

**ATTACHMENT F: EMERGENCY AND REMEDIAL RESPONSE PLAN
40 CFR 146.94(a)**

Elk Hills A1-A2 Storage Project

Facility Information

Facility name: CTV I: Elk Hills A1-A2
357-7R and 355-7R

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Well location: Elk Hills Oil Field, Kern County, CA
35.32802963 / -119.5449982

This Emergency and Remedial Response Plan (ERRP) describes actions that Carbon TerraVault I LLC (CTV) shall take to address movement of the injection fluid or formation fluid in a manner that may endanger an underground source of drinking water (USDW) during the construction, operation, or post-injection site care periods.

The Emergency and Remedial Response Plan would be implemented in response to events that could be detected in the course of monitoring pursuant to the Testing and Monitoring Plan, including exceedances of Actionable Testing limits described in the QASP (Table 7: Actionable Testing and Monitoring Outputs).

If CTV obtains evidence that the injected CO₂ stream and/or associated pressure front may cause an endangerment to a USDW, CTV must perform the following actions:

1. Initiate shutdown plan for the injection well.
2. Take all steps reasonably necessary to identify and characterize any release.
3. Notify the permitting agency (UIC Program Director) of the emergency event within 24 hours.
4. Implement applicable portions of the approved ERRP.

Where the phrase “initiate shutdown plan” is used, the following protocol will be employed: CTV will immediately cease injection. However, in some circumstances, CTV will, in consultation with the UIC Program Director, determine whether gradual cessation of injection (using the parameters set forth in the individual Well Construction, Operating and Plugging details (COP) documents) is appropriate.

Local Resources and Infrastructure

Resources in the vicinity of the Elk Hills A1-A2 Storage facility that may be affected as a result of an emergency event at the project site include:

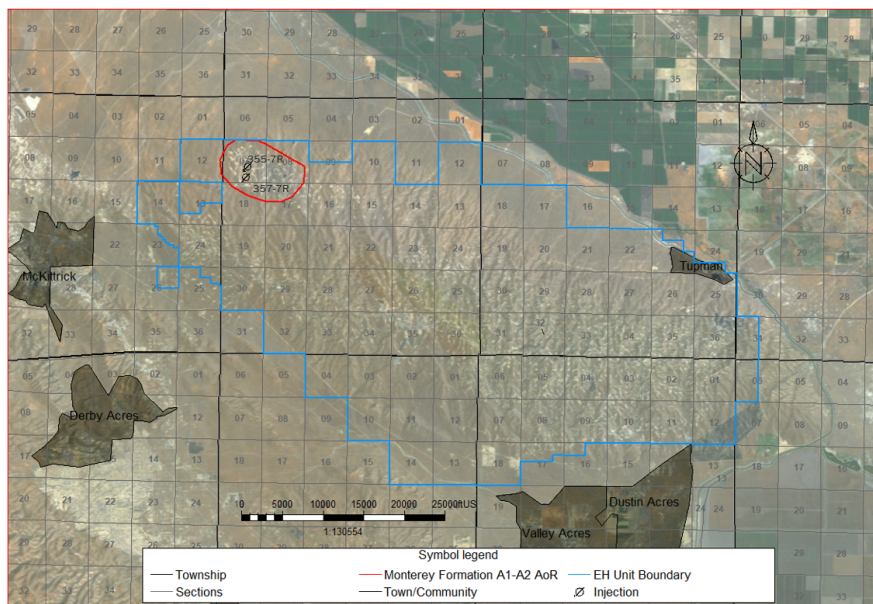
1. Elk Hills oil and gas production resources not associated with the Elk Hills A1-A2 Storage project. These oil and gas operations are operated by California Resources Corporation (CRC) an owner of the Elk Hills A1-A2 Storage project.
2. Upper Tulare USDW overlying the CO₂ plume. The USDW is not being utilized in the AoR and CTV does not expect usage in the foreseeable future.
3. The nearest town/community from the project is McKittrick, 3.1 miles from the AoR. The population was 115 at the 2010 U.S. Census.

Infrastructure in the vicinity of the Elk Hills A1-A2 Storage facility that that may be affected as a result of an emergency at the project site include:

1. Elk Hills infrastructure owned and operated by CTV that is associated with oil and gas operations.

Resources and infrastructure addressed in this plan are shown in Figure 1.

Figure 1: Map of the site resources and infrastructure. The project is located 3.1 miles from the census designated area of McKittrick.



Potential Risk Scenarios

The following events related to the Elk Hills A1-A2 facility that could potentially result in an emergency response:

- Well integrity failure
- Injection well or monitoring equipment failure (e.g., shut-off valve or pressure gauge, etc.);
- Potential Brine or CO2 Leakage to a USDW;
- A natural disaster (e.g., tornado, lightning strike); or
- Induced or natural seismic event.

Response actions will depend on the severity of the event(s) triggering an emergency response. “Emergency events” are categorized as shown in Table 1.

Table 1. Degrees of risk for emergency events.

Emergency Condition	Definition
Major emergency	Event poses immediate substantial risk to human health, resources, or infrastructure. Emergency actions involving local authorities (evacuation or isolation of areas) should be initiated.
Serious emergency	Event poses potential serious (or significant) near term risk to human health, resources, or infrastructure if conditions worsen or no response actions taken.
Minor emergency	Event poses no immediate risk to human health, resources, or infrastructure.

Emergency Identification and Response Actions

Steps to identify and characterize the event will be dependent on the specific issue identified, and the severity of the event. The potential risk scenarios identified in Part 2 are detailed below.

Well Integrity Failure

Integrity loss at the injection well and/or verification well may endanger USDWs. Pursuant to 40 CFR 146.91(c)(3), CTV must notify the UIC Program Director within 24 hours of any triggering of a shut-off system (i.e., down-hole or at the service).

Integrity loss may have occurred if the following events occur:

- Automatic shutdown devices are activated:
 - Wellhead pressure exceeds the specified shutdown pressure specified in the permit.
 - Annulus pressure indicates a loss of external or internal well containment.
 - Pursuant to 40 CFR 146.91(c)(3), CTV must notify the UIC Program Director within 24 hours of any triggering of a shut-off system (i.e., down-hole or at the service).
- Mechanical integrity test results identify a loss of mechanical integrity.

Severity: Low to moderate, dependent on the magnitude of the event.

Timing of event: Injection/Post-Injection

Avoidance measures: Well maintenance, monitoring and control of injection flow and pressure.

Detection methods: Mechanical integrity testing, unexpected injection wells pressure and rate changes, annulus pressure increase, and visual (CO₂ at surface).

Potential response actions:

- Notify the plant superintendent and project manager.
- Limit access to wellhead to authorized personnel only.
- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).
- Determine the severity of the event, based on the information available, within 24 hours of notification.
- For a Major or Serious emergency (loss or increase of pressure or fluid volumes and/or loss of mechanical integrity during testing and maintenance):
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Initiate shutdown plan.
 - Shut-in injection well and vent CO₂ from surface facilities.
 - Communicate with CTV personnel and local authorities to initiate evacuation plans, as necessary.
 - Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.
 - If contamination is detected, identify, and implement appropriate remedial actions (in consultation with the UIC Program Director).
 - If there is damage to the wellhead, repair the damage and conduct a survey to ensure that leakage has ceased.
 - Perform a well log/MIT to detect CO₂ movement outside of the casing.
 - Confirm well integrity prior to restarting injection (upon approval of the UIC Program Director).
- For a Minor emergency (downhole and surface sensor/monitoring equipment failure):
 - Conduct assessment to determine whether there has been a loss of mechanical integrity.
 - If there has been a loss of mechanical integrity, initiate shutdown plan.
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Initiate shutdown plan.
 - Shut-in injection well and vent CO₂ from surface facilities.
 - Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.

- If contamination is detected, identify, and implement appropriate remedial actions (in consultation with the UIC Program Director).
- If there is damage to the wellhead, repair the damage and conduct a survey to ensure that leakage has ceased.
- Perform a well log/MIT to detect CO₂ movement outside of the casing.
- Confirm well integrity prior to restarting injection (upon approval of the UIC Program Director).

Response personnel: Emergency response personnel, drilling crew, geotechnical professionals, and environmental or water treatment professionals.

Equipment: Drill rig, logging equipment, cement or casing and air and water testing equipment.

Injection Well or Monitoring Equipment Failure

The failure of monitoring equipment for wellhead pressure, temperature, and/or annulus pressure may indicate a problem with the injection well that could endanger USDWs.

Severity: Low

Timing of event: Injection

Avoidance measures: Well maintenance, and careful monitoring and control of injection flow and pressure.

Detection methods: Anomalies in monitoring data, and visual failure of equipment.

Potential response actions:

- Notify the plant superintendent and project manager.
- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).
- Determine the severity of the event, based on the information available, within 24 hours of notification.
- For a Major or Serious emergency (failure of sensors that will require shutdown of well to repair, requires extended repair time (>48 hours) and/or well intervention to remediate):
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Communicate with CTV personnel and local authorities to isolate the area and initiate evacuation plans, as necessary.
 - Initiate shutdown plan.
 - Shut-in injection well and vent CO₂ from surface facilities.

- Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.
- Identify and, if necessary, implement appropriate remedial actions (in consultation with the UIC Program Director).
- Verify whether contamination has occurred via handheld CO₂ monitors.
- Confirm well integrity prior to restarting injection and upon approval of the UIC Program Director.
- For a Minor emergency (sensor or monitoring failure that does not require shutdown of the well to repair):
 - Conduct assessment to determine whether there has been a loss of mechanical integrity.
 - If there has been a loss of mechanical integrity, initiate shutdown plan and refer to Major or Serious emergency guidelines.
 - Evaluate the cause of failure, and mitigate if necessary (i.e., repair equipment).
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.

Response Personnel: Emergency response personnel, drilling crew, geotechnical professionals, and environmental or water treatment professionals.

Equipment: Drill rig, logging equipment, cement or casing and air and water testing equipment.

Potential Brine or CO₂ Leakage to USDW

Elevated concentrations of indicator parameter(s) in groundwater sample(s) or other evidence of fluid (brine) movement out of the injection zone or CO₂ leakage into a USDW. This may be identified through elevated concentrations of indicator parameter(s) in groundwater sample(s) or other evidence of fluid (brine) or CO₂ leakage into a USDW. For example, a pressure increase of 50 PSI or a pH of 1.

Severity: Serious

Timing of event: Injection

Avoidance measures: CTV will operate the project to ensure containment of CO₂. Contamination to USDWs will be avoided by:

1. Ensuring injection well integrity through well maintenance and mechanical integrity testing

2. Maintaining the injection pressure below the fracture gradient of the confining Reef Ridge Shale and assessing data from seismic monitoring to ensure competency of the Reef Ridge confining layer.
3. Reviewing monitoring well data to understand plume extent.
4. Monitoring of the Lower Etchegoin dissipation interval that overlies the confining Reef Ridge Shale to establish leakage before migration to USDW.

Detection methods: Pressure or water composition change in Etchegoin Formation or USDW monitoring well. Detection limits are 0.001 PSI for the pressure gauge and 0.2 for pH.

Potential response actions:

- Notify the plant superintendent and project manager.
- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).
- Determine the severity of the event, based on the information available, within 24 hours of notification.
- For all emergencies (Major, Serious, or Minor):
 - Initiate shutdown plan.
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Shut-in all injection wells and vent CO₂ from surface facilities.
 - If the presence of indicator parameters is confirmed, develop (in consultation with the UIC Program Director) a case-specific work plan to:
 - Install additional groundwater monitoring points near the affected groundwater well(s) to delineate the extent of impact; and
 - Remediate unacceptable impacts to the affected USDW.
 - Arrange for an alternate potable water supply, if the USDW was being utilized and has been caused to exceed drinking water standards.
 - Proceed with efforts to remediate USDW to mitigate any unsafe conditions (e.g., install system to intercept/extract brine or CO₂ or “pump and treat” to aerate CO₂-laden water).
 - Continue groundwater remediation and monitoring on a frequent basis (frequency to be determined by CTV and the UIC Program Director) until unacceptable adverse USDW impact has been fully addressed.
 - If there is a well integrity issue perform MITs, refer to the Mechanical Integrity Failure scenario.
 - If the leak poses a risk to air quality a perimeter will be established vi hand-held air monitoring devices.

Response personnel: Emergency response personnel, drilling crew, geotechnical professionals, and environmental or water treatment professionals.

Equipment: Drill rig, logging equipment, groundwater remediation equipment, cement or casing and air and water testing equipment.

Natural Disaster

Well problems (integrity loss, leakage, or malfunction) may arise as a result of a natural disaster affecting the normal operation of the injection well. Natural disasters (e.g., tornado or lightning strike) may disturb surface and/or subsurface facilities.

Severity: Minor to catastrophic

Timing of event: Pre-injection, injection, and/or post injection phases.

Avoidance measures: N/A

Detection methods: N/A

Potential response actions:

If a natural disaster occurs that affects normal operation of the injection well, CTV will perform the following:

- Notify the UIC Program Director within 24 hours of the emergency event, per 40 CFR 146.91(c).
- Determine the severity of the event, based on the information available, within 24 hours of notification.
- For a Major or Serious emergency:
 - Initiate shutdown plan.
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Shut-in all injection wells and vent CO₂ from surface facilities.
 - Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.
 - If contamination has occurred refer to the Potential Brine or CO₂ Leakage to USDW scenario.
 - Communicate with CTV personnel and local authorities to initiate evacuation procedures (if necessary).
 - If there is a well integrity issue for the injector or monitoring well, refer to the Mechanical Integrity Failure scenario.
 - Perform MITs on the injection wells to identify if a loss of external mechanical integrity occurred.
 - If contamination or endangerment is detected, identify, and implement appropriate remedial actions (in consultation with the UIC Program Director).

- For a Minor emergency:
 - Conduct assessment to determine whether there has been a loss of mechanical integrity.
 - If there has been a loss of mechanical integrity, initiate shutdown plan.
 - Contact security to restrict access to the Elk Hills A1-A2 Storage site.
 - Shut-in all injection wells and vent CO₂ from surface facilities.
 - Continuously monitor well pressure, temperature, and annulus pressure to assess integrity loss and determine the root cause of failure.

Response personnel: Emergency response personnel, drilling crew, geotechnical professionals, and environmental or water treatment professionals.

Equipment: Drill rig, logging equipment, cement or casing and air and water testing equipment.

Induced or Natural Seismic Event

Based on the project operating conditions, it is highly unlikely that injection operations would ever induce a seismic event outside the AoR. Therefore, this portion of the response plan is developed for any seismic event with an epicenter within a two-mile radius of the injection wells.

To monitor the area for seismicity, CTV will install surface and shallow borehole seismometers to continuously record the Elk Hills A1-A2 site for seismic activity. In addition to the CTV seismic monitoring, the Southern California Earthquake Data Center has deployed a network to monitor natural seismicity in the area.

Severity: Minor to Major

Timing of event: Injection / Post injection

Avoidance measures: N/A

Detection methods: The seismic monitoring network.

Potential response Actions:

Based on the periodic analysis of the monitoring data, observed level of seismic activity, and local reporting of felt events, the site will be assigned an operating state. The operating state is determined using threshold criteria which correspond to the site's potential risk and level of seismic activity. The operating state provides operating personnel information about the potential risk of further seismic activity and guides them through a series of response actions.

The seismic monitoring system structure is presented in Table 2. The table corresponds each level of operating state with the threshold conditions and operational response actions.

Table 2. Seismic monitoring system, for seismic events > M1.5 with an epicenter within a two-mile radius of the injection well.

Operating State	Threshold Condition ^{1,2}	Response Action ³
Green	Seismic events less than or equal to M1.5	<ol style="list-style-type: none"> 1. Continue normal operation within permitted levels. 2. Document the event in semiannual reports to the EPA.
Yellow	Five (5) or more seismic events within a 30-day period having a magnitude greater than M1.5 but less than or equal to M2.0	<ol style="list-style-type: none"> 1. Continue normal operation within permitted levels. 2. Initiate gradual shutdown of the injection wells if it is determined appropriate. 3. Review seismic and operational data to determine location and magnitude of seismic event. If the event falls near the extents of the plume, estimate potential impacts to USDWs. Perform a pressure falloff test to determine if the storage complex has been compromised by the seismic event. 4. Within 24 hours of the incident, notify the UIC Program Director of the operating status of the well. 5. Document the event in semiannual reports to the EPA.
Orange	Seismic event greater than M1.5 and local observation or felt report	<ol style="list-style-type: none"> 1. Continue normal operation within permitted levels. 2. Initiate gradual shutdown of the injection wells if it is determined appropriate. 3. Review seismic and operational data to determine location and magnitude of seismic event. If the event falls near the extents of the plume, estimate potential impacts to USDWs. Perform a pressure falloff test to determine if the storage complex has been compromised by the seismic event. 4. Within 24 hours of the incident, notify the UIC Program Director, of the operating status of the well. 5. Report findings to the UIC Program Director and perform corrective actions. 6. Document the event in semiannual reports to the EPA
	Seismic event greater than M2.0 and no felt report	

¹ Specified magnitudes refer to magnitudes determined by local Southern California Earthquake Data Center or USGS seismic monitoring stations or reported by the USGS National Earthquake Information Center using the national seismic network.

² “Felt report” and “local observation and report” refer to events confirmed by local reports of felt ground motion or reported on the USGS “Did You Feel It?” reporting system.

³ Reporting findings to the UIC Program Director and issuing corrective action will occur within 25 business days (five weeks) of change in operating state.

Operating State	Threshold Condition ^{1,2}	Response Action ³
Magenta	Seismic event greater than M2.0 and local observation or report	<ol style="list-style-type: none"> 1. Initiate gradual shutdown of the injection wells if it is determined appropriate. 2. Vent CO₂ from surface facilities. 3. Within 24 hours of the incident, notify the UIC Program Director, of the operating status of the well. 4. Limit access to wellhead to authorized personnel only. 5. Communicate with facility personnel and local authorities to initiate evacuation plans, as necessary. 6. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with the UIC Program Director). 7. Determine if leaks to ground water or surface water occurred. 8. Review seismic and operational data to determine location and magnitude of seismic event. If the event falls near the extents of the plume, estimate potential impacts to USDWs. Perform a pressure falloff test to determine if the storage complex has been compromised by the seismic event. 9. If USDW contamination is detected or endangerment, or CO₂ leaked: <ol style="list-style-type: none"> a. Notify the UIC Program Director within 24 hours of the determination. b. Contact environmental and geotechnical professionals for expertise and advice. 10. Assess monitoring plans and where necessary intensify the monitoring plan to ensure containment. 11. Report findings to the UIC Program Director and perform corrective actions. 12. Document the event in semiannual reports to the EPA.
Red	Seismic event greater than M2.0, and local observation or report, and local report and confirmation of damage ⁴	<ol style="list-style-type: none"> 1. Initiate shutdown plan for all injection wells. 2. Vent CO₂ from surface facilities. 3. Within 24 hours of the incident, notify the UIC Program Director of the operating status of the well.

⁴ Onset of damage is defined as cosmetic damage to structures, such as bricks dislodged from chimneys and parapet walls, broken windows, and fallen objects from walls, shelves, and cabinets.

Operating State	Threshold Condition ^{1,2}	Response Action ³
	Or Seismic event >M3.5	<ol style="list-style-type: none"> 4. Limit access to wellhead to authorized personnel only. 5. Communicate with facility personnel and local authorities to initiate evacuation plans, as necessary. 6. Monitor well pressure, temperature, and annulus pressure to verify well status and determine the cause and extent of any failure; identify and implement appropriate remedial actions (in consultation with the UIC Program Director). 7. Review seismic and operational data to determine location and magnitude of seismic event. If the event falls near the extents of the plume, estimate potential impacts to USDWs. Perform a pressure falloff test to determine if the storage complex has been compromised by the seismic event. 8. Determine if leaks to ground water or surface water occurred. 9. If USDW contamination or endangerment is detected, or CO₂ leaked: <ol style="list-style-type: none"> a. Notify the UIC Program Director within 24 hours of the determination. b. Contact environmental and geotechnical professionals for expertise and advice. 10. Assess monitoring plans and where necessary intensify the monitoring plan to ensure containment. 11. Report findings to the UIC Program Director and perform corrective actions. 12. Document the event in semiannual reports to the EPA.

Response personnel: Emergency response personnel, drilling crew, geotechnical professionals, and environmental or water treatment professionals.

Equipment: Depending on the operating state drill rig, logging equipment, cement or casing and air and water testing equipment.

Response Personnel and Equipment

Site personnel, project personnel, and local authorities will be relied upon to implement this ERRP.

Site personnel to be notified (not listed in order of notification):

1. Project Manager

Ken Haney (661- 763-6101)

2. Field Manager

David Hauptman (661-858-3864)

3. Environmental Manager

Brian Pellens (661-321-6240)

4. Security and Emergency Response Director (24 hour contact)

Bill Blair (562-743-8336)

5. Public and Media Liaison

Joe Ashley (661-301-6551)

A site-specific emergency contact list will be developed and maintained during the life of the project. CTV will provide the current site-specific emergency contact list to the UIC Program Director.

Table 3. Contact information for key local, state, and other authorities.

Agency	Phone Number
Local police	9-1-1 (Emergency) 661-861-3110 (Non-emergency)
California Governor's Office of Emergency Services (Cal OES)	(916) 845-8506
UIC Program Director (EPA Region 9)	David Albright (albright.david@epa.gov)
EPA National Response Center (24 hours)	800-424-8802
Kern County Fire Department	9-1-1 (Emergency) 661-324-6551 (Non-emergency)
California Air Resources Board (CARB)	800-242-4450
Poison Control Center	800-342-9293
California Office of Emergency Services (24 hours)	800-852-7550
State Water Quality Control Board (Central Valley)	916-255-3000
Kern Medical	661-326-2000

Equipment needed in the event of an emergency and remedial response will vary, depending on the triggering emergency event. Response actions (cessation of injection, well shut-in, and evacuation) will generally not require specialized equipment to implement. Where specialized equipment (such as a drilling rig or logging equipment) is required, CTV shall be responsible for its procurement.

Emergency Communications Plan

CTV will communicate to the public about any event that requires an emergency response to ensure that the public understands what happened and whether or not there are any environmental or safety implications. The amount of information, timing, and communications method(s) will be appropriate to the event, its severity, whether any impacts to drinking water or other environmental resources occurred, any impacts to the surrounding community, and their awareness of the event.

CTV will describe what happened, any impacts to the environment or other local resources, how the event was investigated, what responses were taken, and the status of the response. For

responses that occur over the long-term (e.g., ongoing cleanups), CTV will provide periodic updates on the progress of the response action(s).

CTV will also communicate with entities who may need to be informed about or take action in response to the event, including local water systems, CO₂ source(s) and pipeline operators, landowners, and Regional Response Teams (as part of the National Response Team).

Plan Review

This ERRP shall be reviewed:

- At least once every five (5) years following its approval by the permitting agency;
- Within one (1) year of an area of review (AOR) re-evaluation;
- Within 30 days, or other time prescribed by the EPA director, following any significant changes to the injection process or the injection facility, or an emergency event; or
- As required by the permitting agency.

If the review indicates that no amendments to the ERRP are necessary, CTV will provide the permitting agency with the documentation supporting the “no amendment necessary” determination.

If the review indicates that amendments to the ERRP are necessary, amendments shall be made and submitted to the permitting agency within three months following an event that initiates the ERRP review procedure.

Staff Training and Exercise Procedures

All CTV staff and contractors operating at the CO₂ sequestration facilities, or working in the AoR will be subjected to the following training either prior to deployment in the field or annually:

CO₂ Facilities Training

Onsite and classroom training for facility and infrastructure security, maintenance, and operations.

CO₂ Safety Training

Carbon dioxide detection equipment: Operation and maintenance of personal monitors, portable multi-gas monitors and stationary monitors throughout the facility.

Carbon Dioxide Hazards: Accidental exposure, adverse health effects, workplace exposure limits and first aid.

Emergency Response: Training in the event of CO₂ leakage and exercise and drills simulating potential emergency situations.