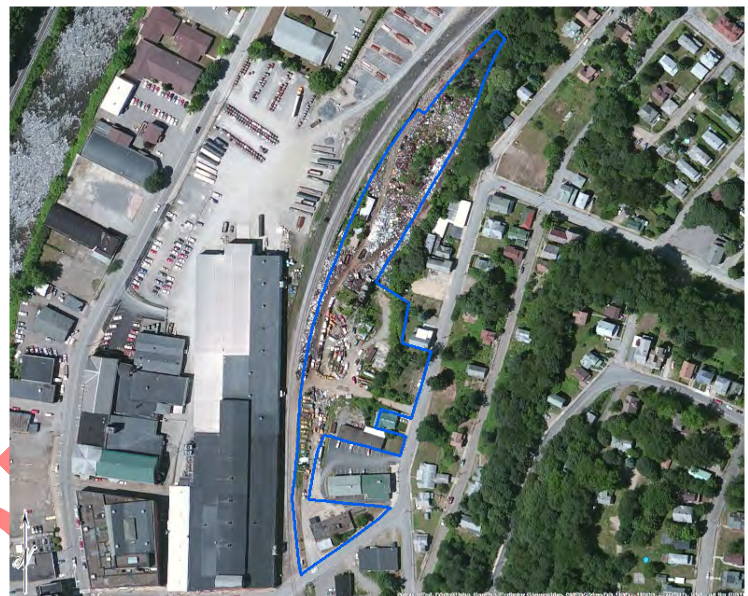
DRAFT - ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES – PRELIMINARY EVALUATION

U.S. EPA Brownfields Site-Specific Assessment Grant #95301801
Kraft Dahlstrom Site
58 Spruce Street
Oil City, Venango County, Pennsylvania
Moody Project No. 23-005 MM
October 27, 2023

Prepared for and submitted to:
Oil Region Alliance of Business, Industry & Tourism
217 Elm Street
Oil City, PA 16310-1412

U.S. EPA, Region 3, 3MD70
1650 Arch Street
Philadelphia, PA 19103-2029



Prepared by:

Stephen Roberts, G.I.T.
Assistant Project Manager

Reviewed by:

Mark B. Miller, P.G.
Senior Associate

Moody AND ASSOCIATES, INC. Groundwater and Environmental Professionals Since 1891

11548 Cotton Road, Suite 101 • Meadville, PA 16335 • Phone: 814.724.4970 • Fax: 814.724.4973 • www.moody-s.com

ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES
PRELIMINARY EVALUATION
U.S. EPA Brownfields Site-Specific Assessment Grant #95301801
Kraft Dahlstrom Site
Oil City, Venango County, Pennsylvania

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

ANALYSIS OF BROWNFIELDS CLEANUP ALTERNATIVES
PRELIMINARY EVALUATION
U.S. EPA Brownfields Site-Specific Assessment Grant #95301801
Kraft Dahlstrom Site
Oil City, Venango County, Pennsylvania

I. INTRODUCTION & BACKGROUND

a. Site Location and Description

This Analysis of Brownfields Cleanup Alternatives – Preliminary Evaluation (ABCA) has been prepared by Moody and Associates, Inc. (Moody) on behalf of the Oil Region Alliance of Business, Industry and Tourism (ORA) for the Kraft Dahlstrom Site located at 58 Spruce Street in Oil City, Venango County, Pennsylvania, hereinafter referenced as the subject site. The subject site consists of approximately 3.79 acres situated on six parcels, identified as Venango County tax parcel numbers 16.034-140..-000, 16.034-154..-000, 16.034-155..-000, 16.034-161..-000, 16.034-164..-000, and 16.034-149..-000. Parcel 16.034-140..-000 was previously Gil E Dahlstrom Iron & Metal and will herein be referenced as the Dahlstrom parcel. Parcels 16.034-154..-000, 16.034-155..-000, 16.034-161..-000, 16.034-164..-000, and 16.034-149..-000 were previously owned by Kraft Concrete Products and will herein be referenced as the Kraft parcels. First development of the subject site is unknown but appears developed as early as 1886 in historical records. The subject site has historically been used for railroad operations, lumber supplies, concrete block manufacturing, cigar manufacturing, dry cleaning, and as a scrap yard. The subject site is currently unutilized, but remnants of the scrap yard operations along with vacant buildings remain on the subject site.

FIGURE 1 represents a portion of the Oil City, Pennsylvania, United States Geological Survey (USGS) 7 ½ Minute Topographic Map illustrating the location of the subject site. FIGURE 2 is an aerial photograph showing the approximate subject site property boundaries, neighboring properties, and other relevant features.

There are 2 buildings remaining on the subject site, while 4 buildings have been demolished as part of assessment and remedial activities. Descriptions of the buildings are as follows:

- The building to the north of the Club (former dry-cleaning building) was built in circa 1963 and contains offices and garage/storage areas. The building was originally utilized as a dry-cleaner until circa 1968. It was later converted to office space for the concrete block manufacturing company. The building contains a suspended AST that was empty upon inspection. Drainage features in the western end of the building concrete are indicative of possible dry-cleaning operations in the building in the past.

- Two buildings were present on the northwestern portion of the property on the Dahlstrom property. The southern building was the previous office and scale house (Dahlstrom office building) and contained files and assorted debris on the floor throughout the building. The Dahlstrom office building is still present at the subject site. The northern building was a garage (Dahlstrom garage) for the scrap yard and contained approximately two feet of scrap on the floor throughout the building. The Dahlstrom garage building was demolished in circa 2021. A homemade smelter was observed in the northwest corner of the Dahlstrom garage building which had an exhaust pipe exiting the western wall.

- Two buildings were previously present in the middle of the subject site on the Kraft property. The southern building was an old office building (office building) with a collapsed roof. The northern building was an old boiler room (boiler room building) for concrete manufacturing. These buildings were demolished in circa 2021 as part of assessment and remedial activities.

- An additional building was present at the very southern edge of the subject site from circa 1906 to 2022 when it was demolished to allow for additional site characterization. The building (concrete block manufacturing building) contained shop areas, the old office space and furnace areas for curing concrete blocks. The building has been utilized for wood manufacturing until circa 1963 when it started being utilized for concrete block manufacturing. A floor drain was present in the shop area which reportedly discharged to municipal sewer.

The subject site buildings are connected to the municipal public water supply and sanitary sewer systems if either was utilized in the specific building. There are no known water wells or septic located on the property.

The adjoining property to the west is railroad property and the Webco Industries plant is located to the west of the railroad. The adjoining property to the north and west of the Dahlstrom property is railroad easement property. The adjoining properties to the east are residential and the adjoining properties to the south are commercial.

The subject site is located within the High Plateau Section of the Appalachian Plateaus Physiographic Province of Pennsylvania. The High Plateau Section is characterized by broad, rounded to flat uplands having deep, angular valleys. According to the Pennsylvania Geological Survey publication entitled Geologic Map of Pennsylvania (1980), the bedrock underlying the subject site is made up of the Corry Sandstone through Riceville Formation, Undivided, the Cuyahoga Group, and the Shenango Formation. The Corry Sandstone through Riceville Formation, Undivided consists of sandstone, siltstone, and shale; mostly light to dark gray, but some sandstone is greenish yellow, and a few reddish shales occur. The Cuyahoga Group consists of medium-gray siltstone and dark-gray shale containing interbedded light-gray, flaggy sandstone. The Shenango Formation consists of light-gray sandstone and some beds of medium-gray shale and siltstone; upper third of formation is more shaly.

The subject site is relatively flat-lying. The subject site lies at an approximate elevation of 1010 feet above mean sea level (msl). Shallow groundwater in this area is generally expected to flow to the west toward Oil Creek, which is located approximately 600 feet to the west of the subject site at an approximate elevation of 985 feet above msl.

b. Forecasted Climate Conditions

According to the US Global Change Research Program (USGCRP), climate trends for the northeast region of the United States include increased temperatures with more frequent, intense and longer heat was, increased precipitation with greater variability, increased extreme precipitation events, and rises in sea level. The *Impacts, Risks, Adaptation in the United States: Fourth National Climate Assessment, Volume II* Chapter 18: Northeast is included as APPENDIX A. Some of these factors, most specifically increased precipitation that may affect flood waters and stormwater runoff, are most applicable to the cleanup of the subject site.

The subject site is not in a Federal Emergency Management Agency (FEMA) flood hazard area. The FEMA FIRM Panel image showing the flood hazard areas in the vicinity of the subject site is included in APPENDIX B.

The subject site currently does not have stormwater management. Under current subject site conditions, increased precipitation and extreme weather could result in additional stormwater runoff and potential erosion which may mobilize contamination found in surface soils at the subject site.

Based on the nature of the subject site and its proposed reuse, changing temperature, rising sea levels, wildfires, changing dates of ground thaw/freezing, changing ecological zone, saltwater intrusion and changing groundwater table are not likely to significantly effect the subject site.

c. Site Assessment Findings

Prior to taking ownership of the subject site, the ORA hired Moody to prepare an ASTM Phase I Environmental Site Assessment (ESA) for the subject site, dated January 29, 2021. The ASTM Phase I ESA identified the following Recognized Environmental Concerns (RECs) for the subject site:

- The historical use of the subject site for railroad operations is considered to be a REC.
- The unidentified pipe existing the bank to the east of the old concrete block garage foundation is considered to be a REC.
- The four reported USTs at the subject site are considered to be a REC.
- The presence of a former dry-cleaning facility along with an empty AST and drainage features in the concrete of the former dry-cleaning building is considered to be a REC.
- The reported pile of approximately 100 car batteries between the Dahlstrom office and the Dahlstrom garage with battery acid dumped to the ground surface is considered to be a REC.
- The three homemade smelters present on the Dahlstrom property and associated burnt waste on the ground is considered to be a REC.
- The solvent plume on the Webco site originating from an upgradient source is considered to be a REC.
- The scrap piles extending from the northern edge of the former dry-cleaning building to the northern extent of the subject site containing 55-gallon drums, waste from oil and gas operations, gas tanks, car batteries, and other unknown components is considered to be a REC.
- Firsthand historical observation by Moody personnel of oil staining from drums leaking/dumping to the surface on the Kraft property is considered to be a REC.
- Petroleum staining in numerous locations on the Kraft and Dahlstrom properties north of the former dry-cleaning building is considered to be a REC.

An EPA Sampling and Analysis Plan (SAP) dated May 12, 2021 was generated to address the RECs related to the Kraft parcels. An Amended SAP dated May 6, 2022 was generated to address all RECs at the subject site including the Kraft and Dahlstrom parcels. The Amended SAP is included in APPENDIX C. The following Phase II assessment work has been completed at the subject site to address the identified RECs and to help characterize the contamination at the subject site:

- Scrap piles and debris were removed to ground surface on the Dahlstrom parcel and disposed of offsite.
- The concrete block manufacturing building was demolished to allow for further site characterization and the demolition debris was disposed of offsite.
- Ten monitoring wells were installed at the subject site to characterize subsurface soils and groundwater. Soil samples were taken from each boring and analyzed for metals and volatile/semi-volatile organic compounds (organics). One round of groundwater samples has been collected from these monitoring wells to date. The groundwater samples were analyzed for the same parameters.
- Three additional borings were advanced at the subject site to assess subsurface soils. These borings were not converted into permanent monitoring wells and no groundwater samples were obtained from these borings.
- Twelve surface soil samples were collected at the subject site. The locations of these surface soil samples were chosen to assess the RECs outlined in the ASTM Phase I ESA.
- UST locations identified in the ASTM Phase I ESA were investigated to determine if tanks were present and if tanks were present whether they were regulated under Pennsylvania Chapter 245 Administration of the Storage Tank and Spill Prevention Program Regulations.
    - Trenches were dug in suspected areas of buried USTs. No USTs were found by this method.
    - An identified UST on the north wall of the boiler room building was determined to be unregulated and was disposed of offsite. Soil samples were obtained below the tank and the results were below the regulatory action limits.
    - An identified UST on the eastern edge of the demolished concrete block manufacturing building was excavated and disposed of offsite. The tank was determined to be unregulated. Soil samples were obtained below the tank and the results indicated organic constituents above regulatory action levels in the soils. Free product was also observed in the bottom of the excavation.

- The tenth monitoring well installed at the subject site was located immediately downgradient of the UST east of the demolished concrete block building. A subsurface soil sample and a groundwater sample was collected from this monitoring well and the results were below the regulatory action limits.

- And X-Ray Fluorescence (XRF) meter was utilized to assess surface soils at the subject site. A grid with 40 foot centers was laid out across the subject site and XRF readings were recorded at each grid center location.

Summary tables showing analytical results of Phase II assessment sampling are included as TABLES 1-4. FIGURE 2 is an aerial photograph showing sample locations, property boundaries including the division between the Dahlstrom and Kraft parcels, and other relevant subject site features.

A meeting with the Pennsylvania Department of Environmental Protection was held on September 29, 2023 to present and discuss the Phase II assessment work. Data and mapping was presented to the PADEP prior to the meeting. Following the meeting with the PADEP a Phase II Assessment Report was completed. The following is a summary of the conclusions of the Phase II Assessment Report.

Results of Phase II assessment work show heavy concentration of metals in soils on the Dahlstrom parcel. Metals above regulatory action levels include Antimony, Arsenic, Copper, Lead, Nickel, Zinc and Mercury. On the Kraft parcels, Arsenic is found in soils above regulatory action levels, but at lower levels. It is expected that the Arsenic concentrations on the Kraft parcels will be addressed through the qualitative risk assessment and that direct contact will not have unacceptable risk to receptors. Lead concentrations decrease to below current regulatory action levels on the Kraft parcels. The PADEP is currently evaluating the regulatory action levels for Lead and has published the proposed new values. Surface soil samples obtained on the western portion of the Kraft parcels at SS-4 and SS-6 would exceed the proposed regulatory action levels for Lead.

Organic constituents were found above regulatory action levels in soils underneath the removed UST east of the demolished concrete block manufacturing building. Organic constituents were also found above regulatory action levels in soils at MW-4 which was installed east of the office building. MW-4 was the only monitoring well with reported organic constituents above regulatory action levels in groundwater.

Additional site characterization work was proposed at the September 29, 2023 PADEP meeting to further characterize groundwater. No additional site characterization work was proposed or requested for soils.

d. Project Goal

The planned reuse for the subject site is mixed use. Site reuse planning incorporates new building construction for education and commercial businesses (including restaurants and local retailers), parking lots to support these additions, truck traffic tying the subject site into the adjoining Webco Industries plant utilizing the current scale house (Dahlstrom office building), recreational areas and greenspace, and a bike path that would move the Erie to Pittsburgh Trail off of roadways and through the subject site. Compelling to the ORA in the identification of this subject site for a brownfields project is the recognizably detrimental impact to the adjacent neighborhood. The subject site, with its wall of salvage material and decrepit buildings, had formed a border to Blocks #1 and #2 of Census Tract 2007.00, resulting in significant disinvestment in the community. This area is designated a Federal Opportunity Zone and is documented as the poorest tract in Venango County with 65% Low-to-Moderate income percentage of 64.48% in Block #1 and 71% in Block #2. Remediation of the contamination at this subject site is the first step for the neighborhood to work toward a comprehensive revitalization plan, a plan which would address safe access to food sources and a safe, clean playground area where none currently exists.

The property is not zoned for single family dwellings and the ORA does not foresee any future residential use of the property.

II. APPLICABLE REGULATIONS AND CLEANUP STANDARDS

a. Cleanup Oversight Responsibility

The cleanup will be overseen by the Pennsylvania Department of Environmental Protection (PADEP). A Notice of Intent to Remediate (NIR) was submitted to the PADEP and the subject site was entered into Pennsylvania's Voluntary Cleanup Program (VCP) known as the Land Recycling Program (Act 2) on September 27, 2023. The PADEP eFACTS Facility ID associated with the subject site is 869478.

b. Cleanup Standards for Major Contaminants

The ORA currently anticipates that the PADEP Act 2 Site-Specific Standard will be utilized to obtain liability protection and site closure at the subject site. The Site-Specific Standard requires a Cleanup Plan and a Risk Assessment Report that will determine acceptable risks at the subject site for a multitude of receptors through complete exposure pathways, including recreational users. Institutional/engineering controls and activity use limitations are anticipated as part of the Site-Specific Standard site closure and would be detailed in the Cleanup Plan.

c. Laws & Regulations Applicable to the Cleanup

Laws and regulations that are applicable to this cleanup include the Federal Small Business Liability Relief and Brownfields Revitalization Act and the Pennsylvania Land Recycling Program Act 2. Federal, state, and local laws regarding procurement of contractors to conduct the cleanup will be followed. Under Act 2, a PADEP approved Cleanup Plan will be required prior to implementation of the preferred alternative.

III. CLEANUP ALTERNATIVES

a. Cleanup Alternatives Considered

Phase II assessment of groundwater and soils has been conducted at the subject site. Additional assessment of groundwater has been proposed during a September 29, 2023 PADEP meeting. No additional assessment of soils was proposed or requested during the meeting. The PADEP concurs that sufficient characterization work has been completed to date or will be completed by July 15, 2024 to justify the cleanup alternatives presented in this report.

The proposed reuse of the subject site is mixed use. The subject site reuse planning incorporates new building construction for education and commercial businesses (including restaurants and local retailers), parking lots to support these additions, truck traffic tying the subject site into the adjoining Webco Industries plant utilizing the current scale house (Dahlstrom office building), recreational areas and greenspace, and a bike path that would move the Erie to Pittsburgh Trail off of roadways and through the subject site. Compelling to the ORA in the identification of this subject site for a brownfields project is the recognizably detrimental impact to the adjacent neighborhood. The subject site, with its wall of salvage material and decrepit buildings, had formed a border to Blocks #1 and #2 of Census Tract 2007.00, resulting in significant disinvestment in the community. This area is designated a Federal Opportunity Zone and is documented as the poorest tract in Venango County with 65% Low-to-Moderate income percentage of 64.48% in Block #1 and 71% in Block #2. Remediation of the contamination at this subject site is the first step for the neighborhood to work toward a comprehensive revitalization plan, a plan which would address safe access to food sources and a safe, clean playground area where none currently exists.

The proposed cleanup alternatives are mainly focused on addressing the soil contamination at the subject site to allow for the proposed reuse. Based on current Phase II assessment work, groundwater is expected to be addressed through monitoring and institutional controls and is not included in the proposed cleanup alternatives.

Addressing the soil contamination at the subject site includes removing the direct contact exposure pathway that is known to exist on the Dahlstrom parcel and western portion of the Kraft parcels, addressing the contaminated soils found during removal of the UST near the demolished concrete block manufacturing building, and allowing for the redevelopment of recreational, commercial, industrial uses along with greenspaces.

To address contamination at the subject site, five different alternatives were considered, including Alternative #1: No Action, Alternative #2: Soil and Asphalt Cap, and Alternative #3: Bulk Excavation with Offsite Disposal.

b. Evaluation of Cleanup Alternatives

To satisfy EPA requirements, the effectiveness, implementability, and cost of each alternative must be considered prior to selecting a recommended cleanup alternative.

<ins>Effectiveness – Including Climate Change Considerations</ins>

- Alternative #1: No Action is inexpensive but not effective in controlling or preventing the exposure of receptors to contamination at the subject site.

- Alternative #2: Capping contaminated areas with a combination of soil and asphalt is more expensive than Alternative 1. This alternative is an effective way to prevent receptors from coming into direct contact with contaminated soils in the scrap metal area on the Dahlstrom parcel and western portion of the Kraft parcels, if the cap is maintained, and potentially an effective way to prevent vapor intrusion risk to receptors. Depending on the severity of vapor intrusion risk, installation of a sub-slab depressurization system within existing subject site buildings may still be required along with an institutional control recorded on the deed requiring vapor barriers on any new construction at the subject site in areas with vapor intrusion risk. While bulk excavation and offsite disposal the direct contact area is not a part of this alternative, minor hotspot excavation to remove contaminated soils in the location of the removed UST near the demolished concrete block manufacturing building would be included as part of this alternative. The subject site would require stormwater management including engineered drainage to meet state regulations based on the addition of a large impervious barrier and to maintain the integrity of the soil capped areas.

- Alternative #3: Bulk excavation with offsite disposal is the most expensive of all considered alternatives. This alternative is an effective way to eliminate risk at the subject site, since contamination will be removed and the majority of exposure pathways will no longer exist. Installation of a sub-slab depressurization system within existing subject site buildings and an institutional control recorded on the deed requiring vapor barriers on any new construction at the subject site may still be required in areas with vapor intrusion risk. The horizontal extent and depth of contamination at the subject site makes this alternative cost prohibitive.

General Climate Consideration Notes:
Part of the design planning is to manage the stormwater drain through the subject site to be discharged offsite to the southeast. Therefore, increased stormwater discharge due to greater storm intensity is not expected to impact the subject site with proper engineering.

<u>Implementability</u>

- Alternative #1: No Action is easy to implement since no actions will be conducted.

- Alternative #2: Capping with a mixture of soil and asphalt is relatively easy to implement, although ongoing monitoring and maintenance of the cap will require periodic coordination and reporting. This alternative may require the installation and monitoring of a sub-slab depressurization system on the existing site buildings and the implementation of a land use restriction on the property.

- Alternative #3: Bulk Excavation with Offsite Disposal is moderately difficult to implement. Coordination (e.g., dust suppression and monitoring) during cleanup activities and short-term disturbance to the community (e.g., trucks transporting contaminated soils and backfill) are anticipated. One consideration that may make excavation slightly more difficult to implement is the increased frequency of heavy rainfall events that has been experienced in recent years. Although efforts will be made to schedule the work in the dry weather months, the amount of precipitation over a short period of time from one of these heavy rainfall events could raise the groundwater level and increase dewatering needs.

Cost

- Alternative #1: No Action has minimal cost.

- Alternative #2: Capping with a mixture of soil and asphalt costs are estimated to be on the order of $1,000,000.

- Alternative #3: Bulk Excavation with Offsite Disposal is estimated to cost roughly $13,250,000. Costs for this alternative could increase if a heavy rainfall event occurs during remediation, increasing dewatering needs.

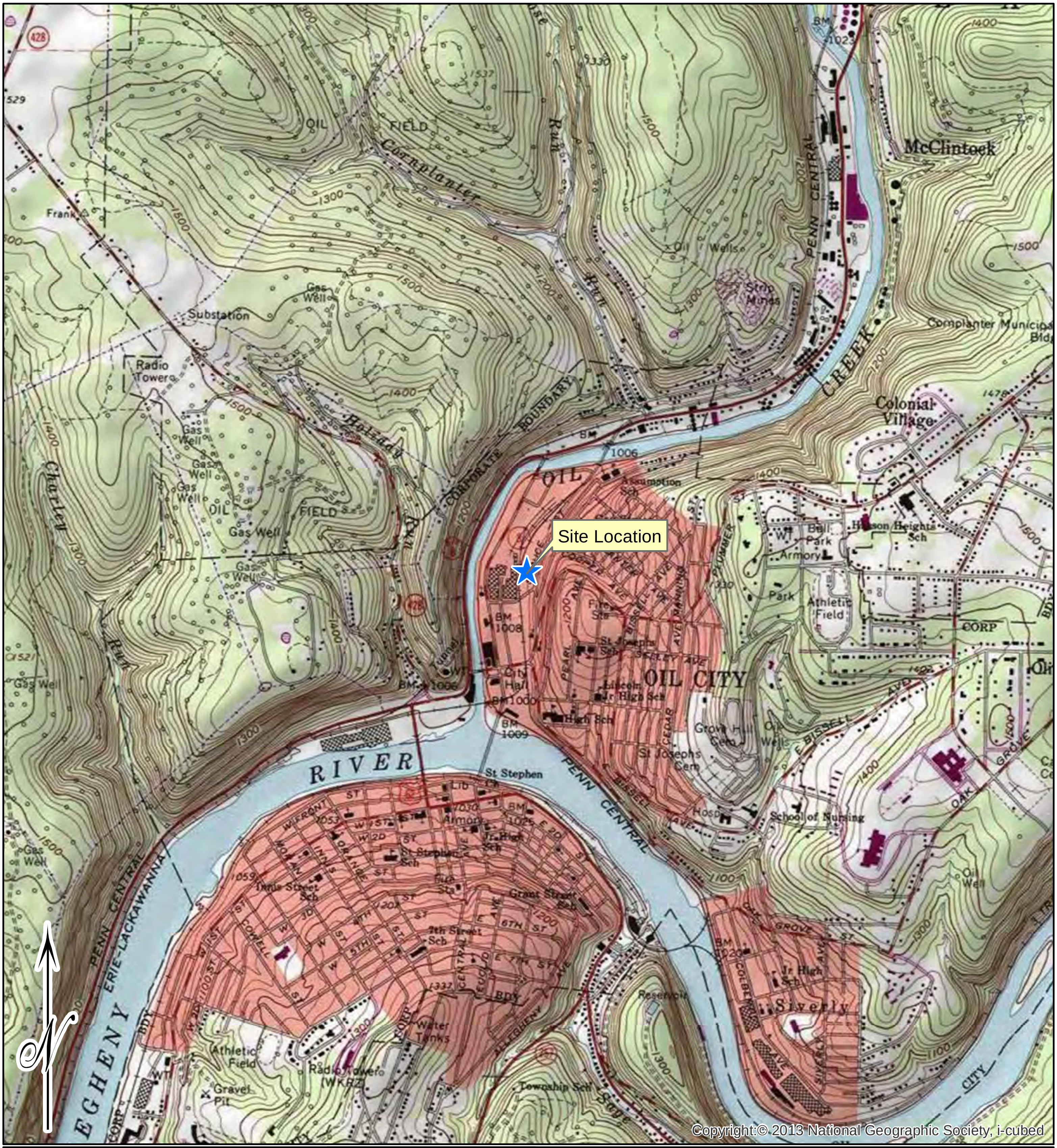
c. Recommended Cleanup Alternative

The recommended cleanup alternative is Alternative #2: Soil and Asphalt Cap. Alternative #1: No Action cannot be recommended since it does not address site risks. Alternative #3: Bulk Excavation with Offsite Disposal cannot be recommended as it is cost prohibitive.

Green and Sustainable Remediation Measures for Selected Alternative

To make the selected alternative greener, or more sustainable, several techniques are planned. The most recent Best Management Practices (BMPs) issued under ASTM Standard E-2893: Standard Guide for Greener Cleanups will be used as a reference in this effort. The ORA will require the cleanup contractor to follow an idle-reduction policy and use heavy equipment with advanced emissions controls operated on ultra-low sulfur diesel. The excavation work would be conducted during the dry-weather months (summertime) in order to minimize groundwater infiltration into the excavation area, in turn reducing dewatering needs and the amount of dewatering liquids requiring disposal/treatment. The number of mobilizations to the subject site would be minimized and erosion control measures would be used to minimize runoff into environmentally sensitive areas. In addition, the ORA plans to ask bidding cleanup contractors to propose additional green remediation techniques in their response to the Request for Proposals for the cleanup contract.

FIGURES



Legend

★ Site Location

Scale:
1 in = 2,000 ft

0 1,000 2,000
Feet

Prepared for:

Oil Region Alliance

Map Reference:

This exhibit is based on the ESRI USA Topographic Map. ESRI.com USGS Topographic 7.5' Quadrangle: Oil City, PA.

NAD 83 State Plane - PA North

FIGURE 1

Kraft and Dahlstrom Site

Project #: 20-222-MM

Drawn by:	Checked by:	Date:	Revision:
SMR		12/17/2020	0

11548 Cotton Road
Suite 101
Meadville, Pa 16335
814.724.4970 voice
814.724.4973 fax
www.moody-s.com

Moody and Associates, Inc.

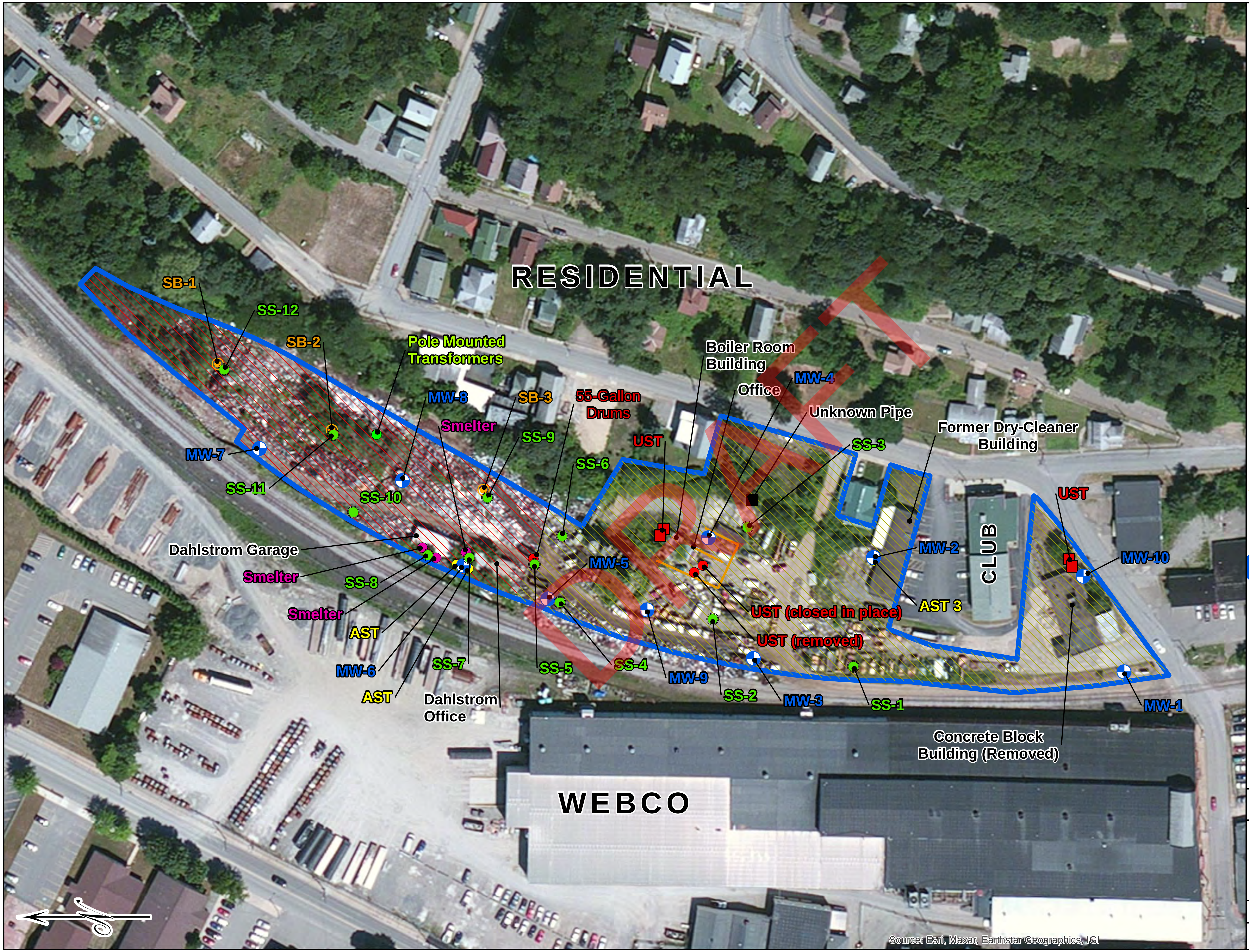


FIGURE 2

SITE FEATURES MAP

Kraft and Dahlstrom Site
Oil City, Pennsylvania

Prepared for:
Oil Region Alliance

LEGEND

- 55-Gallon Drums
- Pole Mounted Transformers
- AST
- Smelter
- Approximate UST Location
- Unknown Pipe
- Monitoring Well
- Soil Boring
- Surface Soil Sampling Location
- UST Sampling Location
- Trench
- DAHLSTROM PROPERTY
- KRAFT PROPERTY
- SUBJECT SITE

Map Reference:

This exhibit is based on the World Imagery - Esri and it's data suppliers

NAD 83 State Plane - PA North

Scale: 1 in = 100 ft

0 50 100
Feet

Project #: 20-257-MM

11548 Cotton Road
Suite 101
Meadville, PA 16335
(814) 724-4970
(814) 724-4973
www.moody-s.com

Drawn by:	Checked by:	Date:	Revision:
SMR		9/26/2023	0

TABLES

DRAFT

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Subsurface Soil Sampling Results
Comparison Against PADEP Standards

TABLE 1

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)														Selected Soil Standards					Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	SB-1	SB-2	SB-3	MW-10	DUP-1	Residential		Non-Residential				
		12-16'	8-12'	10-12'	12-14'	2-4'	12-14'	3-4'	2-3'	2-4'	7-8'	4-5'	4-5'			Used Aquifer Soil to Groundwater	Residential (0-15 FT)	Used Aquifer Soil to Groundwater	Direct Contact (0-2 FT)	Direct Contact (2-15 FT)		
		6/13/2022	6/13/2022	6/13/2022	6/15/2022	6/13/2022	6/14/2022	6/14/2022	6/14/2022	6/15/2022	6/14/2022	6/14/2022	6/14/2022	8/28/2023	8/28/2023						SV_{SOIL} (mg/kg)	SV_{SOIL} (mg/kg)
Metals																						
Antimony	7440-36-0	<5.5	<6.2	<5.7	<5.7	<6.8	<6.3	502	24.4	<6.2	<5.5	<6.3	<6.1	<5.9	<6.0	27	88	27	1,300	190,000	NS	NS
Arsenic	7440-38-2	13	9.3	8.5	18.7	23.5	23.6	73.0	77.6	18.7	6.2	17.7	26.5	12.8	14.1	29	12	29	61	190,000	NS	NS
Barium	7440-39-3	74.9	63.2	42.3	77.8	33.5	66.1	168	853	223	47.0	81.4	104	49	56.5	8200	44000	8200	190,000	190,000	NS	NS
Cadmium	7440-43-9	<1.1	<1.2	<1.1	<1.1	<1.4	<1.3	<1.4	19.6	<1.2	<1.1	<1.3	1.4	<1.2	<1.2	38	110	38	1,600	190,000	NS	NS
Chromium	7440-47-3	8.8	13.5	8.1	9.7	15.6	18.4	13.9	113	17	12.3	15.1	23.9	12.9	13.4	NS	NS	NS	NS	NS	NS	NS
Copper	7440-50-8	20.3	16.5	21.7	25.5	54.6	21.8	314	1930	54.5	14.0	49.4	164	17.4	17.7	43000	7200	43000	100,000	190,000	NS	NS
Lead	7439-92-1	13.3	12.1	8.4	39.8	13.2	26.8	2960	6400	393	16.3	28.1	266	15.4	15.9	450	500	450	1,000	190,000	NS	NS
Nickel	7440-02-0	15.2	16.7	10.1	17.1	17.9	23.4	17.8	170	20.4	19.6	21.5	43.5	19.5	19.3	650	4400	650	64,000	190,000	NS	NS
Selenium	7782-49-2	<5.5	<6.2	<5.7	<5.7	<6.8	<6.3	<7.0	22.4	<6.2	<5.5	<6.3	<6.1	<5.9	<6.0	26	1100	26	16,000	190,000	NS	NS
Titanium	7440-32-6	91.9	78.3	29.8	47.9	57.2	60.9	229	134	136	34.5	49.2	182	63.7	70.1	NS	NS	NS	NS	NS	NS	NS
Zinc	7440-66-6	53.5	47.4	34.8	54.0	59.9	78.2	92.7	3120	228	97.3	79.2	331	57.5	54.0	12000	66000	12000	190,000	190,000	NS	NS
Mercury	7439-97-6	<0.11	<0.12	<0.11	<0.11	<0.13	<0.12	0.44	3.2	1.1	<0.11	<0.12	0.50	<0.12	<0.12	10	35	10	510	190,000	NS	NS
VOCs																						
1,1,1-Trichloroethane	71-55-6	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	20	10000	20	10000	10000	7.2	7.4
1,1,2,2-Tetrachloroethane	79-34-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.084	7.6	0.43	38	44	0.026	0.13
1,1,2-Trichloroethane	79-00-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	0.017	<0.0048	<0.0046	0.5	3.8	0.5	16	18	0.15	0.15
1,1-Dichloroethane	75-34-3	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	3.1	280	16	1400	1600	0.75	3.9
1,1-Dichloroethene	75-35-4	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.7	3800	0.7	10000	10000	0.19	0.19
1,2,4-Trichlorobenzene	120-82-1	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	27	39	27	160	190	27	27
1,2,4-Trimethylbenzene	95-63-6	<0.0050	<0.0051	<0.0050	300	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	0.021	<0.0061	<0.0072	0.12	0.11	73	1100	300	4700	5400	73	300
1,2-Dichlorobenzene	95-50-1	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	60	3800	60	10000	10000	59	59
1,2-Dichloroethane	107-06-2	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	17	0.5	85	98	0.1	0.1
1,2-Dichloroethene (Total)	540-59-0	<0.0099	<0.010	<0.010	<5.32	<0.012	<0.011	<0.023	<0.012	<0.014	<0.0089	<0.012	<0.014	<0.0097	<0.0093	NS	NS	NS	NS	NS	NS	NS
1,2-Dichloropropane	78-87-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	0.12	0.5	0.6	0.69	0.11	0.11
1,3,5-Trimethylbenzene	108-67-8	<0.0050	<0.0051	<0.0050	106	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	0.007	<0.0061	<0.0072	0.040	0.039	23	1100	93	4700	5400	23	93
1,3-Dichlorobenzene	541-73-1	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	61	10000	61	10000	10000	NS	NS
1,4-Dichlorobenzene	106-46-7	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	10	40	10	200	230	10	10
2-Butanone (MEK)	78-93-3	<0.0099	0.079	<0.010	<5.32	<0.012	<0.011	<0.023	0.026	<0.014	<0.0089	<0.012	<0.014	<0.0097	<0.0093	400	10000	400	10000	10000	76	1100
2-Hexanone	591-78-6	<0.0099	<0.010	<0.010	<5.32	<0.012	<0.011	<0.023	<0.012	<0.014	<0.0089	<0.012	<0.014	<0.0097	<0.0093	6.3	570	26	2400	2700	1.6	6.4
4-Methyl-2-pentanone (MIBK)	108-10-1	<0.0099	<0.010	<0.010	<5.32	<0.012	<0.011	<0.023	<0.012	<0.014	<0.0089	<0.012	<0.014	<0.0097	<0.0093	280	10000	780	10000	10000	43	210
Acetone	67-64-1	0.055	0.057	0.055	<26.6	<0.060	0.093	<0.11	0.24	0.11	0.057	<0.061	<0.072	<0.048	<0.046	3100	10000	8800	10000	10000	350	4700
Benzene	71-43-2	<0.0050	<0.0051	<0.0050	2.67	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	57	0.5	280	330	0.13	0.13
Bromochloromethane	74-97-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	9	760	9	3200	3600	1.6	1.6
Bromodichloromethane	75-27-4	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	8	12	8	60	69	2.7	2.7
Bromoform	75-25-2	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	8	400	8	2000	2300	3.5	3.5
Bromomethane	74-83-9	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	1	95	1	400	460	0.54	0.54
Carbon disulfide	75-15-0	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	0.021	<0.011	<0.0059	<0.0071	0.012	<0.0061	<0.0072	<0.0048	0.0073	150	10000	620	10000	10000	130	530
Carbon tetrachloride	56-23-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	75	0.5	370	430	0.26	0.26
Chlorobenzene	108-90-7	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	10	950	10	3900	4500	6.1	6.1
Chloroethane	75-00-3	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	2100	10000	8800	10000	10000	450	1900
Chloroform	67-66-3	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	8	19	8	96	110	2	2
Chloromethane	74-87-3	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	3	250	3	1200	1400	0.38	0.38
Dibromochloromethane	124-48-1	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	8	220	8	1100	10000	NS	NS
Ethylbenzene	100-41-4	<0.0050	<0.0051	<0.0050	68.1	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	0.0050	0.0062	70	180	70	880	1000	46	46
Isopropylbenzene (Cumene)	98-82-8	<0.0050	<0.0051	<0.0050	8.21	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	0.0058	0.0061	600	7600	2500	10000	10000	600	2500
Methyl-tert-butyl ether	1634-04-4	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	2	1700	2	8500	9800	0.28	1.4
Methylene Chloride	75-09-2	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	1300	0.5	10000	10000	0.076	1.5
Naphthalene	91-20-3	<0.0050	<0.0051	<0.0050	26.1	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	0.0063	<0.0061	0.015	0.025	0.031	25	13	25	66	77	25	25
Styrene	100-42-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	24	10000	24	10000	10000	24	79
TOTAL BTEX		<0.030	<0.031	<0.030	615	<0.036	<0.034	<0.068	<0.036	<0.043	<0.027	<0.036	<0.043	0.030	0.034	NS	NS	NS	NS	NS	NS	NS
Tetrachloroethene	127-18-4	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	0.12	<0.0048	<0.0046	0.5	760	0.5	3200	3600	0.43	0.43
Toluene	108-88-3	<0.0050	<0.0051	<0.0050	17.5	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	100	10000	100	10000	10000	44	44
Trichloroethene	79-01-6	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.5	38	0.5	160	180	0.17	0.17
Vinyl chloride	75-01-4	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	0.2	0.93	0.2	61	290	0.027	0.027
Xylene (Total)	1330-20-7	<0.015	<0.015	<0.015	527	<0.018	<0.017	<0.034	<0.018	<0.021	<0.013	<0.018	<0.022	0.025	0.028	1000	1900	1000	7900	9100	990	990
cis-1,2-Dichloroethene	156-59-2	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	7	440	7	6400	10000	NS	NS
cis-1,3-Dichloropropene	10061-01-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	NS	NS	NS	NS	NS	NS	NS
m&p-Xylene	179601-23-1	<0.0099	<0.010	<0.010	388	<0.012	<0.011	<0.023	<0.012	<0.014	<0.0089	<0.012	<0.014	0.020	0.022	NS	NS	NS	NS	NS	NS	NS
o-Xylene	95-47-6	<0.0050	<0.0051	<0.0050	139	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	0.0050	0.0053	NS	NS	NS	NS	NS	NS	NS
trans-1,2-Dichloroethene	156-60-5	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	10	4400	10	10000	10000	NS	NS
trans-1,3-Dichloropropene	10061-02-6	<0.0050	<0.0051	<0.0050	<2.66	<0.0060	<0.0057	<0.011	<0.0059	<0.0071	<0.0045	<0.0061	<0.0072	<0.0048	<0.0046	NS	NS	NS	NS	NS	NS	NS
SVOCs																						
1,2,4-Trichlorobenzene	120-82-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	27	39	27	160	190	27	27
1,2-Dichlorobenzene	95-50-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	60	3800	60	10000	10000	59	59
1,3-Dichlorobenzene	541-73-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	61	10000	61	10000	10000	NS	NS
1,4-Dichlorobenzene	106-46-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10	40	10	200	230	10	10
1-Methylnaphthalene	90-12-0	<0.36	<0.40	<0.37	4.3	<4.3	<0.40	<4.7	0.47	<4.2	<0.36	<0.40	<4.0	0.99	0.93	NS	NS	NS	NS	NS	NS	NS
2,4,5-Trichlorophenol	95-95-4	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	2100	22000	5900	190000	190000	NS	NS
2,4,6-Trichlorophenol	88-06-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10	220	28	3200	190000	NS	NS
2,4-Dichlorophenol	120-83-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2	660	2	9600	190000	NS	NS
2,4-Dimethylphenol	105-67-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	69	4400	190	10000	10000	NS	NS
2,4-Dinitrophenol	51-28-5	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	6.9	440	NS	6400	190000	NS	NS
2,4-Dinitrotoluene	121-14-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.21	60	0.88	290	190000	NS	NS
2,6-Dinitrotoluene	606-20-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.043	12	0.18	61	190000	NS	NS
2-Chloronaphthalene	91-58-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	6000	18000	17000	190000	190000	NS	NS
2-Chlorophenol	95-57-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	4.4	1100	4.4	10000	10000	NS	NS
2-Methylnaphthalene	91-57-6	<0.36	<0.40	<0.37	10.7	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	1.7	1.6	25	57	100	240	270	25	100
2-Methylphenol(o-Cresol)	95-48-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	170	11000	490	160000	190000	NS	NS
2-Nitroaniline	88-74-4	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	0.011	0.95	0.044	3.9	4.5	0.83	17

DRAFT

TABLE 1

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Subsurface Soil Sampling Results
Comparison Against PADEP Standards

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)														Selected Soil Standards					Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	SB-1	SB-2	SB-3	MW-10	DUP-1	Residential		Non-Residential				
		12-16'	8-12'	10-12'	12-14'	2-4'	12-14'	3-4'	2-3'	2-4'	7-8'	4-5'	4-5'			Used Aquifer Soil to	Residential (0-15 FT)	Used Aquifer Soil to	Direct Contact (0-2 FT)	Direct Contact (2-15 FT)		
2-Nitrophenol	88-75-5	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	28	1800	78	26000	190000	NS	NS
3&4-Methylphenol(m&p Cresol)		<0.72	<0.81	<0.73	<0.73	<8.6	<0.81	<9.4	<0.90	<8.3	<0.73	<0.80	<8.0	<0.77	<0.79	NS	NS	NS	NS	NS	NS	NS
3,3'-Dichlorobenzidine	91-94-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	7.7	41	33	200	190000	NS	NS
3-Nitroaniline	99-09-2	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	NS	NS	NS	NS	NS	NS	NS
4,6-Dinitro-2-methylphenol	534-52-1	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	0.28	18	0.78	260	190000	NS	NS
4-Bromophenylphenyl ether	101-55-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	NS	NS	NS	NS	NS	NS	NS
4-Chloro-3-methylphenol	59-50-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	720	22000	2000	190000	190000	NS	NS
4-Chloroaniline	106-47-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.42	93	1.8	460	190000	NS	NS
4-Chlorophenylphenyl ether	7005-72-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	NS	NS	NS	NS	NS	NS	NS
4-Nitroaniline	100-01-6	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	3.3	880	14	4600	190000	NS	NS
4-Nitrophenol	100-02-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	6	1800	6	26000	190000	NS	NS
Acenaphthene	83-32-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2600	13000	4700	190000	190000	NS	NS
Acenaphthylene	208-96-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2400	13000	6600	190000	190000	NS	NS
Anthracene	120-12-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	350	66000	NS	190000	190000	NS	NS
Azobenzene	103-33-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	NS	NS	NS	NS	NS	NS	NS
Benzo(a)anthracene	56-55-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	26	6.1	340	130	190000	NS	NS
Benzo(a)pyrene	50-32-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	46	4.2	46	91	190000	NS	NS
Benzo(b)fluoranthene	205-99-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	25	3.5	170	76	190000	NS	NS
Benzo(g,h,i)perylene	191-24-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	180	13000	180	190000	190000	NS	NS
Benzo(k)fluoranthene	207-08-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	200	3.5	610	76	190000	NS	NS
Benzoic acid	65-85-0	<5.4	<6.1	<5.5	<27.5	<64.8	<6.1	<70.7	<6.8	<62.4	<5.5	<6.0	<60.2	<5.8	<5.9	14000	190000	39000	190000	190000	NS	NS
Benzyl alcohol	100-51-6	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	350	10000	970	10000	10000	NS	NS
Butylbenzylphthalate	85-68-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	**0.60**	<0.40	<4.0	<0.38	<0.40	2900	9800	10000	10000	10000	NS	NS
Carbazole	86-74-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	21	930	89	4600	190000	NS	NS
Chrysene	218-01-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	220	35	230	760	190000	NS	NS
Di-n-butylphthalate	84-74-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<3.1	<3.2	1400	10000	4000	10000	10000	NS	NS
Di-n-octylphthalate	117-84-0	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10000	2200	10000	10000	10000	NS	NS
Dibenz(a,h)anthracene	53-70-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	23	1	270	22	190000	NS	NS
Dibenzofuran	132-64-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	90	220	250	3200	190000	NS	NS
Diethylphthalate	84-66-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2800	10000	7800	10000	10000	NS	NS
Dimethylphthalate	131-11-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	NS	NS	NS	NS	NS	NS	NS
Fluoranthene	206-44-0	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	**5.1**	<0.38	<0.40	3200	8800	3200	130000	190000	NS	NS
Fluorene	86-73-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2800	8800	3800	130000	190000	NS	NS
Hexachloro-1,3-butadiene	87-68-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10	220	42	1200	10000	NS	NS
Hexachlorobenzene	118-74-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.96	12	NS	57	190000	NS	NS
Hexachlorocyclopentadiene	77-47-4	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	91	1300	91	10000	10000	NS	NS
Hexachloroethane	67-72-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.56	46	0.56	230	270	0.56	0.56
Indeno(1,2,3-cd)pyrene	193-39-5	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	1400	3.5	18000	76	190000	NS	NS
Isophorone	78-59-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10	10000	10	10000	10000	NS	NS
N-Nitroso-di-n-propylamine	621-64-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.0025	0.22	0.013	1.1	1.3	NS	NS
N-Nitrosodimethylamine	62-75-9	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.00014	0.012	0.0018	0.16	0.18	0.00015	0.0094
N-Nitrosodiphenylamine	86-30-6	<0.36	**0.53**	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	3	170	15	860	990	NS	NS
Naphthalene	91-20-3	<0.36	<0.40	**0.37**	**19.5**	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	25	13	25	66	77	25	25
Nitrobenzene	98-95-3	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.12	11	0.63	55	63	0.052	1.2
Pentachlorophenol	87-86-5	<0.89	<1.0	<0.92	<0.92	<10.8	<1.0	<11.8	<1.1	<10.4	<0.91	<1.0	<10.0	<0.96	<0.99	5	47	5	230	190000	NS	NS
Phenanthrene	85-01-8	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	**5.0**	**0.42**	**0.49**	10000	66000	10000	190000	190000	NS	NS
Phenol	108-95-2	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	200	3800	200	16000	18000	380	7900
Pyrene	129-00-0	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	2200	6600	2200	96000	190000	NS	NS
bis(2-Chloroethoxy)methane	111-91-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	10	660	29	9600	10000	NS	NS
bis(2-Chloroethyl) ether	111-44-4	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	0.015	1.3	0.076	6.7	7.6	0.0056	0.14
bis(2-Chloroisopropyl) ether	108-60-1	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	<0.36	<0.40	<4.0	<0.38	<0.40	30	44	30	220	250	8	8
bis(2-Ethylhexyl)phthalate	117-81-7	<0.36	<0.40	<0.37	<0.37	<4.3	<0.40	<4.7	<0.45	<4.2	**0.41**	**0.68**	<4.0	<0.38	<0.40	130	1300	130	6500	10000	NS	NS

Key:

BOLD	= Parameter was detected above the laboratory reporting limit
	= Exceeds PADEP Residential Soil to Groundwater MSC or Direct Contact MSC
	= Exceeds PADEP Non-Residential Soil to Groundwater MSC or Direct Contact MSC
	= Exceeds PADEP Residential Vapor Screening Value
	= Exceeds PADEP Non-Residential Vapor Screening Value
< 0.0077	= Denotes parameter not detected above laboratory reporting limit listed
NS	= No Standard Listed
NA	= Not Analyzed

DRAFT

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Groundwater Sampling Results
Comparison Against PADEP Standards

TABLE 2

Parameter	CAS	Regulated Substances in Ground Water (all results reported in mg/L)											Groundwater MSCs Used Aquifers TDS <= 2500 Residential (mg/L)	Groundwater MSCs Used Aquifers TDS <= 2500 Non-Residential (mg/L)	Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	DUP-1				
		8/10/2022	8/10/2022	8/10/2022	8/10/2022	8/11/2022	8/11/2022	8/11/2022	8/11/2022	8/10/2022	8/28/2023	8/28/2023			SV_{GW} (mg/L)	SV_{GW} (mg/L)
Metals																
Antimony	7440-36-0	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	0.006	0.006	NS	NS
Arsenic	7440-38-2	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	0.01	0.01	NS	NS
Barium	7440-39-3	**0.0419**	**0.182**	**0.0593**	**0.174**	**0.0769**	**0.130**	**0.170**	**0.231**	**0.0995**	**0.10**	**0.11**	2	2	NS	NS
Cadmium	7440-43-9	<0.0020	<0.0020	<0.0020	**0.0023**	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.005	0.005	NS	NS
Chromium	7440-47-3	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.1	0.1	NS	NS
Copper	7440-50-8	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.069**	<0.0050	1	1	NS	NS
Lead	7439-92-1	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.005	0.005	NS	NS
Nickel	7440-02-0	**0.0085**	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.021**	**0.019**	0.1	0.1	NS	NS
Selenium	7782-49-2	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	0.05	0.05	NS	NS
Titanium	7440-32-6	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	NS	NS	NS	NS
Zinc	7440-66-6	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	<0.0200	**0.0240**	<0.0200	<0.0200	**0.0500**	**0.0260**	2	2	NS	NS
Mercury	7439-97-6	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.002	0.002	NS	NS
VOCs																
1,1,1-Trichloroethane	71-55-6	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.2	0.2	12	160
1,1,2,2-Tetrachloroethane	79-34-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.00084	0.0043	0.054	0.82
1,1,2-Trichloroethane	79-00-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	0.011	0.14
1,1-Dichloroethane	75-34-3	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.031	0.16	0.11	1.6
1,1-Dichloroethene	75-35-4	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.007	0.007	0.3	3.8
1,2,4-Trichlorobenzene	120-82-1	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	**0.0045**	<0.0040	<0.0040	0.07	0.07	0.08	1
1,2,4-Trimethylbenzene	95-63-6	<0.0010	<0.0010	<0.0010	**1.2**	<0.0010	<0.0010	<0.0010	**0.0011**	**0.017**	<0.0010	<0.0010	0.13	0.53	0.51	6.4
1,2-Dichlorobenzene	95-50-1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.6	0.6	5.4	69
1,2-Dichloroethane	107-06-2	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	0.034	0.51
1,2-Dichloroethene (Total)	540-59-0	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	NS	NS	NS	NS
1,2-Dichloropropane	78-87-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	0.005	0.005
1,3,5-Trimethylbenzene	108-67-8	<0.0010	<0.0010	<0.0010	**0.34**	<0.0010	<0.0010	<0.0010	<0.0010	**0.0058**	<0.0010	<0.0010	0.13	0.53	0.36	4.5
1,3-Dichlorobenzene	541-73-1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.6	0.6	NS	NS
1,4-Dichlorobenzene	106-46-7	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.075	0.075	0.075	0.68
2-Butanone (MEK)	78-93-3	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	4	4	3900	49000
2-Hexanone	591-78-6	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.063	0.26	16	200
4-Methyl-2-pentanone (MIBK)	108-10-1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	2.8	7.8	1000	13000
Acetone	67-64-1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	31	88	37000	470000
Benzene	71-43-2	<0.0010	<0.0010	<0.0010	**0.52**	<0.0010	<0.0010	<0.0010	<0.0010	**0.0016**	<0.0010	<0.0010	0.005	0.005	0.023	0.35
Bromochloromethane	74-97-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.09	0.09	1.2	15
Bromodichloromethane	75-27-4	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.08	0.08	0.08	0.2
Bromoform	75-25-2	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.08	0.08	2	30
Bromomethane	74-83-9	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040	0.01	0.01	0.026	0.33
Carbon disulfide	75-15-0	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	1.5	6.2	2	25
Carbon tetrachloride	56-23-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	0.006	0.091
Chlorobenzene	108-90-7	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.0015**	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.1	0.1	0.76	9.6
Chloroethane	75-00-3	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	21	88	35	440
Chloroform	67-66-3	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.08	0.08	0.08	0.18
Chloromethane	74-87-3	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.03	0.03	0.053	0.81
Dibromochloromethane	124-48-1	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.08	0.08	NS	NS
Ethylbenzene	100-41-4	<0.0010	<0.0010	<0.0010	**0.67**	<0.0010	<0.0010	<0.0010	<0.0010	**0.0056**	<0.0010	<0.0010	0.7	0.7	0.7	0.86
Isopropylbenzene (Cumene)	98-82-8	<0.0010	<0.0010	<0.0010	**0.039**	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.84	3.5	1.9	24
Methyl-tert-butyl ether	1634-04-4	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.02	0.02	6.3	96
Methylene Chloride	75-09-2	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	7.6	95
Naphthalene	91-20-3	<0.0040	<0.0040	<0.0040	**0.072**	<0.0040	<0.0040	<0.0040	<0.0040	**0.013**	<0.0040	<0.0040	0.1	0.1	0.1	1.3
Styrene	100-42-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.1	0.1	18	220
TOTAL BTEX		<0.0060	<0.0060	<0.0060	**7.3**	<0.0060	<0.0060	<0.0060	<0.0060	**0.063**	<0.0060	<0.0060	NS	NS	NS	NS
Tetrachloroethene	127-18-4	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	**0.0010**	<0.0010	<0.0010	0.005	0.005	0.11	1.3
Toluene	108-88-3	<0.0010	<0.0010	<0.0010	**0.84**	<0.0010	<0.0010	<0.0010	<0.0010	**0.0057**	<0.0010	<0.0010	1	1	34	430
Trichloroethene	79-01-6	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.005	0.005	0.009	0.11
Vinyl chloride	75-01-4	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.002	0.002	0.002	0.053
Xylene (Total)	1330-20-7	<0.0030	<0.0030	<0.0030	**5.3**	<0.0030	<0.0030	<0.0030	<0.0030	**0.050**	<0.0030	<0.0030	10	10	10	12
cis-1,2-Dichloroethene	156-59-2	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.07	0.07	NS	NS
cis-1,3-Dichloropropene	10061-01-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	NS	NS	NS	NS
m&p-Xylene	179601-23-1	<0.0020	<0.0020	<0.0020	**4.0**	<0.0020	<0.0020	<0.0020	<0.0020	**0.036**	<0.0020	<0.0020	NS	NS	NS	NS
o-Xylene	95-47-6	<0.0010	<0.0010	<0.0010	**1.3**	<0.0010	<0.0010	<0.0010	<0.0010	**0.013**	<0.0010	<0.0010	NS	NS	NS	NS
trans-1,2-Dichloroethene	156-60-5	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.1	0.1	NS	NS
trans-1,3-Dichloropropene	10061-02-6	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	NS	NS	NS	NS

DRAFT

TABLE 2

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Groundwater Sampling Results
Comparison Against PADEP Standards

Parameter	CAS	Regulated Substances in Ground Water (all results reported in mg/L)											Groundwater MSCs Used Aquifers TDS <= 2500 Residential	Groundwater MSCs Used Aquifers TDS <= 2500 Non-Residential	Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	DUP-1				
SVOCs																
1,2,4-Trichlorobenzene	120-82-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.07	0.07	0.08	1
1,2-Dichlorobenzene	95-50-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.6	0.6	5.4	69
1,3-Dichlorobenzene	541-73-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.6	0.6	NS	NS
1,4-Dichlorobenzene	106-46-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.075	0.075	0.075	0.68
1-Methylnaphthalene	90-12-0	<0.0011	<0.0010	<0.00099	**0.0064**	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	NS	NS	NS	NS
2,4,5-Trichlorophenol	95-95-4	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	3.5	9.7	NS	NS
2,4,6-Trichlorophenol	88-06-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.035	0.097	NS	NS
2,4-Dichlorophenol	120-83-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.02	0.02	NS	NS
2,4-Dimethylphenol	105-67-9	<0.0011	<0.0010	<0.00099	**0.0070**	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.69	1.9	NS	NS
2,4-Dinitrophenol	51-28-5	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.069	0.19	NS	NS
2,4-Dinitrotoluene	121-14-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0021	0.0088	NS	NS
2,6-Dinitrotoluene	606-20-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00043	0.0018	NS	NS
2-Chloronaphthalene	91-58-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	2.8	7.8	NS	NS
2-Chlorophenol	95-57-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.04	0.04	NS	NS
2-Methylnaphthalene	91-57-6	<0.0011	<0.0010	<0.00099	**0.013**	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0063	0.026	0.38	4.8
2-Methylphenol(o-Cresol)	95-48-7	<0.0011	<0.0010	<0.00099	**0.0021**	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	1.7	4.9	NS	NS
2-Nitroaniline	88-74-4	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.00011	0.00044	69	870
2-Nitrophenol	88-75-5	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.28	0.78	NS	NS
3&4-Methylphenol(m&p Cresol)		<0.0021	<0.0020	<0.0020	<0.0022	<0.0021	<0.0021	<0.0021	<0.021	<0.0021	<0.0020	<0.0020	NS	NS	NS	NS
3,3'-Dichlorobenzidine	91-94-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0014	0.006	NS	NS
3-Nitroaniline	99-09-2	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	NS	NS	NS	NS
4,6-Dinitro-2-methylphenol	534-52-1	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.0028	0.0078	NS	NS
4-Bromophenylphenyl ether	101-55-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	NS	NS	NS	NS
4-Chloro-3-methylphenol	59-50-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	3.5	9.7	NS	NS
4-Chloroaniline	106-47-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0033	0.014	NS	NS
4-Chlorophenylphenyl ether	7005-72-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	NS	NS	NS	NS
4-Nitroaniline	100-01-6	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.033	0.14	NS	NS
4-Nitrophenol	100-02-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.06	0.06	NS	NS
Acenaphthene	83-32-9	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	2.1	3.8	NS	NS
Acenaphthylene	208-96-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	2.1	5.8	NS	NS
Anthracene	120-12-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.066	0.066	NS	NS
Azobenzene	103-33-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	NS	NS	NS	NS
Benzo(a)anthracene	56-55-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0003	0.0039	NS	NS
Benzo(a)pyrene	50-32-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0002	0.0002	NS	NS
Benzo(b)fluoranthene	205-99-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00018	0.0012	NS	NS
Benzo(g,h,i)perylene	191-24-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00026	0.00026	NS	NS
Benzo(k)fluoranthene	207-08-9	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00018	0.00055	NS	NS
Benzoic acid	65-85-0	<0.016	<0.015	<0.015	<0.016	<0.015	<0.016	<0.016	<0.15	<0.016	<0.015	<0.015	140	390	NS	NS
Benzyl alcohol	100-51-6	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	3.5	9.7	NS	NS
Butylbenzylphthalate	85-68-7	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.34	1.4	NS	NS
Carbazole	86-74-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.033	0.14	NS	NS
Chrysene	218-01-9	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0018	0.0019	NS	NS
Di-n-butylphthalate	84-74-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	3.5	9.7	NS	NS
Di-n-octylphthalate	117-84-0	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.35	0.97	NS	NS
Dibenz(a,h)anthracene	53-70-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.000052	0.0006	NS	NS
Dibenzofuran	132-64-9	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.035	0.097	NS	NS
Diethylphthalate	84-66-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	28	78	NS	NS
Dimethylphthalate	131-11-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	NS	NS	NS	NS
Fluoranthene	206-44-0	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.26	0.26	NS	NS
Fluorene	86-73-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	1.4	1.9	NS	NS
Hexachloro-1,3-butadiene	87-68-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0084	0.035	NS	NS
Hexachlorobenzene	118-74-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.001	0.001	NS	NS
Hexachlorocyclopentadiene	77-47-4	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.05	0.05	NS	NS
Hexachloroethane	67-72-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.001	0.001	0.031	0.48
Indeno(1,2,3-cd)pyrene	193-39-5	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00018	0.0023	NS	NS
Isophorone	78-59-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.1	0.1	NS	NS
N-Nitroso-di-n-propylamine	621-64-7	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.000025	0.00013	NS	NS
N-Nitrosodimethylamine	62-75-9	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0000014	0.000018	0.019	0.71
N-Nitrosodiphenylamine	86-30-6	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.019	0.096	NS	NS
Naphthalene	91-20-3	<0.0027	<0.0026	<0.0025	**0.090**	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.1	0.1	0.1	1.3
Nitrobenzene	98-95-3	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.0012	0.0063	1.4	21
Pentachlorophenol	87-86-5	<0.0027	<0.0026	<0.0025	<0.0027	<0.0026	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.001	0.001	NS	NS
Phenanthrene	85-01-8	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	1.1	1.1	NS	NS

DRAFT

TABLE 2

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Groundwater Sampling Results
Comparison Against PADEP Standards

Parameter	CAS	Regulated Substances in Ground Water (all results reported in mg/L)											Groundwater MSCs Used Aquifers TDS <= 2500 Residential	Groundwater MSCs Used Aquifers TDS <= 2500 Non-Residential	Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
		MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	DUP-1				
Phenol	108-95-2	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	2	2	34000	84000
Pyrene	129-00-0	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.13	0.13	NS	NS
bis(2-Chloroethoxy)methane	111-91-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.1	0.29	NS	NS
bis(2-Chloroethyl) ether	111-44-4	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.00015	0.00076	0.24	3.6
bis(2-Chloroisopropyl) ether	108-60-1	<0.0011	<0.0010	<0.00099	<0.0011	<0.0010	<0.0010	<0.0010	<0.010	<0.0011	<0.0010	<0.00099	0.3	0.3	1.7	25
bis(2-Ethylhexyl)phthalate	117-81-7	<0.0027	**0.0027**	<0.0025	<0.0027	**0.0027**	<0.0026	<0.0026	<0.026	<0.0027	<0.0025	<0.0025	0.006	0.006	NS	NS

Key:

BOLD	= Parameter was detected above the laboratory reporting limit
(yellow)	= Exceeds PADEP Residential Groundwater MSC
(red)	= Exceeds PADEP Non-Residential Groundwater MSC
(blue outline)	= Exceeds PADEP Residential Vapor Screening Value
(purple outline)	= Exceeds PADEP Non-Residential Vapor Screening Value
< 0.0077	= Denotes parameter not detected above laboratory reporting limit listed
NS	= No Standard Listed
NA	= Not Analyzed

DRAFT

DRAFT

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Surface Soil Sampling Results
Comparison Against PADEP Standards

TABLE 3

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)												Selected Soil Standards			
														Residential		Non-Residential	
		SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10	SS-11	SS-12	Used Aquifer Soil to Groundwater	Residential (0-15 FT)	Used Aquifer Soil to Groundwater	Direct Contact (0-2 FT)
		6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022				
Metals																	
Antimony	7440-36-0	<5.3	<5.4	<5.7	<5.7	<5.6	<5.8	**159**	**1080**	**7.8**	**10.8**	**21.7**	**8.9**	27	88	27	1,300
Arsenic	7440-38-2	**12.5**	**12.3**	**10**	**13.8**	<5.6	**15.5**	**12.4**	**13.3**	**93.5**	**55**	**42.6**	**62.1**	29	12	29	61
Barium	7440-39-3	**152**	**94.5**	**109**	**130**	**434**	**214**	**390**	**1130**	**379**	**434**	**683**	**688**	8200	44000	8200	190,000
Cadmium	7440-43-9	<1.1	**3.8**	<1.1	**4.8**	<1.1	**3.4**	**35.6**	**21.8**	**8.8**	**24.5**	**20.7**	**24.5**	38	110	38	1,600
Chromium	7440-47-3	**25.2**	**32**	**22.5**	**24.2**	**18.1**	**30.3**	**443**	**222**	**237**	**274**	**174**	**215**	NS	NS	NS	NS
Copper	7440-50-8	**55.8**	**126**	**48**	**617**	**56.4**	**226**	**15400**	**81200**	**763**	**998**	**1250**	**837**	43000	7200	43000	100,000
Lead	7439-92-1	**61.6**	**194**	**25.2**	**343**	**66.8**	**249**	**6210**	**18500**	**1200**	**1310**	**2000**	**1270**	450	500	450	1,000
Nickel	7440-02-0	**26.7**	**34.7**	**24.6**	**33.2**	**21.7**	**67.8**	**3930**	**74.9**	**199**	**275**	**369**	**2500**	650	4400	650	64,000
Selenium	7782-49-2	<5.3	<5.4	<5.7	<5.7	<5.6	<5.8	<7.1	**24**	**16.3**	**13.3**	**13.6**	**13.3**	26	1100	26	16,000
Thallium	7440-28-0	<5.3	<5.4	<5.7	<5.7	<5.6	<5.8	<7.1	<7.0	<6.1	<6.6	<6.7	<5.9	14	2.2	14	32
Zinc	7440-66-6	**208**	**419**	**116**	**403**	**169**	**775**	**22800**	**9890**	**2580**	**9130**	**9060**	**3620**	12000	66000	12000	190,000
Mercury	7439-97-6	**0.15**	**0.31**	<0.11	**0.52**	**0.32**	**0.58**	**0.6**	**0.17**	**41.5**	**6.1**	**4**	**13.1**	10	35	10	510
VOCs																	
1,1,1-Trichloroethane	71-55-6	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	20	10000	20	10000
1,1,2,2-Tetrachloroethane	79-34-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.084	7.6	0.43	38
1,1,2-Trichloroethane	79-00-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	3.8	0.5	16
1,1-Dichloroethane	75-34-3	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	3.1	280	16	1400
1,1-Dichloroethene	75-35-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.7	3800	0.7	10000
1,2,4-Trichlorobenzene	120-82-1	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	27	39	27	160
1,2,4-Trimethylbenzene	95-63-6	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	73	1100	300	4700
1,2-Dichlorobenzene	95-50-1	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	60	3800	60	10000
1,2-Dichloroethane	107-06-2	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	17	0.5	85
1,2-Dichloroethene (Total)	540-59-0	<0.011	<0.010	<0.011	<0.012	<0.010	<0.012	<0.019	<0.019	<0.012	<0.0012	<0.015	<0.011	NS	NS	NS	NS
1,2-Dichloropropane	78-87-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	0.12	0.5	0.6
1,3,5-Trimethylbenzene	108-67-8	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	23	1100	93	4700
1,3-Dichlorobenzene	541-73-1	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	61	10000	61	10000
1,4-Dichlorobenzene	106-46-7	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	10	40	10	200
2-Butanone (MEK)	78-93-3	**0.028**	**0.022**	**0.023**	<0.012	**0.024**	<0.012	**0.093**	<0.019	**0.025**	**0.0038**	**0.19**	**0.1**	400	10000	400	10000
2-Hexanone	591-78-6	<0.011	<0.010	<0.011	<0.012	<0.010	<0.012	<0.019	<0.019	<0.012	<0.0012	<0.015	<0.011	6.3	570	26	2400
4-Methyl-2-pentanone (MIBK)	108-10-1	<0.011	<0.010	<0.011	<0.012	<0.010	<0.012	<0.019	<0.019	<0.012	<0.0012	<0.015	<0.011	280	10000	780	10000
Acetone	67-64-1	**0.12**	**0.14**	**0.13**	<0.059	**0.18**	<0.060	**0.69**	**0.15**	**0.25**	**0.035**	**1.1**	**0.72**	3100	10000	8800	10000
Benzene	71-43-2	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	**0.037**	<0.0061	<0.00059	<0.0075	<0.0055	0.5	57	0.5	280
Bromochloromethane	74-97-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	9	760	9	3200
Bromodichloromethane	75-27-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	8	12	8	60
Bromoform	75-25-2	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	8	400	8	2000
Bromomethane	74-83-9	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	1	95	1	400
Carbon disulfide	75-15-0	**0.0069**	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	150	10000	620	10000
Carbon tetrachloride	56-23-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	75	0.5	370
Chlorobenzene	108-90-7	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	10	950	10	3900
Chloroethane	75-00-3	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	2100	10000	8800	10000
Chloroform	67-66-3	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	8	19	8	96
Chloromethane	74-87-3	<0.0057	**0.015**	<0.0055	<0.0059	<0.0051	<0.0060	**0.017**	**0.034**	<0.0061	**0.00061**	<0.0075	<0.0055	3	250	3	1200
Dibromochloromethane	124-48-1	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	8	220	8	1100
Ethylbenzene	100-41-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	70	180	70	880
Isopropylbenzene (Cumene)	98-82-8	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	600	7600	2500	10000
Methyl-tert-butyl ether	1634-04-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	2	1700	2	8500
Methylene Chloride	75-09-2	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	1300	0.5	10000
Naphthalene	91-20-3	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	25	13	25	66
Styrene	100-42-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	24	10000	24	10000
TOTAL BTEX		<0.034	<0.030	<0.033	<0.036	<0.030	<0.036	<0.056	<0.056	<0.037	<0.0035	<0.045	<0.033	NS	NS	NS	NS
Tetrachloroethene	127-18-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	**0.037**	<0.00059	<0.0075	<0.0055	0.5	760	0.5	3200
Toluene	108-88-3	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	100	10000	100	10000
Trichloroethene	79-01-6	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.5	38	0.5	160
Vinyl chloride	75-01-4	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	0.2	0.93	0.2	61
Xylene (Total)	1330-20-7	<0.017	<0.015	<0.016	<0.018	<0.015	<0.018	<0.028	<0.028	<0.018	<0.0018	<0.022	<0.016	1000	1900	1000	7900
cis-1,2-Dichloroethene	156-59-2	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	7	440	7	6400
cis-1,3-Dichloropropene	10061-01-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	NS	NS	NS	NS
m&p-Xylene	179601-23-1	<0.011	<0.010	<0.011	<0.012	<0.010	<0.012	<0.019	<0.019	<0.012	<0.0012	<0.015	<0.011	NS	NS	NS	NS
o-Xylene	95-47-6	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	NS	NS	NS	NS

DRAFT

TABLE 3

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Surface Soil Sampling Results
Comparison Against PADEP Standards

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)												Selected Soil Standards			
		SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10	SS-11	SS-12	Residential		Non-Residential	
		6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	Used Aquifer Soil to Groundwater	Residential (0-15 FT)	Used Aquifer Soil to Groundwater	Direct Contact (0-2 FT)
trans-1,2-Dichloroethene	156-60-5	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	10	4400	10	10000
trans-1,3-Dichloropropene	10061-02-6	<0.0057	<0.0051	<0.0055	<0.0059	<0.0051	<0.0060	<0.0094	<0.0093	<0.0061	<0.00059	<0.0075	<0.0055	NS	NS	NS	NS
SVOCs																	
1,2,4-Trichlorobenzene	120-82-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	27	39	27	160
1,2-Dichlorobenzene	95-50-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	60	3800	60	10000
1,3-Dichlorobenzene	541-73-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	61	10000	61	10000
1,4-Dichlorobenzene	106-46-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10	40	10	200
1-Methylnaphthalene	90-12-0	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	NS	NS	NS	NS
2,4,5-Trichlorophenol	95-95-4	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	2100	22000	5900	190000
2,4,6-Trichlorophenol	88-06-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10	220	28	3200
2,4-Dichlorophenol	120-83-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	2	660	2	9600
2,4-Dimethylphenol	105-67-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	69	4400	190	10000
2,4-Dinitrophenol	51-28-5	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	6.9	440	NS	6400
2,4-Dinitrotoluene	121-14-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.21	60	0.88	290
2,6-Dinitrotoluene	606-20-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.043	12	0.18	61
2-Chloronaphthalene	91-58-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	6000	18000	17000	190000
2-Chlorophenol	95-57-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	4.4	1100	4.4	10000
2-Methylnaphthalene	91-57-6	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	25	57	100	240
2-Methylphenol(o-Cresol)	95-48-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	170	11000	490	160000
2-Nitroaniline	88-74-4	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	0.011	0.95	0.044	3.9
2-Nitrophenol	88-75-5	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	28	1800	78	26000
3&4-Methylphenol(m&p Cresol)		<7.0	<7.0	<0.72	<7.3	<7.1	<0.76	<0.92	<8.8	<7.9	<8.5	<8.5	<7.8	NS	NS	NS	NS
3,3'-Dichlorobenzidine	91-94-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	7.7	41	33	200
3-Nitroaniline	99-09-2	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	NS	NS	NS	NS
4,6-Dinitro-2-methylphenol	534-52-1	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	0.28	18	0.78	260
4-Bromophenylphenyl ether	101-55-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	NS	NS	NS	NS
4-Chloro-3-methylphenol	59-50-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	720	22000	2000	190000
4-Chloroaniline	106-47-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.42	93	1.8	460
4-Chlorophenylphenyl ether	7005-72-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	NS	NS	NS	NS
4-Nitroaniline	100-01-6	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	3.3	880	14	4600
4-Nitrophenol	100-02-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	6	1800	6	26000
Acenaphthene	83-32-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	2600	13000	4700	190000
Acenaphthylene	208-96-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	2400	13000	6600	190000
Anthracene	120-12-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	350	66000	NS	190000
Azobenzene	103-33-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	NS	NS	NS	NS
Benzo(a)anthracene	56-55-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	26	6.1	340	130
Benzo(a)pyrene	50-32-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	46	4.2	46	91
Benzo(b)fluoranthene	205-99-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	**4.7**	<4.3	<4.2	<3.9	25	3.5	170	76
Benzo(g,h,i)perylene	191-24-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	180	13000	180	190000
Benzo(k)fluoranthene	207-08-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	**4.2**	<4.3	<4.2	<3.9	200	3.5	610	76
Benzoic acid	65-85-0	<52.4	<52.5	<5.4	<54.5	<53.3	<5.7	<6.9	<66.1	<58.9	<63.9	<63.7	<58.2	14000	190000	39000	190000
Benzyl alcohol	100-51-6	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	350	10000	970	10000
Butylbenzylphthalate	85-68-7	<3.5	<3.5	<0.36	<3.6	<3.6	**3.2**	<0.46	<4.4	<3.9	<4.3	**8.7**	<3.9	2900	9800	10000	10000
Carbazole	86-74-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	21	930	89	4600
Chrysene	218-01-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	220	35	230	760
Di-n-butylphthalate	84-74-2	<3.5	<3.5	<0.36	<3.6	<3.6	**2.0**	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	1400	10000	4000	10000
Di-n-octylphthalate	117-84-0	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10000	2200	10000	10000
Dibenz(a,h)anthracene	53-70-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	23	1	270	22
Dibenzofuran	132-64-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	90	220	250	3200
Diethylphthalate	84-66-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	2800	10000	7800	10000
Dimethylphthalate	131-11-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	NS	NS	NS	NS
Fluoranthene	206-44-0	**4.0**	<3.5	<0.36	<3.6	<3.6	**0.41**	<0.46	<4.4	**4.8**	<4.3	<4.2	<3.9	3200	8800	3200	130000
Fluorene	86-73-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	2800	8800	3800	130000
Hexachloro-1,3-butadiene	87-68-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10	220	42	1200
Hexachlorobenzene	118-74-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.96	12	NS	57
Hexachlorocyclopentadiene	77-47-4	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	91	1300	91	10000
Hexachloroethane	67-72-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.56	46	0.56	230
Indeno(1,2,3-cd)pyrene	193-39-5	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	1400	3.5	18000	76
Isophorone	78-59-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10	10000	10	10000
N-Nitroso-di-n-propylamine	621-64-7	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.0025	0.22	0.013	1.1

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
Surface Soil Sampling Results
Comparison Against PADEP Standards

TABLE 3

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)												Selected Soil Standards			
		SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	SS-9	SS-10	SS-11	SS-12	Residential		Non-Residential	
		6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	6/15/2022	**Used Aquifer Soil to Groundwater**	**Residential (0-15 FT)**	**Used Aquifer Soil to Groundwater**	**Direct Contact (0-2 FT)**
N-Nitrosodimethylamine	62-75-9	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.00014	0.012	0.0018	0.16
N-Nitrosodiphenylamine	86-30-6	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	3	170	15	860
Naphthalene	91-20-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	25	13	25	66
Nitrobenzene	98-95-3	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.12	11	0.63	55
Pentachlorophenol	87-86-5	<8.7	<8.8	<0.90	<9.1	<8.9	<0.95	<1.2	<11.0	<9.8	<10.7	<10.6	<9.7	5	47	5	230
Phenanthrene	85-01-8	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10000	66000	10000	190000
Phenol	108-95-2	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	200	3800	200	16000
Pyrene	129-00-0	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	**4.2**	<4.3	<4.2	<3.9	2200	6600	2200	96000
bis(2-Chloroethoxy)methane	111-91-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	10	660	29	9600
bis(2-Chloroethyl) ether	111-44-4	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	0.015	1.3	0.076	6.7
bis(2-Chloroisopropyl) ether	108-60-1	<3.5	<3.5	<0.36	<3.6	<3.6	<0.38	<0.46	<4.4	<3.9	<4.3	<4.2	<3.9	30	44	30	220
bis(2-Ethylhexyl)phthalate	117-81-7	<3.5	<3.5	<0.36	<3.6	<3.6	**4.1**	**167**	<4.4	<3.9	**4.8**	<4.2	<3.9	130	1300	130	6500

Key:

BOLD	= Parameter was detected above the laboratory reporting limit
(yellow)	= Exceeds PADEP Residential Soil to Groundwater MSC or Direct Contact MSC
(red)	= Exceeds PADEP Non-Residential Soil to Groundwater MSC or Direct Contact MSC
< 0.0077	= Denotes parameter not detected above laboratory reporting limit listed
NS	= No Standard Listed
NA	= Not Analyzed

DRAFT

Oil Region Alliance - Kraft/Dahlstrom Site
Oil City, Pennsylvania
UST Soil Sampling Results
Comparison Against PADEP Standards

TABLE 4

Parameter	CAS	Regulated Substances in Soil (all results reported in mg/kg)				Selected Soil Standards					Vapor Intrusion Screening Values Residential	Vapor Intrusion Screening Values Non-Residential
						Residential		Non-Residential				
		Batch Plant UST #1	Batch Plant UST #2	Fuel Oil UST #1	Fuel Oil UST #2	Used Aquifer Soil to Groundwater	Residential (0-15 FT)	Used Aquifer Soil to Groundwater	Direct Contact (0-2 FT)	Direct Contact (2-15 FT)		
		6/13/2022	6/13/2022	6/13/2022	6/13/2022						SV_{SOIL} (mg/kg)	SV_{SOIL} (mg/kg)
VOCs												
1,1,1-Trichloroethane	71-55-6	<0.0060	<0.0095	NA	NA	20	10000	20	10000	10000	7.2	7.4
1,1,2,2-Tetrachloroethane	79-34-5	<0.0060	<0.0095	NA	NA	0.084	7.6	0.43	38	44	0.026	0.13
1,1,2-Trichloroethane	79-00-5	<0.0060	<0.0095	NA	NA	0.5	3.8	0.5	16	18	0.15	0.15
1,1-Dichloroethane	75-34-3	<0.0060	<0.0095	NA	NA	3.1	280	16	1400	1600	0.75	3.9
1,1-Dichloroethene	75-35-4	<0.0060	<0.0095	NA	NA	0.7	3800	0.7	10000	10000	0.19	0.19
1,2,4-Trichlorobenzene	120-82-1	<0.0060	<0.0095	NA	NA	27	39	27	160	190	27	27
1,2,4-Trimethylbenzene	95-63-6	<0.0060	<0.0095	**32.7**	**0.024**	73	1100	300	4700	5400	73	300
1,2-Dichlorobenzene	95-50-1	<0.0060	<0.0095	NA	NA	60	3800	60	10000	10000	59	59
1,2-Dichloroethane	107-06-2	<0.0060	<0.0095	NA	NA	0.5	17	0.5	85	98	0.1	0.1
1,2-Dichloroethene (Total)	540-59-0	<0.012	<0.019	NA	NA	NS	NS	NS	NS	NS	NS	NS
1,2-Dichloropropane	78-87-5	<0.0060	<0.0095	NA	NA	0.5	0.12	0.5	0.6	0.69	0.11	0.11
1,3,5-Trimethylbenzene	108-67-8	<0.0060	<0.0095	**11.6**	**0.011**	23	1100	93	4700	5400	23	93
1,3-Dichlorobenzene	541-73-1	<0.0060	<0.0095	NA	NA	61	10000	61	10000	10000	NS	NS
1,4-Dichlorobenzene	106-46-7	<0.0060	<0.0095	NA	NA	10	40	10	200	230	10	10
2-Butanone (MEK)	78-93-3	**0.013**	**0.024**	NA	NA	400	10000	400	10000	10000	76	1100
2-Hexanone	591-78-6	<0.012	<0.019	NA	NA	6.3	570	26	2400	2700	1.6	6.4
4-Methyl-2-pentanone (MIBK)	108-10-1	<0.012	<0.019	NA	NA	280	10000	780	10000	10000	43	210
Acetone	67-64-1	**0.15**	**0.32**	NA	NA	3100	10000	8800	10000	10000	350	4700
Benzene	71-43-2	<0.0060	<0.0095	**0.89**	**0.031**	0.5	57	0.5	280	330	0.13	0.13
Bromochloromethane	74-97-5	<0.0060	<0.0095	NA	NA	9	760	9	3200	3600	1.6	1.6
Bromodichloromethane	75-27-4	<0.0060	<0.0095	NA	NA	8	12	8	60	69	2.7	2.7
Bromoform	75-25-2	<0.0060	<0.0095	NA	NA	8	400	8	2000	2300	3.5	3.5
Bromomethane	74-83-9	<0.0060	<0.0095	NA	NA	1	95	1	400	460	0.54	0.54
Carbon disulfide	75-15-0	<0.0060	<0.0095	NA	NA	150	10000	620	10000	10000	130	530
Carbon tetrachloride	56-23-5	<0.0060	<0.0095	NA	NA	0.5	75	0.5	370	430	0.26	0.26
Chlorobenzene	108-90-7	<0.0060	<0.0095	NA	NA	10	950	10	3900	4500	6.1	6.1
Chloroethane	75-00-3	<0.0060	<0.0095	NA	NA	2100	10000	8800	10000	10000	450	1900
Chloroform	67-66-3	<0.0060	<0.0095	NA	NA	8	19	8	96	110	2	2
Chloromethane	74-87-3	<0.0060	<0.0095	NA	NA	3	250	3	1200	1400	0.38	0.38
Dibromochloromethane	124-48-1	<0.0060	<0.0095	NA	NA	8	220	8	1100	10000	NS	NS
Ethylbenzene	100-41-4	<0.0060	<0.0095	**3.7**	**0.044**	70	180	70	880	1000	46	46
Isopropylbenzene (Cumene)	98-82-8	<0.0060	<0.0095	**2.1**	**0.065**	600	7600	2500	10000	10000	600	2500
Methyl-tert-butyl ether	1634-04-4	<0.0060	<0.0095	<0.34	<0.0063	2	1700	2	8500	9800	0.28	1.4
Methylene Chloride	75-09-2	<0.0060	<0.0095	NA	NA	0.5	1300	0.5	10000	10000	0.076	1.5
Naphthalene	91-20-3	<0.0060	<0.0095	**21.3**	**0.037**	25	13	25	66	77	25	25
Styrene	100-42-5	<0.0060	<0.0095	NA	NA	24	10000	24	10000	10000	24	79
TOTAL BTEX		<0.036	<0.057	NA	NA	NS	NS	NS	NS	NS	NS	NS
Tetrachloroethene	127-18-4	<0.0060	<0.0095	NA	NA	0.5	760	0.5	3200	3600	0.43	0.43
Toluene	108-88-3	<0.0060	<0.0095	**1.8**	<0.0063	100	10000	100	10000	10000	44	44
Trichloroethene	79-01-6	<0.0060	<0.0095	NA	NA	0.5	38	0.5	160	180	0.17	0.17
Vinyl chloride	75-01-4	<0.0060	<0.0095	NA	NA	0.2	0.93	0.2	61	290	0.027	0.027
Xylene (Total)	1330-20-7	<0.018	<0.028	NA	NA	1000	1900	1000	7900	9100	990	990
cis-1,2-Dichloroethene	156-59-2	<0.0060	<0.0095	NA	NA	7	440	7	6400	10000	NS	NS
cis-1,3-Dichloropropene	10061-01-5	<0.0060	<0.0095	NA	NA	NS	NS	NS	NS	NS	NS	NS
m&p-Xylene	179601-23-1	<0.012	<0.019	NA	NA	NS	NS	NS	NS	NS	NS	NS
o-Xylene	95-47-6	<0.0060	<0.0095	NA	NA	NS	NS	NS	NS	NS	NS	NS
trans-1,2-Dichloroethene	156-60-5	<0.0060	<0.0095	NA	NA	10	4400	10	10000	10000	NS	NS
trans-1,3-Dichloropropene	10061-02-6	<0.0060	<0.0095	NA	NA	NS	NS	NS	NS	NS	NS	NS
SVOCs												
1,2,4-Trichlorobenzene	120-82-1	<3.9	<3.6	NA	NA	27	39	27	160	190	27	27
1,2-Dichlorobenzene	95-50-1	<3.9	<3.6	NA	NA	60	3800	60	10000	10000	59	59
1,3-Dichlorobenzene	541-73-1	<3.9	<3.6	NA	NA	61	10000	61	10000	10000	NS	NS
1,4-Dichlorobenzene	106-46-7	<3.9	<3.6	NA	NA	10	40	10	200	230	10	10
1-Methylnaphthalene	90-12-0	<3.9	<3.6	NA	NA	NS	NS	NS	NS	NS	NS	NS
2,4,5-Trichlorophenol	95-95-4	<9.8	<9.1	NA	NA	2100	22000	5900	190000	190000	NS	NS
2,4,6-Trichlorophenol	88-06-2	<3.9	<3.6	NA	NA	10	220	28	3200	190000	NS	NS
2,4-Dichlorophenol	120-83-2	<3.9	<3.6	NA	NA	2	660	2	9600	190000	NS	NS
2,4-Dimethylphenol	105-67-9	<3.9	<3.6	NA	NA	69	4400	190	10000	10000	NS	NS
2,4-Dinitrophenol	51-28-5	<9.8	<9.1	NA	NA	6.9	440	NS	6400	190000	NS	NS
2,4-Dinitrotoluene	121-14-2	<3.9	<3.6	NA	NA	0.21	60	0.88	290	190000	NS	NS
2,6-Dinitrotoluene	606-20-2	<3.9	<3.6	NA	NA	0.043	12	0.18	61	190000	NS	NS
2-Chloronaphthalene	91-58-7	<3.9	<3.6	NA	NA	6000	18000	17000	190000	190000	NS	NS
2-Chlorophenol	95-57-8	<3.9	<3.6	NA	NA	4.4	1100	4.4	10000	10000	NS	NS
2-Methylnaphthalene	91-57-6	<3.9	<3.6	NA	NA	25	57	100	240	270	25	100
2-Methylphenol(o-Cresol)	95-48-7	<3.9	<3.6	NA	NA	170	11000	490	160000	190000	NS	NS
2-Nitroaniline	88-74-4	<9.8	<9.1	NA	NA	0.011	0.95	0.044	3.9	4.5	0.83	17
2-Nitrophenol	88-75-5	<3.9	<3.6	NA	NA	28	1800	78	26000	190000	NS	NS
3&4-Methylphenol(m&p Cresol)		<7.8	<7.3	NA	NA	NS	NS	NS	NS	NS	NS	NS
3,3'-Dichlorobenzidine	91-94-1	<3.9	<3.6	NA	NA	7.7	41	33	200	190000	NS	NS
3-Nitroaniline	99-09-2	<9.8	<9.1	NA	NA	NS	NS	NS	NS	NS	NS	NS
4,6-Dinitro-2-methylphenol	534-52-1	<9.8	<9.1	NA	NA	0.28	18	0.78	260	190000	NS	NS
4-Bromophenylphenyl ether	101-55-3	<3.9	<3.6	NA	NA	NS	NS	NS	NS	NS	NS	NS
4-Chloro-3-methylphenol	59-50-7	<3.9	<3.6	NA	NA	720	22000	2000	190000	190000	NS	NS
4-Chloroaniline	106-47-8	<3.9	<3.6	NA	NA	0.42	93	1.8	460	190000	NS	NS
4-Chlorophenylphenyl ether	7005-72-3	<3.9	<3.6	NA	NA	NS	NS	NS	NS	NS	NS	NS
4-Nitroaniline	100-01-6	<9.8	<9.1	NA	NA	3.3	880	14	4600	190000	NS	NS
4-Nitrophenol	100-02-7	<3.9	<3.6	NA	NA	6	1800	6	26000	190000	NS	NS
Acenaphthene	83-32-9	<3.9	<3.6	NA	NA	2600	13000	4700	190000	190000	NS	NS
Acenaphthylene	208-96-8	<3.9	<3.6	NA	NA	2400	13000	6600	190000	190000	NS	NS
Anthracene	120-12-7	<3.9	<3.6	NA	NA	350	66000	NS	190000	190000	NS	NS
Azobenzene	103-33-3	<3.9	<3.6	NA	NA	NS	NS	NS	NS	NS	NS	NS
Benzo(a)anthracene	56-55-3	<3.9	<3.6	NA	NA	26	6.1	340	130	190000	NS	NS
Benzo(a)pyrene	50-32-8	<3.9	<3.6	NA	NA	46	4.2	46	91	190000	NS	NS
Benzo(b)fluoranthene	205-99-2	<3.9	<3.6	NA	NA	25	3.5	170	76	190000	NS	NS
Benzo(g,h,i)perylene	191-24-2	<3.9	<3.6	NA	NA	180	13000	180	190000	190000	NS	NS
Benzo(k)fluoranthene	207-08-9	<3.9	<3.6	NA	NA	200	3.5	610	76	190000	NS	NS
Benzoic acid	65-85-0	<58.6	<54.6	NA	NA	14000	190000	39000	190000	190000	NS	NS
Benzyl alcohol	100-51-6	<3.9	<3.6	NA	NA	350	10000	970	10000	10000	NS	NS
Butylbenzylphthalate	85-68-7	<3.9	<3.6	NA	NA	2900	9800	10000	10000	10000	NS	NS
Carbazole	86-74-8	<3.9	<3.6	NA	NA	21	930	89	4600	190000	NS	NS
Chrysene	218-01-9	<3.9	<3.6	NA	NA	220	35	230	760	190000	NS	NS
Di-n-butylphthalate	84-74-2	<3.9	<3.6	NA	NA	1400	10000	4000	10000	10000	NS	NS
Di-n-octylphthalate	117-84-0	<3.9	<3.6	NA	NA	10000	2200	10000	10000	10000	NS	NS
Dibenz(a,h)anthracene	53-70-3	<3.9	<3.6	NA	NA	23	1	270	22	190000	NS	NS
Dibenzofuran	132-64-9	<3.9	<3.6	NA	NA	90	220	250	3200	190000	NS	NS
Diethylphthalate	84-66-2	<3.9	<3.6	NA	NA	2800	10000	7800	10000	10000	NS	NS
Dimethylphthalate	131-11-3	<3.9	<3.6	NA	NA	NS	NS	NS	NS	NS	NS	NS
Fluoranthene	206-44-0	<3.9	<3.6	NA	NA	3200	8800	3200	130000	190000	NS	NS
Fluorene	86-73-7	<3.9	<3.6	NA	NA	2800	8800	3800	130000	190000	NS	NS
Hexachloro-1,3-butadiene	87-68-3	<3.9	<3.6	NA	NA	10	220	42	1200	10000	NS	NS
Hexachlorobenzene	118-74-1	<3.9	<3.6	NA	NA	0.96	12	NS	57	190000	NS	NS
Hexachlorocyclopentadiene	77-47-4	<3.9	<3.6	NA	NA	91	1300	91	10000	10000	NS	NS
Hexachloroethane	67-72-1	<3.9	<3.6	NA	NA	0.56	46	0.56	230	270	0.56	0.56
Indeno(1,2,3-cd)pyrene	193-39-5	<3.9	<3.6	NA	NA	1400	3.5	18000	76	190000	NS	NS
Isophorone	78-59-1	<3.9	<3.6	NA	NA	10	10000	10	10000	10000	NS	NS
N-Nitroso-di-n-propylamine	621-64-7	<3.9	<3.6	NA	NA	0.0025	0.22	0.013	1.1	1.3	NS	NS
N-Nitrosodimethylamine	62-75-9	<3.9	<3.6	NA	NA	0.00014	0.012	0.0018	0.16	0.18	0.00015	0.0094
N-Nitrosodiphenylamine	86-30-6	<3.9	<3.6	NA	NA	3	170	15	860	990	NS	NS
Naphthalene	91-20-3	<3.9	<3.6	NA	NA	25	13	25	66	77	25	25
Nitrobenzene	98-95-3	<3.9	<3.6	NA	NA	0.12	11	0.63	55	63	0.052	1.2
Pentachlorophenol	87-86-5	<9.8	<9.1	NA	NA	5	47	5	230	190000	NS	NS
Phenanthrene	85-01-8	<3.9	<3.6	NA	NA	10000	66000	10000	190000	190000	NS	NS
Phenol	108-95-2	<3.9	<3.6	NA	NA	200	3800	200	16000	18000	380	7900
Pyrene	129-00-0	<3.9	<3.6	NA	NA	2200	6600	2200	96000	190000	NS	NS
bis(2-Chloroethoxy)methane	111-91-1	<3.9	<3.6	NA	NA	10	660	29	9600	10000	NS	NS
bis(2-Chloroethyl) ether	111-44-4	<3.9	<3.6	NA	NA	0.015	1.3	0.076	6.7	7.6	0.0056	0.14
bis(2-Chloroisopropyl) ether	108-60-1	<3.9	<3.6	NA	NA	30	44	30	220	250	8	8
bis(2-Ethylhexyl)phthalate	117-81-7	<3.9	<3.6	NA	NA	130	1300	130	6500	10000	NS	NS

Key:

BOLD	= Parameter was detected above the laboratory reporting limit
	= Exceeds PADEP Residential Soil to Groundwater MSC or Direct Contact MSC
	= Exceeds PADEP Non-Residential Soil to Groundwater MSC or Direct Contact MSC
	= Exceeds PADEP Residential Vapor Screening Value
	= Exceeds PADEP Non-Residential Vapor Screening Value
< 0.0077	= Denotes parameter not detected above laboratory reporting limit listed
NS	= No Standard Listed
NA	= Not Analyzed

APPENDIX A

Excerpt from Fourth National Climate Assessment, Volume II

18 Northeast

Federal Coordinating Lead Author
Ellen L. Mecray
National Oceanic and Atmospheric Administration

Chapter Lead
Lesley-Ann L. Dupigny-Giroux
University of Vermont

Chapter Authors
Mary D. Lemcke-Stampone
University of New Hampshire

Glenn A. Hodgkins
U.S. Geological Survey

Erika E. Lentz
U.S. Geological Survey

Katherine E. Mills
Gulf of Maine Research Institute

Erin D. Lane
U.S. Department of Agriculture

Rawlings Miller
WSP (formerly U.S. Department of Transportation Volpe Center)

David Y. Hollinger
U.S. Department of Agriculture

William D. Solecki
City University of New York–Hunter College

Gregory A. Wellenius
Brown University

Perry E. Sheffield
Icahn School of Medicine at Mount Sinai

Anthony B. MacDonald
Monmouth University

Christopher Caldwell
College of Menominee Nation

Review Editor
Jayne F. Knott
University of New Hampshire

Technical Contributors are listed at the end of the chapter.

Recommended Citation for Chapter

Dupigny-Giroux, L.A., E.L. Mecray, M.D. Lemcke-Stampone, G.A. Hodgkins, E.E. Lentz, K.E. Mills, E.D. Lane, R. Miller, D.Y. Hollinger, W.D. Solecki, G.A. Wellenius, P.E. Sheffield, A.B. MacDonald, and C. Caldwell, 2018: Northeast. In *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 669–742. doi: 10.7930/NCA4.2018.CH18

On the Web: https://nca2018.globalchange.gov/chapter/northeast

18 Northeast

Bartram Bridge in Pennsylvania

Key Message 1

Changing Seasons Affect Rural Ecosystems, Environments, and Economies

The seasonality of the Northeast is central to the region's sense of place and is an important driver of rural economies. Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry. The region's rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow.

Key Message 2

Changing Coastal and Ocean Habitats, Ecosystems Services, and Livelihoods

The Northeast's coast and ocean support commerce, tourism, and recreation that are important to the region's economy and way of life. Warmer ocean temperatures, sea level rise, and ocean acidification threaten these services. The adaptive capacity of marine ecosystems and coastal communities will influence ecological and socioeconomic outcomes as climate risks increase.

Key Message 3

Maintaining Urban Areas and Communities and Their Interconnectedness

The Northeast's urban centers and their interconnections are regional and national hubs for cultural and economic activity. Major negative impacts on critical infrastructure, urban economies, and nationally significant historic sites are already occurring and will become more common with a changing climate.

Key Message 4

Threats to Human Health

Changing climate threatens the health and well-being of people in the Northeast through more extreme weather, warmer temperatures, degradation of air and water quality, and sea level rise. These environmental changes are expected to lead to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, and a lower quality of life. Health impacts are expected to vary by location, age, current health, and other characteristics of individuals and communities.

Key Message 5

Adaptation to Climate Change Is Underway

Communities in the Northeast are proactively planning and implementing actions to reduce risks posed by climate change. Using decision support tools to develop and apply adaptation strategies informs both the value of adopting solutions and the remaining challenges. Experience since the last assessment provides a foundation to advance future adaptation efforts.

Executive Summary

The distinct seasonality of the Northeast's climate supports a diverse natural landscape adapted to the extremes of cold, snowy winters and warm to hot, humid summers. This natural landscape provides the economic and cultural foundation for many rural communities, which are largely supported by a diverse range of agricultural, tourism, and natural resource-dependent industries (see Ch. 10: Ag & Rural, Key Message 4).[1] The recent dominant trend in precipitation throughout the Northeast has been towards increases in rainfall intensity,[2] with increases in intensity exceeding those in other regions of the contiguous United States. Further increases in rainfall intensity are expected,[3] with increases in total precipitation expected during the winter and spring but with little change in the summer.[4] Monthly precipitation in the Northeast is projected to be about 1 inch greater for December through April by end of century (2070–2100) under the higher scenario (RCP8.5).[4]

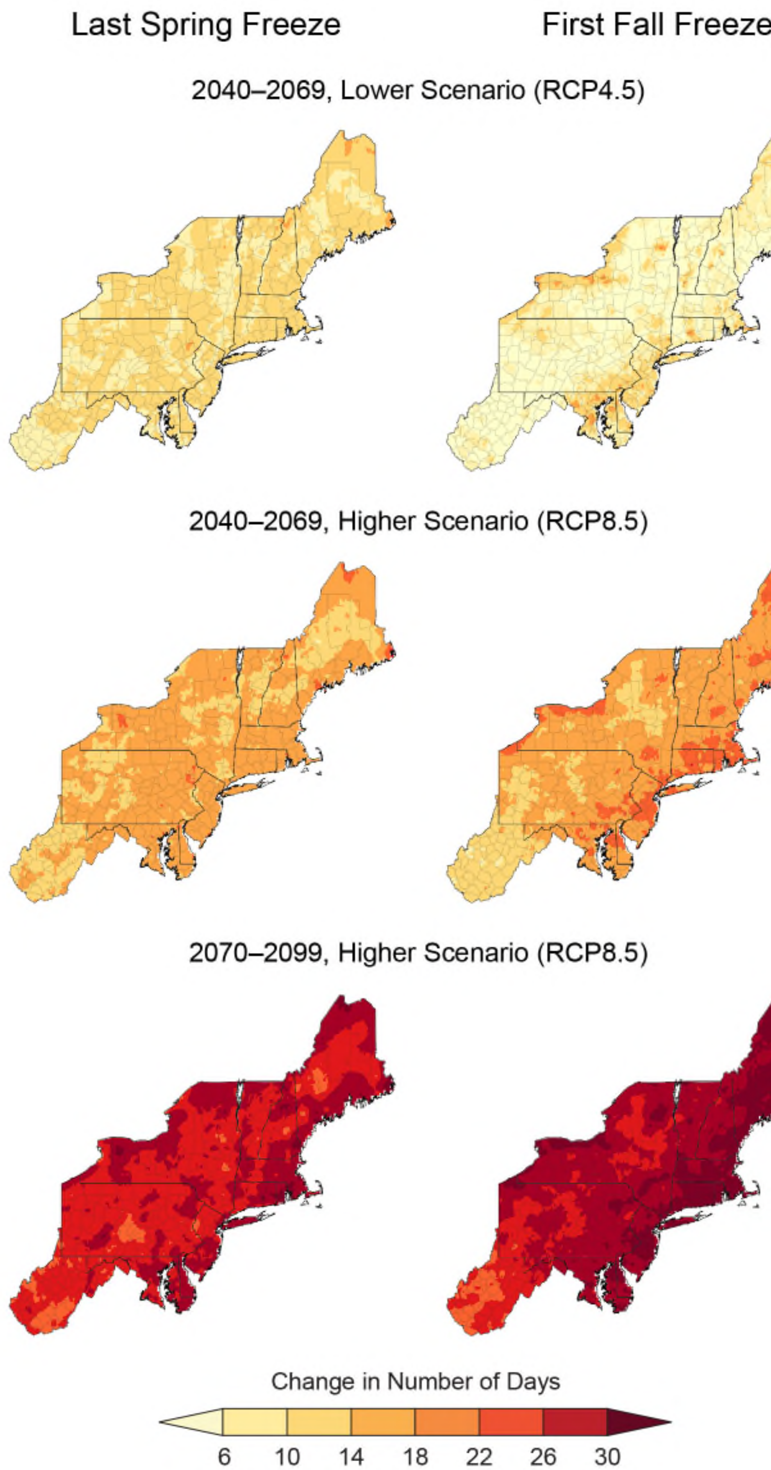
Ocean and coastal ecosystems are being affected by large changes in a variety of climate-related environmental conditions. These ecosystems support fishing and aquaculture,[5] tourism and recreation, and coastal communities.[6] Observed and projected increases in temperature, acidification, storm frequency and intensity, and sea levels are of particular concern for coastal and ocean ecosystems, as well as local communities and their interconnected social and economic systems. Increasing temperatures and changing seasonality on the Northeast Continental Shelf have affected marine organisms and the ecosystem in various ways. The warming trend experienced in the Northeast Continental Shelf has been associated with many fish and invertebrate species moving northward and to greater depths.[7,8,9,10,11] Because of the diversity of the Northeast's coastal landscape, the impacts from storms and sea level rise will vary at different locations along the coast.[12,13]

Northeastern cities, with their abundance of concrete and asphalt and relative lack of vegetation, tend to have higher temperatures than surrounding regions due to the urban heat island effect. During extreme heat events, nighttime temperatures in the region's big cities are generally several degrees higher than surrounding regions, leading to higher risk of heat-related death. Urban areas are at risk for large numbers of evacuated and displaced populations and damaged infrastructure due to both extreme precipitation events and recurrent flooding, potentially requiring significant emergency response efforts and consideration of a long-term commitment to rebuilding and adaptation, and/or support for relocation where needed. Much of the infrastructure in the Northeast, including drainage and sewer systems, flood and storm protection assets, transportation systems, and power supply, is nearing the end of its planned life expectancy. Climate-related disruptions will only exacerbate existing issues with aging infrastructure. Sea level rise has amplified storm impacts in the Northeast (Key Message 2), contributing to higher surges that extend farther inland, as demonstrated in New York City in the aftermath of Superstorm Sandy in 2012.[14,15,16] Service and resource supply infrastructure in the Northeast is at increasing risk of disruption, resulting in lower quality of life, economic declines, and increased social inequality.[17] Loss of public services affects the capacity of communities to function as administrative and economic centers and triggers disruptions of interconnected supply chains (Ch. 16: International, Key Message 1).

Increases in annual average temperatures across the Northeast range from less than 1°F (0.6°C) in West Virginia to about 3°F (1.7°C) or more in New England since 1901.[18,19] Although the relative risk of death on very hot days is lower today than it was a few decades ago, heat-related illness and death remain significant public health problems in the Northeast.[20,21,22,23] For example, a study in New York City estimated that in 2013 there were 133 excess deaths due to extreme heat.[24] These projected increases in temperature are expected to lead to substantially more premature deaths, hospital admissions, and emergency department visits across the Northeast.[23,25,26,27,28,29] For example, in the Northeast we can expect approximately 650 additional premature deaths per year from extreme heat by the year 2050 under either a lower (RCP4.5) or higher (RCP8.5) scenario and from 960 (under RCP4.5) to 2,300 (under RCP8.5) more premature deaths per year by 2090.[29]

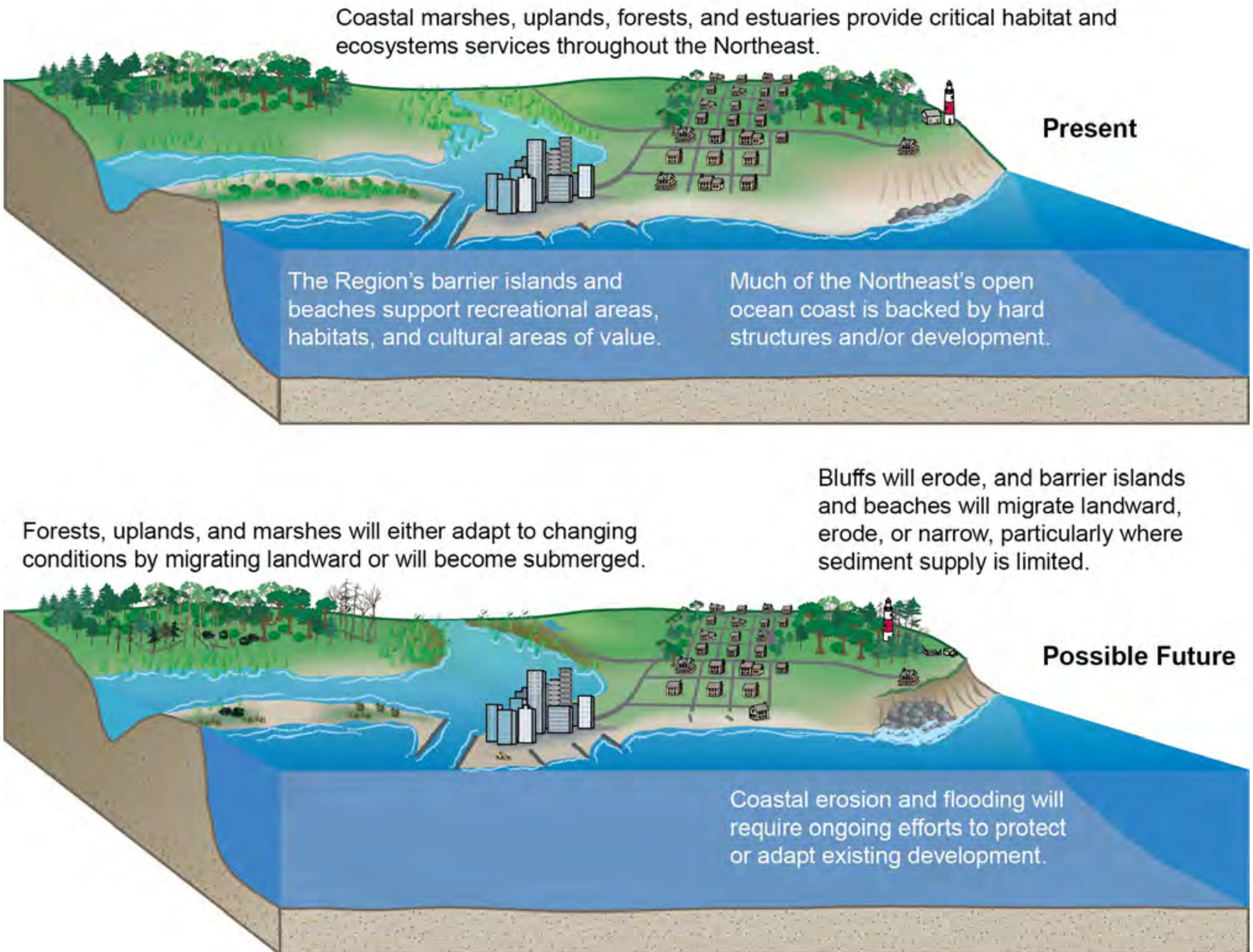
Communities, towns, cities, counties, states, and tribes across the Northeast are engaged in efforts to build resilience to environmental challenges and adapt to a changing climate. Developing and implementing climate adaptation strategies in daily practice often occur in collaboration with state and federal agencies (e.g., New Jersey Climate Adaptation Alliance 2017, New York Climate Clearinghouse 2017, Rhode Island STORMTOOLS 2017, EPA 2017, CDC 2015[30,31,32,33,34]). Advances in rural towns, cities, and suburban areas include low-cost adjustments of existing building codes and standards. In coastal areas, partnerships among local communities and federal and state agencies leverage federal adaptation tools and decision support frameworks (for example, NOAA's Digital Coast, USGS's Coastal Change Hazards Portal, and New Jersey's Getting to Resilience). Increasingly, cities and towns across the Northeast are developing or implementing plans for adaptation and resilience in the face of changing climate (e.g., EPA 2017[33]). The approaches are designed to maintain and enhance the everyday lives of residents and promote economic development. In some cities, adaptation planning has been used to respond to present and future challenges in the built environment. Regional efforts have recommended changes in design standards when building, replacing, or retrofitting infrastructure to account for a changing climate.

Lengthening of the Freeze-Free Period



These maps show projected shifts in the date of the last spring freeze (left column) and the date of the first fall freeze (right column) for the middle of the century (as compared to 1979–2008) under the lower scenario (RCP4.5; top row) and the higher scenario (RCP8.5; middle row). The bottom row shows the shift in these dates for the end of the century under the higher scenario. By the middle of the century, the freeze-free period across much of the Northeast is expected to lengthen by as much as two weeks under the lower scenario and by two to three weeks under the higher scenario. By the end of the century, the freeze-free period is expected to increase by at least three weeks over most of the region. *From Figure 18.3 (Source: adapted from Wolfe et al. 2018[35]).*

Coastal Impacts of Climate Change



(top) The northeastern coastal landscape is composed of uplands and forested areas, wetlands and estuarine systems, mainland and barrier beaches, bluffs, headlands, and rocky shores, as well as developed areas, all of which provide a variety of important services to people and species. (bottom) Future impacts from intense storm activity and sea level rise will vary across the landscape, requiring a variety of adaptation strategies if people, habitats, traditions, and livelihoods are to be protected. *From Figure 18.7 (Source: U.S. Geological Survey)*.

Background

The Northeast region is characterized by four distinct seasons and a diverse landscape that is central to the region's cultural identity, quality of life, and economic success. It is both the most heavily forested and most densely populated region in the country. Residents have ready access to beaches, forests, and other natural areas and use them heavily for recreation. Colorful autumn foliage, winter recreation, and summer vacations in the mountains or at the beach are all important parts of the Northeast's cultural identity, and this tourism contributes billions of dollars to the regional economy. The seasonal climate, natural systems, and accessibility of certain types of recreation are threatened by declining snow and ice, rising sea levels, and rising temperatures. By 2035, and under both lower and higher scenarios (RCP4.5 and RCP8.5), the Northeast is projected to be more than 3.6°F (2°C) warmer on average than during the preindustrial era. This would be the largest increase in the contiguous United States and would occur as much as two decades before global average temperatures reach a similar milestone.[36]

The region's oceans and coasts support a rich maritime heritage and provide an iconic landscape, as well as economic and ecological services. Highly productive marshes,[37,38] fisheries,[39,40] ecosystems,[41,42] and coastal infrastructure[43,44] are sensitive to changing environmental conditions, including shifts in temperature, ocean acidification, sea level, storm surge, flooding, and erosion. Many of these changes are already affecting coastal and marine ecosystems, posing increasing risks to people, traditions, infrastructure, and economies (e.g., Colburn et al. 2016[45]). These risks are exacerbated by increasing demands on these ecosystems to support human use and development. The Northeast has experienced some of the highest rates of sea level rise[46] and ocean warming[39] in the United States, and these exceptional increases relative to other regions are projected to continue through the end of the century.[47,48,49,50]

The Northeast is quite varied geographically, with a wide spectrum of communities including densely populated cities and metropolitan regions and relatively remote hamlets and villages (Figure 18.1). Rural and urban areas have distinct vulnerabilities, impacts, and adaptation responses to climate change.[51,52] The urbanized parts of the Northeast are dependent on the neighboring rural areas' natural and recreational services, while the rural communities are dependent on the economic vitality and wealth-generating capacity of the region's major cities. Rural and urban communities together are under increasing threat of climate change and the resulting impacts, and adaptation strategies reveal their interdependence and opportunities for successful climate resilience.[51] Rural–urban linkages[53,54,55] in the region could also be altered by climate change impacts.

In rural areas, community identity is often built around the prominence of small, multigenerational, owner-operated businesses and the natural resources of the local area. Climate variability can affect human migration patterns[56] and may change flows into or out of the Northeast as well as between rural and urban locations. Published research in this area, however, is limited. The Northeast has long been losing residents to other regions of the country.[57] Droughts and flooding can adversely affect ecosystem function, farm economic viability, and land use. Although future projections of major floods remain ambiguous, more intense precipitation events (Ch. 2: Climate, KM 6)[58] have increased the risk of some types of inland floods, particularly in valleys, where people, infrastructure, and agriculture tend to be concentrated. With little redundancy in their infrastructure and, therefore, limited economic resilience, many rural communities have limited ability to cope with climate-related changes.

Population Density

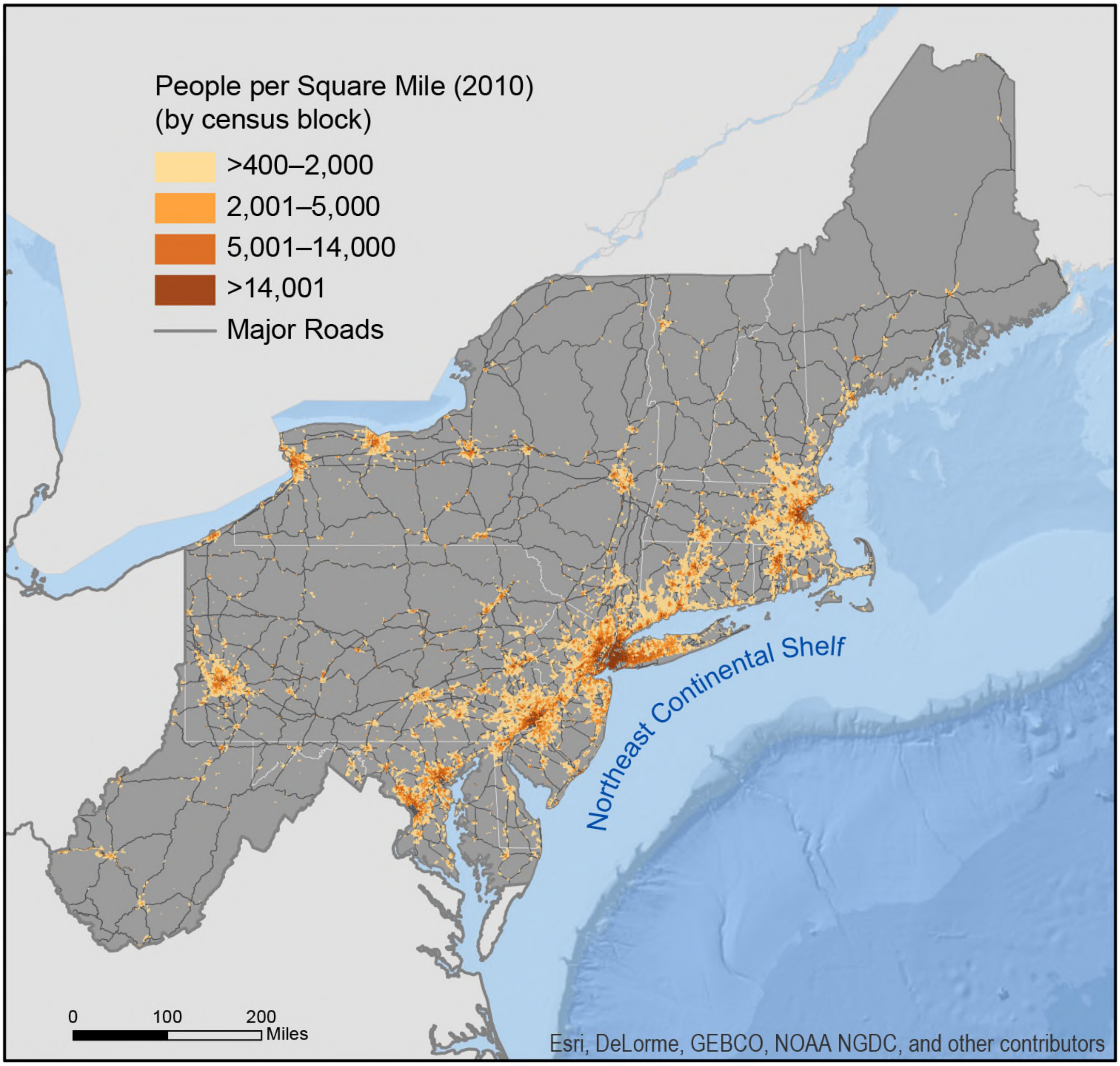


Figure 18.1: A map showing primary roads and population density highlights the diverse characteristics of the region in terms of settlement patterns, interconnections among population centers of varying sizes, and variability in relief across the ocean shelf. Sources: U.S. Department of Transportation, U.S. Geological Survey, and ERT, Inc. *This caption was revised in June 2019. See Errata for details: https://nca2018.globalchange.gov/downloads*

Residents in urban areas face multiple climate hazards, including temperature extremes, episodes of poor air quality, recurrent waterfront and coastal flooding, and intense precipitation events that can lead to increased flooding on urban streams. These physical changes may lead to large numbers of evacuated and displaced populations and damaged infrastructure; sustaining communities may require significant investment and planning to provide emergency response efforts, a long-term commitment to rebuilding and adaptation, and support for relocation. Underrepresented communities, such as the poor, elderly, language-isolated, and recent immigrants, are more vulnerable due to their limited ability to prepare for and cope with extreme weather and climate events.[59] Service infrastructure in the Northeast is at increasing risk of disruption, resulting in lower quality of life, economic declines, and enhanced social inequality.[17] Interdependencies across critical infrastructure sectors such as water, energy, transportation, and telecommunication (and related climate security issues) can lead to cascading failures during extreme weather and climate-related disruptions (Ch. 17: Complex Systems).[17,59,60] The region's high density of built environment sites and facilities, large number of historic structures, and older housing and infrastructure compared to other regions suggest that urban centers in the Northeast are particularly vulnerable to climate shifts and extreme weather events. For example, because much of the historical development of industry and commerce in New England occurred along rivers, canals, coasts, and other bodies of water, these areas often have a higher density of contaminated sites, waste management facilities, and petroleum storage facilities that are potentially vulnerable to flooding. As a result, increases in flood frequency or severity could increase the spread of contaminants into soils and waterways, resulting in increased risks to the health of nearby ecosystems, animals, and people—a set of phenomena well documented following Superstorm Sandy.[61,62,63]

The changing climate of the Northeast threatens the health and well-being of residents through environmental changes that lead to health-related impacts and costs, including additional deaths, emergency room visits and hospitalizations, higher risk of infectious diseases, lower quality of life, and increased costs associated with healthcare utilization. Health impacts of climate change vary across people and communities of the Northeast and depend on social, socioeconomic, demographic, and societal factors; community adaptation efforts; and underlying individual vulnerability (see Key Message 5) (see also Ch. 28: Adaptation).

Maintaining functioning, sustainable communities in the face of climate change requires effective adaptation strategies that anticipate and buffer impacts, while also enabling communities to capitalize upon new opportunities. Many northeastern cities already have or are rapidly developing short-term and long-term plans to mitigate climate effects and to plan for efficient investments in sustainable development and long-term adaptation strategies. Although timely adaptation to climate-related impacts would help reduce threats to people's health, safety, economic well-being, and ways of life, changes to those societal elements will not be avoided completely.

Key Message 1

Changing Seasons Affect Rural Ecosystems, Environments, and Economies

The seasonality of the Northeast is central to the region's sense of place and is an important driver of rural economies. Less distinct seasons with milder winter and earlier spring conditions are already altering ecosystems and environments in ways that adversely impact tourism, farming, and forestry. The region's rural industries and livelihoods are at risk from further changes to forests, wildlife, snowpack, and streamflow.

The distinct seasonality of the Northeast's climate supports a diverse natural landscape adapted to the extremes of cold, snowy winters and warm to hot, humid summers. This natural landscape provides the economic and cultural foundation for many rural communities, which are largely supported by a diverse range of agricultural, tourism, and natural resource-dependent industries (Ch. 10: Ag & Rural, KM 4).[1] The outdoor recreation industry contributes nearly $150 billion in consumer spending to the Northeast economy and supports more than one million jobs across the region.[64] Additionally, agriculture, fishing, forestry, and related industries together generate over $100 billion in economic activity annually, supporting more than half a million jobs in production and processing region-wide.[65] Projected changes in the Northeast's seasons will continue to affect terrestrial and aquatic ecosystems, forest productivity, agricultural land use, and other resource-based industries.[1] Alpine, freshwater aquatic, and certain forest habitats are most at risk.[66] Without efforts to mitigate climate change, warming winters and earlier spring conditions under a higher scenario (RCP8.5) will affect native ecosystems and the very character of the rural Northeast.[67]

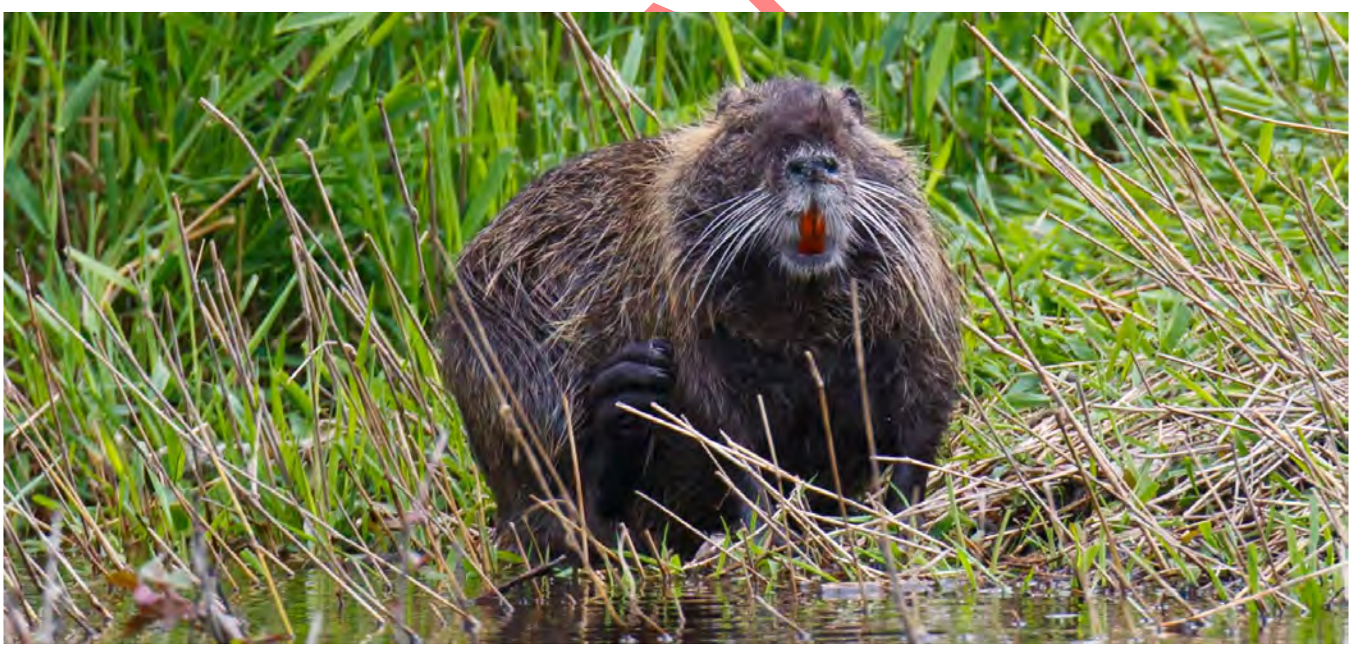
Seasonal differences in Northeast temperature have decreased in recent years as winters have warmed three times faster than summers.[3] By the middle of this century, winters are projected to be milder still, with fewer cold extremes, particularly across inland and northern portions of the Northeast.[3] This will likely result in a shorter and less pronounced cold season with fewer frost days and a longer transition out of winter into the growing season.[68] Under the higher scenario (RCP8.5), the trend of decreasing seasonality continues for the northern half of the region through the end of the century, but by then summer temperatures across the Mid-Atlantic are projected to rise faster than those in winter.[4]

A Changing Winter–Spring Transition

Forests are already responding to the ongoing shift to a warmer climate, and changes in the timing of leaf-out affect plant productivity, plant–animal interactions, and other essential ecosystem processes.[69,70] Warmer late-winter and early-spring temperatures in the Northeast have resulted in trends towards earlier leaf-out and blooming, including changes of 1.6 and 1.2 days per decade, respectively, for lilac and honeysuckle (Ch. 7: Ecosystems, Figure 7.3).[71] The increase in growing season length is partially responsible for observed increases in forest growth and carbon sequestration.[72]

While unusual winter or early-spring warmth has caused plants to start growing and emerge from winter dormancy earlier in the spring, the increased vulnerability of species to subsequent cold spells is yet unknown. Early emergence from winter dormancy causes plants to lose their tolerance to cold temperatures and risk damage by temperatures they would otherwise tolerate. Early budbreak followed by hard freezes has led to widespread loss of fruit crops and reduced seasonal growth of native tree species in the Northeast.[35,73]

Shifting seasonality can also negatively affect the health of forests (Ch. 6: Forests, KM 1) and wildlife, thereby impacting the rural industries dependent upon them. Warmer winters will likely contribute to earlier insect emergence[74] and expansion in the geographic range and population size of important tree pests such as the hemlock woolly adelgid, emerald ash borer, and southern pine beetle.[75,76,77] Increases in less desired herbivore populations are also likely, with white-tailed deer and nutria (exotic South American rodents) already being a major concern in different parts of the region.[78] According to State Farm Insurance,[79] motorists in West Virginia and Pennsylvania are already the first and third group of claimants most likely to file an insurance claim that is deer-related. Erosion from nutria feeding in lower Eastern Shore watersheds of Maryland has resulted in widespread conversion of marsh to shallow open water, changing important ecosystems that can buffer against the adverse impacts from climate change.[80] Species such as moose, which drive a multimillion-dollar tourism industry, are already experiencing increased parasite infections and deaths from ticks.[81,82,83] Warmer spring temperatures are associated with earlier arrivals of migratory songbirds,[84] while birds dependent upon spruce–fir forests in the northern and mountainous parts of the region are already declining and especially vulnerable to future change.[85] Northern and high-elevation tree species such as spruce and fir are among the most vulnerable to climate change in the Northeast.[70,86,87]



A nutria shows off its signature orange teeth. These large South American rodents are already a major concern in parts of the Northeast. Photo credit: ©Jason Erickson/iStock/Getty Images Plus.

Challenges for Natural Resource-Based Industries

Shorter, more moderate winters will present new challenges for rural industries. Poor surface and road conditions or washout have the potential to limit future logging operations, which need frozen or snow-covered soils to meet environmental requirements for winter operations.[70,88] Maple syrup production is linked to climate through potential shifts in sugar maple habitat,[89] tapping season timing and duration,[90,91] and the quality of both the trees and sap.[92,93] Climate change is making sugar maple tapping more challenging by increasing variability within and between seasons. Research into how the industry can adapt to these changes is ongoing.[89,94,95] With changes in weather and ecology come shifts in the cultural relationships to seasons as they have historically existed. Indigenous women from across these northeastern forests have come together to protect and sustain cultural traditions of the land they call Maple Nation. These climate impacts not only threaten the maple tree itself but also the seeds, soil, water, plants, and cultural lifeways that Indigenous peoples and tribal nations in the region associate with them.[96,97]

On the other hand, the impacts of warming on forests and ecosystems during the summer and autumn are less well understood.[98] In the summer, flowering in many agricultural crops and tree fruits is regulated in part by nighttime temperature, and growers risk lower yields as these temperatures rise.[35] Warmer autumn temperatures[98] influence processes such as leaf senescence (the change in leaf color as photosynthesis ceases), fruit ripening, insect phenology,[35] and the start of bird migration and animal hibernation.[99] October temperatures are the best predictor of leaf senescence in the northern hemisphere,[100] but other climatic factors can also shift the timing of autumn processes. Agricultural drought can advance leaf coloring and leaf drop, while abundant soil moisture can delay senescence.[101,102] Early frost events or strong winds can also result in sudden leaf senescence and loss.[98] Many deciduous trees are projected to experience an overall increase in their amount of autumn foliage color.[103]

As Northeast winters warm, scenarios project a combination of less early winter snowfall and earlier snowmelt, leading to a shorter snow season.[104,105] The proportion of winter precipitation falling as rain has already increased and will likely continue to do so in response to a northward shift in the snow–rain transition zone projected under both lower and higher scenarios (RCP4.5 and RCP8.5).[106,107,108] The shift in precipitation type and fewer days below freezing[3,4,35] are expected to result in fewer days with snow on the ground; decreased snow depth, water equivalent, and extent; an earlier snowmelt;[105,109,110] and less lake ice.[111] Warming during the winter–spring transition has already led to earlier snowmelt-related runoff in areas of the Northeast with substantial snowpack (Figure 18.2).[112] Earlier snowmelt-related runoff and lower spring peak streamflows in these areas are expected in the 2041–2095 period compared with the 1951–2005 period.[105]

Historical Changes in the Timing of Snowmelt-Related Streamflow

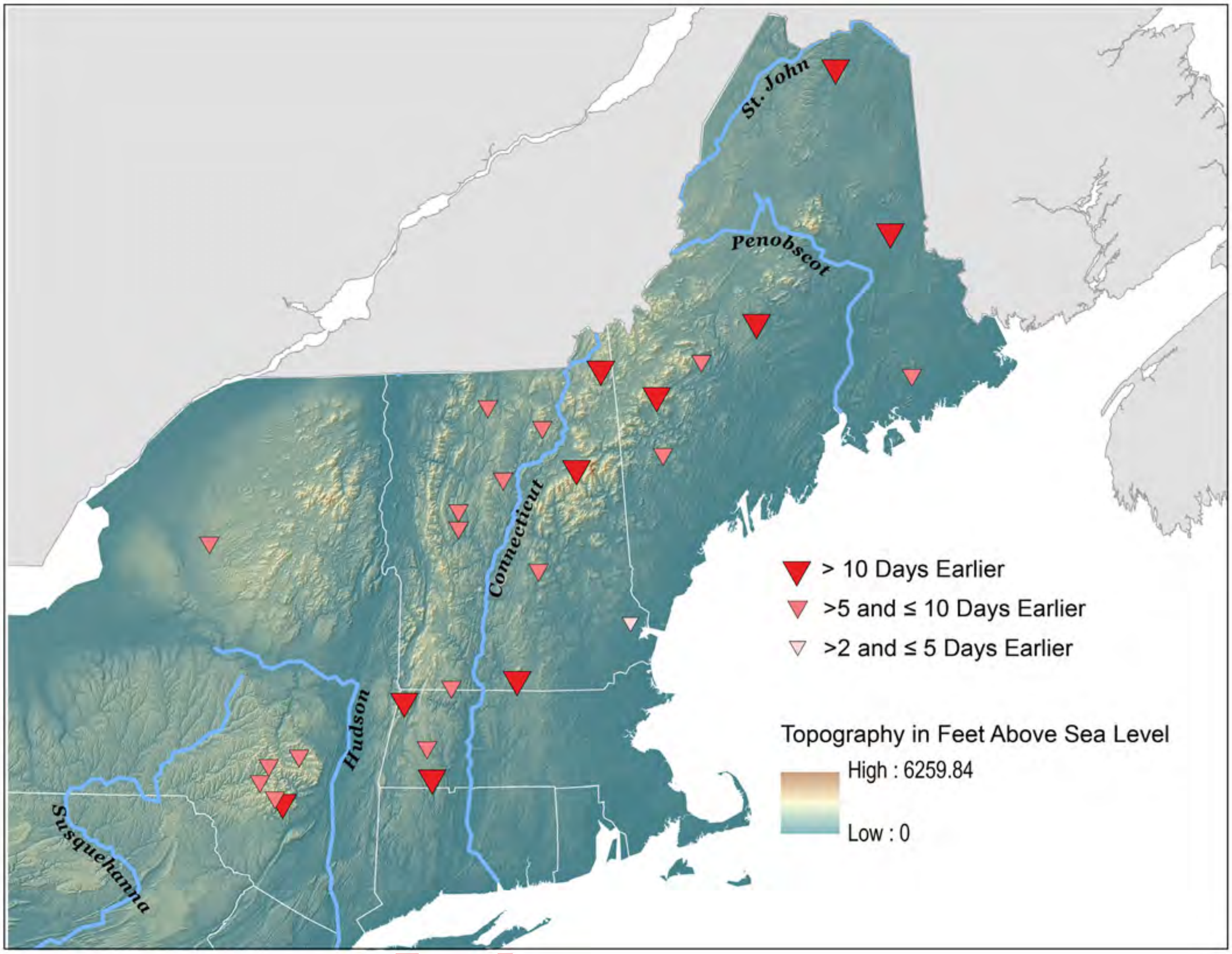


Figure 18.2: This map of part of the Northeast region shows consistently earlier snowmelt-related streamflow timing for rivers from 1960 to 2014. Each symbol represents the change for an individual river over the entire period. Changes in the timing of snowmelt potentially interfere with the reproduction of many aquatic species[113] and impact water-supply reservoir management because of higher winter flows and lower spring flows.[114] The timing of snowmelt-related streamflow in the Northeast is sensitive to small changes in air temperature. The average winter–spring air temperature increase of 1.67°F in the Northeast from 1940 to 2014 is thought to be the cause of average earlier streamflow timing of 7.7 days.[112] The timing of snowmelt-related streamflow is a valuable long-term indicator of winter–spring changes in the Northeast. Source: adapted from Dudley et al. 2017;[112] Digital Elevation Model CGIAR–CSI (CGIAR Consortium for Spatial Information). Reprinted with permission from Elsevier.

The Northeast winter recreation industry is an important economic resource for rural areas, supporting approximately 44,500 jobs and generating between $2.6–$2.7 billion in revenue annually.[115,116] Like other outdoor tourism industries, it is strongly influenced by weather and climate, making it particularly vulnerable to climate change.[116,117,118] Even under the lower scenario (RCP4.5), the average length of the winter recreation season and the number of recreational visits are projected to decrease by mid-century.[118] Under the same scenario, lost time for snowmaking is expected to delay the start of the ski season across southern areas, potentially impacting revenues during the winter holiday season. Activities that rely on natural snow and ice cover are projected to remain economically viable in only far northern parts of the region by end of century under the higher scenario (RCP8.5).[117,118]

Sensitivity to projected changes in winter climate varies geographically, and venues are adapting by investing in artificial snowmaking, opening higher-elevation trails, and offering a greater range of activities and services.[115,117] As the margin for an economically viable winter recreation season (a season with more than 100 days for skiing; more than 50 for snowmobiling) shifts northward and toward higher elevations, some affected areas will be able to extend their seasons with artificial snowmaking. However, the capacity of some vulnerable southern and low-elevation locations to adapt in the long term is expected to be limited by warming nighttime temperatures.[115,116,119] Markets farther north may benefit from a greater share of regional participation depending on recreationist preferences like travel time[118,120] and perceived snow cover conditions informed by local weather, referred to as the backyard effect.[121]

Intense Precipitation

The recent dominant trend in precipitation throughout the Northeast has been towards increases in rainfall intensity,[2,58] with recent increases in intensity exceeding those in other regions in the contiguous United States. Further increases in rainfall intensity are expected,[3] with increases in precipitation expected during the winter and spring with little change in the summer.[4] Monthly precipitation in the Northeast is projected to be about 1 inch greater for December through April by end of century (2070–2100) under the higher scenario (RCP8.5).[4]

Studies suggest that Northeast agriculture, with nearly $21 billion in annual commodity sales,[122] will benefit from the changing climate over the next half-century[35,123] due to greater productivity over a longer growing season (Figure 18.3) (see also Ch. 10: Ag & Rural). However, excess moisture is already a leading cause of crop loss in the Northeast.[35] Recent and projected increases in precipitation amount, intensity, and persistence[124,125] indicate increasing impacts on agricultural operations. Increased precipitation can result in soil compaction,[126] delays in planting, and reductions in the number of days when fields are workable.[127] If the trend in the frequency of heavy rainfall prior to the last frost continues, overly wet fields could potentially prevent Northeast farmers from taking full advantage of an earlier spring.[35] Increased soil erosion and agricultural runoff—including manure, fertilizer, and pesticides[128,129]—are linked to excess nutrient loading of water bodies as well as possible food safety or public health issues from food and waterborne infections.[130] Warmer winters are likely to increase livestock productivity in the Northeast[129] but are expected to also increase pressure from weeds and pests,[35] demand for pesticides,[128] and the risk of human health effects from increased chemical exposures.[130]

The projected changes in precipitation intensity and temperature seasonality would also affect streams and the biological communities that live in them. Freshwater aquatic ecosystems are vulnerable to changes in streamflow, higher temperatures, and reduced water quality.[131] Such ecosystems are especially vulnerable to increases in high flows, decreases in low flows, and the timing of snowmelt.[113,132,133] The impact of heavy precipitation on streamflows partly depends upon watershed conditions such as prior soil moisture and snowpack conditions, which vary throughout the year.[134,135,136,137] Although the annual minimum streamflows have increased during the last century,[138,139,140] late-summer warming[4,141] could lead to decreases in the minimum streamflows in the late summer and early fall by mid-century.[142]

Species that are particularly vulnerable to temperature and flow changes include stream invertebrates, freshwater mussels, amphibians, and coldwater fish.[66,131,143] For example, a recent study of the habitat suitable for dragonflies and damselflies (species that are a good indicator of ecosystem health along rivers) in the Northeast projected, under both the lower and higher scenarios (RCP4.5 and RCP8.5), habitat declines of 45%–99% by 2080, depending on the species.[144] Other particularly vulnerable groups include species with water-dependent habitats, such as salamanders and coldwater fish.[66,145] Increasing temperatures within freshwater streams threaten coldwater fisheries across northern New England and south through the Appalachian Mountains. A decrease in recreational fishing revenue is expected by end of this century under a higher scenario (RCP8.5) with the loss of coldwater habitat.[29,131,146]

Lengthening of the Freeze-Free Period

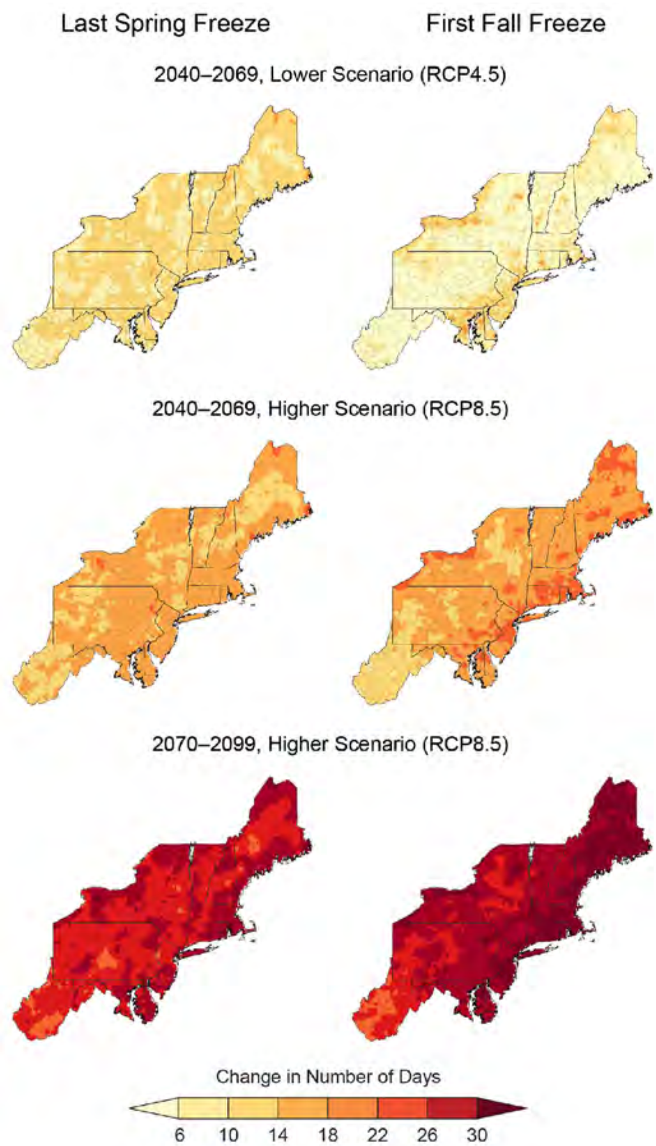


Figure 18.3: These maps show projected shifts in the date of the last spring freeze (left column) and the date of the first fall freeze (right column) for the middle of the century (as compared to 1979–2008) under the lower scenario (RCP4.5; top row) and the higher scenario (RCP8.5; middle row). The bottom row shows the shift in these dates for the end of the century under the higher scenario. By the middle of the century, the freeze-free period across much of the Northeast is expected to lengthen by as much as two weeks under the lower scenario and by two to three weeks under the higher scenario. By the end of the century, the freeze-free period is expected to increase by at least three weeks over most of the region. Source: adapted from Wolfe et al. 2018.[35]

Key Message 2

Changing Coastal and Ocean Habitats, Ecosystem Services, and Livelihoods

The Northeast's coast and ocean support commerce, tourism, and recreation that are important to the region's economy and way of life. Warmer ocean temperatures, sea level rise, and ocean acidification threaten these services. The adaptive capacity of marine ecosystems and coastal communities will influence ecological and socioeconomic outcomes as climate risks increase.

Ocean and coastal ecosystems are being affected by large changes in a variety of climate-related environmental conditions. These ecosystems support fishing and aquaculture,[5] tourism and recreation, and coastal communities.[6] They also provide important ecosystem services (benefits to people provided by the functions of various ecosystems), including carbon sequestration,[147] wave attenuation,[148,149] and fish[150] and shorebird[151] habitats. Observed and projected increases in temperature, acidification, storm frequency and intensity, and sea levels are of particular concern for coastal and ocean ecosystems, as well as local communities and their interconnected social and economic systems (Box 18.1).

Change in Sea Surface Temperature on the Northeast Continental Shelf

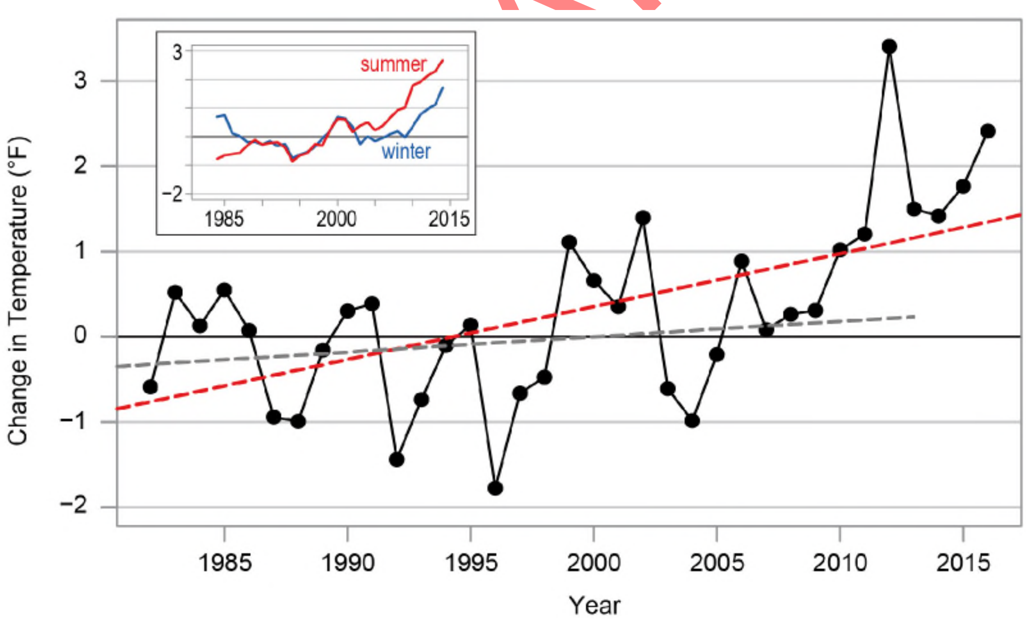


Figure 18.4: The figure shows annual average sea surface temperature (SST) differences from the 1982–2011 average (black dots and line). Over the period 1982–2016, sea surface temperature on the Northeast Continental Shelf has warmed at a rate of 0.06°F (0.033°C) per year (red dashed line). This rate is three times faster than the 1982–2013 global SST warming rate of 0.018°F (0.01°C) per year (gray dotted line).[39] The inset shows Northeast Continental Shelf seasonal SST differences from the 1982–2011 average as five-year rolling means for summer (July, August, September; red line) and winter (January, February, March; blue line). These seasons are centered on the warmest (summer) and coolest (winter) months for Northeast Shelf SSTs. Both seasons have warmed over the time period, but the summer warming rate has been stronger. Source: Gulf of Maine Research Institute.

Ocean Warming

Ocean and coastal temperatures along the Northeast Continental Shelf have warmed by 0.06°F (0.033°C) per year over the period 1982–2016 (Figure 18.4), which is three times faster than the 1982–2013 global average rate of 0.018°F (0.01°C) per year.[39] Over the last decade (2007–2016), the regional warming rate has been four times faster than the long-term trend, with temperatures rising 0.25°F (0.14°C) per year (Figure 18.4). Variability in ocean temperatures over the Northeast Continental Shelf (see Figure 18.1 for the location) has been related to the northern position of the Gulf Stream, the volume of water entering from the Labrador Current, and large-scale background warming of the oceans.[39,48,152,153] In addition to this warming trend, seasonality is also changing. Warming has been strongest during the summer months, and the duration of summer-like sea surface temperatures has expanded.[154] In parts of the Gulf of Maine, the summer-like season lengthened by two days per year since 1982, largely due to later fall cooling; the summer-like period expanded less rapidly (about 1 day per year) in the Mid-Atlantic, primarily due to earlier spring warming.[154]

Increasing temperatures and changing seasonality on the Northeast Continental Shelf have affected marine organisms and the ecosystem in various ways (Ch. 7: Ecosystems, KM 1; Ch. 9: Oceans). Seasonal ocean temperature changes have shifted characteristics of the spring phytoplankton blooms[158] and the timing of fish and invertebrate reproduction,[163,164] migration of marine fish that return to freshwater to spawn,[165,166] and marine fisheries.[155] As the timing of ecosystem conditions and biological events shifts, interactions between species and human activities such as fishing or whale watching will likely be affected.[42,155,163,166,167,168] These changes have the potential to affect economic activity and social features of fishing communities, working waterfronts, travel and tourism, and other natural resource-dependent local economies.

The warming trend experienced in the Northeast Continental Shelf has been associated with many fish and invertebrate species moving northward and to greater depths (Ch. 1: Overview, Figure 1.2h).[7,8,9,10,11] As these shifts have occurred, communities of animals present in a given area have changed substantially.[169] Species interactions can be affected if species do not shift at the same rate; generally, species groups appear to be moving together,[10] but overlap between pairs of specific species has changed.[42]

Rising ocean temperatures have also affected the productivity of marine populations. Species at the southern extent of their range, such as northern shrimp, surf clams, and Atlantic cod, are declining as waters warm,[39,170,171] while other species, such as black sea bass, are experiencing increased productivity.[11] Some species, such as American lobster and surf clam, have declined in southern regions where temperatures have exceeded their biological tolerances but have increased in northern areas as warming waters have enhanced their productivity.[40,171,172,173] The productivity of some harvested and cultured species may also be indirectly influenced by changing levels of marine pathogens and diseases. For example, increasing prevalence of shell disease in lobsters and several pathogens in oysters have been associated with rising water temperatures;[174,175] other pathogens that infect shellfish pose risks to human health (see Key Message 4).

Temperature-related changes in the distribution and productivity of species are affecting fisheries. Some fishermen now travel farther to catch certain species[176] or target new species that are becoming more prevalent as waters warm.[155] However, these types of responses do not always keep pace with ecosystem change due to constraints associated with markets, shoreside infrastructure, and regulatory limits such as access to quota licenses or permits.[177,178,179] In addition, stock assessment and fishery management processes do not explicitly account for temperature influences on the managed species. In the case of Gulf of Maine cod, rising temperatures have been associated with changes in recruitment, growth, and mortality; failure to account for declining productivity as a result of warming led to catch advice that allowed for overfishing on the stock.[39,180] Proactive conservation and management measures can support climate resilience of fished species. For example, long-standing industry and management measures to protect female and large lobsters have supported the growth of the Gulf of Maine–Georges Bank stock

Box 18.1: Ocean Heat Wave Provides Glimpse of Climate Future

In 2012, sea surface temperatures on the Northeast Continental Shelf rose approximately 3.6°F (2°C) above the 1982–2011 average. This departure from normal was similar in magnitude to the changes projected for the end of the century under the higher scenario (RCP8.5) and represented the largest, most intense warm water event ever observed in the Northwest Atlantic Ocean (Ch. 9: Oceans).[155,156,157] This heat wave altered seasonal cycles of phytoplankton and zooplankton,[158,159] brought Mid-Atlantic fish species into the Gulf of Maine,[155] and altered the occurrence of North Atlantic right whales in the Gulf of Maine.[160] Commercial fisheries were also affected. A fishery for squid developed quickly along the coast of Maine, but the New England lobster fishery was negatively affected. Specifically, early spring warming triggered an early start of the fishing season, creating a glut of lobster in the supply chain and leading to a severe price collapse.[155] During 2012, the dockside price for lobster hit its lowest level in the past decade and dropped from an average per-pound value of $3.62 for June and July 2000–2011 to just $2.37 in those months in 2012. The experience during the 2012 ocean heat wave revealed vulnerabilities in the lobster industry and prompted a variety of adaptive responses, such as expanding processing capacity and further developing domestic and international markets[161] in an attempt to buffer against similar industry impacts in the future. Although an outlier when compared with our current climate, the ocean temperatures in 2012 were well within the range projected for the region by the end of the century under the higher scenario (RCP8.5).[162] The 2012 ocean heat wave provided a glimpse of impacts affecting ecological and social systems, and experiences during this event can serve as a stress test to guide adaptation planning in years to come (akin to 2015 in the Northwest) (see Ch. 24: Northwest, Box 24.7).

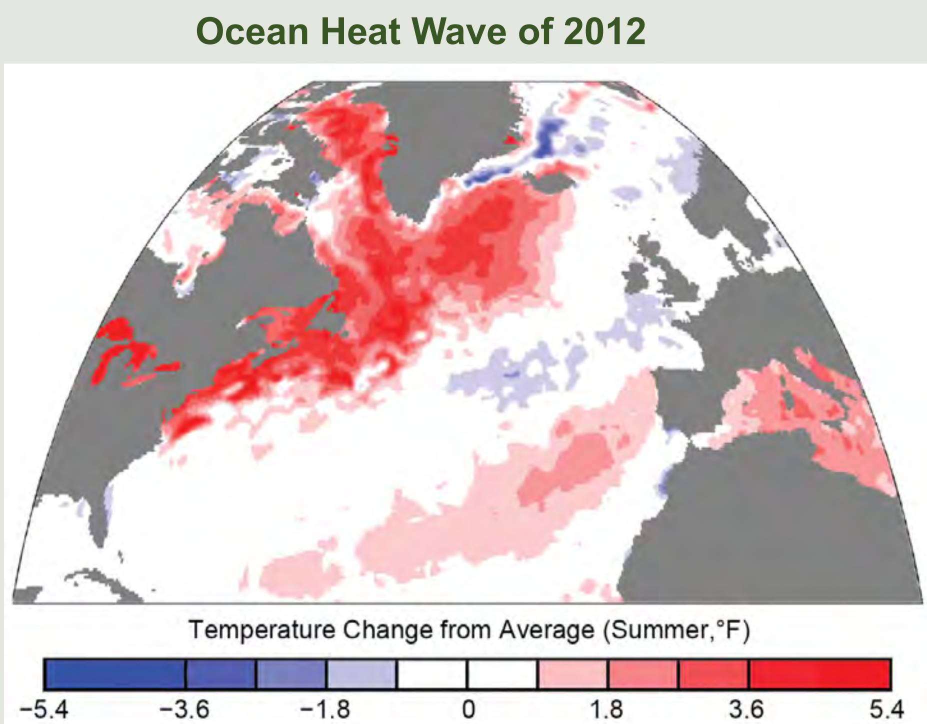


Figure 18.5: The map shows the difference between sea surface temperatures (SST) for June–August 2012 in the Northwest Atlantic and the average values for those months in 1982–2011.[155] While ocean temperatures during 2012 were exceptionally high compared to the current climate, they were within the range of end-of-century temperatures projected for the region under the higher scenario (RCP8.5). This heat wave affected the Northeast Continental Shelf ecosystem and fisheries, and similar extreme events are expected to become more common in the future (Ch. 9: Oceans). Source: adapted from Mills et al. 2013.[155] Reprinted with permission from Elsevier.

as waters warmed, but the lack of these measures in southern New England exacerbated declines in that stock as temperatures increased.[40]

Ocean Acidification

In addition to warming, coastal waters in the Northeast, particularly in the Gulf of Maine, are sensitive to the effects of ocean acidification because they have a low capacity for maintaining stable pH levels.[181,182] These waters are particularly vulnerable to acidification due to hypoxia (low-oxygen conditions)[183] and freshwater inputs, which are expected to increase as climate change progresses.[142,181,184] At the coastal margins, acidification is exacerbated by nutrient loading from land-based runoff and atmospheric deposition during heavy rainfall events. When added to the system, these nutrients promote the growth of algae that release carbon dioxide, which contributes to acidification, as they decay.[185]

Fisheries and aquaculture rely on shell-forming organisms that can suffer in more acidic conditions (Ch. 9: Oceans).[181,182,186] Some of the most valuable wild- and culture-based fisheries in the region harvest shelled organisms—including lobsters, scallops, blue crabs, oysters, surf clams, and mussels.[5] To date, there have been few studies of how local populations and different life stages will be affected by ocean acidification,[182] but actions taken by industry to counter the potential negative impacts are emerging. For example, when an oyster hatchery in Maine experienced low survival rates of larval oysters following exposure to low pH water during large runoff events, it collaborated with scientists to develop systems to monitor and control carbonate conditions in the facility (Ch. 9: Oceans).[187]

Future Projections of Ocean Warming and Acidification

Climate projections indicate that in the future, the ocean over the Northeast Continental Shelf will experience more warming than most other marine ecosystems around the world.[48,49] Continued warming and acidification are expected to further affect species and fisheries in the region. Future projections indicate that declines in the density of a zooplankton species, *Calanus finmarchicus*—an important food source for many fish and whales in the Northeast Shelf region—will occur as waters continue to warm through the end of the century.[188] Northward species distribution trends are projected to continue as ocean waters warm further.[189] A species vulnerability assessment indicated that approximately 50% of the commercial, forage, and protected fish and invertebrate species on the Northeast Continental Shelf will be highly or very highly vulnerable to climate change through 2050 under the higher scenario (RCP8.5).[143] In general, species in the southern portion of the region are expected to remain stable through mid-century, but many species in the northern portion are expected to be negatively affected by warming and acidification over that timeframe.[143,186] Species population models projected forward under future ocean conditions also indicate declines of species that support some of the most valuable and iconic fisheries in the Northeast, including Atlantic cod,[39,190] Atlantic sea scallops,[191] and American lobster.[40] In addition, species that are already endangered and federally protected in the Northeast—such as Atlantic sturgeon, Atlantic salmon, and right whales—are expected to be further threatened by climate change.[192,193,194,195]

Changes in Distribution and Abundance of Marine Species

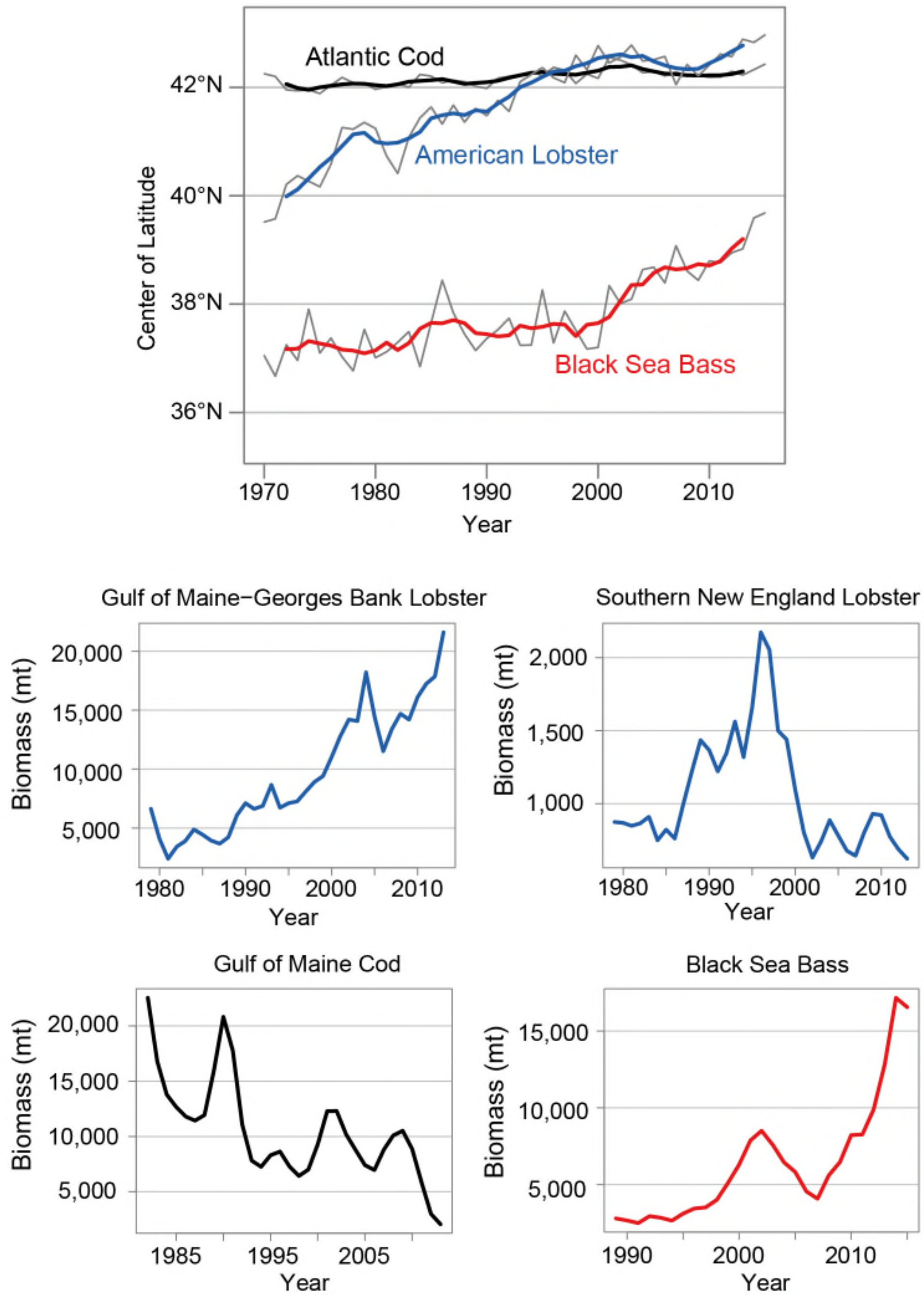


Figure 18.6: The figure shows changes over time in geographic distribution (top panel) and biomass (four bottom panels) for various marine species along the Northeast Shelf. As waters in the region have warmed, the spatial distributions of many fish species have been shifting northward, while population trends of several marine species show more variability over time. The top panel shows shifts in spatial distribution over time for select fish species, based on their latitudinal centers of biomass. The four panels on the bottom show biomass estimates for the same marine resource stocks. Gulf of Maine cod, a coldwater species, has not shifted in location but has declined in biomass, while black sea bass (a warmwater species) has moved northward and increased in biomass as waters have warmed. The lobster distribution shift reflects declines in productivity of the southern stock and increasing biomass of the northern stock. Sources: (black sea bass) adapted from Northeast Fisheries Science Center 2017;[204] (all others) Gulf of Maine Research Institute.