in the air as a colorless gas. It is not flammable and does not dissolve in water very easily. It was used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. Because of its harmful effects, these uses are now banned and it is only used in some industrial applications.

What happens to carbon tetrachloride when it enters the environment?

- ❏ It moves very quickly into the air upon release, so most of it is in the air.
- ❏ It evaporates quickly surface water.
- ❏ Only a small amount sticks to soil particles; the rest evaporates or moves into the groundwater.
- ❏ It is very stable in air (lifetime 30-100 years).
- ❏ It can be broken down or transformed in soil and water within several days.
- ❏ When it does break down, it forms chemicals that can destroy ozone in the upper atmosphere.
- ❏ It does not build up in animals. We do not know if it build up in plants.

How might I be exposed to carbon tetrachloride?

- ❏ Breathing contaminated air near manufacturing plants or waste sites.
- ❏ Breathing workplace air when it is used.
- ❏ Drinking contaminated water near manufacturing plants and waste sites.
- ❏ Breathing contaminated air and skin contact with water while showering or cooking with contaminated water.
- ❏ Swimming or bathing in contaminated water.
- ❏ Contact with or eating contaminated soil (pica child) at waste sites.

How can carbon tetrachloride affect my health?

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects can occur after ingestion or breathing carbon tetrachloride, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it enlarges and cells are damaged or destroyed. Kidneys also are damaged, causing a build up of wastes in the blood. If exposure is low and brief, the liver and kidneys can repair the damaged cells and function normally again. Effects of carbon tetrachloride are more severe in persons who drink large amounts of alcohol.

If exposure is very high, the nervous system, including the brain, is affected. People may feel intoxicated and experience headaches, dizziness, sleepiness, and nausea and vomiting. These effects may subside if exposure is stopped, but in severe cases, coma and even death may occur.

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There have been no studies of the effects of carbon tetrachloride on reproduction in humans, but studies in rats showed that long-term inhalation may cause decreased fertility.

How likely is carbon tetrachloride to cause cancer?

Studies in humans have not been able to determine whether or not carbon tetrachloride can cause cancer because usually there has been exposure to other chemicals at the same time. Swallowing or breathing carbon tetrachloride for years caused liver tumors in animals. Mice that breathed carbon tetrachloride also developed tumors of the adrenal gland. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that carbon tetrachloride is possibly carcinogenic to humans, whereas the EPA determined that carbon tetrachloride is a probable human carcinogen.

How can carbon tetrachloride affect children?

The health effects of carbon tetrachloride have not been studied in children, but they are likely to be similar to those seen in adults exposed to the chemical. We do not know whether children differ from adults in their susceptibility to carbon tetrachloride.

A few survey-type studies suggest that maternal drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects. Studies in animals showed that carbon tetrachloride can cause early fetal deaths, but did not cause birth defects. A study with human breast milk in a test tube suggested that it would be possible for carbon tetrachloride to pass from the maternal circulation to breast milk, but there is no direct demonstration of this occurring.

How can families reduce the risks of exposure to carbon tetrachloride?

❑ Discard any product that contains carbon tetrachloride that you may have at home and may have used in the past.

❑ Household chemicals should be stored out of the reach of children in their original containers.

❑ Sometimes older children sniff household chemical products to get high. Talk to your children about the dangers of sniffing chemicals.

Is there a medical test to determine whether I've been exposed to carbon tetrachloride?

Several sensitive and specific tests are available to measure carbon tetrachloride in exposed persons. The most convenient way is simply to measure carbon tetrachloride in the exhaled air. Carbon tetrachloride also can be measured in blood, fat, or other tissues. These tests are not usually done in the doctor's office because they require special equipment. Although these tests can show that a person has been exposed to carbon tetrachloride, the results cannot be used to reliably predict whether any adverse health effect might result. Because carbon tetrachloride leaves the body fairly quickly, these methods are best suited to detecting exposures that have occurred within the last several days.

Has the federal government made recommendations to protect human health?

The EPA has set a limit for carbon tetrachloride in drinking water of 5 parts of carbon tetrachloride per billion parts of water (5 ppb). The EPA has also set limits on how much carbon tetrachloride can be released from an industrial plant into waste water and is preparing to set limits on how much carbon tetrachloride can escape from an industrial plant into outside air.

The Occupational Safety and Health Administration (OSHA) set a limit of 10 ppm for carbon tetrachloride in workplace air for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Carbon Tetrachloride (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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FORMALDEHYDE
CAS # 50-00-0

This fact sheet answers the most frequently asked health questions (FAQs) about formaldehyde. For more information, call the ATSDR Information Center at 1-800-CDC-INFO. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Everyone is exposed to small amounts of formaldehyde in air and some foods and products. Formaldehyde can cause irritation of the skin, eyes, nose, and throat. High levels of exposure may cause some types of cancers. This substance has been found in at least 26 of the 1,467 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is formaldehyde?
(Pronounced fôr-măl′də-hīd′)

At room temperature, formaldehyde is a colorless, flammable gas that has a distinct, pungent smell. It is also known as methanal, methylene oxide, oxymethyline, methylaldehyde, and oxomethane. Formaldehyde is naturally produced in small amounts in our bodies.

It is used in the production of fertilizer, paper, plywood, and urea-formaldehyde resins. It is also used as a preservative in some foods and in many products used around the house, such as antiseptics, medicines, and cosmetics.

What happens to formaldehyde when it enters the environment?

- Formaldehyde dissolves easily but does not last a long time in water.
- Most formaldehyde in the air breaks down during the day.
- The breakdown products of formaldehyde are formic acid and carbon monoxide.
- Formaldehyde does not build up in plants and animals.

How might I be exposed to formaldehyde?

- Smog is a major source of formaldehyde exposure.
- Cigarettes and other tobacco products, gas cookers, and open fireplaces are sources of formaldehyde exposure.
- It is used in many industries and in hospitals and laboratories.
- Formaldehyde is given off as a gas from the manufactured wood products used in new mobile homes.
- The amount of formaldehyde in foods is very small.
- Household sources, such as fiberglass, carpets, permanent press fabrics, paper products, and some household cleaners.

How can formaldehyde affect my health?

Low levels of formaldehyde can cause irritation of the eyes, nose, throat, and skin. It is possible that people with asthma may be more sensitive to the effects of inhaled formaldehyde.

Drinking large amounts of formaldehyde can cause severe pain, vomiting, coma, and possible death.

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ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html

How likely is formaldehyde to cause cancer?

Some studies of people exposed to formaldehyde in workplace air found more cases of cancer of the nose and throat than expected, but other studies did not confirm this finding.

In animal studies, rats exposed to high levels of formaldehyde in air developed nose cancer. The Department of Health and Human Services (DHHS) has determined that formaldehyde may reasonably be anticipated to be a carcinogen.

How can formaldehyde affect children?

The most common route of exposure is by breathing it, which is likely to cause nose and eye irritation (burning, itchy, tearing, and sore throat) in children as well as in adults.

Animal studies suggest that formaldehyde will not cause birth defects in humans. It is not likely to be transferred to a child in breast milk.

How can families reduce the risk of exposure to formaldehyde?

Formaldehyde is usually found in the air, and levels are usually higher indoors than outdoors. Opening windows and using fans to bring fresh air indoors are the easiest ways to lower levels in the house. Not smoking and not using unvented heaters indoors can lower the formaldehyde levels.

Removing formaldehyde sources in the home can reduce exposure. Formaldehyde is given off from a number of products used in the home. Providing fresh air, sealing unfinished manufactured wood surfaces, and washing new permanent press clothing before wearing can help lower exposure.

Is there a medical test to show whether I've been exposed to formaldehyde?

Laboratory tests can measure formaldehyde in blood, urine, and breath. These tests do not tell you how much formaldehyde you have been exposed to or if harmful effects will occur. The tests are not routinely available at your doctor's office.

What recommendations has the federal government made to protect human health?

The EPA recommends that an adult should not drink water containing more than 1 milligram of formaldehyde per liter of water (1 mg/L) for a lifetime exposure, and a child should not drink water containing more than 10 mg/L for 1 day or 5 mg/L for 10 days.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit for formaldehyde of 0.75 parts per million (ppm) for an 8-hour workday, 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) recommends an exposure limit of 0.016 ppm.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for formaldehyde. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Services.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone:1-800-CDC-INFO, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html
ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.