CENTER FOR TOXICOLOGY AND ENVIRONMENTAL HEALTH, LLC

CSXT Crude Oil Derailment
Phase III-IV: Staging, Transit, and Clean & Purge

Air Monitoring and Sampling Report

Lynchburg, Virginia

5/9/2014 – 6/11/2014

CTEH® Project Number: 106190

Project Number: R000129324

Contract Number: ENV0000115704

August 2014

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Executive Summary

At 1432 EDT[1] on April 30, 2014, CSXT® Railroad requested the Center for Toxicology and Environmental Health® (CTEH®) provide toxicology and air monitoring support in response to a crude oil train derailment and fire in Lynchburg, VA. Air monitoring activities were specific to the distinct phases of the emergency response, beginning with the initial emergency response phase (Phase I) and continuing through product transfer (Phase II), tank car staging operations (Phase III), and tank car clean-and-purge phases (Phase IV). Members of the CTEH® Toxicology Emergency Response Program (TERP®) provided air monitoring support throughout the duration of each phase of the incident. Phase III included tank car staging in Lynchburg Rail Yard and subsequent relocation to Gladstone Rail Yard for remediation activities. Phase IV consisted primarily of tank car clean-and-purge operations and transfer operations for one tank car. Throughout the duration of Phases III and IV, CTEH® conducted air monitoring to evaluate the potential presence of airborne crude oil constituents using real-time air monitoring equipment. The constituents monitored included benzene, n-hexane, hydrogen sulfide (H_2S), lower explosive limit (LEL), and total volatile organic compounds (VOC).

Phase III and IV air monitoring was conducted in the work area. The work area was further divided into the Lynchburg Rail Yard and the Gladstone Rail Yard during these phases. CTEH® personnel used real-time air monitoring instruments to provide air monitoring coverage in the work areas throughout operations.

During Phase III of the incident, there were no detections of chemicals of interest in the work areas. During Phase IV, there were no detections of benzene, n-hexane, or H_2S in the work areas; VOC detections were recorded above site-specific action levels during clean-and-purge operations and product transfer operations at the Gladstone Rail Yard. VOC detections ranged between 0.1 and 123 ppm for the duration of the transfer operation for one tank car (20 minutes). The LEL detections were instantaneous readings that required no protective action. During this time workers were positioned upwind of the source and therefore not exposed to these concentrations. Based on the results of real-time air monitoring, there were no airborne crude oil constituents present at sustained concentrations that would represent a health concern to workers.

After the 17 tank cars had been cleaned and purged, CTEH® performed air monitoring and vapor accumulation tests of all of the cars. LEL was not detected in any of the cars. CTEH® air monitoring activities ceased at the conclusion of Phase IV on June 11, 2014.

[1] All times are reported in Eastern Daylight Time (EDT).

1.0 Description of the Incident and Response

At approximately 1432 EDT on April 30, 2014, CSXT® requested that the Center for Toxicology and Environmental Health (CTEH®) provide toxicology and air monitoring support in response to a train derailment and fire involving crude oil tank cars in Lynchburg, VA. Preliminary reports indicated that 17 tank cars were involved in the derailment. Three of the tank cars were partially submerged in the James River, and one was on fire. A map of the incident site is provided in **Figure 1.0**. CTEH® provided air monitoring support throughout the duration of each phase of the incident. This report covers air monitoring support provided during Phases III and IV.

Phase III monitoring began with the start of Lynchburg Rail Yard staging operations on May 9, 2014, continued through May 13, 2014, resumed on May 19, 2014, and concluded with the completion of the Gladstone Rail Yard staging operations on May 20, 2014. CTEH® personnel collected real-time air monitoring data from work areas in Lynchburg Rail Yard, near tank cars during transit, and during staging activities in Gladstone Rail Yard. Readings were communicated to CSXT® on-site officials for use in decisions regarding safety and operations control.

Phase IV included clean-and-purge operations of 17 tank cars and limited transfer of crude oil in the Gladstone Rail Yard, the location of all Phase IV activities. Phase IV monitoring began with the start of clean-and-purge operations on June 2, 2014 and continued until the conclusion of the clean-and-purge operations on June 11, 2014. Of the 17 tank cars, one tank car contained approximately 450 gallons of crude oil. This crude oil was transferred out of the tank car on June 9, 2014, and then stored in two 250-gallon totes on June 10, 2014, allowing HEPACO Inc. to clean and purge the tank car. The fluids generated as a result of cleaning and purging, and were captured using a vacuum truck.

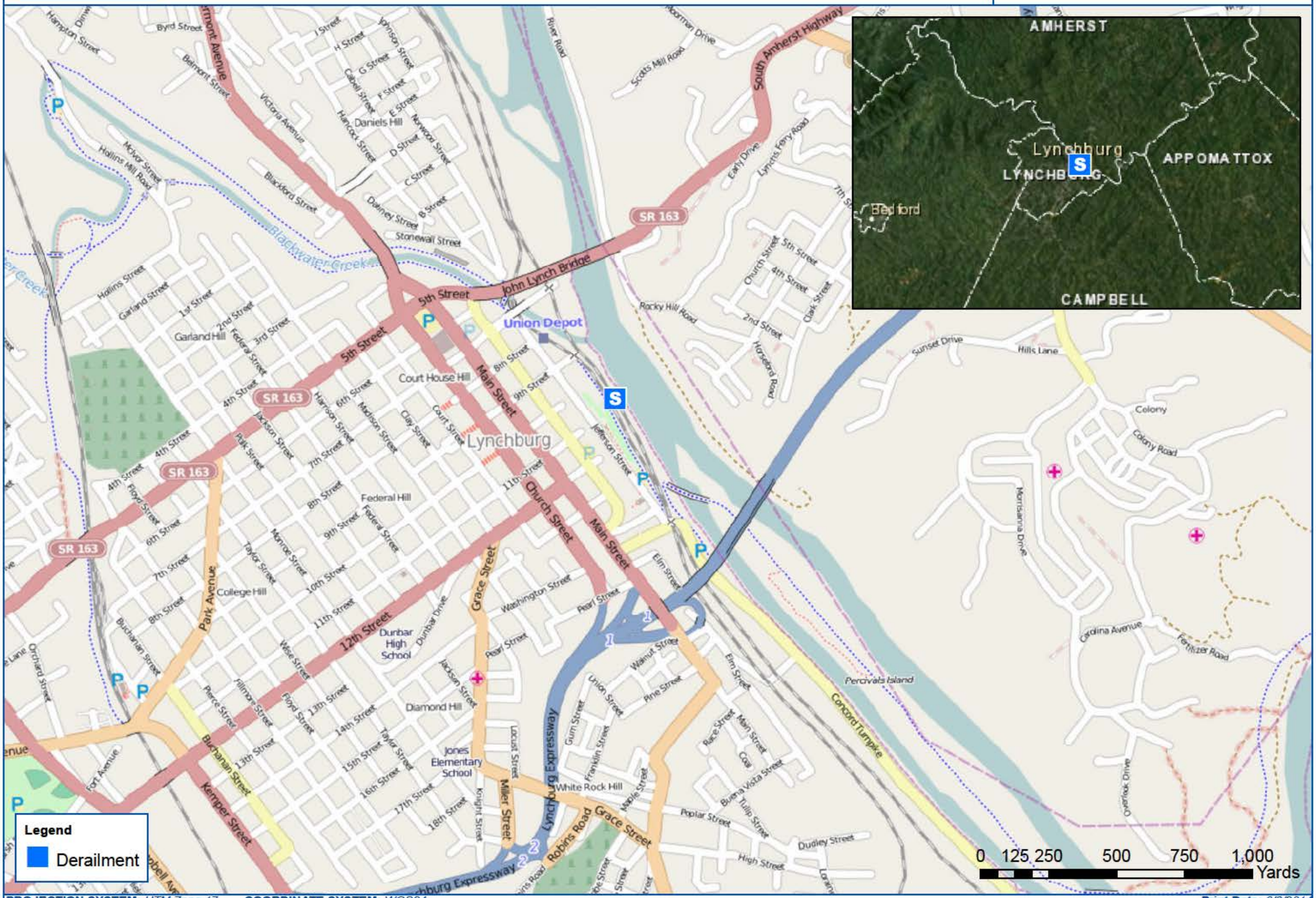
CTEH® personnel collected real-time air monitoring data throughout Phase IV and communicated this data to HEPACO on-site personnel for use in decisions regarding safety and operations control. Real-time air monitoring activities were conducted in and around clean-and-purge activities and near the vacuum truck used for the collection of waste water. Additionally, CTEH® provided confirmatory air monitoring support to HEPACO workers during their confined space entry operations and clean-and-purge assessments. On June 11, 2014, clean-and-purge operations were completed and tank cars were reassessed by CTEH® personnel using real-time air monitoring equipment. After confirming that LEL was not detected in any of the 17 tank cars, CTEH® personnel were demobilized from site on June 11, 2014.

CTEH

Figure 1.1:

Incident Site Location

Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/3/2014*

2.0 Air Monitoring Strategy

A preliminary air Sampling and Analysis Plan (SAP) was developed based on the initial information available regarding the incident. The Phase III and IV SAPs are provided in **Appendix A**. The SAPs include details regarding the real-time monitoring methods and instrumentation.

Air monitoring was conducted throughout Phases III and IV in the established work areas of the Lynchburg Rail Yard in Lynchburg, VA and the Gladstone Rail Yard in Gladstone, VA, respectively. The work areas consisted of the areas within each rail yard where either tank car staging or clean-and-purge operations were occurring. A map of the work area monitoring zones is provided in **Figure 2.1**.

During Phase III of the incident, CTEH® personnel provided real-time air monitoring coverage throughout the duration of staging operations in the Lynchburg Rail Yard and the Gladstone Rail Yard work areas using handheld real-time air monitoring instruments. The chemicals of interest monitored for included benzene, H_2S, LEL, and total volatile organic compounds (VOC).

During Phase IV of the incident, CTEH® personnel provided air monitoring coverage using handheld real-time air monitoring instruments throughout the clean-and-purge operations, which included staging, ventilation, transfers, pre-treatment, and equipment breakdown. The chemicals of interest monitored for included benzene, n-hexane, LEL, and VOC.

In addition to work area monitoring and at the request of CSXT® and HEPACO, CTEH® personnel supported HEPACO workers by providing confirmatory confined space air monitoring to assist in their decision-making process. CTEH® personnel did not enter any confined space on-site, but instead lowered handheld monitoring equipment attached to a rope into the tank cars. CTEH® conducted air monitoring within the tank cars after clean-and-purge operations to detect the presence of residual volatile vapors. It should be noted that the objective of the air monitoring within the tank cars, i.e. to detect the presence of volatile vapors in the cars, was different than the objectives of ambient air monitoring outlined in the SAP.

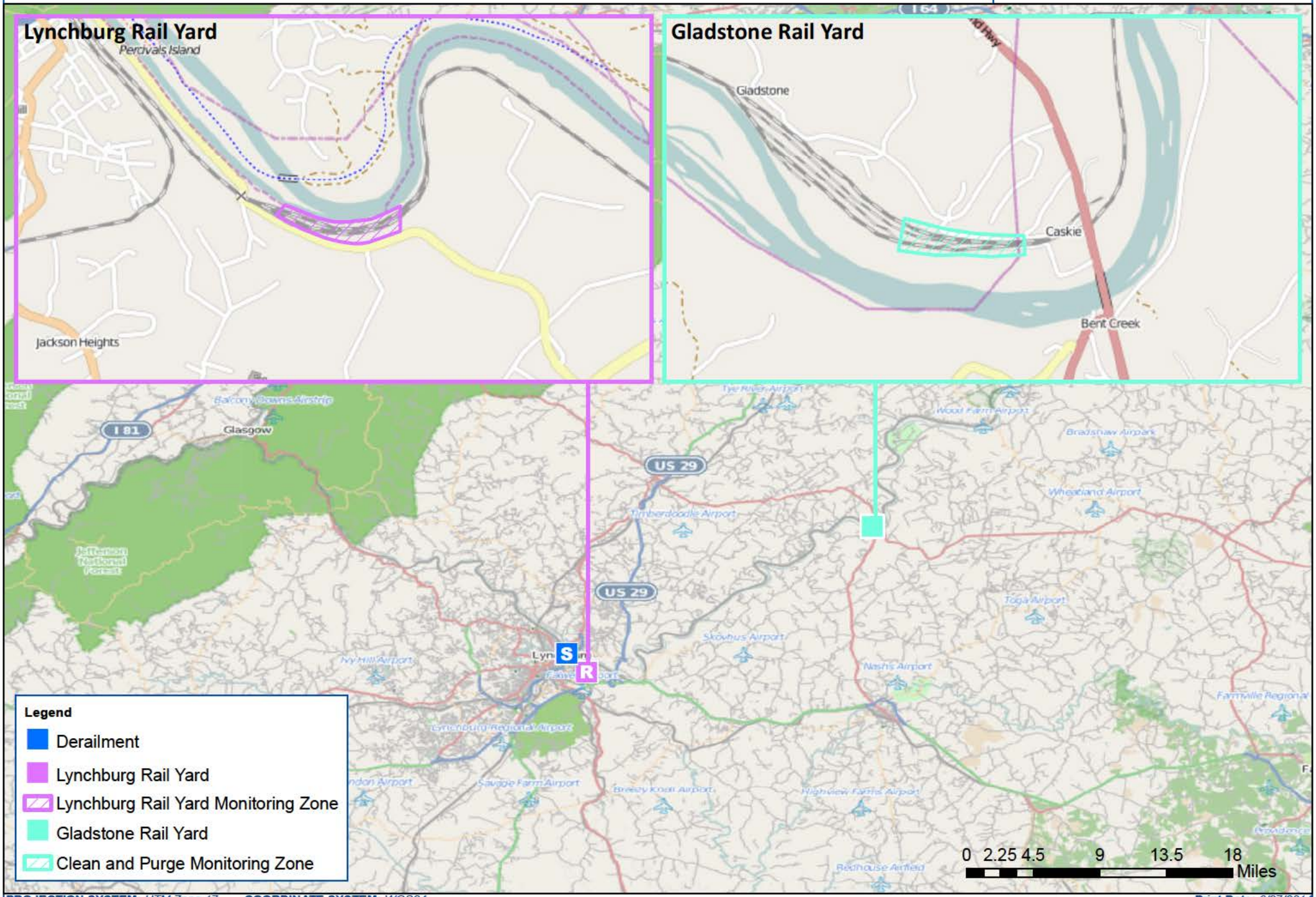
The following sections describe the chemicals of interest for the response, their applicable exposure guidelines, and site-specific actions levels employed.

CTEH

Figure 2.1:

Real-Time Monitoring Sampling Zones

Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* **COORDINATE SYSTEM:** *WGS84* **Print Date:** *6/27/2014*

2.1 Chemicals of Interest

The chemicals of interest during Phase III and IV of the incident response were those determined to have the greatest potential for human health impacts based on the relative air concentrations of volatile organic compounds emitted from fresh crude oil (identified as Bakken sweet crude) and published information regarding health-based worker and community exposure guidelines. These chemicals included chemicals of interest were benzene, toluene, n-hexane, and hydrogen sulfide (H_2S). Additionally, CTEH® personnel monitored for total volatile organic compounds (VOC) and flammability as a measure of the lower explosive limit (LEL). After preliminary toluene monitoring indicated that the presence of toluene did not pose a hazard, monitoring for toluene was discontinued. H_2S was not detected above site-specific action levels in Phases I-III and was therefore not included as a chemical of interest in Phase IV. Further detail regarding chemicals of interest is available in the SAP provided in **Appendix A.** The MSDS for Bakken sweet crude oil is provided in **Appendix E**.

2.1.1 Occupational Exposure Standards/Guidelines for Use during Chemical Release Emergencies

The Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established workplace exposure standards and guidelines, respectively. **Table B.1.1** (Appendix B) summarizes the worker exposure standards and guidelines for the chemicals of interest. These standards and guidelines are intended for chronic worker exposure occurring over a working lifetime and are therefore not directly related to the acute types of exposure likely to occur following an accidental chemical release. However, they do provide a point of reference. A detailed description of occupational and community exposure standards and guidelines is provided in **Appendix B**.

2.1.2 Community Exposure Guidelines for Use during Chemical Release Emergencies

The U.S. Department of Energy's Subcommittee on Consequence Assessment and Protective Actions (SCAPA) has established Protective Action Criteria (PACs) for over 3,300 chemicals for planning and response to uncontrolled releases of hazardous chemicals. These criteria, combined with estimates of exposure, provide the information necessary to evaluate chemical release events for the purpose of taking appropriate protective actions. During an emergency response, these criteria may be used to evaluate the severity of the event and to inform decisions regarding what protective actions should be taken. **Table B.2.1** (Appendix B) provides the PACs for the chemicals of interest during this response.

2.2 CTEH® Site-Specific Action Levels

CTEH® site-specific action levels were employed in all sampling zones to provide information for corrective action to limit exposure. These values do not replace occupational exposure standards or guidelines but are intended to be a concentration limit that triggers a course of action to better address worker and public safety. CTEH® site-specific action levels for the chemicals of interest and flammability in the work area are provided in the SAP (Appendix A).

3.0 Air Monitoring Results

Real-time air monitoring was conducted to provide site management with information regarding the potential for chemical exposures within the work areas as outlined in the SAP. For ease of review, the results from air-monitoring assessments have been grouped according to their location category: Lynchburg Rail Yard and Gladstone Rail Yard. Additional information is provided in the following appendices:

- Appendix C – Cumulative maps of each analyte
- Appendix D – Complete summaries of each location category
- Appendix E – MSDS for Bakken Sweet Crude Oil

3.1 Community Results

Three air monitoring readings (two readings for VOCs, one reading for LEL) were collected using hand-held instruments along the railway as tank cars were in transit between the Lynchburg Rail Yard and the Gladstone Rail Yard on May 19, 2014. These readings were taken outside of the monitoring areas outlined in the SAP. VOCs and LEL were not detected in these community readings.

3.2 Work Area Results

Table 3.2.1 summarizes the readings taken by CTEH® personnel during Phase III using real-time air monitoring equipment in the work area. This includes tank car staging in Lynchburg Rail Yard and in Gladstone Rail Yard following tank car relocation. **Table 3.2.2** summarizes the readings taken by CTEH® personnel during Phase IV of the response. This includes pre-purge and post-purge monitoring of tank cars as requested by and coordinated with the onsite HEPACO lead solely for confirmatory purposes of HEPACO air monitoring. Work area readings represent ambient air conditions, whereas pre-purge and post-purge readings represent conditions inside the tank cars. **Table 3.2.3** summarizes data collected at the request of CSXT® to determine the potential presence of vapors accumulating in the tank cars after sealing them overnight. Eleven of the 17 cars were sealed for at least 28 hours while the remaining six cars were undergoing clean-and-purge operations. These six cars were then sealed for less than 28 hours. **Figure 3.2.1** displays the distribution of real-time readings throughout the Lynchburg Rail Yard staging site. **Figure 3.2.2** demonstrates the distribution of real-time readings throughout the Gladstone Rail Yard work site. Cumulative maps of real-time readings by analyte can be found in **Appendix C**, and complete summaries of each location category can be found in **Appendix D**.

Table 3.2.1 Work Area Phase III Real-Time Summary

PHASE III Activity	Analyte	Total Number of Readings	Total Number of Detections	Concentration Range
Lynchburg Rail Yard	H2S	62	0	< 1 ppm
	LEL	224	0	< 1 %
	VOC	276	0	< 0.1 ppm
Gladstone Tank Car Staging	LEL	26	0	< 1 %
	VOC	34	0	< 0.1 ppm
	Benzene	1	0	< 0.05 ppm
	H2S	8	0	< 1 ppm
Total # of readings	All	631	0	NA

Table 3.2.2 Work Area and Tank Monitoring Phase IV Real-Time Summary

PHASE IV Activity	Analyte	Total Number of Readings	Total Number of Detections	Concentration Range
Work Area Monitoring	LEL	433	2	3 - 4 %
	VOC	450	47	0.1 - 123 ppm
	Benzene	7	0	< 0.05 ppm
	n-Hexane	3	1	4 ppm
Pre-Purge Monitoring*	LEL	6	4	4 - 100 %
	VOC	2	2	125 - 846 ppm
Post-Purge Monitoring*	LEL	16	0	< 1 %
	VOC	16	14	2 - 86 ppm
Total # of readings	All	933	70	NA

*Not outlined in the SAP

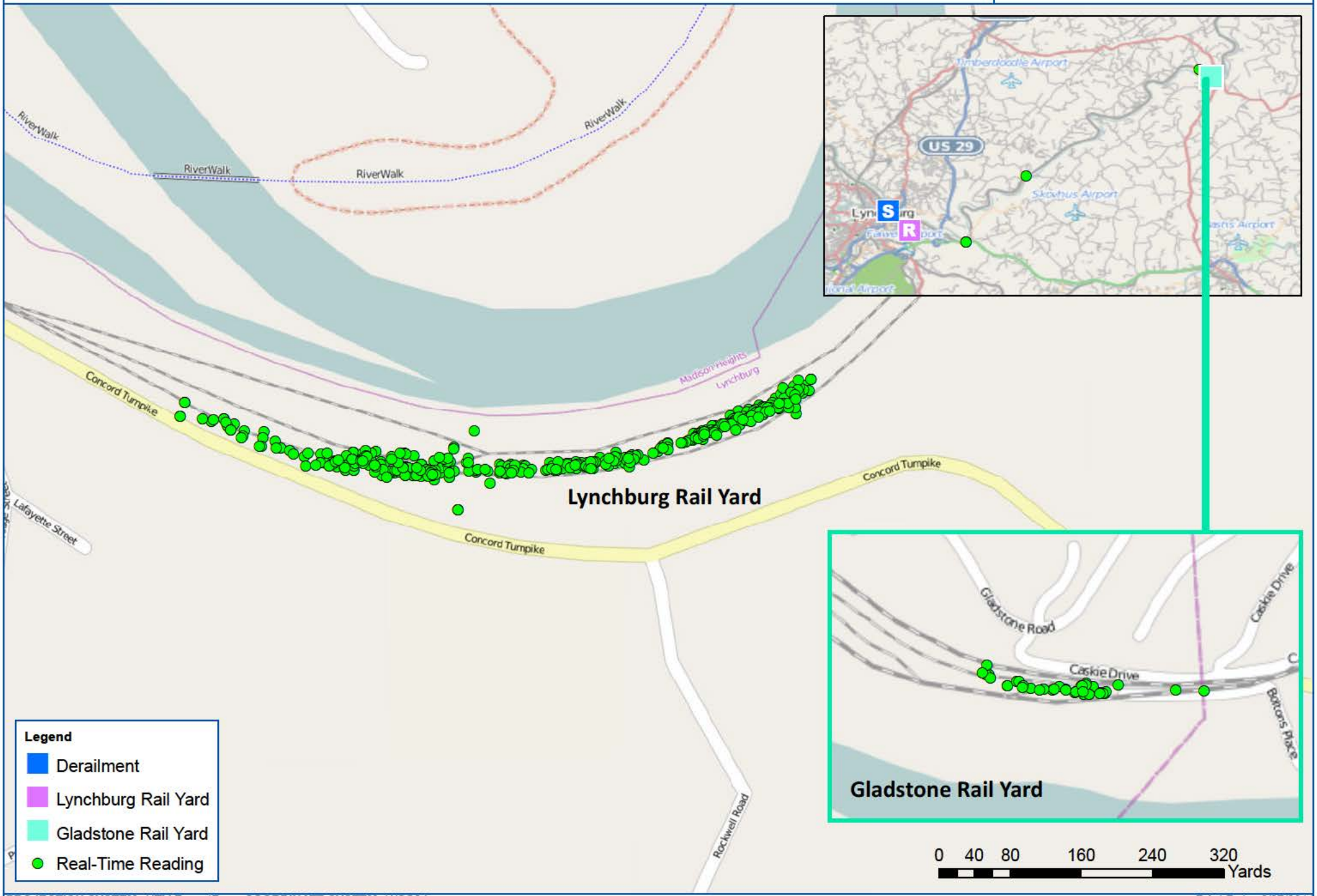
Table 3.2.3 Specific Task – Vapor Accumulation Test Real-Time Summary*

Duration Tank Car was Sealed	Analyte	Total Number of Readings	Total Number of Detections	Concentration Range
< 28 hours	LEL	6	0	< 1 %
	VOC	6	6	3.4 - 194 ppm
> 28 hours	LEL	11	0	< 1 %
	VOC	11	11	4.7 - 144 ppm
Total # of readings	All	34	17	NA

*Specific Task plan is not included in the SAP

Figure 3.2.1:
Phase III Real-Time Monitoring Locations

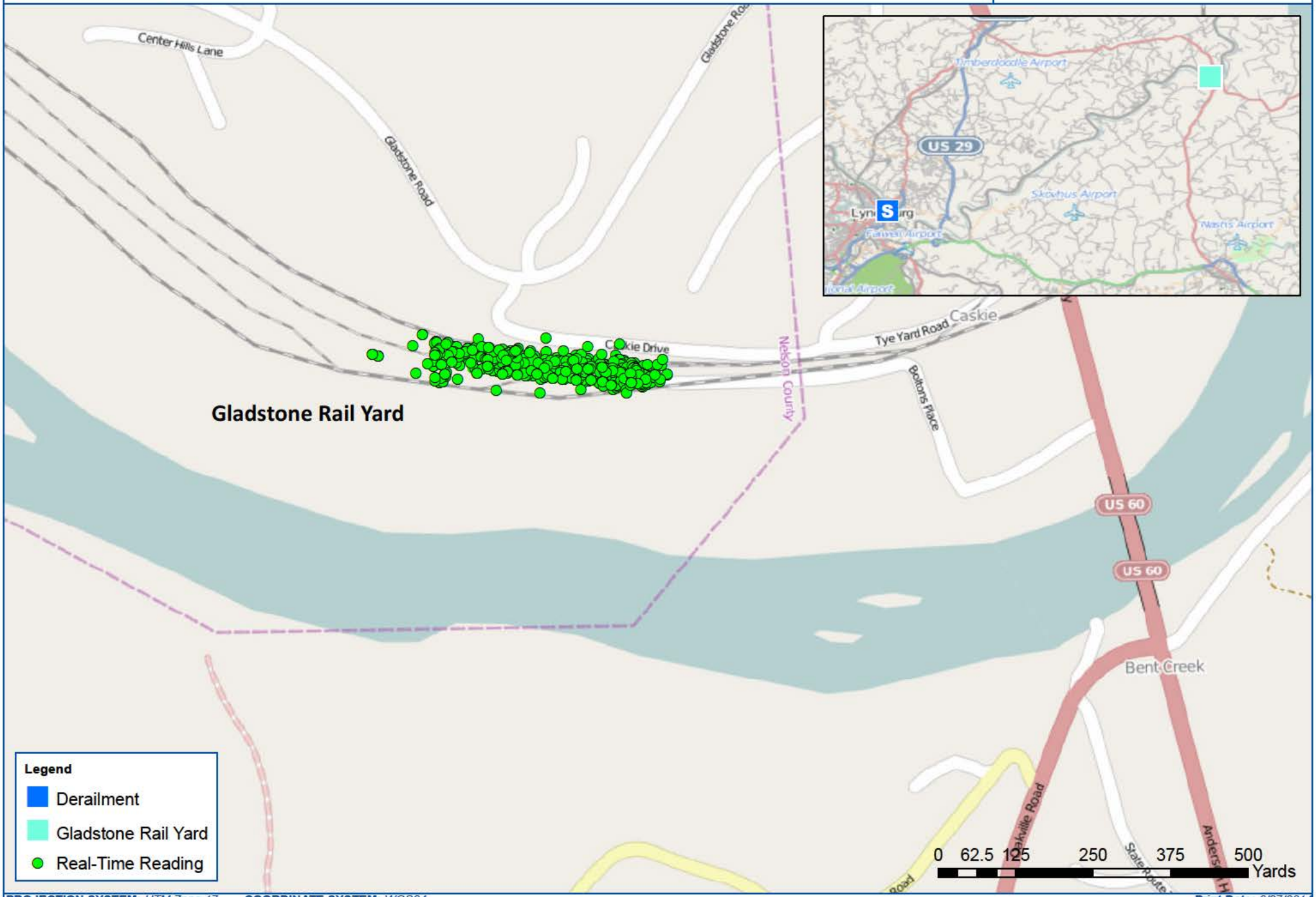
Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/27/2014*

Figure 3.2.2:
Phase IV Real-Time Monitoring Locations

Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/27/2014*

4.0 Discussion

CTEH® provided real-time air monitoring for CSXT® during Phases III and IV of the Lynchburg crude oil derailment. Phase III air monitoring was conducted from May 9 to May 13, 2014 and from May 19 to May 20, 2014. Phase IV air monitoring was conducted from June 2 to June 11, 2014.

CTEH® personnel recorded a total of three real-time readings in the community between Lynchburg Rail Yard and Gladstone Rail Yard during the relocation of tank cars. No detections of VOC or LEL were observed.

CTEH® personnel recorded over 600 real-time readings in the work areas during Phase III of the incident and observed no detections for any chemicals of interest throughout. Over 500 real-time readings were recorded in the Lynchburg Rail Yard during tank car staging from May 9, 2014, to May 13, 2014. CTEH® personnel recorded over 60 real-time readings during tank car staging after the 17 tank cars had been relocated to Gladstone Rail Yard on May 19, 2014.

CTEH® personnel recorded over 900 real-time readings during Phase IV of the incident, nearly 900 of which were representative of ambient air quality in the work areas. Forty readings were recorded to assess vapor concentrations in the tank cars before and after purging operations at the request of HEPACO to support on-site supervisors in their decisions regarding safety and operations control. Elevated concentrations of VOC and LEL were detected in the tank cars during these assessments, especially prior to purging operations; however, these readings are not representative of the air quality in the surrounding work area. No concentrations of benzene were detected in the work areas during Phase IV.

On June 10, 2014, two detections of VOC (93.9 and 123 ppm) and two detections of LEL (3 and 4%) occurred during product transfer operations in which concentrations were above site-specific action levels. Workers were transferring crude oil from a vacuum truck into two 250-gallon totes in a field south of the rail yard. VOC detections were sustained at 30 ppm approximately 2-3 meters downwind of the operation for the duration of the transfer (20 minutes). VOC and LEL detections peaked at 123 ppm and 4%, respectively, but neither were sustained at these concentrations. After these elevated detections were observed, HEPACO workers were instructed to remain upwind of the totes. No further concentrations of VOCs or LEL were detected following the completion of transfer operations. The highest of these VOC detections was still well below the ACGIH TLV-STEL value of 500 ppm and the PAC-1 value of 200 ppm for gasoline.

On June 5, 2014, an instantaneous VOC detection of 97 ppm and an n-hexane detection of 4 ppm were recorded directly above a tank car man-way opening. As these reading were not representative of breathing zone of any workers present, no additional action was taken to halt work operations or to

reassess safety measures. Each of these detections was still well below the ACGIH TLV-TWA and PAC-1 values for each.

At HEPACO's request, CTEH® personnel recorded eight real-time readings, classified as pre-purge monitoring. For this specific task, CTEH® real-time air monitoring equipment was lowered into the tank cars through the man-ways to a depth of about three feet above the base of the tank car. These readings served solely as confirmatory readings for HEPACO air monitoring equipment and were not representative of the ambient air quality in the work area. Of these eight readings, there were four LEL detections ranging from 4% to 100%, and two VOC detections ranging from 125 to 846 ppm. HEPACO reassessed their work plans based on the results of these LEL and VOC readings.

On June 10, 2014, post-purge tank car monitoring was conducted on 16 of the 17 tank cars (one car had yet to be cleaned and purged by this time) at the request of CSXT®. The readings collected during this specific task monitoring were not representative of ambient air quality in the work areas. No concentrations of LEL were detected in any of the tank cars. Concentrations of VOC were detected in all but two of the tank cars, ranging from 4.6 to 70 ppm. On June 11, 2014, CTEH® personnel inspected each tank car for any accumulation of vapors using real-time air monitoring equipment. Eleven of the 17 tank cars had been sealed for at least 28 hours while the remaining six cars had been sealed for less than 28 hours as they were undergoing clean-and-purge operations. No concentrations of LEL were detected in any of the tank cars, while VOC detections ranged from 2 to 194 ppm. These readings were promptly communicated to a CSXT® safety manager. The tank cars were subsequently sealed for storage until further action would be taken.

VOCs associated with crude oil were not detected in the community during Phase III operations. The results of real-time ambient air monitoring in the work areas during Phase III and IV indicate that concentrations of airborne crude oil constituents were sufficiently low and of short duration and that they did not represent a health concern to workers. Based on these results, it is unlikely that site workers or members of the community surrounding railroad operations were exposed to airborne concentrations of crude oil constituents that would produce adverse health effects during Phase III and IV of the Lynchburg crude oil derailment.

5.0 References

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USEPA. Acute Exposure Guideline Levels: AEGL Chemicals. Washington, DC: U.S. Environmental Protection Agency; 2011. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm

USEPA. Air Quality Index Reporting: Final Rule. Federal Register. 1999 Aug 4; 64(149):42530-42549.

Appendix A

Sampling and Analysis Plan

Incident:	**Lynchburg, VA Crude Oil Incident**
Location:	**Lynchburg Rail Yard- Lynchburg, VA**
Client:	**CSX**
Version History:	**1.0**

CTEH® Project-Specific Action Levels

CTEH® project-specific action levels may be employed in all sampling zones to provide information for corrective action to limit exposure. These values do not replace occupational or community exposure standards or guidelines but are intended to be a concentration limit that triggers a course of action to better address worker and public safety. The following chemicals were determined to have the greatest potential for human health impacts based on the relative levels in air of volatile organics emitted from fresh crude oil, together with published information regarding health-based worker and community exposure guidelines.

Plan/Assignment: **Lynchburg Rail Yard Staging Area – PHASE III**
Objective: Report air levels before they reach those requiring respiratory protection or other precautionary actions

Analyte	Plan	Action Level	Basis	Action to be Taken
Total VOCs	Work Area	30 ppm	1/10 ACGIH TLV for gasoline – Based on similar concentrating of n-Hexane in automotive gasoline	Report reading to site management, evaluate work practices. If VOC detected, conduct further evaluation.
Benzene	Work Area	0.5 – 2.5 ppm	OSHA PEL Action level – Readings sustained for 15 minutes (STEL is 5 ppm)	Evacuate area or don air purifying respirator; report reading to site management.
Toluene	Work Area	20 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to site management, evaluate work practices.
Hexane	Work Area	50 ppm	ACGIH® TLV (n-hexane) – Reading sustained for 15 minutes	Report reading to site management, evaluate work practices.
Hydrogen Sulfide	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate area, report reading to site management.

Plan: **All – FLAMMABILITY**
Objective: Report areas where flammability is most likely

Analyte	Instrument Reading	Corrected Value	Correction Factor	Basis	Action to be Taken
LEL	1 %	2.5 %	2.5 for crude oil LEL*	1% LEL	Egress and notify site management
VOCs	NA	NA	NA For crude oil PID	1% LEL as VOC	Egress and notify site management

*Rough estimate based on common crude oil volatiles

Methods

Real-Time Methods					
Chemical	Instrument	Detection Limit*	Tube#/Lamp	Notes	Correction Factor
VOC	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 0 – 5,000	NA
Benzene	UltraRAE	0.05 ppm	PID 9.8 eV lamp	Change SEP tube frequently (Ben. Cal Gas)	NA
	MultiRAE	0.05 ppm	PID 10.6 eV lamp	Measuring range: 0 – 2,650	0.53
	Colorimetric	0.05 ppm	Gastec tube #121L	Range: 0.1 to 10 Volume: 500 ml	1
Toluene	MultiRAE	0.05 ppm	PID 10.6 eV lamp	Measuring range: 0 – 2,500	0.5
	Colorimetric	0.5 ppm	Gastec tube #122L	Range: 2 to 50 Volume: 200 ml	1
Hexane	MultiRAE	0.43 ppm	PID 10.6 eV lamp	Measuring range: 0 – 21,500	4.3
	Colorimetric	1 ppm	Gastec tube #102L	Range: 4 to 50 Volume: 500 ml	1/12
Hydrogen Sulfide	MultiRAE	1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	MultiRAE	0.33 ppm	PID 10.6 eV lamp	Measuring range: 0 – 330 ppm	3.3
	MultiRAE Pro	0.1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	Colorimetric	0.1 ppm	Gastec tube #4LL	Range:0.25 to 2.5 Volume: 1,000 ml	1/10
LEL	MultiRAE	2.5 %	Sensor	Measuring range: 0 – 100%	2.5

*For electronic instruments the detection limit and range is listed as the resolution adjusted by the correction factor.

General Information on Procedures (Assessment Techniques) Used

Procedure	Description
Hand-held Survey	CTEH staff members may utilize handheld instruments (e.g. MultiRAE Plus; ppbRAE, Gastec colorimetric detector tubes, etc.) to measure airborne chemical concentrations. CTEH will use these hand-held instruments primarily to measure the breathing zone. Additionally, measurements can be made at grade level, as well as in elevated workspaces, as indicated by chemical properties or site conditions.
Analytical sampling	Analytical sampling may be used to validate the hand-held data monitoring data, or to provide data beyond the scope of the real-time instruments. Analytical samples may be collected as whole air samples in evacuated canisters or on specific collection media, and sent to an off-site laboratory for further chemical analysis.

Sampling Areas

Sampling Area	Description
Lynchburg Yard Staging Area	The general area around the area where contents of the affected tank cars will be transferred.
Other	During the course of the staging operations, some additional areas or specific tasks may require a unique set of action levels or sampling (e.g. decontamination zones, commercial zones, etc.)

Quality Assurance/Quality Control Procedures

Method	Procedure
Real-time	• Real time instruments may be calibrated in excess of the manufacturer's recommendations. o At a minimum whenever indicated by site conditions or instrument readings. • Co-located sampling for analytical analysis may be conducted, if necessary, to assess accuracy and precision in the field. • Lot numbers and expiration dates may be recorded with use of Gastec colorimetric tubes.
Analytical	• Chain of custody documents may be completed for each sample. • Level II data validation may be performed on 20% of all samples. • Level IV data validation may be performed on 10% of all samples.
Other	

Change from version 1.0 to 1.1
• *In the section titled:*

	Name/Position	Signature	Date Signed
Prepared By:	David Cawthon/Project Toxicologist	[redacted]	5/15/14

Incident:	**Lynchburg, VA Crude Oil Incident**
Location:	**Gladstone Rail Yard- Gladstone, VA**
Client:	**CSX**
Version History:	**1.0**

CTEH® Project-Specific Action Levels

CTEH® project-specific action levels may be employed in all sampling zones to provide information for corrective action to limit exposure. These values do not replace occupational or community exposure standards or guidelines but are intended to be a concentration limit that triggers a course of action to better address worker and public safety. The following chemicals were determined to have the greatest potential for human health impacts based on the relative levels in air of volatile organics emitted from fresh crude oil, together with published information regarding health-based worker and community exposure guidelines.

Plan/Assignment: **Clean &Purge Operations – PHASE IV**
Objective: Report air levels before they reach those requiring respiratory protection or other precautionary actions

Analyte	Plan	Action Level	Basis	Action to be Taken
Total VOCs	Work Area	30 ppm	1/10 ACGIH TLV for gasoline – Based on similar concentrating of n-Hexane in automotive gasoline	Report reading to site management, evaluate work practices. If VOC detected, conduct further evaluation.
Benzene	Work Area	0.5 – 2.5 ppm	OSHA PEL Action level – Readings sustained for 15 minutes (STEL is 5 ppm)	Evacuate area or don air purifying respirator; report reading to site management.
Toluene	Work Area	20 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Report reading to site management, evaluate work practices.
Hexane	Work Area	50 ppm	ACGIH® TLV (n-hexane) – Reading sustained for 15 minutes	Report reading to site management, evaluate work practices.
Hydrogen Sulfide	Work Area	1 ppm	ACGIH® TLV – Reading sustained for 15 minutes	Evacuate area, report reading to site management.

Plan: **All – FLAMMABILITY**
Objective: Report areas where flammability is most likely

Analyte	Instrument Reading	Corrected Value	Correction Factor	Basis	Action to be Taken
LEL	1 %	2.5 %	2.5 for crude oil LEL*	1% LEL	Egress and notify site management
VOCs	NA	NA	NA For crude oil PID	1% LEL as VOC	Egress and notify site management

*Rough estimate based on common crude oil volatiles

Methods

Real-Time Methods					
Chemical	Instrument	Detection Limit*	Tube#/Lamp	Notes	Correction Factor
VOC	MultiRAE	0.1 ppm	PID 10.6 eV lamp	Measuring range: 0 – 5,000	NA
Benzene	UltraRAE	0.05 ppm	PID 9.8 eV lamp	Change SEP tube frequently (Ben. Cal Gas)	NA
	MultiRAE	0.05 ppm	PID 10.6 eV lamp	Measuring range: 0 – 2,650	0.53
	Colorimetric	0.05 ppm	Gastec tube #121L	Range: 0.1 to 10 Volume: 500 ml	1
Toluene	MultiRAE	0.05 ppm	PID 10.6 eV lamp	Measuring range: 0 – 2,500	0.5
	Colorimetric	0.5 ppm	Gastec tube #122L	Range: 2 to 50 Volume: 200 ml	1
Hexane	MultiRAE	0.43 ppm	PID 10.6 eV lamp	Measuring range: 0 – 21,500	4.3
	Colorimetric	1 ppm	Gastec tube #102L	Range: 4 to 50 Volume: 500 ml	1/12
Hydrogen Sulfide	MultiRAE	1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	MultiRAE	0.33 ppm	PID 10.6 eV lamp	Measuring range: 0 – 330 ppm	3.3
	MultiRAE Pro	0.1 ppm	Sensor	Measuring range: 0 – 100 ppm	
	Colorimetric	0.1 ppm	Gastec tube #4LL	Range:0.25 to 2.5 Volume: 1,000 ml	1/10
LEL	MultiRAE	2.5 %	Sensor	Measuring range: 0 – 100%	2.5

*For electronic instruments the detection limit and range is listed as the resolution adjusted by the correction factor.

General Information on Procedures (Assessment Techniques) Used

Procedure	Description
Hand-held Survey	CTEH staff members may utilize handheld instruments (e.g. MultiRAE Plus; ppbRAE, Gastec colorimetric detector tubes, etc.) to measure airborne chemical concentrations. CTEH will use these hand-held instruments primarily to measure the breathing zone. Additionally, measurements can be made at grade level, as well as in elevated workspaces, as indicated by chemical properties or site conditions.
Analytical sampling	Analytical sampling may be used to validate the hand-held data monitoring data, or to provide data beyond the scope of the real-time instruments. Analytical samples may be collected as whole air samples in evacuated canisters or on specific collection media, and sent to an off-site laboratory for further chemical analysis.

Sampling Areas

Sampling Area	Description
Clean & Purge Operation	The general area around the area where contents of the affected tank cars will be transferred.
Other	During the course of the staging operations, some additional areas or specific tasks may require a unique set of action levels or sampling (e.g. decontamination zones, commercial zones, etc.)

Quality Assurance/Quality Control Procedures

Method	Procedure
Real-time	• Real time instruments may be calibrated in excess of the manufacturer's recommendations. o At a minimum whenever indicated by site conditions or instrument readings. • Co-located sampling for analytical analysis may be conducted, if necessary, to assess accuracy and precision in the field. • Lot numbers and expiration dates may be recorded with use of Gastec colorimetric tubes.
Analytical	• Chain of custody documents may be completed for each sample. • Level II data validation may be performed on 20% of all samples. • Level IV data validation may be performed on 10% of all samples.
Other	

Change from version 1.0 to 1.1
• *In the section titled:*

	Name/Position	Signature	Date Signed
Prepared By:	David Cawthon/Project Toxicologist	[redacted]	5/15/14

Appendix B

Exposure Guidelines and Standards

B. Exposure Guidelines and Standards

Various government agencies and professional organizations have developed exposure guidelines specific for the chemicals of interest in the workplace and for the general public. These are health-protective values developed to protect workers and the general public from overexposures.

B.1 Occupational Exposure Standards/Guidelines

The Occupational Safety and Health Administration (OSHA) and The American Conference of Governmental Industrial Hygienists (ACGIH) have established workplace exposure standards and guidelines, respectively. **Table B.1.1** summarizes the worker exposure standards and guidelines for the chemicals of interest.

Table B.1.1 Occupational Exposure Standards and Guidelines

Analyte	ACGIH		OSHA	
	TLV-TWA[a]	TLV-STEL[b]	PEL-TWA[c]	PEL-C[d]
Total VOC (as gasoline)	300 ppm	500 ppm	NE	NE
Benzene	0.5 ppm	2.5 ppm	1 ppm	5 ppm
Toluene	20 ppm	NE	200 ppm	300, 500** ppm
n-Hexane	50 ppm	NE	500 ppm	NE
Hydrogen Sulfide	1 ppm	5 ppm	NE	20, 50** ppm

NE = Not Established

a. ACGIH TLV-TWA = Threshold Limit Value – Time Weighted Average (TLV-TWA). The TWA concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may repeatedly be exposed, day after day, without adverse effect (ACGIH, 2014b).

b. ACGIH TLV-STEL = Threshold Limit Value – Short Term Exposure Limit (TLV-STL). A 15 minute TWA exposure that should not be exceeded at any time during a workday, even if the 8-hour TWA is within the TLV-TWA. The TLV-STEL is the concentration to which it is believed that workers can be exposed continuously for a short period of time without suffering from 1) irritation, 2) chronic or irreversible tissue damage, 3) dose-rate dependent toxic effects, or 4) narcosis of sufficient degree to increase the likelihood of accidental injury, impaired self-rescue, or materially reduced work efficiency. Exposures above the TLV-TWA up to the TLV-STEL should be less than 15 minutes, should not occur more than 4 times per day, and there should be at least 60 minutes between successive exposures in this range (ACGIH, 2014b).

c. OSHA PEL-TWA = Permissible Exposure Limit – Time Weighted Average (PEL-TWA). Permissible concentration in the air of a substance that shall not be exceeded in any 8-hour work shift of a 40-hour work week (OSHA 29 CFR: 1910.1000).

d. OSHA PEL-C = Permissible Exposure Limit – Ceiling (PEL-C). The exposure limit that shall at no time be exceeded. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure, which shall not be exceeded at any time during the working day (OSHA 29 CFR: 1910.1000).

B.2 Community Exposure Guidelines for Use during Chemical Release Emergencies

The U.S. Department of Energy's Subcommittee on Consequence Assessment and Protective Actions (SCAPA) has established Protective Action Criteria (PACs) for over 3,300 chemicals for planning and response to uncontrolled releases of hazardous chemicals. These criteria, combined with estimates of exposure, provide the information necessary to evaluate chemical release events for the purpose of taking appropriate protective actions. During an emergency response, these criteria may be used to evaluate the severity of the event and to inform decisions regarding what protective actions should be taken.

PAC values are based on the following exposure limit values:

- Acute Exposure Guideline Level (AEGL) values published by the U.S. Environmental Protection Agency (EPA)
- Emergency Response Planning Guideline (ERPG) values provided by the American Industrial Hygiene Association (AIHA)
- Temporary Emergency Exposure Limit (TEEL) values developed by SCAPA

For any particular chemical, the following hierarchy is used to establish its PAC:

- Use AEGLs (including final or interim values) if they are available.
- If AEGLs are not available, use ERPGs.
- If neither AEGLs or ERPGs are available, use TEELs.

AEGLs, ERPGs, and TEELs have three common benchmark values for each chemical. Each successive benchmark is associated with an increased severity of potential effect(s) associated with exposure to the specified level. The three benchmarks present estimated threshold levels for:

- Mild, transient health effects.
- Irreversible or other serious health effects that could impair the ability to take protective action.
- Life-threatening health effects.

Table B.2.1 provides the PACs for the chemicals of interest during this response.

Table B.2.1 Protective Action Criteria*

Chemical	PAC-1	PAC-2	PAC-3
Total VOC (as gasoline)	200 ppm	1,000 ppm	4,000 ppm
Benzene	52 ppm	800 ppm	4,000 ppm
Toluene	200 ppm	1,200 ppm	4,500 ppm
n-Hexane	300** ppm	3,300 ppm	8,600 ppm
Hydrogen Sulfide	0.51 ppm	27 ppm	50 ppm

*PAC values correspond to 60-minute AEGL values.

**Due to insufficient and animal data addressing the level of effects defined by AEGL-1, no AEGL-1 values are recommended for n-hexane. Alternatively, n-hexane PAC-1 is derived from the TEEL values.

a. PAC-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure (DOE/SCAPA, 2012).

b. PAC-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, longlasting, adverse health effects or an impaired ability to escape (DOE/SCAPA, 2012).

c. PAC-3 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening adverse health effects or death (DOE/SCAPA, 2012).

Appendix C

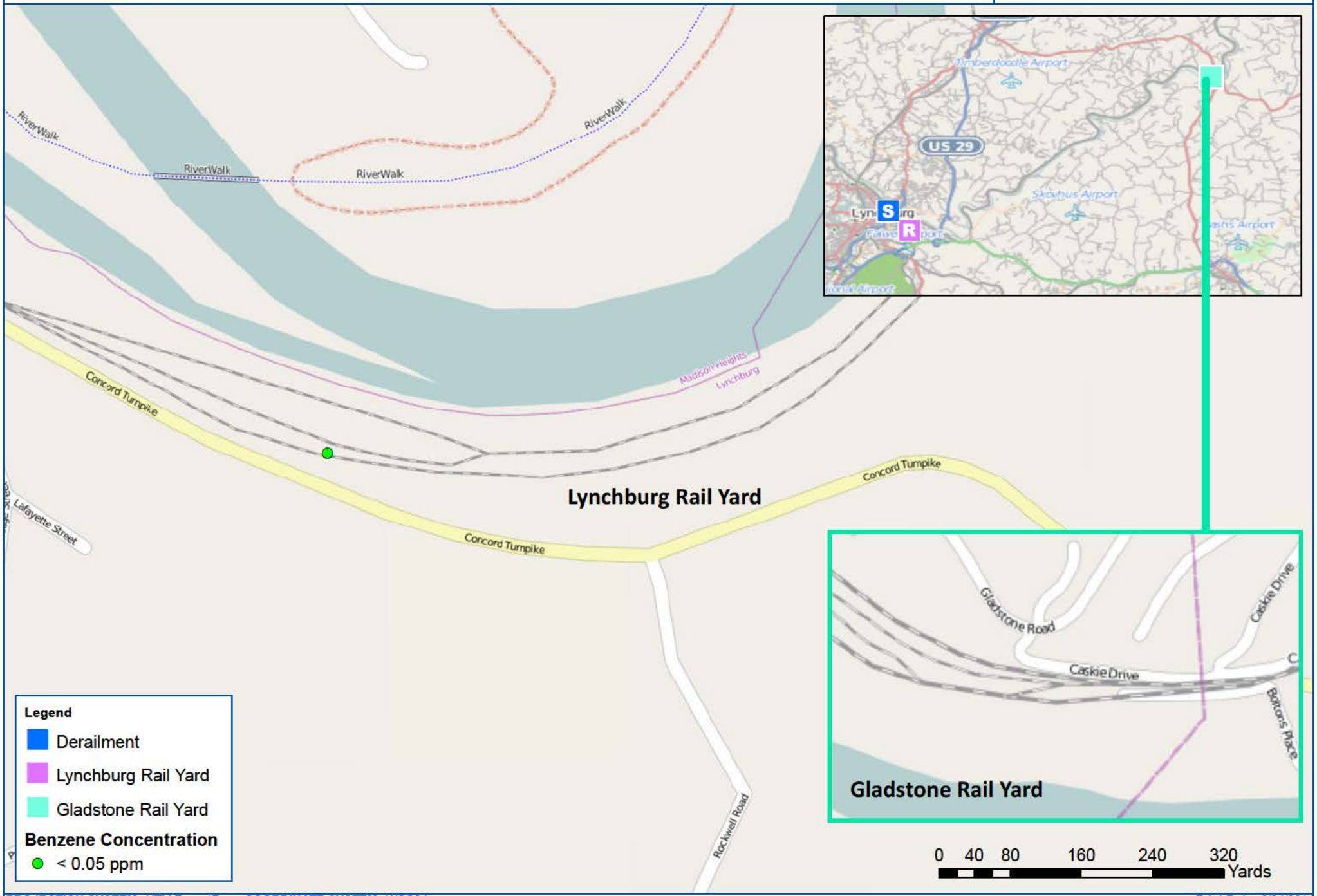
Cumulative Maps of Real-Time Data Locations by Analyte

Phase III

Lynchburg, VA Derailment

Benzene Real-Time Monitoring Locations between May 09, 2014 00:00 and May 20, 2014 12:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

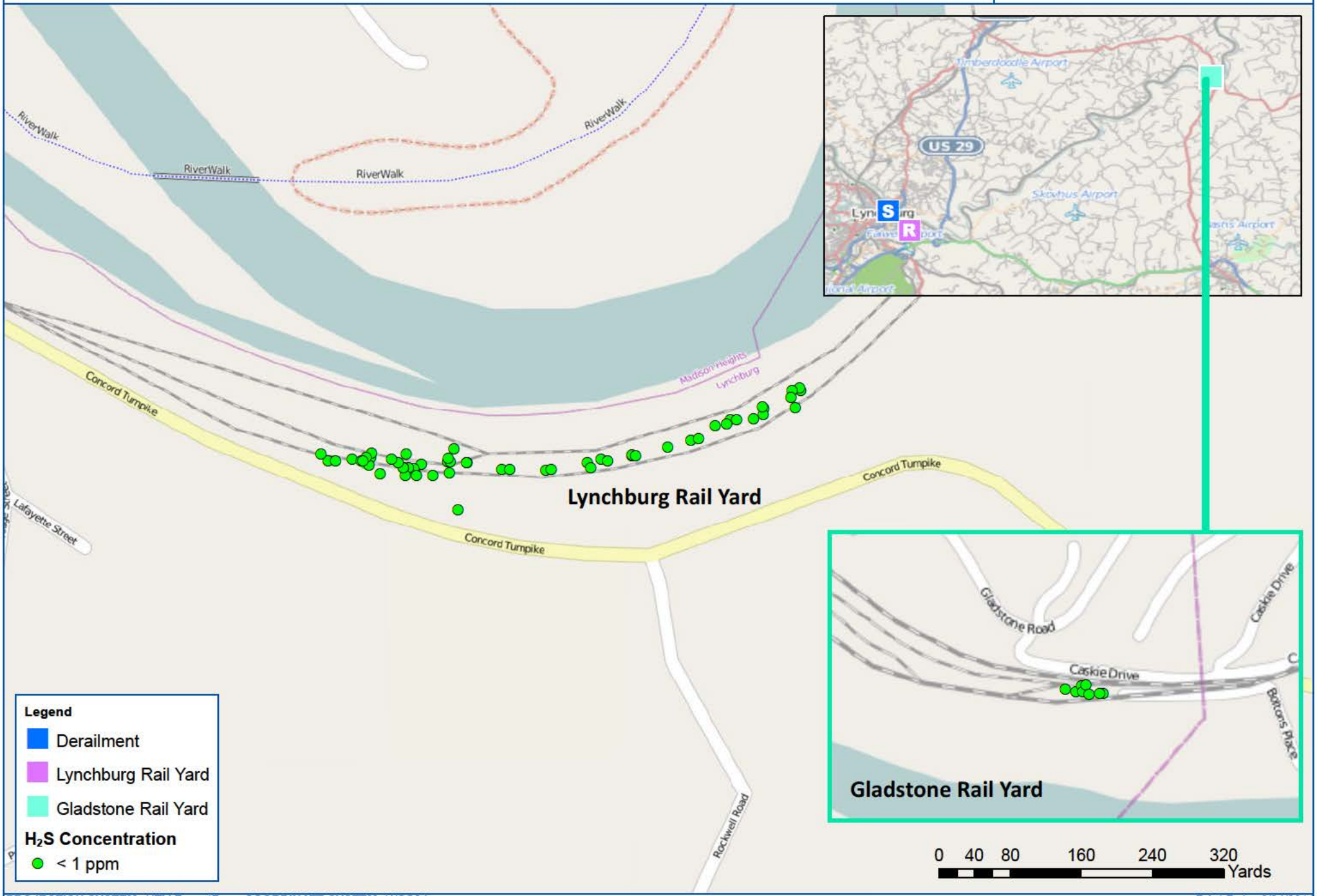


PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/24/2014*

Lynchburg, VA Derailment

H_2S Real-Time Monitoring Locations between May 09, 2014 00:00 and May 20, 2014 12:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

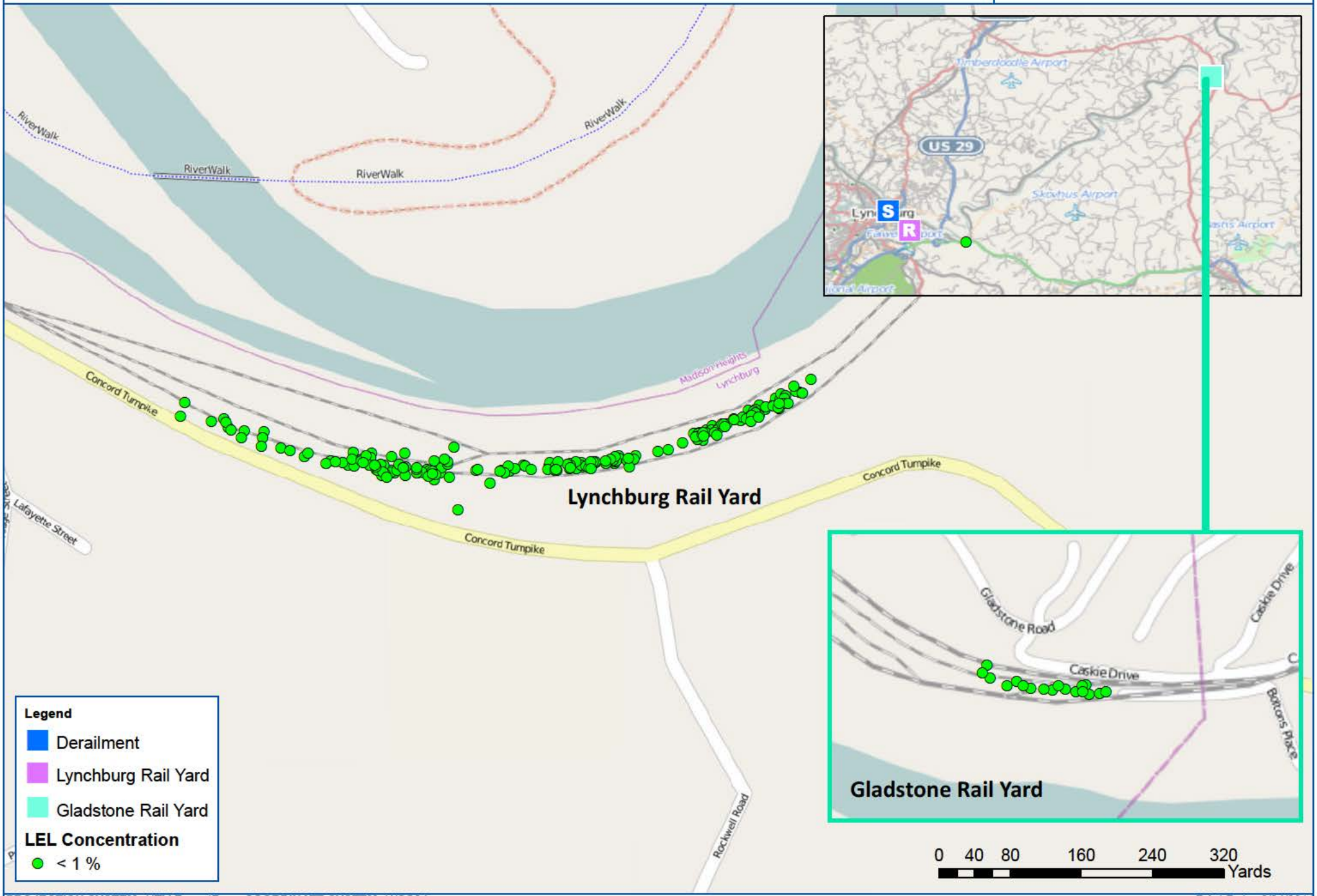


PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/24/2014*

Lynchburg, VA Derailment

LEL Real-Time Monitoring Locations between May 09, 2014 00:00 and May 20, 2014 12:00

Project: 106190
Client: CSXT
City: Lynchburg, VA



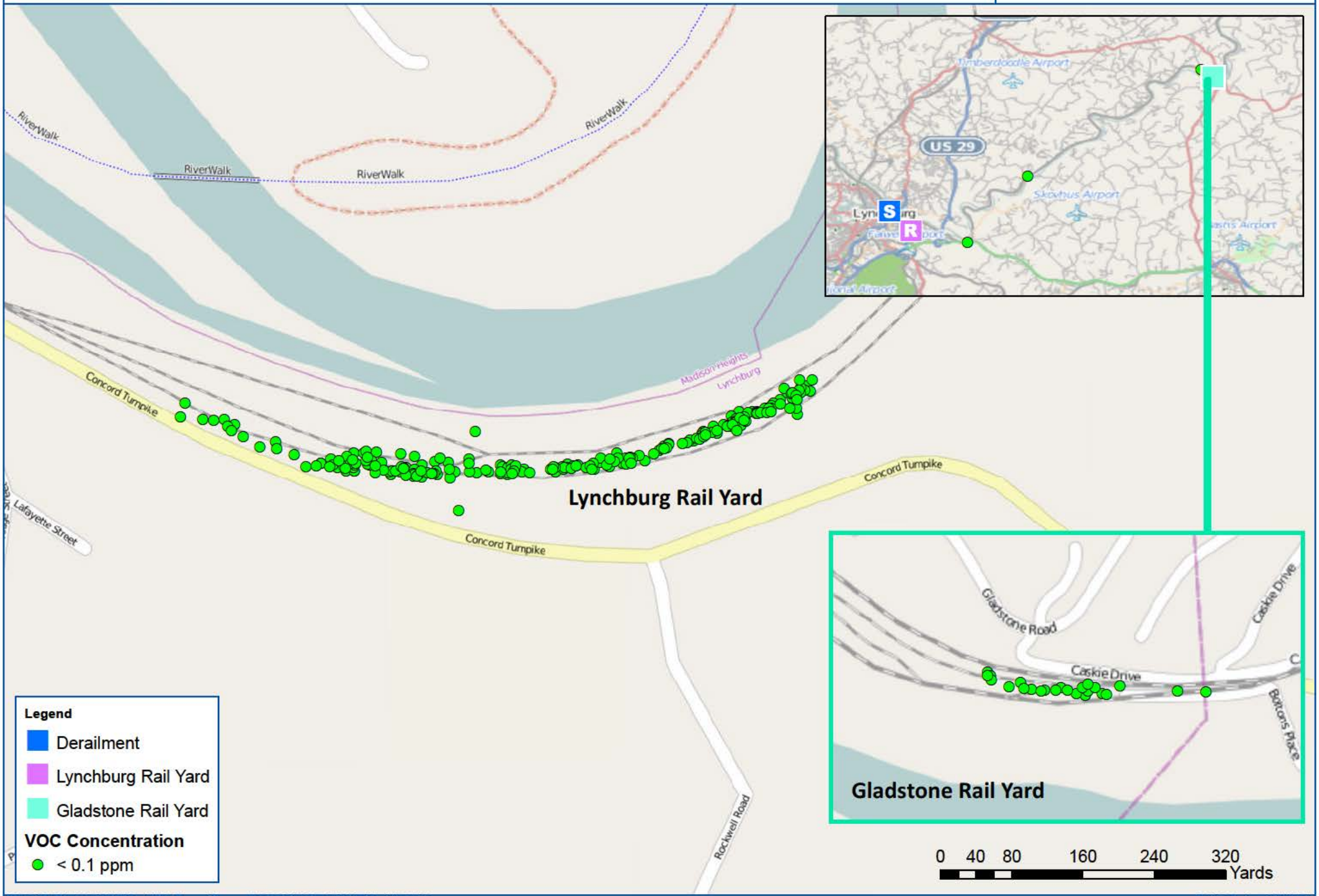
PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84*

Print Date: *6/24/2014*

Lynchburg, VA Derailment

VOC Real-Time Monitoring Locations between May 09, 2014 00:00 and May 20, 2014 12:00

Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/24/2014*

Phase IV

Lynchburg, VA Derailment

Work Area Benzene Real-Time Monitoring Locations between June 2, 2014 08:00 and June 11, 2014 16:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84*

Print Date: *6/26/2014*

Lynchburg, VA Derailment

Work Area Hexane Real-Time Monitoring Locations between June 2, 2014 08:00 and June 11, 2014 16:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84*

Print Date: *6/26/2014*

Lynchburg, VA Derailment

Work Area LEL Real-Time Monitoring Locations between June 2, 2014 08:00 and June 11, 2014 16:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/26/2014*

Lynchburg, VA Derailment

Work Area VOC Real-Time Monitoring Locations between June 2, 2014 08:00 and June 11, 2014 16:00

Project: 106190
Client: CSXT
City: Lynchburg, VA

PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84* Print Date: *6/26/2014*

Appendix D

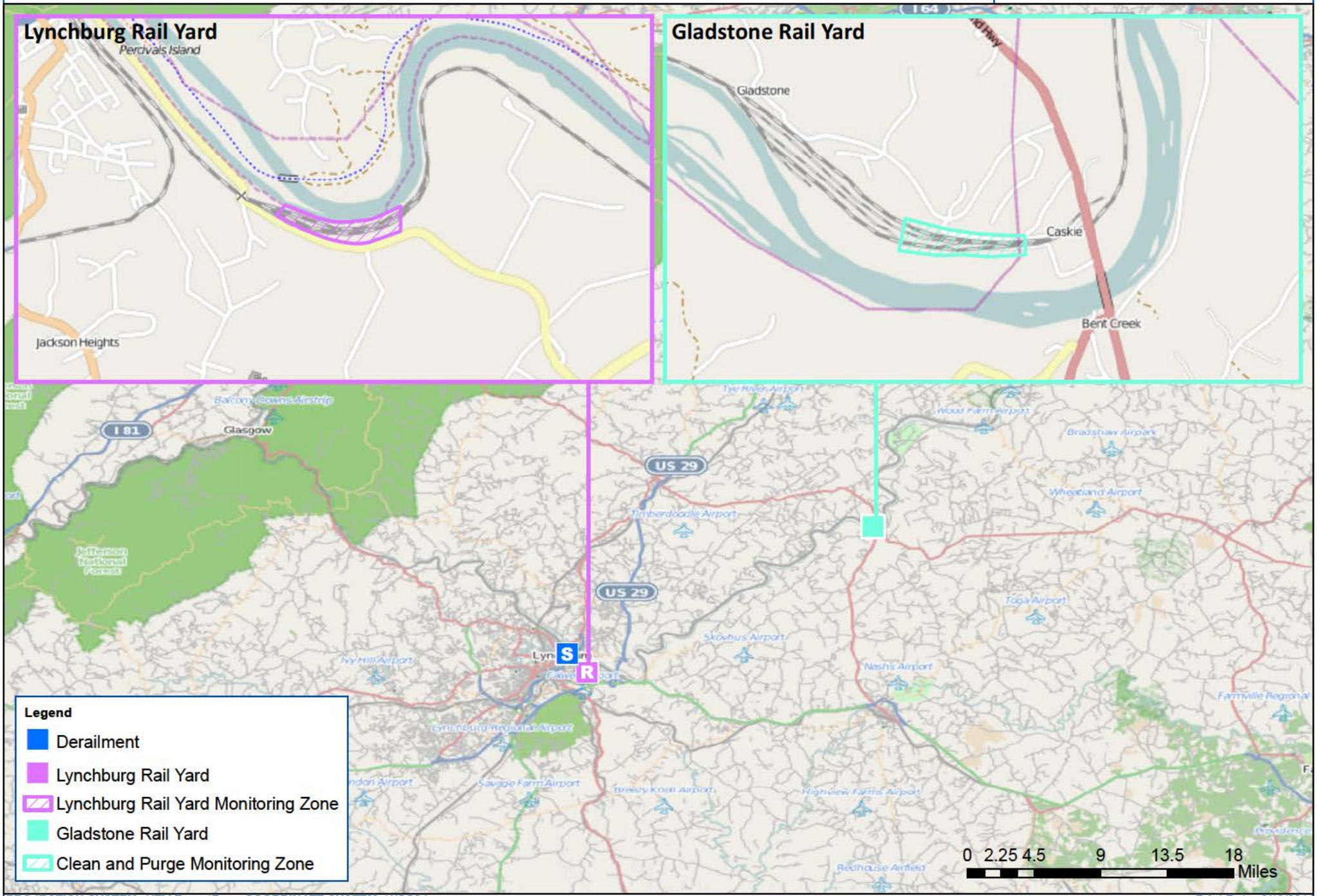
Summaries of Location Categories

Location	Analyte	Total Number of Readings	Total Number of Detections	Concentration Range
PHASE III Activity				
Community	VOC	2	0	< 1 ppm
	LEL	1	0	< 1 %
Lynchburg Rail Yard	H2S	62	0	< 1 ppm
	LEL	224	0	< 1 %
	VOC	276	0	< 0.1 ppm
Gladstone Tank Car Staging	LEL	26	0	< 1 %
	VOC	34	0	< 0.1 ppm
	Benzene	1	0	< 0.05 ppm
	H2S	8	0	< 1 ppm
Total # of readings	All	631	0	NA
PHASE IV Activity				
Work Area Monitoring	LEL	433	2	3 - 4 %
	VOC	450	47	0.1 - 123 ppm
	Benzene	7	0	< 0.05 ppm
	n-Hexane	3	1	4 ppm
Pre-Purge Monitoring*	LEL	6	4	4 - 100 %
	VOC	2	2	125 - 846 ppm
Post-Purge Monitoring*	LEL	16	0	< 1 %
	VOC	16	14	2 - 86 ppm
Total # of readings	All	933	70	NA
Duration Tank Car was Sealed				
< 28 hours	LEL	6	0	< 1 %
	VOC	6	6	3.4 - 194 ppm
> 28 hours	LEL	11	0	< 1 %
	VOC	11	11	4.7 - 144 ppm
Total # of readings	All	34	17	NA

Lynchburg, VA Derailment

Real-Time Monitoring Sampling Zones

Project: 106190
Client: CSXT
City: Lynchburg, VA

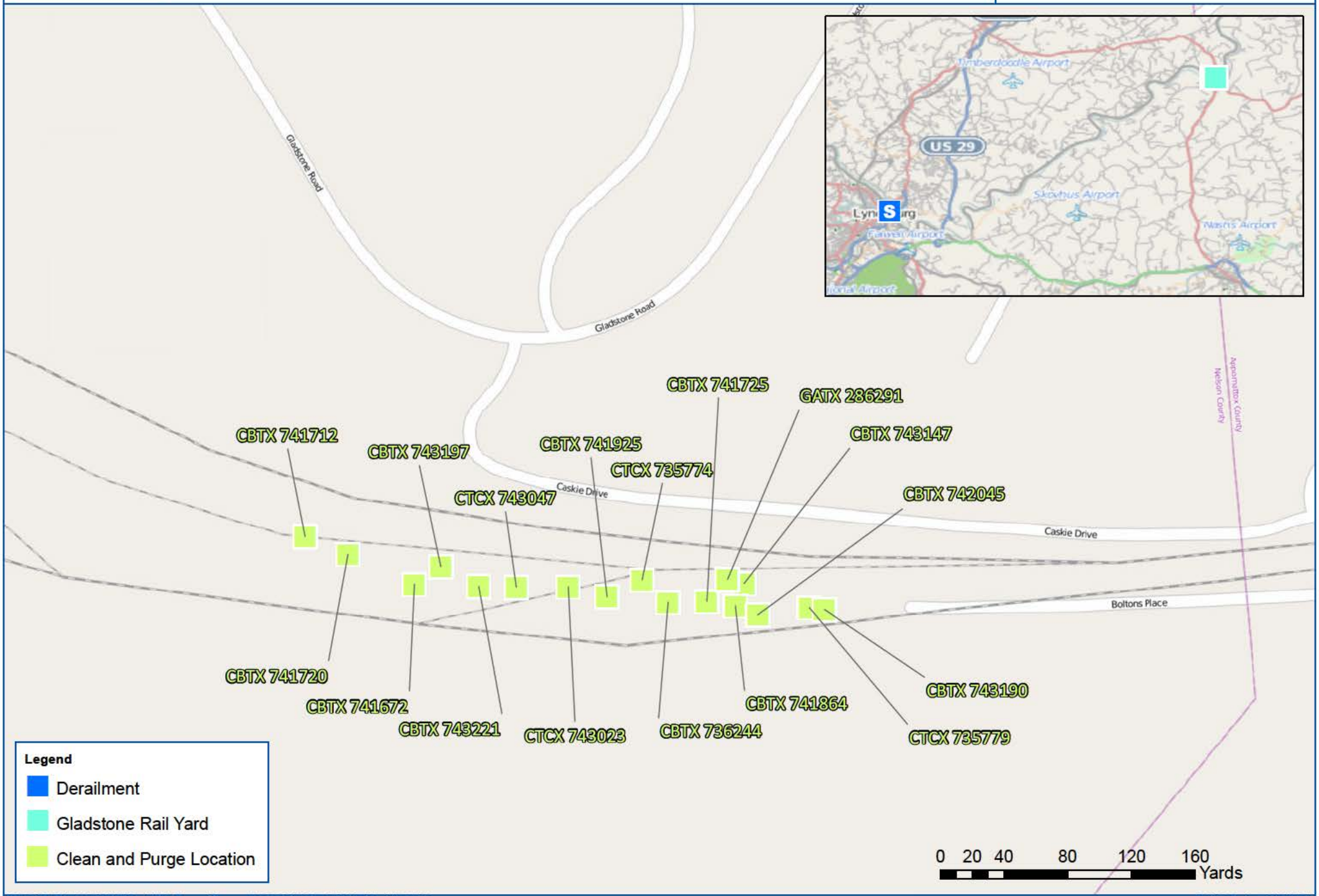


PROJECTION SYSTEM: *UTM Zone 17* **COORDINATE SYSTEM:** *WGS84* **Print Date:** *6/19/2014*

Lynchburg, VA Derailment

Gladstone Rail Yard Clean and Purge Locations

Project: 106190
Client: CSXT
City: Lynchburg, VA

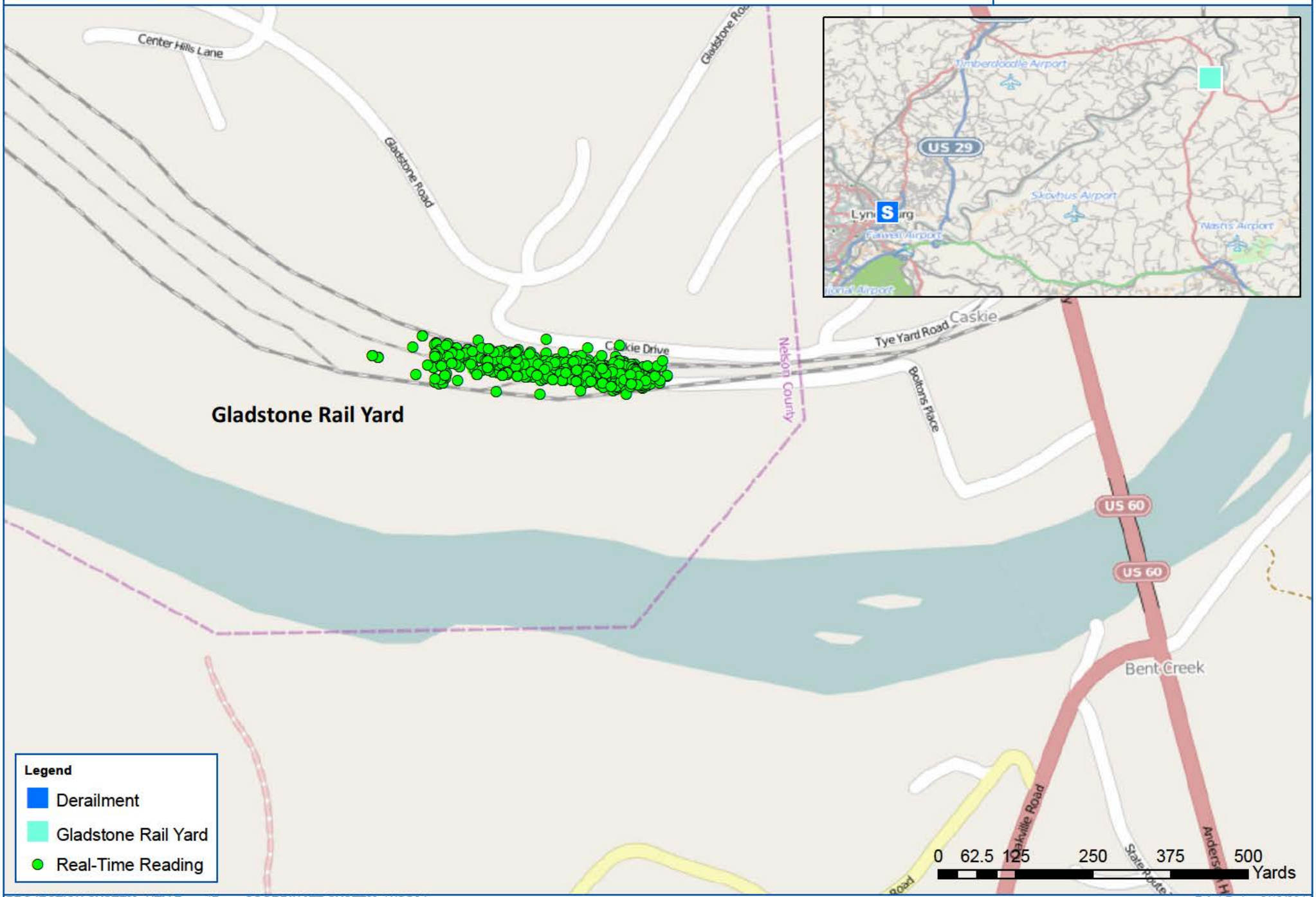


PROJECTION SYSTEM: *UTM Zone 17* **COORDINATE SYSTEM:** *WGS84* **Print Date:** *6/19/2014*

Lynchburg, VA Derailment

Real-Time Monitoring Locations between June 2, 2014 08:00 and June 11, 2014 16:00

Project: 106190
Client: CSXT
City: Lynchburg, VA



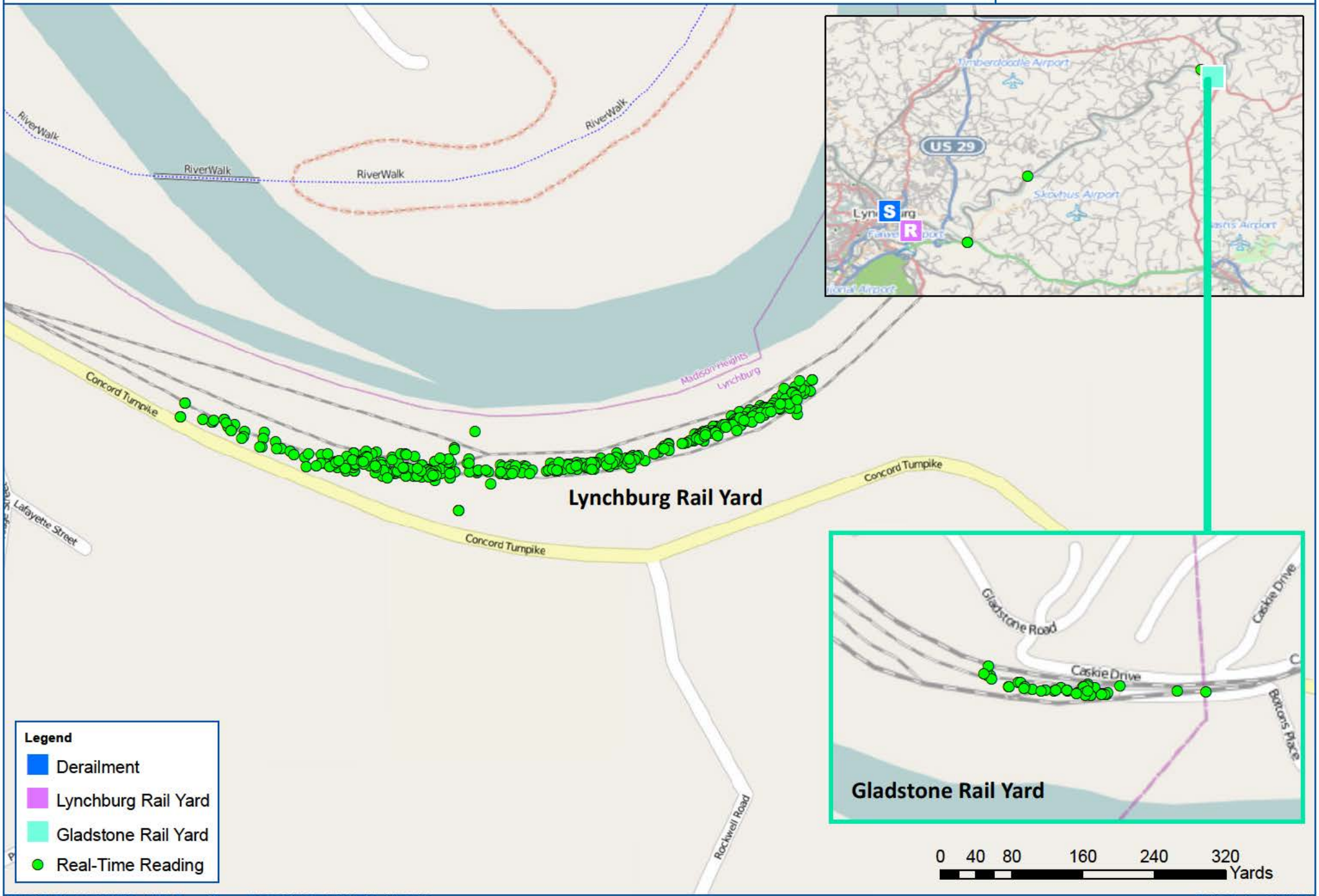
PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84*

Print Date: *6/19/2014*

Lynchburg, VA Derailment

Real-Time Monitoring Locations between May 09, 2014 00:00 and May 20, 2014 12:00

Project: 106190
Client: CSXT
City: Lynchburg, VA



PROJECTION SYSTEM: *UTM Zone 17* COORDINATE SYSTEM: *WGS84*

Print Date: *6/19/2014*

Appendix E

MSDS for Bakken Sweet Crude Oil

Safety Data Sheet

Material Name: Bakken Crude Oil
Product Synonym(s): Crude Petroleum, Hydrocarbons of Petroleum

* * * Section 1 - Product and Company Identification * * *

Manufacturer Information

Statoil
6300 Bridge Point Parkway
Building 2, Suite 500
Austin, TX 78730

Phone: 512-427-3300

* * * Section 2 - Hazards Identification * * *

GHS Classification:

Flammable Liquids - Category 2
Carcinogenicity - Category 1B
Specific Target Organ Toxicity Repeat Exposure - Category 2

GHS LABEL ELEMENTS

Symbol(s)

Signal Word

Danger

Hazard Statements

Highly flammable liquid and vapor.
May cause cancer.
May cause damage to organs (liver, kidneys, blood, nervous system, and skin) through prolonged or repeated exposure.

Precautionary Statements

Prevention

Keep away from heat/sparks/open flames/hot surfaces. No smoking
Keep container tightly closed.
Ground/bond container and receiving equipment.
Use explosion-proof electrical/ventilating/lighting/equipment.
Use only non-sparking tools.
Take precautionary measures against static discharge.
Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Do not breathe dust/fume/gas/mist/vapors/spray

Wear protective gloves/protective clothing/eye protection/face protection.

Response

IF ON SKIN (or hair): Wash with plenty of soap and water. Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
IF exposed or concerned: Get medical advice/attention.
In case of fire: Use water spray, fog or fire fighting foam.

Storage

Store in a well-ventilated place. Keep cool.
Store locked up.

Disposal

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 3 - Composition / Information on Ingredients * * *

CAS #	Component	Percent
Not Available	C10 to C49+ isoparaffins	32.5
Not Available	C10 to C49+ cyclic paraffins	19.8
Not Available	C12+ mono-aromatics	8.5
Not Available	Poly aromatic hydrocarbons	4.9
Not Available	C10 to C49+ n paraffins	3.7
Not Available	C16+ di-aromatics	2.8
Not Available	C7 cyclic paraffins	2.6
Not Available	C8 cyclic paraffins	2.3
Not Available	Trimethyl benzenes	2.3
Not Available	Dimethyl naphthalene	1.5
142-82-5	n-Heptane	1
96-37-7	Methylcyclopentane	0.9
111-84-2	Nonane	0.9
Not Available	Dimethyl benzenes	0.9
75-28-5	Isobutane	0.9
111-65-9	Octane	0.9
Not Available	Trimethyl naphthalene	0.9
110-54-3	Hexane	0.9
96-14-0	3-Methylpentane	0.8
592-27-8	2-Methylheptane	0.8
591-76-4	2-Methylhexane	0.8
109-66-0	Pentane	0.8
108-88-3	Toluene	0.8
124-18-5	Decane	0.7
Not Available	Tetramethyl benzenes	0.7
Not Available	Pentamethyl benzenes	0.6
78-78-4	Isopentane	0.6
Not Available	Low level and unidentified hydrocarbons	0.5
107-83-5	2-Methylpentane	0.5

589-34-4	3-Methylhexane	0.5
Not Available	C10 cyclic paraffins	0.5
106-42-3	p-Xylene	0.4
108-38-3	m-Xylene	0.4
589-81-1	Heptane, 3-methyl-	0.4
Not Available	C9 cyclic paraffins	0.4
90-12-0	1-Methylnaphthalene	0.3
Not Available	Decane isomers	0.3
589-53-7	4-Methylheptane	0.2
91-57-6	2-Methylnaphthalene	0.2
74-98-6	Propane	0.2
95-47-6	o-Xylene	0.1
91-20-3	Naphthalene	0.1
100-41-4	Ethylbenzene	0.1
79-29-8	2,3-Dimethylbutane	0.1
71-43-2	Benzene	0.1
584-94-1	2,3-Dimethylhexane	0.1
583-48-2	Hexane, 3,4-dimethyl-	0.1
Not Available	Nonane isomers	0.1

* * * Section 4 - First Aid Measures * * *

First Aid: Eyes

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

First Aid: Skin

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops. Thermal burns require immediate medical attention depending on the severity and the area of the body burned.

First Aid: Ingestion

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Monitor for breathing difficulties. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

First Aid: Inhalation

Remove person to fresh air. If person is not breathing, provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

* * * Section 5 - Fire Fighting Measures * * *

General Fire Hazards

See Section 9 for Flammability Properties.

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

Hazardous Combustion Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

Extinguishing Media

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

Unsuitable Extinguishing Media

None

Fire Fighting Equipment/Instructions

Firefighters should wear full protective gear.

* * * Section 6 - Accidental Release Measures * * *

Recovery and Neutralization

Carefully contain and stop the source of the spill, if safe to do so.

Materials and Methods for Clean-Up

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal.

Emergency Measures

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Product may release substantial amounts of flammable vapors and gases (e.g., methane, ethane, and propane), at or below ambient temperature depending on source and process conditions and pressure.

Personal Precautions and Protective Equipment

Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

Environmental Precautions

Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection - do not discharge solid water stream patterns into the liquid resulting in splashing.

Prevention of Secondary Hazards

None

* * * Section 7 - Handling and Storage * * *

Handling Procedures

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Storage Procedures

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Incompatibilities

Keep away from strong oxidizers.

*** Section 8 - Exposure Controls / Personal Protection ***

Component Exposure Limits

n-Heptane (142-82-5)

ACGIH: 400 ppm TWA (listed under Heptane, all isomers)
500 ppm STEL (listed under Heptane, all isomers)
OSHA: 500 ppm TWA; 2000 mg/m3 TWA
NIOSH: 85 ppm TWA; 350 mg/m3 TWA
440 ppm Ceiling (15 min); 1800 mg/m3 Ceiling (15 min)

Octane (111-65-9)

ACGIH: 300 ppm TWA
OSHA: 500 ppm TWA; 2350 mg/m3 TWA
NIOSH: 75 ppm TWA; 350 mg/m3 TWA
385 ppm Ceiling (15 min); 1800 mg/m3 Ceiling (15 min)

Nonane (111-84-2)

ACGIH: 200 ppm TWA
NIOSH: 200 ppm TWA; 1050 mg/m3 TWA

Hexane (110-54-3)

ACGIH: 50 ppm TWA
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 500 ppm TWA; 1800 mg/m3 TWA
NIOSH: 50 ppm TWA; 180 mg/m3 TWA

Isobutane (75-28-5)

ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases: Alkane C1-4)
NIOSH: 800 ppm TWA; 1900 mg/m3 TWA

Toluene (108-88-3)

ACGIH: 20 ppm TWA
OSHA: 200 ppm TWA
300 ppm Ceiling
NIOSH: 100 ppm TWA; 375 mg/m3 TWA
150 ppm STEL; 560 mg/m3 STEL

Pentane (109-66-0)

ACGIH: 600 ppm TWA (listed under Pentane, all isomers)
OSHA: 1000 ppm TWA; 2950 mg/m3 TWA
NIOSH: 120 ppm TWA; 350 mg/m3 TWA
610 ppm Ceiling (15 min); 1800 mg/m3 Ceiling (15 min)

2-Methylhexane (591-76-4)
ACGIH: 400 ppm TWA (listed under Heptane, all isomers)
500 ppm STEL (listed under Heptane, all isomers)

Isopentane (78-78-4)
ACGIH: 600 ppm TWA (listed under Pentane, all isomers)

3-Methylhexane (589-34-4)
ACGIH: 400 ppm TWA (listed under Heptane, all isomers)
500 ppm STEL (listed under Heptane, all isomers)

p-Xylene (106-42-3)
ACGIH: 100 ppm TWA
150 ppm STEL
NIOSH: 100 ppm TWA; 435 mg/m3 TWA
150 ppm STEL; 655 mg/m3 STEL

m-Xylene (108-38-3)
ACGIH: 100 ppm TWA
150 ppm STEL
NIOSH: 100 ppm TWA; 435 mg/m3 TWA
150 ppm STEL; 655 mg/m3 STEL

1-Methylnaphthalene (90-12-0)
ACGIH: 0.5 ppm TWA
Skin - potential significant contribution to overall exposure by the cutaneous route

2-Methylnaphthalene (91-57-6)
ACGIH: 0.5 ppm TWA
Skin - potential significant contribution to overall exposure by the cutaneous route

Propane (74-98-6)
ACGIH: 1000 ppm TWA (listed under Aliphatic hydrocarbon gases: Alkane C1-4)
OSHA: 1000 ppm TWA; 1800 mg/m3 TWA
NIOSH: 1000 ppm TWA; 1800 mg/m3 TWA

o-Xylene (95-47-6)
ACGIH: 100 ppm TWA
150 ppm STEL
NIOSH: 100 ppm TWA; 435 mg/m3 TWA
150 ppm STEL; 655 mg/m3 STEL

Ethylbenzene (100-41-4)
ACGIH: 20 ppm TWA
OSHA: 100 ppm TWA; 435 mg/m3 TWA
NIOSH: 100 ppm TWA; 435 mg/m3 TWA
125 ppm STEL; 545 mg/m3 STEL

Benzene (71-43-2)

ACGIH: 0.5 ppm TWA
2.5 ppm STEL
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
10 ppm TWA (applies to industry segments exempt from the benzene standard at 29 CFR 1910.1028); 1 ppm TWA
5 ppm STEL (see 29 CFR 1910.1028)
25 ppm Ceiling
NIOSH: 0.1 ppm TWA
1 ppm STEL

Naphthalene (91-20-3)

ACGIH: 10 ppm TWA
15 ppm STEL
Skin - potential significant contribution to overall exposure by the cutaneous route
OSHA: 10 ppm TWA; 50 mg/m3 TWA
NIOSH: 10 ppm TWA; 50 mg/m3 TWA
15 ppm STEL; 75 mg/m3 STEL

Engineering Measures

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

Personal Protective Equipment: Respiratory

A NIOSH/ MSHA-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

Personal Protective Equipment: Hands

Gloves constructed of nitrile or neoprene are recommended.

Personal Protective Equipment: Eyes

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

Personal Protective Equipment: Skin and Body

Chemical protective clothing such as of E.I. DuPont TyChem®, Saranex® or equivalent recommended based on degree of exposure. Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

*** Section 9 - Physical & Chemical Properties ***

Appearance:	Thick, dark yellow to brown or greenish black	**Odor:**	Moderate, Characteristic
Physical State:	Liquid	**pH:**	Not Determined
Vapor Pressure:	Not Determined	**Vapor Density:**	Not Determined
Boiling Point:	130°F	**Melting Point:**	Not Determined
Solubility (H2O):	Insoluble to slightly soluble	**Specific Gravity:**	0.7601
Evaporation Rate:	Not Determined	**VOC:**	Present per speciated review
Octanol/H2O Coeff.:	Not Determined	**Flash Point:**	<-50°F
Flash Point Method:	Setaflash	**Upper Flammability Limit (UFL):**	Not Determined
Lower Flammability Limit (LFL):	Not Determined	**Burning Rate:**	Not Determined
Auto Ignition:	Not Determined		

*** Section 10 - Chemical Stability & Reactivity Information ***

Chemical Stability

This is a stable material.

Hazardous Reaction Potential

Will not occur.

Conditions to Avoid

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources.

Incompatible Products

Keep away from strong oxidizers.

Hazardous Decomposition Products

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke).

*** Section 11 - Toxicological Information ***

Acute Toxicity

A: General Product Information

Harmful if swallowed.

B: Component Analysis - LD50/LC50

n-Heptane (142-82-5)

Inhalation LC50 Rat 103 g/m3 4 h; Oral LD50 Mouse 5000 mg/kg; Dermal LD50 Rabbit 3000 mg/kg

Octane (111-65-9)

Inhalation LC50 Rat 118 g/m3 4 h; Inhalation LC50 Rat 25260 ppm 4 h

Nonane (111-84-2)

Inhalation LC50 Rat 3200 ppm 4 h

Hexane (110-54-3)

Inhalation LC50 Rat 48000 ppm 4 h; Oral LD50 Rat 25 g/kg; Dermal LD50 Rabbit 3000 mg/kg

Isobutane (75-28-5)

Inhalation LC50 Rat 658 mg/L 4 h

Toluene (108-88-3)
Inhalation LC50 Rat 12.5 mg/L 4 h; Inhalation LC50 Rat >26700 ppm 1 h; Oral LD50 Rat 636 mg/kg; Dermal LD50 Rabbit 8390 mg/kg; Dermal LD50 Rat 12124 mg/kg

Pentane (109-66-0)
Inhalation LC50 Rat 364 g/m3 4 h; Dermal LD50 Rabbit 3000 mg/kg; Oral LD50 Rat >2000 mg/kg

Decane (124-18-5)
Inhalation LC50 Mouse 72300 mg/m3 2 h; Oral LD50 Rat >5000 mg/kg; Dermal LD50 Rat >2000 mg/kg

Isopentane (78-78-4)
Inhalation LC50 Rat 280000 mg/m3 4 h

p-Xylene (106-42-3)
Inhalation LC50 Rat 4550 ppm 4 h; Oral LD50 Rat >3392 mg/kg

m-Xylene (108-38-3)
Oral LD50 Rat 5000 mg/kg; Dermal LD50 Rabbit 14100 µL/kg

1-Methylnaphthalene (90-12-0)
Oral LD50 Rat 1840 mg/kg

2-Methylnaphthalene (91-57-6)
Oral LD50 Rat 1630 mg/kg

Propane (74-98-6)
Inhalation LC50 Rat 658 mg/L 4 h

o-Xylene (95-47-6)
Inhalation LC50 Rat 2180 ppm 4 h; Oral LD50 Rat 3609 mg/kg

Ethylbenzene (100-41-4)
Inhalation LC50 Rat 17.2 mg/L 4 h; Oral LD50 Rat 3500 mg/kg; Dermal LD50 Rabbit 15354 mg/kg

Benzene (71-43-2)
Inhalation LC50 Rat 13050-14380 ppm 4 h; Oral LD50 Rat 1800 mg/kg

Naphthalene (91-20-3)
Inhalation LC50 Rat >340 mg/m3 1 h; Oral LD50 Rat 490 mg/kg; Dermal LD50 Rat >2500 mg/kg; Dermal LD50 Rabbit >20 g/kg

Potential Health Effects: Skin Corrosion Property/Stimulativeness

May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

Potential Health Effects: Eye Critical Damage/ Stimulativeness

Contact with eyes may cause moderate to severe irritation.

Potential Health Effects: Ingestion

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea.

Potential Health Effects: Inhalation

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

Respiratory Organs Sensitization/Skin Sensitization

This product is not reported to have any skin sensitization effects.

Generative Cell Mutagenicity

Some crude oils and crude oil fractions have been positive in mutagenicity studies.

Carcinogenicity

A: General Product Information

May cause cancer.

B: Component Carcinogenicity

Toluene (108-88-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999]; Monograph 47 [1989] (Group 3 (not classifiable))

p-Xylene (106-42-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999] (listed under Xylenes) (Group 3 (not classifiable))

m-Xylene (108-38-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999] (listed under Xylenes) (Group 3 (not classifiable))

1-Methylnaphthalene (90-12-0)

ACGIH: A4 - Not Classifiable as a Human Carcinogen

2-Methylnaphthalene (91-57-6)

ACGIH: A4 - Not Classifiable as a Human Carcinogen

o-Xylene (95-47-6)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
IARC: Monograph 71 [1999] (listed under Xylenes) (Group 3 (not classifiable))

Ethylbenzene (100-41-4)

ACGIH: A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans
IARC: Monograph 77 [2000] (Group 2B (possibly carcinogenic to humans))

Benzene (71-43-2)

ACGIH: A1 - Confirmed Human Carcinogen
OSHA: 5 ppm STEL (Cancer hazard, Flammable, See 29 CFR 1910.1028, 15 min); 0.5 ppm Action Level; 1 ppm TWA
NIOSH: potential occupational carcinogen
NTP: Known Human Carcinogen (Select Carcinogen)
IARC: Monograph 100F [2012]; Supplement 7 [1987]; Monograph 29 [1982[(Group 1 (carcinogenic to humans))

Naphthalene (91-20-3)

ACGIH: A4 - Not Classifiable as a Human Carcinogen
NTP: Reasonably Anticipated To Be A Human Carcinogen (Possible Select Carcinogen)
IARC: Monograph 82 [2002] (Group 2B (possibly carcinogenic to humans))

Reproductive Toxicity

This product is not reported to have any reproductive toxicity effects.

Specified Target Organ General Toxicity: Single Exposure

This product is not reported to have any specific target organ general toxicity single exposure effects.

Specified Target Organ General Toxicity: Repeated Exposure

May cause damage to organs (liver, kidneys, blood, nervous system and skin) through prolonged or repeated exposure.

Aspiration Respiratory Organs Hazard

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

* * * Section 12 - Ecological Information * * *

Ecotoxicity

A: General Product Information

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations.

B: Component Analysis - Ecotoxicity - Aquatic Toxicity

n-Heptane (142-82-5)

Test & Species		Conditions
96 Hr LC50 Cichlid fish	375.0 mg/L	
24 Hr EC50 Daphnia magna	>10 mg/L	

Octane (111-65-9)

Test & Species		Conditions
48 Hr EC50 water flea	0.38 mg/L	

Hexane (110-54-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	2.1-2.98 mg/L [flow-through]	
24 Hr EC50 Daphnia magna	>1000 mg/L	

Toluene (108-88-3)

Test & Species		Conditions
96 Hr LC50 Pimephales promelas	15.22-19.05 mg/L [flow-through]	1 day old
96 Hr LC50 Pimephales promelas	12.6 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.89-7.81 mg/L [flow-through]	
96 Hr LC50 Oncorhynchus mykiss	14.1-17.16 mg/L [static]	
96 Hr LC50 Oncorhynchus mykiss	5.8 mg/L]semi-static]	
96 Hr LC50 Lepomis macrochirus	11.0-15.0 mg/L [static]	
96 Hr LC50 Oryzias latipes	54 mg/L [static]	
96 Hr LC50 Poecilia reticulata	28.2 mg/L [semi-static]	
96 Hr LC50 Poecilia reticulata	50.87-70.34 mg/L [static]	
96 Hr EC50 Pseudokirchneriella subcapitata	>433 mg/L	
72 Hr EC50 Pseudokirchneriella subcapitata	12.5 mg/L [static]	
48 Hr EC50 Daphnia magna	5.46 - 9.83 mg/L [Static]	
48 Hr EC50 Daphnia magna	11.5 mg/L	

Pentane (109-66-0)

Test & Species		Conditions
96 Hr LC50 Oncorhynchus mykiss	9.87 mg/L	
96 Hr LC50 Pimephales promelas	11.59 mg/L	

96 Hr LC50 Lepomis macrochirus	9.99 mg/L
48 Hr EC50 Daphnia magna	9.74 mg/L

Decane (124-18-5)

Test & Species	Conditions
24 Hr EC50 Chlorella vulgaris	0.043 mg/L
48 Hr EC50 Daphnia magna	0.029 mg/L

Isopentane (78-78-4)

Test & Species	Conditions
48 Hr EC50 Daphnia magna	2.3 mg/L

p-Xylene (106-42-3)

Test & Species	Conditions
96 Hr LC50 Pimephales promelas	7.2-9.9 mg/L [static]
96 Hr LC50 Oncorhynchus mykiss	2.6 mg/L
96 Hr LC50 Oncorhynchus mykiss	2.6 mg/L [static]
96 Hr LC50 Poecilia reticulata	8.8 mg/L [semi-static]
3 Hr EC50 Chlorella vulgaris	105.1 mg/L
72 Hr EC50 Pseudokirchneriella subcapitata	3.2 mg/L [static[
48 Hr EC50 Daphnia magna	3.55 - 6.31 mg/L [Static]

m-Xylene (108-38-3)

Test & Species	Conditions
96 Hr LC50 Pimephales promelas	14.3-18 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	8.4 mg/L [semi-static]
96 Hr LC50 Poecilia reticulata	12.9 mg/L [semi-static]
72 Hr EC50 Pseudokirchneriella subcapitata	4.9 mg/L [static]
48 Hr EC50 Daphnia magna	2.81 - 5.0 mg/L [Static]

o-Xylene (95-47-6)

Test & Species	Conditions
96 Hr LC50 Pimephales promelas	11.6-22.4 mg/L [flow-through]
96 Hr LC50 Lepomis macrochirus	11.6-22.4 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	5.59-11.6 mg/L [flow-through]

96 Hr LC50 Poecilia reticulata	12 mg/L
192 Hr EC50 Pseudokirchneriella subcapitata	4.2 mg/L
72 Hr EC50 Pseudokirchneriella subcapitata	4.7 mg/L [static]
48 Hr EC50 Daphnia magna	3.2 mg/L
48 Hr EC50 Daphnia magna	2.61 - 5.59 mg/L [Flow through]
48 Hr EC50 Daphnia magna	0.78 - 2.51 mg/L [Static]

Ethylbenzene (100-41-4)

Test & Species	Conditions
96 Hr LC50 Oncorhynchus mykiss	11.0-18.0 mg/L [static]
96 Hr LC50 Oncorhynchus mykiss	4.2 mg/L [semi-static]
96 Hr LC50 Pimephales promelas	7.55-11 mg/L [flow-through]
96 Hr LC50 Lepomis macrochirus	32 mg/L [static]
96 Hr LC50 Pimephales promelas	9.1-15.6 mg/L [static]
96 Hr LC50 Poecilia reticulata	9.6 mg/L [static]
72 Hr EC50 Pseudokirchneriella subcapitata	4.6 mg/L
96 Hr EC50 Pseudokirchneriella subcapitata	>438 mg/L
72 Hr EC50 Pseudokirchneriella subcapitata	2.6 - 11.3 mg/L [static]
96 Hr EC50 Pseudokirchneriella subcapitata	1.7 - 7.6 mg/L [static]
48 Hr EC50 Daphnia magna	1.8 - 2.4 mg/L

Benzene (71-43-2)

Test & Species	Conditions
96 Hr LC50 Pimephales promelas	10.7-14.7 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	5.3 mg/L [flow-through]
96 Hr LC50 Lepomis macrochirus	22.49 mg/L [static]
96 Hr LC50 Poecilia reticulata	28.6 mg/L [static]
96 Hr LC50 Pimephales promelas	22330-41160 µg/L [static]
96 Hr LC50 Lepomis macrochirus	70000-142000 µg/L [static]
72 Hr EC50 Pseudokirchneriella subcapitata	29 mg/L
48 Hr EC50 Daphnia magna	8.76 - 15.6 mg/L [Static]

48 Hr EC50 Daphnia magna	10 mg/L

Naphthalene (91-20-3)

Test & Species	Conditions
96 Hr LC50 Pimephales promelas	5.74-6.44 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	1.6 mg/L [flow-through]
96 Hr LC50 Oncorhynchus mykiss	0.91-2.82 mg/L [static]
96 Hr LC50 Pimephales promelas	1.99 mg/L [static]
96 Hr LC50 Lepomis macrochirus	31.0265 mg/L [static]
72 Hr EC50 Skeletonema costatum	0.4 mg/L
48 Hr LC50 Daphnia magna	2.16 mg/L
48 Hr EC50 Daphnia magna	1.96 mg/L [Flow through]
48 Hr EC50 Daphnia magna	1.09 - 3.4 mg/L [Static]

Persistence/Degradability

No information available.

Bioaccumulation

No information available.

Mobility in Soil

No information available.

* * * Section 13 - Disposal Considerations * * *

Waste Disposal Instructions

See Section 7 for Handling Procedures. See Section 8 for Personal Protective Equipment recommendations.

Disposal of Contaminated Containers or Packaging

Dispose of contents/container in accordance with local/regional/national/international regulations.

* * * Section 14 - Transportation Information * * *

DOT Information

Shipping Name: Petroleum Crude Oil
Hazard Class: 3
UN #: 1267
Packing Group: I

*** Section 15 - Regulatory Information ***

Regulatory Information

US Federal Regulations

Component Analysis

This material contains one or more of the following chemicals required to be identified under SARA Section 302 (40 CFR 355 Appendix A), SARA Section 313 (40 CFR 372.65) and/or CERCLA (40 CFR 302.4).

Hexane (110-54-3)

CERCLA: 5000 lb final RQ; 2270 kg final RQ

Toluene (108-88-3)

CERCLA: 1000 lb final RQ; 454 kg final RQ

p-Xylene (106-42-3)

CERCLA: 100 lb final RQ; 45.4 kg final RQ

m-Xylene (108-38-3)

CERCLA: 1000 lb final RQ; 454 kg final RQ

o-Xylene (95-47-6)

CERCLA: 1000 lb final RQ; 454 kg final RQ

Ethylbenzene (100-41-4)

SARA 313: 0.1 % de minimis concentration
CERCLA: 1000 lb final RQ; 454 kg final RQ

Benzene (71-43-2)

SARA 313: 0.1 % de minimis concentration
CERCLA: 10 lb final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule); 4.54 kg final RQ (received an adjusted RQ of 10 lbs based on potential carcinogenicity in an August 14, 1989 final rule)

Naphthalene (91-20-3)

SARA 313: 0.1 % de minimis concentration
CERCLA: 100 lb final RQ; 45.4 kg final RQ

State Regulations

A: Component Analysis - State

The following components appear on one or more of the following state hazardous substances lists:

Component	CAS	CA	MA	MN	NJ	PA	RI
n-Heptane	142-82-5	Yes	Yes	Yes	Yes	Yes	No
Methylcyclopentane	96-37-7	No	Yes	No	Yes	Yes	No
Octane	111-65-9	Yes	Yes	Yes	Yes	Yes	No
Nonane	111-84-2	Yes	Yes	Yes	Yes	Yes	No
Hexane	110-54-3	No	Yes	Yes	Yes	Yes	No
Isobutane	75-28-5	No	Yes	No	Yes	Yes	No
Toluene	108-88-3	Yes	Yes	Yes	Yes	Yes	No
3-Methylpentane	96-14-0	No	Yes	No	No	Yes	No
Pentane	109-66-0	Yes	Yes	Yes	Yes	Yes	No
2-Methylhexane	591-76-4	No	Yes	No	No	Yes	No
Decane	124-18-5	No	No	No	Yes	Yes	No
Isopentane	78-78-4	No	Yes	No	Yes	Yes	No
3-Methylhexane	589-34-4	No	Yes	No	Yes	Yes	No
2-Methylpentane	107-83-5	No	Yes	Yes	Yes	Yes	No
p-Xylene	106-42-3	Yes	Yes	No	Yes	Yes	No
m-Xylene	108-38-3	Yes	Yes	No	Yes	Yes	No
1-Methylnaphthalene	90-12-0	No	Yes	No	Yes	Yes	No
2-Methylnaphthalene	91-57-6	No	No	No	Yes	No	No
Propane	74-98-6	No	Yes	Yes	Yes	Yes	No
o-Xylene	95-47-6	Yes	Yes	No	Yes	Yes	No
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	Yes	No
2,3-Dimethylbutane	79-29-8	No	Yes	No	Yes	Yes	No
Benzene	71-43-2	Yes	Yes	Yes	Yes	Yes	No
Naphthalene	91-20-3	Yes	Yes	Yes	Yes	Yes	No
2,3-Dimethylhexane	584-94-1	No	Yes	No	No	Yes	No

WARNING! This product contains a chemical known to the state of California to cause cancer.
WARNING! This product contains a chemical known to the state of California to cause reproductive/developmental effects.

Component Analysis - WHMIS IDL

The following components are identified under the Canadian Hazardous Products Act Ingredient Disclosure List:

Component	CAS #	Minimum Concentration
n-Heptane	142-82-5	1 %
p-Xylene	106-42-3	0.1 %
Ethylbenzene	100-41-4	0.1 %
Benzene	71-43-2	0.1 %

Additional Regulatory Information

Component Analysis - Inventory

Component	CAS #	TSCA	CAN	EEC
n-Heptane	142-82-5	Yes	DSL	EINECS
Methylcyclopentane	96-37-7	Yes	DSL	EINECS
Octane	111-65-9	Yes	DSL	EINECS
Nonane	111-84-2	Yes	DSL	EINECS
Hexane	110-54-3	Yes	DSL	EINECS
Isobutane	75-28-5	Yes	DSL	EINECS
Toluene	108-88-3	Yes	DSL	EINECS
3-Methylpentane	96-14-0	Yes	DSL	EINECS
Pentane	109-66-0	Yes	DSL	EINECS
2-Methylhexane	591-76-4	Yes	DSL	EINECS
2-Methylheptane	592-27-8	No	No	EINECS
Decane	124-18-5	Yes	DSL	EINECS
Isopentane	78-78-4	Yes	DSL	EINECS
3-Methylhexane	589-34-4	Yes	NDSL	EINECS
2-Methylpentane	107-83-5	Yes	DSL	EINECS
p-Xylene	106-42-3	Yes	DSL	EINECS
m-Xylene	108-38-3	Yes	DSL	EINECS
Heptane, 3-methyl-	589-81-1	Yes	NDSL	EINECS
1-Methylnaphthalene	90-12-0	Yes	DSL	EINECS
2-Methylnaphthalene	91-57-6	Yes	DSL	EINECS
Propane	74-98-6	Yes	DSL	EINECS
4-Methylheptane	589-53-7	No	No	EINECS
o-Xylene	95-47-6	Yes	DSL	EINECS
Ethylbenzene	100-41-4	Yes	DSL	EINECS
Hexane, 3,4-dimethyl-	583-48-2	Yes	NDSL	EINECS
2,3-Dimethylbutane	79-29-8	Yes	DSL	EINECS
Benzene	71-43-2	Yes	DSL	EINECS
Naphthalene	91-20-3	Yes	DSL	EINECS
2,3-Dimethylhexane	584-94-1	No	No	EINECS

*** Section 16 - Other Information ***

Key/Legend

EPA = Environmental Protection Agency; TSCA = Toxic Substance Control Act; ACGIH = American Conference of Governmental Industrial Hygienists; IARC = International Agency for Research on Cancer; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration., NJTSR = New Jersey Trade Secret Registry.

Literature References

None

End of Sheet

Safety Data Sheet

1. Identification

Product Name:	Crude Oil (Sweet)
Chemical Family:	Petroleum Hydrocarbon Mixture
Manufacturers Name:	Whiting Oil and Gas Corporation
Address:	1700 Broadway, Suite 2300 Denver, Colorado 80290
Product Use:	Feedstock for petroleum and petrochemical refining.
Phone Number for Information:	(303) 837-1661
Emergency Phone Number:	(800) 424-9300 (Chemtrec)

Crude oil is a complex mixture of paraffinic, cycloparaffinic and aromatic hydrocarbons covering carbon numbers ranging from C1 to over C60. It is amber to black in color. Crude oil contains small amounts of sulfur, nitrogen and oxygen compounds as well as trace amounts of heavy metals.

2. Hazard Identification

Crude oil is extremely flammable and can cause eye, skin, gastrointestinal, and respiratory irritation. Inhalation may cause dizziness, nausea, or headache. More serious health effects can occur if crude oil in inhaled or swallowed.

Crude oil may contain variable amounts of benzene and n-hexane. Long-term exposure to these materials has been shown to lead to systemic toxicity such leukemia and peripheral neurotoxicity.

DANGER!
FLAMMABLE LIQUID

MAY CONTAIN BENZENE WHICH CAN CAUSE CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS. ASPIRATION OF LIQUID INTO THE LUNGS CAN PRODUCE CHEMICAL PNEUMONIA OR EVEN DEATH.

NO SMOKING!
KEEP AWAY FROM HEAT/SPARKS/OPEN FLAMES/HOT SURFACES. WEAR PROTECTIVE GLOVES, CLOTHING AND EYE WEAR WHEN HANDLING. AVOID RELEASE INTO THE ENVIRONMENT.

Globally Harmonized System (GHS) Information

Physical Hazards Classification
Flammable Liquids, Category 2

Health Hazards Classification
Acute Toxicity (Skin/Dermal), Category 3
Skin Corrosion/irritation, Category 2
Serious eye damage/eye irritation, Category 2a
Carcinogenicity, Category 1B
Specific Target organ toxicity – single exposure, Category 3 (narcotic effects)
Specific Target organ toxicity – repeated exposure, Category 2 (bone marrow, liver, thymus)
Aspiration hazard, Category 1

Environmental Hazards Classification
Acute Toxicity to the aquatic environment, Category 3
Chronic Toxicity to the aquatic environment, Category 3

GHS Label Information

Symbols:

Signal Word: Danger

Hazard Statements:	**Precautionary Statements:**
Physical Hazards Flammable liquid and vapor **Health Hazards** May cause cancer May be fatal if swallowed and enters airways Causes eye irritation May cause drowsiness or dizziness May cause damage to organs through prolonged or repeated exposure Causes mild skin irritation **Environmental Hazards** Harmful to aquatic life Harmful to aquatic life with long lasting effects	**Prevention** Keep away from heat/sparks/open flames/hot surfaces – no smoking Keep container tightly closed Ground/bond container and receiving equipment Use explosion proof electrical/ventilation/lighting equipment Use only non-sparking tools Take precautionary measures against static discharge Wear protective gloves/protective clothing/eye protection/face protection Obtain special instructions before use Do not handle until all safety precautions have been read and understood Wash hands thoroughly after handling Do not breathe vapors Do not eat, drink or smoke when using this product Use only outdoors or in a well-ventilated area Avoid release to the environment **Response** IF ON SKIN (or hair): Remove all contaminated clothing. Rinse skin with water/shower In case of fire: use appropriate extinguishing media If exposed or concerned: Get medical attention or advice IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.

	If irritation persists get medical advice/attention IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Collect spillage IF SWALLOWED: Immediately call a poison control center or doctor/physician Do not induce vomiting **Storage** Store locked up Store in a well-ventilated place. Keep container tightly closed. **Disposal** Dispose of contents/container in accordance with local/regional/national/international regulations

3. Composition/Information on Ingredients

COMPOSITION	CAS NUMBER	PERCENT
Crude Oil	8002-05-9	100
May Contain Variable Amounts of:		
Natural Gas	8005-14-2	—
Benzene	71-43-2	—
N-Hexane	110-54-3	—

4. First Aid Measures

Eye Contact
Immediately flush eyes while holding eyelids open, with large amounts of clean, low-pressure tepid water for at least 15 minutes. If symptoms, irritation or injury persists, worsen or develop, seek medical attention.

Skin Contact
Remove contaminated clothing/shoes, wipe excess from skin. Immediately flush skin with water for 15 minutes then wash with soap and water. If illness or adverse symptoms develop or irritation persists, seek medial attention. Discard contaminated leather goods.

Inhalation
Remove victim to fresh air and provide oxygen if breathing labored, shallow, or difficult. Rescuer must wear appropriate supplied air respirator to remove worker from contaminated area to fresh air. Give artificial respiration if victim is not breathing. Seek medical attention immediately*.

Ingestion
Do not induce vomiting. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs. Seek medical attention.*

Note to Physician
*If more than 2.0 ML per KG has been ingested and emesis has not occurred, vomiting should be induced with supervision. Keep victim's head below hips to prevent aspiration. If symptoms such as loss of gag reflex, convulsions or unconsciousness occur before emesis, gastric lavage using a cuffed endotracheal tube should be considered.

Aggravated Medical Conditions
Preexisting eye, skin, and respiratory disorders may be aggravated by exposure to crude oil.

5. Fire-Fighting Measures

Extinguishing Media
For small fires, class B fire extinguishing media can be used. Use water fog, foam, dry chemical or CO_2. Do not use a direct stream of water. Product will float and can be reignited on surface of water.

Special Fire Fighting Procedures and Precautions
Warning: Flammable. Clear fire area of unprotected personnel. Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coats, gloves and rubber boots) including a positive pressure NIOSH approved self-contained breathing apparatus (SCBA). Cool containers exposed to fire with water.

Unusual Fire Explosion Hazards
Container exposed to intense heat from fires should be cooled with water to prevent vapor pressure buildup which could result in container rupture (bleve). Container areas exposed to direct flame contact should be cooled with large quantities of water as needed to prevent weakening of container structure. Sulfur oxides and hydrogen sulfide, both of which are toxic, may be released upon combustion.

NFPA Ratings
Health – 2
Flammability – 3
Reactivity – 0
Other – 0

Key: Least-0; Slight-1; Moderate-2; High-3; Extreme-4

6. Accidental Release Measures

Keep the public away. Isolate and evacuate the area. Eliminate all ignition sources. Handling equipment must be grounded or bonded to prevent sparking.

***** Large Spills***** Evacuate the hazard area of unprotected personnel. Wear appropriate respirator and protective clothing. Shut off source of leak only if safe to do so. Dike and contain with sand or soil. If vapor cloud forms, water fog may be used to suppress. Contain run-off. Remove with vacuum trucks or pump to storage/salvage vessels. Soak up residue with an absorbent such as clay, sand or other suitable material; place in non-leaking containers for proper disposal. Flush area with water to remove trace residue and dispose of flush solutions as above.
***** Small Spills***** Take up with an absorbent material and place in non-leaking containers; seal tightly for proper disposal.

7. Handling and Storage

Comply with all regulatory requirements. Store in suitable tanks or closed, labeled containers in a cool, well-ventilated area.

Keep liquid and vapor away from heat, sparks and flame. Surfaces that are sufficiently hot may even ignite liquid product in the absence of sparks or flame. Extinguish pilot lights, cigarettes and turn off other sources of ignition prior to use and until all vapors have been dispersed. Containers, even those that have been emptied, can contain explosive vapors. Do not cut, drill, grind, weld or perform similar operations on or near containers. Static electricity may accumulate and create a fire hazard. Ground fixed equipment. Bond and ground transfer containers and equipment.

Wash hands with soap and water before eating, drinking, smoking or using toilet facilities. Launder contaminated clothing before reuse. Dispose of leather articles including shoes which cannot be decontaminated.

8. Exposure Controls/Personal Protection

Occupational Exposure Limits

COMPONENT	OSHA PEL	ACGIH TLV TWA
Crude Oil	400 ppm ***	Not available
Natural Gas	Not available	Not available
Hexane	500 ppm	500 ppm/STEL 1000 ppm
Benzene	1 ppm**/STEL 5 ppm	0.5 ppm

Notes:
** OSHA's action level is 0.5 ppm (29 CFR 1910.1028)
*** Listed PEL was vacated in 1993

Engineering Controls

Maintain air concentrations below flammable limits and occupational exposure standards for chemical components by using ventilation and other engineering controls.

Personal Protective Equipment

Eye/Face Protection
Use safety glasses, chemical splash goggles and/or a face shield as appropriate to prevent eye contact.

Skin Protection
Wear chemical resistant gloves and other protective clothing, as required, to minimize skin contact. Test data from published literature and/or glove and clothing manufacturers indicate suitable protection is provided by neoprene or nitrile gloves.

Respiratory Protection
Use NIOSH approved respiratory protection as required to prevent overexposure to oil mist and vapor. Do not enter storage compartments unless equipped with a NIOSH approved self-contained breathing apparatus with a full face-piece operated in a positive pressure mode.

Protective Clothing
Wear chemical resistant gloves and other protective clothing, as required, to minimize skin contact. Use safety glasses or chemical splash goggles to prevent eye contact. Test data from published literature and/or glove and clothing manufacturers indicate suitable protection is provided by neoprene or nitrile gloves.

9. Physical and Chemical Properties

Appearance and Odor: Black, dark green or yellow liquid; strong hydrocarbon and possible sulfur odor.

pH:	Neutral
Melting Point/freezing point:	Not available
Boiling Point:	<100°F
Flash Point and Method:	<60°F to >200°F / Pensky-Martens Closed Cup Tester
Evaporation Rate:	Slower (N-Butyl Acetate =1)
Flammable Limits:	(approximate % Volume in air) Lower: 1.0 Upper: 7.0
Vapor Pressure:	0-724 mm Hg
Specific Gravity:	0.7-1.0 (H_2O=1.0)
Vapor Density	1.5-3.0 (Air=1)
Solubility:	Slight (in water)
Partition coefficient (n-octanol/water):	2-6
Auto ignition temperature	>500 °F
Decomposition temperature	Not available
Viscosity	Not available

10. Stability and Reactivity

Stability: Stable
Hazardous polymerization: Will not occur
Conditions and Materials to Avoid: Avoid heat, sparks, flame and contact with strong oxidizing agents.
Hazardous Decomposition Products: Thermal decomposition products are highly dependent on the combustion conditions. A complex mixture of airborne, solid, liquid, particulates and gases will evolve when this material undergoes pyrolysis or combustion. Carbon monoxide and other unidentified organic compounds may be formed upon combustion.

11. Toxicological Information

Acute toxicity - Ingestion may cause irritation of the mouth, throat & gastrointestinal tract leading to nausea, vomiting, diarrhea and restlessness. Vapors can be harmful or fatal if inhaled. Exposure may result in central nervous system (CNS) depression. Early to moderate CNS depression may be evidenced by giddiness, headache, dizziness and nausea; in extreme cases, unconsciousness and death may occur.

Skin corrosion/irritation - Based on the presence of light hydrocarbons, crude oil is presumed to be moderately irritating to the skin. Prolonged and repeated contact may cause various skin disorders such as dermatitis, folliculitis, oil acne, or skin tumors.

Eye damage/irritation - Based on the presence of light hydrocarbons, crude oil is presumed to be moderately irritating to the eyes.

Sensitization - Not known to cause respiratory or skin sensitization

Germ cell mutagenicity – Information not available

Carcinogenicity – May contain benzene which is a confirmed human carcinogen (leukemia). Also, several long term skin painting studies in experimental animals have shown crude oil to produce skin cancer.

Reproductive toxicity – Not a known reproductive toxin

Specific Target Organs/Systemic Toxicity – Blood/bone marrow, nervous system, respiratory system, eyes

Aspiration hazard – Aspiration of this product into the lungs can cause chemical pneumonia and can be fatal. Aspiration can occur while vomiting after ingestion of this product. Aspiration pneumonitis may be evidenced by coughing, labored breathing and cyanosis (bluish skin); in severe cases death may occur.

12. Ecological Information

Coating action of oil can kill birds, plankton, algae and fish. Keep out of all bodies of water and sewage drainage systems.

13. Disposal Considerations

This product, as produced, is not specifically listed as an EPA RCRA hazardous waste according to 40 CFR 261. However, when disposed of, it may meet the criteria of a "characteristic" hazardous waste (e.g. D001 – ignitable). This product could also contain benzene and could be considered hazardous because it exhibits the characteristic of "toxicity." It is the responsibility of the user to determine if the material is considered hazardous for disposal under federal, state and local regulations.

14. Transportation Information

Department of Transportation Classification: Flammable liquid if flash point <200°F.
D.O.T. proper shipping name: Crude Oil Petroleum
Other Requirements: UN 1267
Hazard Class: 3
Packing Group II

15. Regulatory Information

TSCA This product is listed on the TSCA chemical inventory.

SARA Section 302 This product does not contain any components on the EPA's extremely hazardous substance list.

SARA Section 304 This product may contain the following component(s) which in the event of a spill may be subject to SARA reporting requirements: toluene, xylene, hexane, benzene.

SARA Section 311/312 The following hazard categories apply to this product:
Acute health hazard
Chronic health hazard
Fire hazard

SARA Section 313 This product may contain the following component(s) which may be subject to reporting on a toxic release inventory: toluene, xylene, hexane, benzene.

EPA-CWA Spills into or leading to surface waters that cause a sheen must be reported to the National Response Center, 800-424-8802.

16. Other Information

Date Prepared:	August 29, 2008
Revised:	October 30, 2013
Last Reviewed:	October 30, 2013

Disclaimer:

The information and recommendations contained in this SDS are believed to be accurate at the date of its preparation. Whiting Oil and Gas Corporation makes no representations or warranties, express or implied, with respect to the accuracy or completeness of the information contained herein. Whiting Oil and Gas Corporation assumes no responsibility for incorrect handling or use of the product or the inherent hazards in the product itself.

MATERIAL SAFETY DATA SHEET

Crude Oil

MSDS Number: HP012
Issue Date: 1/08
Revision: 12-14-12

CHEMICAL PRODUCT AND COMPANY IDENTIFICATION - SECTION 1

Company Identification: Hiland Crude
302 N. Independence, Suite 100
Enid, OK 73702

FOR CHEMICAL EMERGENCY, SPILL LEAK, FIRE, EXPOSURE, OR ACCIDENT:
In the continental U.S., call: Daytime: (580) 242-6040
After Hours: (800) 495-0653
For additional non-emergency information, call: (580) 616-2024

Product Name: Crude Oil
CAS Number: 8002-05-9
Synonym(s): Crude Petroleum
Chemical Formula: Mixture

COMPOSITION/ INFORMATION ON INGREDIENTS - SECTION 2

Chemical Name	OSHA PEL (ppm)	ACGIH TLV (ppm)	Other (ppm)	CAS Number	% By Weight
Petroleum Crude Oil	500 ppm	350 mg/m^3	1100 ppm IDLH	8002-05-9	95 - 100
Benzene	10 ppm	0.5 ppm	2.5 STEL	71-43-2	0 - 2

Note: *These analytical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.*

HEALTH EFFECTS SUMMARY - SECTION 3

The following information summarizes human experience and results of scientific investigations reviewed by health professionals for hazard evaluation of and development of Precautionary Measures and Occupational Control Procedures recommended in this document.

Primary Route of Entry: Dermal contact and ingestion.
Medical Conditions Which Might be Aggravated: Preexisting skin, eye and respiratory disorders may be aggravated by exposure.
Acute Exposure Effects:

1. **Skin:** Prolonged or repeated liquid contact can cause dermatitis, folliculitis or oil acne.
2. **Eyes:** Irritation.
3. **Inhalation:** Irritation
4. **Ingestion:** May be toxic.

EMERGENCY AND FIRST AID PROCEDURES - SECTION 4

Skin: Remove contaminated clothing. Wash with soap and large amounts of water. If irritation develops, obtain medical attention.
Eyes: Flush eyes with water for at least 15 minutes. Get medical attention if irritation persists.
Inhalation: Move to fresh air. Provide artificial respiration if not breathing. Get medical attention if breathing becomes difficult or respiratory irritation persists.
Ingestion: Do not induce vomiting! Do not give liquids! Obtain immediate medical assistance.

FIRE PROTECTION INFORMATION - SECTION 5

Flash Point: 20 - 100° F
Auto ignition Temperature: Not Determined.
Combustibility: Not Determined
Flammable Limits in Air, % by Volume: LEL: Not determined UEL: Not determined
Extinguishing Media: Use dry chemical, foam or carbon dioxide to extinguish flames.
Special Fire Fighting Procedures: Avoid using water streams. Firefighters should wear proper protective equipment and self-contained breathing apparatus.
Unusual Fire and Explosive Hazards: Can be ignited by heat, spark, or flame. Do not expose to heat, sparks, flame, static, or other sources of ignition.

ACCIDENTAL RELEASE MEASURES - SECTION 6

Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Notify appropriate local, state and federal agencies. Protect bodies of water.

HANDLING AND STORAGE PROCEDURES - SECTION 7

Handle as a flammable liquid. Keep away from heat, sparks, flame, and other sources of ignition. Bond and ground containers during product transfer.

OCCUPATIONAL CONTROL PROCEDURES - SECTION 8

Eye Protection: Wear chemical type goggles or face shield.
Skin Protection: Neoprene or nitrile gloves to prevent skin contact.
Respiratory Protection: Not required under normal conditions.
Ventilation: Use explosion-proof equipment to maintain adequate ventilation to meet occupational exposure limits.

PHYSICAL PROPERTIES - SECTION 9

Appearance: Clear colorless liquid
Odor: Similar to Gasoline
Boiling Point: -20° to 600° F (-29° to 316° C)
Vapor Density: 3.4 (Air = 1).
Viscosity: Not Determined
Specific Gravity: .5 to .75 (Water = 1)
Solubility in Water (wt. %): No
Solubility in Other Solvents: Hydrocarbons

Note: *These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.*

PHYSICAL PROPERTIES - SECTION 9

Appearance: Amber, black, brown to greenish black liquid
Odor: Hydrocarbon
Boiling Point: 100° to 1000° F
Vapor Density: 3 to 5 (Air = 1).
Viscosity: Not Determined
Specific Gravity: .7 to .9 (Water = 1)
Solubility in Water (wt. %): No
Solubility in Other Solvents: Not determined

Note: *These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.*

REACTIVITY DATA - SECTION 10

Stability: Stable under normal conditions.
Incompatibility: Strong oxidizers.
Hazardous Decomposition Products: Combustion may produce carbon monoxide, aldehydes, or other hydrocarbons.
Hazardous Polymerization: Polymerization will not occur.

TOXICOLOGY INFORMATION - SECTION 11

Toxicity: Skin – rabbit; >2 ml/kg
Inhalation – No data available
Oral – rat; >5 gm/kg
Teratogenicity: Not established.
Reproductive Toxicity: Not established.
Mutagenicity: Some crude oils have been positive.
Synergistic Products: Not established.
Sensitization to Product: Not established.
Carcinogenicity: Dermal carcinogenicity positive in mice:

NTP	IARC	OSHA
No	No	No

ECOLOGICAL INFORMATION - SECTION 12

Keep out of sewers, drainage and waterways.

DISPOSAL CONSIDERATIONS - SECTION 13

Dispose of container and unused contents in accordance with federal, state and local requirements.

TRANSPORTATION INFORMATION - SECTION 14

DOT
Proper Shipping Name: Petroleum Crude Oil
Hazard Class/I.D. No./Packing Group: 3, UN 1267, I
Label: Flammable liquid

EMERGENCY RESPONSE GUIDEBOOK – Guide 128

REGULATORY INFORMATION - SECTION 15

TSCA Inventory: No

Reportable Quantity (RQ) Under US EPA CERCLA Regulations: Film or sheen upon or discoloration of any water surface.

SARA Hazard Notification Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370): Yes

Section 313 Toxic Chemical(s): Yes - Benzene

Hazardous Chemical(s) Under OSHA Hazard Communication Standard: Yes.

OTHER INFORMATION - SECTION 16

Hazard Ratings:

NFPA	HMIS
Fire – 3	**Health** – 1
Health – 1	**Flammability** – 3
Reactivity – 0	**Reactivity** – 0
Specific Hazard – N/A.	**PPE** – Neoprene or nitrile gloves

To the best of our knowledge, the information contained herein is accurate. However, neither Hiland Partners, nor any of its subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.