Final Environmental Impact Report
EEA No. 16640

CAPE COD GATEWAY AIRPORT

MASTER PLAN IMPROVEMENT PROJECTS

APPENDICES A-J

Epsilon ASSOCIATES INC.

September 16, 2024

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APPENDIX E

Aircraft Deicing and Washing Program

AIRCRAFT DEICING AND WASHING PROGRAM
BARNSTABLE MUNICIPAL AIRPORT
480 BARNSTABLE ROAD
HYANNIS, MASSACHUSETTS

1.0 INTRODUCTION

This Aircraft Deicing and Washing Program has been prepared for the Barnstable Municipal Airport (the Airport), 480 Barnstable Road, Hyannis, Massachusetts. The purpose of the Program is to establish procedures for Airport tenants to follow during aircraft deicing and washing at the Airport's South Ramp Deicing Pad. The Program is intended to protect groundwater and surface water resources at the Airport, and maintain compliance with local, state, and federal regulations.

Aircraft deicing activities at the Barnstable Municipal Airport (Airport) currently occur on a regular basis during the winter months at three designated deicing locations (Figure 1):

- South Ramp Deicing Area;
- Rectrix Aerodrome Facility Deicing Area; and
- East Ramp General Aviation Deicing Area.

Due to construction completion of the new South Ramp Deicing Pad in October 2015, the Rectrix Aerodrome and East Ramp General Aviation deicing areas were removed from active operations. The paved apron in the South Ramp Deicing Pad drains to a single, centrally located catch basin that discharges to the Barnstable Water Pollution Control Facility (WPCF) during aircraft deicing or washing. During all other times, this same catch basin discharges to the Airport's stormwater conveyance system that ultimately discharges to Upper Gate Pond. The discharge system is controlled through a series of manual gate valves that are operated by Airport Operations personnel. **Notification of Airport Operations prior to deicing or washing is required, to confirm that the system is discharging to the WPCF.**

Photo 1: Stormwater gate valve and operating position indicators.

PLEASE NOTE:
The South Ramp Deicing Pad is located within a "Secured Area." This Secured Area is regulated under TSAR 1542, and any enplaning and deplaning of passengers in this area during deicing operations is **strictly prohibited**.

The South Ramp Deicing and Washing Pad was constructed by the Airport to provide tenants and aircraft operators with a central location to complete these activities, and reduce the potential for environmental impacts. The Massachusetts Department of Environmental Protection (DEP), Cape Cod Commission (CCC), Barnstable Department of Public Works (DPW), and Barnstable WPCF have reviewed the construction plans and may conduct further review and/or inspection of the operations and record keeping procedures. Compliance with the procedures and requirements established in this Program is necessary to avoid increased oversight or potential penalties from these agencies.

2.0 TENANT AND OPERATOR TRAINING

It will be the responsibility of the Airport tenants to notify Airport Operations of their intent to deice or wash aircraft. Prior to using the South Ramp pad for deicing or washing aircraft, aircraft operators or tenants must attend a brief training session with Airport Operations to familiarize themselves with the system components and procedures.

3.0 DEICING FLUID AND DETERGENT FORMULATION AND MONITORING

Due to the decreased environmental impacts over alternative formulations, the Airport currently requires all tenants to utilize Type I propylene glycol based deicing fluids. The use of Type IV deicing fluids is currently being reviewed by the WPCF. Tenants will be notified if Type IV deicing fluids are approved for use. Types II and III deicing fluids are not commonly supplied for use by civilian air transportation airlines, and are prohibited from use at the Airport. Tenants are required to maintain Material Safety Data Sheets (MSDS), purchase orders, invoices, or other similar documentation sufficient to determine the classification of deicing fluid formulations in use, and provide copies of these records to the Airport Managers office prior to their use at the Airport.

In accordance with Barnstable WPCF requirements and the Airport's Stormwater Pollution Prevention Plan (SWPPP), each aircraft owner / tenant agent must maintain a record of the cumulative amount of deicing fluid used each day. The cumulative record should be stored with the deicing fluid equipment or at the hangar office. The volume of deicing fluid used during each calendar month shall be reported to the Airport Manager's office at the end of each month, or at any time Airport Management requests this information. A monthly log sheet is attached.

The Barnstable WPCF has designated the following detergents to be utilized during aircraft washing. **No other detergent products are permitted for use at this time**. An owner / tenant can submit an alternative detergent for review by the WPCF. Please contact Airport

Management for more information on the WPCF approval process. Each aircraft owner / tenant will be responsible for purchasing the approved detergent(s) for their own use. Detergents are to be applied in accordance with the manufacturer's recommendations and only at the specified dilution.

WPCF APPROVED DETERGENTS:

- SIMPLE GREEN™ AIRCRAFT AND PRECISION CLEANER

The South Ramp deicing and washing pad features an oil water separator (O/WS) and pump station with an integrated Mission pump monitoring system. During aircraft deicing or washing (when the pump station is in operation), the Mission pump monitoring system will notify the Barnstable WPCF. The Mission pump monitoring system and Airport Operations notification procedures described in Sections 4.0 and 5.0 are intended to provide a record log of activity for the deicing / washing pad. In the event that any issues are noted at the WPCF, the record log will be reviewed by Airport Management to identify potentially responsible parties. The Airport will not be held liable for any tenant activities, including any that may result from unauthorized use of the deicing pad, use of deicing or detergent products other than those specified here, or activities that are inconsistent with this Program. Unauthorized use of the deicing pad could result in harmful discharges to Upper Gate Pond or the Barnstable WPCF, and any responsible parties may be subject to penalties or enforcement actions from DEP, DPW, and/or the Barnstable WPCF.

4.0 AIRCRAFT DEICING PROCEDURES

The following procedures shall be followed by all aircraft owners and have been established to minimize potential impacts associated with deicing activities at the Airport and maintain compliance with Barnstable WPCF requirements.

- The deice pad will be closed immediately when snow accumulates on the pad, and will remain closed until any standing snow has been removed. The pad is included in the Priority 1 areas of the airport, these are the first areas cleared when snow removal operations are initiated. Tenants are notified of the deice pad status through the Snow Reports issued by Airport Operations on an as-needed basis during winter weather events. Airport Operations will confirm that standing snow has been removed prior to confirming the pad is open for deicing.
- **Prior to any aircraft entering the South Ramp deicing pad, the designated aircraft operator or tenant agent must notify Airport Operations.** Airport Operations will record the request in the daily log, noting the aircraft operator / tenant agent, aircraft call sign / registration number, date, and time of request. The operator must wait for confirmation from Airport Operations that the pad is open for deicing.
- **Airport Operations will log the time the valve for deicing or washing was opened on the appropriate valve use log.**
- The aircraft owner must immediately notify Airport Operations if an aircraft is disabled in the South Ramp Deicing Area. It is the aircraft owner's responsibility to ensure

prompt arrangements are made with Airport Operations or through their own resources to have the disabled aircraft removed from the Secure Area.

- After acknowledgement from Airport Operations, the aircraft operator shall park and adequately secure the aircraft within the demarcated area.
- Prior to any application of deicing fluid Airport Operations will close the manual gate valve labeled "Stormwater Discharge", and open the valve labeled "Deicing / Wash Discharge." Each of the gate valves features a visual indicator on the pavement surface to confirm proper orientation.
- The aircraft operator may then proceed with the application of deicing fluid on the aircraft. Deicing fluids shall be limited to those products that have received prior approval by Airport Management.
- Excessive use of deicing fluid is prohibited.
- After the aircraft has been deiced or washed, the aircraft operator / tenant agent shall notify Airport Operations that operations are complete. Airport Operations will log the notification.
- **Airport Operations will log the time the valve for deicing or washing was closed on the appropriate valve use log.**
- After the gate valves have been positioned to discharge to the airfield stormwater conveyance system, Airport Operations will log the operation.

5.0 AIRCRAFT WASHING PROCEDURES

The following procedures shall be followed by all aircraft owners and have been established to minimize potential impacts associated with aircraft washing activities at the Airport and maintain compliance with Barnstable WPCF requirements. Washing of aircraft is only permitted within tenant hangars that have permitted floor drains discharging to the Barnstable WPCF and/or at the South Ramp deicing / washing pad.

- The washing pad will be closed immediately when snow accumulates on the pad, and will remain closed until any standing snow has been removed. The pad is included in the Priority 1 areas of the airport, these are the first areas cleared when snow removal operations are initiated. Tenants are notified of the deice pad status through the Snow Reports issued by Airport Operations on an as-needed basis during winter weather events. Airport Operations will confirm that standing snow has been removed prior to confirming the pad is open for washing.
- **Prior to any aircraft entering the South Ramp washing pad, the designated aircraft operator or tenant agent must notify Airport Operations.** Airport Operations will record the request in the daily log, noting the aircraft operator / tenant agent, aircraft call sign / registration number, date, and time of request. The operator must wait for confirmation from Airport Operations that the pad is open for washing.
- **Airport Operations will log the time the valve for deicing or washing was opened on the appropriate valve use log.**

- The aircraft owner must immediately notify Airport Operations if an aircraft is disabled in the South Ramp Deicing Area. It is the aircraft owner's responsibility to ensure prompt arrangements are made with Airport Operations or through their own resources to have the disabled aircraft removed from the Secure Area.
- After acknowledgement from Airport Operations, the aircraft operator shall park and secure the aircraft within the demarcated area.
- Prior to any rinsing or application of detergent fluid, Airport Operations will close the manual gate valve labeled "Stormwater Discharge", and open the valve labeled "Deicing / Wash Discharge". Each of the gate valves features a visual indicator on the pavement surface to confirm proper orientation.
- The aircraft operator or tenant agent may then proceed with rinsing / washing the aircraft. Detergents shall be limited to those products that have received prior approval by Airport Management and the Barnstable WPCF.
- Washing of engine bays is prohibited.
- Upon completion, the aircraft operator / tenant agent shall notify Airport Operations. Airport Operations will log the notification.
- **Airport Operations will log the time the valve for deicing or washing was closed on the appropriate valve use log.**
- After the gate valves have been positioned to discharge to the airfield stormwater conveyance system, Airport Operations will log the operation.

The construction of the South Ramp Deicing and Washing Pad was completed by the Airport to provide tenants with a centralized location to conduct these activities, while reducing the potential environmental impact. Tenant compliance with the procedures and requirements established in this Program is necessary to avoid increased oversight or potential penalties from state and local regulatory agencies. Should you have any questions regarding any of these matters, please contact the Airport Manager's office.

Barnstable Municipal Airport (HYA) – Deice/Wash Pad Valve Log

Month: _____ Year: _____

Date	Time Valves Opened to WPCF	Time Valve Closed to WPCF	Date	Time Valve Opened to WPCF	Time Valve Closed to WPCF
1			17		
2			18		
3			19		
4			20		
5			21		
6			22		
7			23		
8			24		
9			25		
10			26		
11			27		
12			28		
13			29		
14			30		
15			31		
16					

Note: The deicing/wash pad valves must remain in position to discharge into the storm water system. Any time the valves are switched to discharge to the Barnstable Water Pollution Control Facility (WPCF) the operation must be logged, similarly the time the valves are returned to storm water must be logged.

APPENDIX F

NPDES – 1: ROUTINE FACILITY INSPECTION FORM

FORM NPDES – 1
ROUTINE FACILITY INSPECTION FORM

STORMWATER POLLUTION PREVENTION PLAN
CAPE COD GATEWAY AIRPORT
HYANNIS, MASSACHUSETTS

NPDES – 1: ROUTINE FACILITY INSPECTION FORM

Cape Cod Gateway Airport is required to document the findings of each routine facility inspection performed and maintain the documentation onsite with the Stormwater Pollution Prevention Plan (SWPPP) as required in Part 3.1.6 of the 2021 MSGP. Routine facility inspections shall be conducted by the Program Manager or Coordinator or designated staff at least four times a year, and monthly during the deicing season. The Airport is not required to submit routine facility inspection findings to EPA, unless specifically requested to do so.

INSPECTION DATE :_____

INSPECTION TIME :_____

PERSONNEL COMPLETING INSPECTION:
(Note: at least one member of the SWPPP Team is required to participate in Routine Facility Inspections)

INSPECTION PERSONNEL:	ORGANIZATION / TITLE:

WEATHER CONDITIONS AT TIME OF INSPECTION:
❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snow ❑ High Winds

❑ Other: Temperature:

Weather Previous 24 Hours:
❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snow ❑ High Winds

❑ Other: Temperature:

Weather Previous 72 Hours:
❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snow ❑ High Winds

❑ Other: Temperature:

AREAS OF INSPECTION:

FACILITY:	OBSERVATIONS / DEFICIENCIES:	RECOMMENDED ACTIONS:
Rectrix Hangar / Apron		
Cape Air Hangar / Apron		
Griffin Hangar / Apron		
Griffin Fuel Island		
Hangar II / Apron		
Gate F Fuel Farm		
Allies Air Hangar / Apron		
Former Ops Garage / Apron		
East Ramp Apron		
Main Terminal / Apron		
South Ramp Deicing Pad		
North Ramp Apron		
Budget Car Service Facility		
Hertz Car Service Facility		
Hertz Fuel Island		
Avis Car Service Facility		
ARFF Facility		
OPS Facility		
Rectrix /Air Cape Cod Hangar / Apron (East Ramp)		
Rectrix / Air Cape Cod Gate P Fuel Farm		
Cape Flight Instruction Hangar / Apron		
AMA Nantucket Inc.		
Hyannis Hangar / Apron		
Hexagon Hangar / Apron		
Steamship Authority Parking Lots		

OUTFALL:	DISCHARGE OBSERVED (YES / NO)	OBSERVATIONS / DEFICIENCIES:	RECOMMENDED ACTIONS:
Outfall A			
Outfall B			
Outfall C			
Outfall D			
Outfall E			
Outfall F			
Outfall H			
Outfall J			
Outfall J-A			

ROUTINE FACILITY INSPECTION SUMMARY:

Previously unidentified discharges of pollutants from the site:

_____

_____

Control measures needing maintenance or repairs:

_____

_____

Failed control measures that need replacement:

_____

_____

Incidents of noncompliance observed:

_____

_____

Additional control measures needed to comply with the permit requirements:

_____

_____

ALL RECORDS ARE TO BE MAINTAINED AT THE AIRPORT MANAGER'S OFFICE.

Certification Statement (Refer to MSGP Subpart 11 Appendix B for Signatory Requirements)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: _____ Title: _____

Signature: _____ Date Signed: _____

APPENDIX G

NPDES – 2: QUARTERLY VISUAL ASSESSMENT FORM

STORMWATER POLLUTION PREVENTION PLAN
CAPE COD GATEWAY AIRPORT
HYANNIS, MASSACHUSETTS

NPDES 2: QUARTERLY VISUAL ASSESSMENT FORM

On a quarterly basis, the Cape Cod Gateway Airport is required to collect a stormwater sample from each outfall and conduct a visual assessment of each sample. The visual assessment must be conducted by qualified personnel, with at least one member of the Airport's stormwater pollution prevention team participating.

Stormwater discharge samples must be collected within the first 30 minutes of an actual discharge from a storm event. If it is not possible to collect the sample within the first 30 minutes of discharge, the sample must be collected as soon as practicable after the first 30 minutes and the sampling personnel must document why it was not possible to take samples within the first 30 minutes. Stormwater discharge sampling shall not occur within 72 hours (three days) of a previous storm event. According to Section 3.2.4.3 of the MSGP, at least one quarterly visual assessment must capture snowmelt discharge. Any deviations from the schedule for visual assessments and/or monitoring must be documented, along with the reason for the deviations.

Visual Assessments include the visual inspection of the stormwater sample for color, odor, clarity, floating solids, settled solids, suspended solids, foam, oil sheen, and other obvious indicators of stormwater pollution.

PERSONNEL COMPLETING INSPECTION:
(Note: at least one member of the SWPPP Team is required to participate in Quarterly Visual Assessments)

INSPECTION PERSONNEL:	**ORGANIZATION / TITLE:**

INSPECTION DATE: _____
INSPECTION TIME: _____

WEATHER CONDITIONS AT TIME OF ASSESSMENT:

_____

_____

Time of Initial Discharge:

_____

Nature of Discharge (snowmelt, runoff):

_____

Weather Previous 24 Hours:

_____

Weather Previous 72 Hours:

_____

VISUAL ASSESSMENT OF OUTFALL DISCHARGE SAMPLES SHOULD BE RECORDED ON THE ATTACHED QUARTERLY VISUAL ASSESSMENT TABLE. ALL RECORDS ARE TO BE MAINTAINED AT THE AIRPORT MANAGER'S OFFICE.

QUARTERLY VISUAL ASSESSMENT SUMMARY:

_____
_____
_____
_____
_____
_____
_____
_____

Certification Statement (Refer to MSGP Subpart 11 Appendix B for Signatory Requirements)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: _____ Title: _____

Signature: _____ Date Signed: _____

STORMWATER POLLUTION PREVENTION PLAN Cape
CAPE COD GATEWAY AIRPORT
HYANNIS, MASSCHUSETTS
QUARTERLY VISUAL ASSESSMENT REPORTING FORM

OUTFALL LOCATION	TIME:	COLOR:	ODOR:	CLARITY:	FLOATING SOLIDS:	SETTLED SOLIDS:	SUSPENDED SOLIDS:	FOAM:	OIL SHEEN:	OTHER INDICATORS
Outfall A										
Outfall B										
Outfall C										
Outfall D										
Outfall E										
Outfall F										
Outfall H										
Outfall J										
Outfall J-A										

ALL QUARTERLY VISUAL ASSESSMENT RECORDS ARE TO BE MAINTAINED AT THE AIRPORT MANAGER'S OFFICE.

APPENDIX H

NPDES 3 - INDICATOR MONITORING REPORT FORM

MSGP Indicator Monitoring Report Form

Name of Facility:	Cape Cod Gateway Airport	NPDES Tracking No.	MAR053164

Sampling Location(s):

Person(s)/Title(s) collecting sample:

Person(s)/Title(s) examining sample:

Date & Time Sample Collected: (If sample is not taken within first 30 minutes, explain why.)

Nature of Discharge: ☐ Rainfall ☐ Snowmelt

Duration of Rainfall Event (hrs):	Rainfall amount for current event (in):	Time since the previous measurable storm event (days):

Previous Storm Ended > 72 hours Before Start of This Storm?	☐ Yes	☐ No* (If no, explain):

Indicator Monitoring Results

PAH Analytes	Units	Outfall								
		A	B	C	D	E	F	H	J	J-A
acenaphthene	-									
acenaphthylene										
anthracene										
benzo[a]anthracene										
benzo[b]fluoranthene										
benzo[k]fluoranthene										
benzo[a]pyrene										

benzo[g,h,i]perylene										
chrysene										
dibenz[a,h]anthracene										
fluoranthene										
fluorene										
indeno[1,2,3-c,d]pyrene										
naphthalene										
phenanthrene										
pyrene										

Include any additional comments, descriptions of pictures taken, and any corrective actions necessary below (attach additional sheets as necessary). If applicable, describe why it was not possible to take samples within the first 30 minutes of stormwater discharge. If applicable, describe any deviations to the monitoring schedule due to freezing conditions.

Certification Statement (Refer to MSGP Subsection 11 Appendix B for Signatory Requirements)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information contained therein. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information contained is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

A. Name:	B. Title:
C. Signature:	D. Date Signed:

Appendix F

JetBlue E190 Letter

27-01 Queens Plaza North
Long Island City, NY 11101
T: 1-800-JETBLUE
jetblue.com

May 2, 2023

To Whom It May Concern,

Subject: JetBlue E190 Retirement

This is letter is meant to reiterate JetBlue's current plan to retire its fleet of 60 E190s by 2026. In 2018, we announced our initial order of 60 A220s and the option for 60 additional aircraft. We converted 10 of 60 options to firm orders in 2019 and 30 additional options in 2022. With these transactions combined, we have 100 firm orders for A220s, all of which are expected to deliver by the end of 2026.

Our 2022 transaction with Airbus enabled the accelerated retirement of the Embraer E190 fleet, of which, we have already retired 12 aircraft. We will continue to steadily wind down the E190 fleet with the last aircraft exiting in 2026.

JetBlue's A220 fleet is outfitted with 140 seats compared with 100 on the E190s that these aircraft are replacing. This 40% jump in seat count allows JetBlue to keep costs low while continuing to grow service in the cities that we serve.

We are excited for the many Customer and economic benefits that this fleet transition enables over the next few years.

Sincerely,

Patrick Staudt

Patrick Staudt

Manager Fleet Strategy & Analysis
JetBlue Airways Corporation
27-01 Queens Plaza North
Long Island City, NY 11101

Appendix G

Upper Gate Pond Permanent Solutions Statement with No Conditions

PERMANENT SOLUTION STATEMENT WITH NO CONDITIONS

Cape Cod Gateway Airport
Hyannis, Massachusetts

RTN 4-28577

November 2023

Prepared for:
Cape Cod Gateway Airport
480 Barnstable Road Hyannis,
MA 02840

Prepared by:
Horsley Witten Group, Inc.
90 Route 6A
Sandwich, MA 02563

PERMANENT SOLUTION STATEMENT WITH NO CONDITIONS
UPPER GATE AND LEWIS PONDS
CAPE COD GATEWAY AIRPORT
HYANNIS, MASSACHUSETTS
RELEASE TRACKING NUMBER 4-28577

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PERMINANT SOLUTION STATEMENT WITH NO CONDITIONS
CAPE COD GATEWAY AIRPORT
HYANNIS, MASSACHUSETTS
RELEASE TRACKING NUMBER 4-28577

1.0 INTRODUCTION

The Horsley Witten Group, Inc. (HW) has prepared this Permanent Solution Statement with No Conditions (PSS-NC) on behalf of the Responsible Party (RP), the Cape Cod Gateway Airport (the "Airport") for its property located at 480 Barnstable Road, Hyannis, Massachusetts. For the purpose of this report, the term "Airport" specifically refers to the Cape Cod Gateway Airport property located at 480 Barnstable Road and the term "Disposal Site" refers to the area impacted by oil and/or hazardous material (OHM) subject to Release Tracking Number (RTN) 4-28577. A Site Locus Map and the Estimated Disposal Site Boundary Map are provided as Figures 1 and 2, respectively.

This PSS-NC focuses on polycyclic aromatic hydrocarbons (PAHs) and lead that were discovered in sediments within Upper Gate Pond and Lewis Pond (the "Ponds", Figure 2). The Ponds are both fresh water and are located on the northern portion of the Airport property. The Airport discharges stormwater into the Ponds under an Environmental Protection Agency Multi-Sector General Permit MAR053164 (the "EPA MSGP"). Prior to discharge in the Ponds, stormwater is treated by Vortechs® hydrodynamic separators as indicated on Figure 3. Calculated total suspended solid (TSS) removal rates for these water quality units range from 81% to 87% with total petroleum hydrocarbon (TPH) removal at 67%. Since the installation of the Vortechs® units in 2011, 100% of stormwater discharged to the Ponds receives pretreatment.

The sediments in the Ponds were initialed sampled by HW in 1997 as part of the North Ramp Phase II Comprehensive Site Assessment (the "Phase II") relating to the investigation and remediation of a hydrocarbon and chlorinated solvent plume at Airport (RTN 4-823). As documented in the Phase II, additional sediment sampling and preparation of a risk characterization was postponed pending updated guidance from the Massachusetts Department of Environmental Protection (MassDEP). At the time of the Phase II, there were questions about whether or not the sediment contamination was associated with the North Ramp petroleum releases or related to typical contaminants found in stormwater runoff from impervious areas that are impacted by aircraft and motor vehicle usage.

Additional sediment samples (Figure 4 and 5) were collected from the Ponds in 2001 (sample locations unknown) 2004, 2005 and 2011. Due to elevated laboratory reporting limits (Tables 1 and 2), it was difficult to determine if the PAHs in sediment were consistent with petroleum residues that are incidental to the normal operation of a vehicle and atmospheric deposition of engine emissions. Samples were also collected from Mary Dunn Pond (Figure 6) to document lead and PAH concentrations (Table 3) in a non-stormwater receiving pond that was located in proximity to Upper Gate Pond and Lewis Pond.

The remediation of the North Ramp hydrocarbon and chlorinated solvent plume was completed in July 2020. At that time, MassDEP agreed to separate the remaining assessment associated with the Ponds and assigned a new RTN (4-28577). Additional sediment samples were collected from the Ponds, an airport outfall on the east ramp (Outfall J), an infiltration basin at Outfall J (Outfall Plaza), and Mary Dunn Pond in 2021 and 2022 as indicated on Figures 3 through 6.

An evaluation of the ratios of fluoranthene to pyrene and phenanthrene to anthracene was conducted to determine if these ratios were consistent with literature values for engine exhaust particles, diesel fuel, or urban runoff in sediment. As indicated on Tables 1 through 3, the samples were most consistent with exhaust particles which would be expected in sediments within stormwater ponds that collect stormwater from runways and parking lot areas. Additional details on ratios for PAH source identification are included on Table 1 of the document titled *Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediment: Identifying Sources and Ecological Hazards,* prepared by Jerry M. Neff, Scott A. Stout, and Donald Gunster, dated May 20, 2004. A copy of this document including Table 1 is included in Appendix A. The elevated lead in the sediments can be attributed to use of leaded aviation gasoline or from historic leaded gasoline.

As such, the PAHs and lead detected in the sediments are consistent with engine emissions from vehicles or aircraft that enter the Ponds or infiltration basins from the Airport's stormwater management system. Runoff from a majority of the runways, taxiways, and ramp areas at the Airport is collected and discharged through three outfalls in Upper Gate Pond (Figure 3) and one outfall in Lewis Pond (Figure 3). Stormwater from the Kmart Plaza Area, Barnstable Road, and Airport Road is discharged to an infiltration basin through Outfall F (Figure 3) and stormwater from the East Ramp is discharged to Outfall J.

The PAHs and lead detected in the sediments at the Airport are consistent with incidental petroleum residuals (including the use of leaded gasoline) and/or engine emissions from vehicles or aircraft that enter the Ponds, outfalls, and infiltration basins from the Airport's stormwater management system. Pursuant to 310 CMR 40.0006, petroleum residues that are incidental to the normal operation of a vehicle and atmospheric deposition of engine emissions are ubiquitous and consistently present in the environment and are considered Anthropogenic Background.

Additionally, pursuant to 310 CMR 40.0317 (3) "releases of OHM that are discharged or emitted from an outfall, stack or other point source, or as fugitive emissions, any of which are regulated under and have received a valid permit, license, or approval, or which are operating under a valid registration, order or guideline issued under a federal or state statute or regulation, unless the release:

- exceeds the amount allowed by the permit, license, approval, registration, order or guideline; and
- represents an Imminent Hazard to health, safety, public welfare or the environment".

The Airports MSGP does not include any criteria or benchmark values for lead or PAHs and the concentrations of lead and PAHs detected in sediment do not pose an imminent hazard pursuant to 310 CMR 40.0950. As such, the normal operation of the Airport's Stormwater system which may include stormwater discharges containing Anthropogenic Background levels of PAHs and lead is not regulated under the MCP. Therefore, this PSS-NC report is being submitted to document the information that confirms the release is related to permitted stormwater runoff consistent with Anthropogenic Background and therefore no further action under the MCP is required.

A Permanent and Temporary Solution Statement Form (BWSC104) is being submitted to the MassDEP concurrently with the submittal of this report.

Details concerning the PSS-NC are set forth below.

2.0 BACKGROUND

The Airport is located in Hyannis, Massachusetts, and provides scheduled airline service and general aviation services and other aviation related activities. The Airport is currently owned by the Town of Barnstable and is operated through the Cape Cod Gateway Airport Commission. The Airport began as a private airport consisting of a single grass runway before being given to the Town of Barnstable in the 1930's. During the 1940's, the U.S. Navy used the Airport and expanded the airfield to include three runways. In 1946, the Airport was returned to use as a two-runway municipal airport (each runway has a designation at each end, being 15-33 and 6-24).

The Airport is comprised of approximately 645 acres of land, with approximately 140 acres that are impervious (e.g., paved areas such as parking lots, runways, concrete walkways, and building rooftops). The Airport's structures include the main terminal and the Air Traffic Control Tower (ATCT), which are located south of the runways and taxiways, as well as several hangars used for general aviation services. The terminal includes office space for Airport employees, ticketing counters for airlines, service counters for auto rental agencies, a restaurant, a retail/art store, space for the TSA, and a general lobby and passenger queuing area. The Airport is located in an area of Hyannis zoned for Business and Industrial uses.

The general aviation facilities are managed primarily by private companies who lease portions of the Airport property. Daily operations typically include a variety of activities from private aircraft flights and charter services, flight school operations, aircraft maintenance and storage, refueling of aircraft, and other aviation related actions. The Airport provides vehicle parking at a main lot located directly in front of the terminal as well as at other locations proximate to hangars across the airport. The Airport is currently served by electric power, telephone, natural gas, municipal sewer, and a few individual septic systems for hangars on the north end of the East Ramp area.

The stormwater from most of the 142-acres of impervious areas at the Airport is collected and sent through a series of drainpipes that flow towards either Upper Gate or Lewis Pond (See Airport Drainage Map, Figure 3). The pipes that channel flow to the Ponds are open jointed pipes, meaning that some of the stormwater, especially from smaller rain events, infiltrates into the ground before it flows all the way to the outfalls at the Ponds. There are four outfalls to the Ponds; three that discharge to Upper Gate Pond and one that discharges to Lewis Pond. These outfalls have been in use for over 40 years, and possibly since the runways were reconfigured in 1946 as mentioned above.

Since 2011, 100% of the stormwater discharging to the ponds has been treated by Vortechs® hydrodynamic separators. Calculated TSS removal rates for these water quality units range from 81% to 87% with TPH removal at 67%.

Release History

The sediments in the Ponds were originally tested by HW in 1997 as part of the Phase II for the North Ramp hydrocarbon and solvent plume (RTN 4-823). There was concern at that time that activities associated with that release may have contributed contamination to the stormwater management facilities at the Airport and that the contamination may have migrated to the two Ponds.

Since that time, further evaluations of the releases associated with the North Ramp have been conducted and it was determined there was limited opportunity for the sources of the releases on the North Ramp to enter the stormwater facilities and discharge to the Ponds. The primary cause of the release at the North Ramp was from floor drains that discharged to leach pits either directly or through an oil/water separator connected to a leaching pit. These releases entered the underlying groundwater and did not migrate towards the Ponds as indicated on Figure 7. Additionally, as indicated on Tables 1 through 3, the ratio of fluoranthene to pyrene and phenanthrene to anthracene for the sediment samples collected in 2021 and 2022 were most consistent with diesel exhaust particles which would be expected in sediments within stormwater ponds that collect stormwater from runways and parking lot areas. PAH ratios are a forensic tool that are routinely utilized to determine potential sources of PAHs in the environment. Forensic analysis could not be conducted on previous samples collected due to elevated laboratory reporting limits. Refer to Appendix A for additional details of forensic rations used in sediment evaluations. It should be noted that due to elevated reporting limits in the PAH data collected prior to 2021, a forensic analysis could not be completed on historic analytical data.

The Airport and its various buildings, terminal runways, taxiways, and hangars include connections to stormwater facilities. The Airport has an overall Stormwater Pollution Prevention Plan (SWPPP) and associated drainage utility map that is updated regularly (Figure 3). Stormwater runoff either infiltrates directly into the sandy soils or is conveyed to other infiltration treatment units (e.g., Vortechs, raingardens, naturalized depressions, leaching catch basins) prior to discharge to the ground or into the Ponds. The SWPPP was prepared in

accordance with the requirements of the EPAs NPDES and annual stormwater reports are submitted to the EPA. As changes to runways, taxiways, and other infrastructure are made, the SWPPP is updated, reviewed, and approved as necessary.

As discussed above, both Upper Gate and Lewis Ponds receive stormwater during larger rain events from the runways, taxiways, and ramp areas at the Airport. Stormwater from the Kmart Plaza Area, Barnstable Road, and Airport Road is discharged to an infiltration basin through Outfall F. Stormwater from the East Ramp is discharged to Lewis Pond through Outfall J. Figure 3 provides an overview of the drainage areas that contribute to the Ponds. Both aircraft and vehicles operate in the paved areas that drain to the Ponds. Therefore, the runoff from these areas likely includes hydrocarbons and lead related to the incidental operation of vehicles and aircraft. It should be noted that aviation gas contains lead.

3.0 CONTENT OF THE PERMANENT SOLUTION

Pursuant to 310 CMR 40.1056(1), a Permanent Solution Statement shall include the following information.

3.1 Site Name, Location, and RTN

Pursuant to 310 CMR 40.1056(1)(a), the Site name, location and RTN are set forth below.

Cape Cod Gateway Airport
Upper Gate and Lewis Ponds
480 Barnstable Road
Hyannis, Massachusetts, 02601

Primary RTN: 4-28577

Secondary RTNs: None

3.2 Type of Permanent Solution

Pursuant to 310 CMR 40.1056(1)(b), the type of Permanent Solution is set forth below.

The Site has a achieved a PSS-NC Pursuant to 310 CMR 40.1041(1) in connection with RTN 4-28577. There are no secondary RTNs associated with the release.

3.3 Method of Risk Characterization

Pursuant to 310 CMR 40.1056(1)(c), the method of risk characterization is set forth below.

As set forth above, the detection of PAHs and lead in Ponds outfalls, and infiltration basin sediment are related to petroleum residuals that are incidental to the normal operation of

aircraft and other vehicles. As such, the concentration of PAHs and lead are consistent with Anthropogenic Background and a condition of No Significant Risk (NSR) exists. The MCP defines background "as those levels of oil and hazardous material that would exist in the absence of the disposal site of concern, including both Natural Background and Anthropogenic Background."

Pursuant to 310 CMR 40.1056(1)(c), completion of a Risk Characterization pursuant to 310 CMR 40.0900 is not required where concentrations of OHM are consistent with or are at background levels. Therefore, no risk characterization was completed in connection with RTN 4-28577.

It should be noted that an Imminent Hazard Evaluation was prepared to satisfy the requirements of 310 CMR 40.0317 (3). The Imminent Hazard Evaluation was prepared consistent with 310 CMR 40.0950. The highest detection of PAHs and lead as indicated on Tables 1 through 3 was used for the evaluation. As indicated on the Imminent Hazard Sort Form included in Appendix B, the Hazard Index is less than 1 and excess lifetime cancer risk is less than 1 in 100,000 and no stressed biota, fish fills, abiotic conditions or other conditions which produce an immediate or acute impact to freshwater fish were identified. As such, an Imminent Hazard to Human Health or the environment does not exist based on the levels of PAHs and lead detected in the sediment.

3.4 Relationship of the Permanent Solution to Other Permanent or Temporary Solution Statements

Pursuant to 310 CMR 40.1056(1)(d), the relationship of the Permanent Solution Statement to any other Permanent or Temporary Solution Statements that have been filed for the Disposal Site, if applicable, together with a statement as to whether any additional response actions are needed for any other portions of the disposal site are set forth below.

This PSS-NC is being submitted in connection with the release associated with RTN 4-28577 and is not related to any other Permanent or Temporary Solution Statements submitted to the MassDEP. No additional response actions are necessary in connection with the release.

3.5 Implementation of an Activity and Use Limitation

Pursuant to 310 CMR 40.1056(1)(e), an indication as to whether the Permanent Solution includes the implementation of an Activity and Use Limitation (AUL), and if so, the type of AUL implemented at the Disposal Site is set forth below.

A level of NSR exists with respect to the release associated with RTN 4-28577 and an AUL is not required to maintain a level of NSR.

3.6 Assumptions about the Current and Future Site Activities

Pursuant to 310 CMR 40.1056(1)(f), an indication as to whether the Permanent Solution is based upon assumptions about the current or future activities, uses or conditions that do not require an AUL pursuant to 310 CMR 40.1013 and a description of those assumptions is set forth below.

The PSS-NC is based upon assumptions that the concentration of OHM at the Disposal Site is consistent with Anthropogenic Background Levels of PAHs and lead. The levels are related to petroleum residuals that are incidental to the normal operation of aircraft and other vehicles in the areas that contribute stormwater runoff that eventually enters the Ponds, outfalls and infiltration basins.

3.7 Active Exposure Pathway Mitigation Measures

Pursuant to 310 CMR 40.1056(1)(g), an indication as to whether the Permanent Solution is based upon the effective operation of one or more Active Exposure Pathway Mitigation Measures pursuant to 310 CMR 40.1025 is set forth below.

The PSS-NC is not based upon the effective operation of one or more Active Exposure Pathway Mitigation Measures, pursuant to 310 CMR 40.1025.

3.8 Licensed Site Professional Opinion

Pursuant to 310 CMR 40.1056(1)(h), an Opinion from an LSP as to whether the requirements of the applicable category of Permanent Solution specified in 310 CMR 40.1000 have been met is set forth below.

As set forth in Section 11.0, the Disposal Site conditions are consistent with the criteria for a PSS-NC, pursuant to 310 CMR 40.1041(1). The certification of the Permanent Solution Statement Category and all documents submitted with the Permanent Solution Statement, as required by 310 CMR 40.0009, is set forth in Section E and G of the *Permanent and Temporary Solution Statement* transmittal form (BWSC 104) submitted concurrently with this report.

3.9 Certification of the Permanent Solution Statement

Pursuant to 310 CMR 40.1056(1)(i), the certification of the Permanent Solution Statement and all documents submitted with the Permanent Solution Statement, as required by 310 CMR 40.0009.

The certification of the PSS-NC is set forth in Section G of the *Permanent and Temporary Solution Statement (BWSC 104)* transmittal form submitted concurrently with this report.

3.10 Evaluation of the Upper Concentration Limits for Permanent Solutions

Pursuant to 310 CMR 40.1056(1)(j), an indication as to whether oil and/or hazardous materials (OHM) concentrations exceed one or more applicable Upper Concentration Limits ("UCLs") in soil or groundwater, as described at 310 CMR 40.0996, is set forth below.

As indicated on Tables 1 through 3, no OHM was detected above the UCLs at the Disposal Site. Additionally, conditions at the Disposal Site are consistent with Anthropogenic Background and a level of NSR exists.

3.11 Compendium of Analytical Data

Pursuant to 310 CMR 40.1056(1)(k), an indication as to whether the analytical data used to support the Permanent Solution was generated pursuant to MassDEP's Compendium of Analytical Methods ("CAM") is set forth below.

The analytical data generated between August 2021 and January 2022 and used to support the PSS-NC was generated consistent with CAM protocols. It is unclear if the analytical data collected prior was generated consistent with CAM protocols.

3.12 Site Map

Pursuant to 310 CMR 40.1056(2)(a), a Site Map and Disposal Site Map are required.

A Disposal Site Map and Site Maps are provided as Figure 2 and Figures 3 through 6, respectively.

3.13 Conceptual Site Model

Pursuant to 310 CMR 40.1056(2)(b), a succinct Conceptual Site Model is required.

A Conceptual Site Model is provided in Section 7.0.

3.14 Source Control and/or Elimination

Pursuant to 310 CMR 40.1056(2)(c), a demonstration that all sources of OHM impacts at the Site have been eliminated or controlled, as specified in 310 CMR 40.1003(5)(a) and (b).

As indicated in Section 2.0 and 3.3, Site conditions are consistent with Anthropogenic Background and a level of NSR exists.

3.15 Control of Subsurface Migration of OHM

Pursuant to 310 CMR 40.1056(2)(d), a demonstration that response actions have been taken to adequately assess and, if necessary, control the subsurface migration of OHM remaining at the Disposal Site, as specified in 310 CMR 40.1003(6)(a).

As indicated in Section 2.0 and 3.3, Site conditions are consistent with Anthropogenic Background and a level of NSR exists.

3.16 Assessment and Control of NAPL

Pursuant to 310 CMR 40.1056(2)(e), where non-aqueous phase liquid ("NAPL") is or has been present, a demonstration that response actions have been taken to adequately assess and if necessary, control NAPL mobility and meet the requirements of 310 CMR 40.1003(7)(a) is necessary.

No NAPL was encountered at the Disposal Site.

3.17 Documentation of Achieving a Level of NSR

Pursuant to 310 CMR 40.1056(2)(f), information supporting the conclusion that a level of NSR has been achieved or exists is required.

Details documenting a level of NSR is set forth above in Section 3.3.

3.18 Evaluation of Background Conditions

Pursuant to 310 CMR 40.1056(2)(g), information documenting the extent to which levels of OHM in the environment have been reduced to background, and/or the results of the feasibility evaluation conducted pursuant to 310 CMR 40.0860 demonstrating that the achievement of Background is not feasible is required.

As indicated in Section 2.0 and 3.3, Site conditions are consistent with Anthropogenic Background and a level of NSR exists. As such, an evaluation of achieving background levels is not required since the Site conditions are consistent with background.

3.19 Activity and Use Limitations Opinion and Transmittal Form

Pursuant to 310 CMR 40.1056(2)(h), a copy of any and all AULs which have been implemented under 310 CMR 40.1070 must be included in the Permanent Solution Statement.

No AULs are required to support the conclusions of this PSS-NC.

3.20 Feasibility of Achieving Background for UCL Exceedances

Pursuant to 310 CMR 40.1056(2)(i), for Permanent Solutions with Conditions where concentrations in soil exceed UCLs at a depth greater than fifteen feet from the ground surface or in an area beneath an engineered barrier, a feasibility of achieving background evaluation pursuant to 310 CMR 40.0860, is required.

As indicated on Tables 1 through 3, no samples exceeded UCLs. In addition, as indicated in Section 2.0 and 3.3, Disposal Site conditions are consistent with Anthropogenic Background and a level of NSR exists. As such, a background evaluation is not necessary.

3.21 Summary of Conditions Associated with the Permanent Solution

Pursuant to 310 CMR 40.1056(2)(j), for a Permanent Solution with Conditions based upon assumptions about the current or future Disposal Site activities, uses or conditions that do not require an AUL pursuant to 310 CMR 40.1013, a summary of the assumptions and conditions is required.

There are no conditions associated with the Permanent Solution being submitted.

3.22 Data Usability Assessment and Representativeness Evaluation

Pursuant to 310 CMR 40.1056(2)(k), a Data Usability Assessment documenting that the data relied upon is scientifically valid and defensible, and of a sufficient level of precision, accuracy, and completeness to support the Permanent Solution, and a Data Representativeness Evaluation, documenting the adequacy of the spatial and temporal data sets to support the Permanent Solution.

Details concerning data usability and representative analysis are set in Sections 10.1 and 10.2, respectively.

3.23 Ongoing Operation, Maintenance, and/or Monitoring

Pursuant to 310 CMR 40.1056(2)(l), a description of any operation, maintenance, and/or monitoring that will be required to confirm and/or maintain those conditions at the Disposal Site upon which the Permanent Solution is based is set forth below.

No operation, maintenance and/or monitoring activities are necessary to confirm or maintain the conditions at the Disposal Site consistent with the PSS-NC.

4.0 SUMMARY OF SITE AND RELEASE CONDITIONS

PAHs and lead that were initially discovered in sediments within the Ponds in 1997 as part of the North Ramp Phase II Comprehensive Site Assessment relating to the investigation and remediation of a hydrocarbon and chlorinated solvent plume at Airport (RTN 4-823). As documented in the Phase II, additional sediment sampling and preparation of a risk characterization was postponed pending updated guidance from the MassDEP. At the time of the Phase II, there were questions about whether the sediment contamination was associated with the North Ramp petroleum releases or related to typical contaminants found in stormwater runoff from impervious areas that are impacted by aircraft and motor vehicle usage.

The Ponds are both fresh water and are located on the northern portion of the Airport property. The Airport discharges stormwater into the Ponds under an EPA MSGP. Prior to discharge in the Ponds, stormwater is treated by Vortechs® hydrodynamic separators as indicated on Figure 3. As indicated above, a forensic evaluation of the data verified that the PAHs detected in the sediments are consistent with engine emissions from vehicles or aircraft that enter the Ponds, outfalls, and infiltration basins from the Airport's stormwater management system and the elevated lead can be attributed to use of leaded aviation gasoline and/or historic use of leaded gasoline in vehicles.

As set forth in 310 CMR 40.0006, petroleum residues that are incidental to the normal operation of a vehicle and atmospheric deposition of engine emissions are ubiquitous and consistently present in the environment and are considered Anthropogenic Background.

4.1 Surrounding Receptors

The Disposal Site is located within a secured fenced area at the Cape Cod Gateway Airport. Potential human receptors include site workers, utility workers and construction workers. Based on the MassDEP Priority Resource Map (Figures 9 and 10), the Disposal Site is located within a MassDEP designated zone of contribution (Zone II) to Public Water Supply (PWS) wells and within a Medium-Yield Sole Source Aquifer. There is a Natural Heritage and Endangered Species Program ("NHESP") Priority Habitat or Rare Species Habitats and protected open space located within 500 feet of the Disposal Site. It should be noted that the Site utilizes municipal water and groundwater samples collected from monitoring wells located in proximity to the Ponds (Figure 8) did not indicate exceedances of the applicable Method 1 groundwater standards as indicated on Table 4.

5.0 SUMMARY OF RESPONSE ACTIONS

A description of the work completed including a subsurface investigation is set forth below.

A number of investigations have been conducted to evaluate the presence of OHM in the sediments found on the bottom of the Ponds after the collection of initial sediment samples by HW in 1997. The field work conducted to date by HW and others after 1997 includes the following:

- Collection of a sediment sample from Lewis Pond (LP-EP1), Upper Gate Pond (HYAS2), and Mary Dunn Pond (HYAS3) in 2001 for PAHs and Lead. The location of these samples is unknown.

- Collection of a sediment sample from Lewis Pond (HYAS1), and three from Upper Gate Pond in 2004 for PAHs and Lead.

- Collection of four sediment samples from Lewis Pond, five from Upper Gate Pond, and two from Mary Dunn Pond in 2005 for PAHs and Lead.

- Collection of ten sediment samples from Lewis Pond, 11 from Upper Gate Pond, and ten from Mary Dunn Pond in 2011 for PAHs and Lead.

- Collection of 21 groundwater samples in 2011 from monitoring wells H-401S, HW-401D, HW-402, HW-403 and HW-404. In general, each well was sampled quarterly during 2011.

- Collection of ten sediment samples from Lewis Pond, three from Upper Gate Pond, and one from Mary Dunn Pond in 2021 for PAHs and Lead.

- Collection of a sediment sample from Outfall J and Outfall Plaza (Outfall F) in 2022 for PAHs and Lead.

Refer to Figures 3 through 6 and Figure 8 for sampling locations and Tables 1 through 5 for tabulated analytical results. Laboratory data packages for the 2021 and 2022 sampling events are included in Appendix C.

6.0 SOURCE CONTROL AND/OR ELIMATION

As indicated above, the source of the PAHs and lead in sediment is related to Anthropogenic Background conditions associated with the operation of a stormwater discharge outfall permitted by the EPA under a MSGP. Prior to discharge in the Ponds, stormwater is treated by Vortechs® hydrodynamic separators as indicated on Figure 3. The calculated TSS removal rates for these water quality units range from 81% to 87% with TPH removal at 67%. Since the installation of the Vortechs® units in 2011, 100% of stormwater discharged to the Ponds receives pretreatment.

7.0 CONCEPTUAL SITE MODEL

The Ponds are both fresh water and are located on the northern portion of the Airport property. The Airport discharges stormwater into the Ponds under an EPA MSGP. Prior to discharge in the Ponds, stormwater is treated by Vortechs® hydrodynamic separators as indicated on Figure 3. Calculated TSS removal rates for these water quality units range from 81% to 87% with TPH removal at 67%. Since the installation of the Vortechs® units in 2011, 100% of stormwater discharged to the Ponds receives pretreatment.

The sediments in the Ponds were initialed sampled by HW in 1997 as part of the North Ramp Phase II Comprehensive Site Assessment relating to the investigation and remediation of a hydrocarbon and chlorinated solvent plume at Airport (RTN 4-823). As documented in this report, additional sediment sampling and preparation of a risk characterization was postponed pending updated guidance from the MassDEP. At the time of the Phase II, there were questions about whether or not the sediment contamination was associated with the North

Ramp petroleum releases or related to typical contaminants found in stormwater runoff from impervious areas that are impacted by aircraft and motor vehicle usage. Between 2001 and 2022, 61 sediment samples and 21 groundwater samples were collected to determine if the detections of lead and PAHs in the Pond were the result of the release at the North Ramp or, if they were consistent with Anthropogenic Background. Due to elevated PAH reporting limits in the data collected prior to 2021, forensic analysis of PAH ratios was not possible.

The remediation of the North Ramp hydrocarbon and chlorinated solvent plume was completed in July 2020. At that time, MassDEP agreed to separate the remaining assessment associated with the Ponds and assigned a new RTN (4-28577). As indicated above, further evaluations of the releases associated with the North Ramp have been conducted and it was determined there was limited opportunity for the sources of the releases on the North Ramp to enter the stormwater facilities and discharge to the Ponds. The primary cause of the release at the North Ramp was from floor drains that discharged to leach pits either directly or through an oil/water separator connected to a leaching pit. These releases entered the underlying groundwater and did not migrate towards the Ponds as indicated on Figure 7

Changes in laboratory instrumentation and methods has allowed for lower reporting limits and a forensic evaluation of the sediment data was conducted in 2021 and 2022. The evaluation focused on the ratios of fluoranthene to pyrene and phenanthrene to anthracene to determine if these ratios were consistent with literature values for vehicle exhaust particles, diesel fuel, or urban runoff in sediment. As indicated on Tables 1 through 3, the samples were most consistent with diesel exhaust particles which would be expected in sediments within stormwater ponds that collect stormwater from runways and parking lot areas. Additional details on ratios for PAH source identification are included in Appendix A and can help to identify multiple sources including:

Gasoline Auto Exhaust soot	Diesel Engine Soot	Diesel Exhaust Particles
Highway Dust	Urban Runoff	Diesel Fuel
Crude Oils	Residential Fuel Oil	Coal

The PAHs and lead detected in the sediments are consistent with incidental petroleum residuals (including the use of leaded gasoline) and/or engine emissions from vehicles or aircraft that enter the Ponds, outfalls or drainage basins from the Airport's stormwater management system. As set forth in 310 CMR 40.0006, petroleum residues that are incidental to the normal operation of a vehicle and atmospheric deposition of engine emissions are ubiquitous and consistently present in the environment and are considered Anthropogenic Background.

8.0 RISK CHARACTERIZATION

Pursuant to 310 CMR 40.1056(1)(c), completion of a Risk Characterization pursuant to 310 CMR 40.0900 is not required where concentrations of OHM are consistent with or are at background levels. Therefore, no risk characterization was completed in connection with RTN 4-28577.

It should be noted that an Imminent Hazard Evaluation was prepared to satisfy the requirements of 310 CMR 40.0317 (3). The Imminent Hazard Evaluation was prepared consistent with 310 CMR 40.0950. The highest detection of PAHs and Lead as indicated on Tables 1 through 3 was used for the evaluation. As indicated on the Imminent Hazard Sort Form included in Appendix B, the Hazard Index is less than 1 and the excess lifetime cancer risk is less than 1 in 100,000. No stressed biota, fish fills, abiotic conditions or other conditions which produce an immediate or acute impact to freshwater fish were identified. As such, an Imminent Hazard to Human Health or the environment does not exist based on the levels of PAHs and lead detected in the sediment.

9.0 MANAGEMENT OF REMEDIAL WASTE

No remediation waste was generated during response actions.

10.0 DATA QUALITY EVALUATION

Pursuant to 310 CMR 40.1056 (2)(k), a Data Usability Assessment documenting that the data relied upon is scientifically valid and defensible, and is of a sufficient level of precision, accuracy, and completeness to support the Permanent Solution and a Data Representativeness Evaluation, documenting the adequacy of the spatial and temporal data sets to support the Permanent Solution is set forth below.

10.1 Data Usability Assessment

According to MassDEP Policy #WSC-10-320 *Compendium of Analytical Methods* (CAM), all response action submittals are required to provide details on any known conditions of findings which may affect the validity of analytical data, including unsatisfactory analytical results received on quality assurance / quality control blanks, duplicates, surrogates, or spiked samples. In accordance with Table 2 of WSC-07-350, CAM compliant data is defined as data with "Presumptive Certainty" when the analytical results are determined using an "MCP Analytical Method" that complies with method-specific quality control (QC) requirements, are reported with a narration of method-specific deficiencies, as necessary, and are reported with the CAM required deliverables specified in the CAM for MCP analytical data. Samples collected in 2021 and 2022 that are being relied upon to make the determination of NSR were analyzed by a MassDEP certified laboratory and in accordance with CAM protocols, where applicable. It is unclear if the samples collected prior to 2021 were analyzed using CAM methods.

Laboratory analytical data has been evaluated and determined to be usable for the purpose of supporting this Permanent Solution Statement. No limitations and/or significant qualifications on the use of the laboratory data used to support this Permanent Solution Statement exist. As indicated above, the analytical data generated between 2021 and 2022 and used to support the PSS-NC was generated consistent with CAM protocols. It is unclear if the historical analytical data (2011 and prior) was generated consistent with CAM protocols. The data collected

between 2021 and 2022 was used to determine that the release conditions were consist with Anthropogenetic Background and are discussed in additional detail below.

10.1.1 Field Data Usability Assessment

Table 3 of MassDEP Policy #WSC-07-350 provides the following summary of field quality control elements to be considered when evaluating the quality of analytical results:

- Sample Procedure
- Sample Containers and Sample Preservation
- Holding Time
- Matrix Spikes/Matrix Duplicates
- Equipment Bland/Trip Blanks

Samples were placed in the appropriate laboratory-provided, pre-cleaned and, as appropriate, pre-preserved containers. Sample sizes were sufficient, holding times were achieved and sample collection procedure verified that field quality control ("QC") requirements were met. The samples were maintained on ice and transported to the laboratory under chain-of custody protocol.

As indicated in Table VII A-4 of MassDEP Policy #WSC-CAM, field duplicates, and matrix spikes/matrix spike duplicates are only mandatory for drinking water samples. Drinking water samples are defined as samples collected from a public water supply or private water supply well.

10.1.2 Rejection of Analytical Data as the Result of Gross Failure

None of the analytical data meets the definition of rejected data as defined in Appendix IV of MassDEP Policy #WSC-07-350.

10.1.3 Data Representativeness and Usability Conclusion

Sediment samples were collected throughout the investigation of the Disposal Site. The sampling locations were sufficient to delineate the boundaries of the Disposal Site, identify background conditions, calculate EPCs, identify any potential Hot Spots, identify potential exposure pathways and receptors, and demonstrate source elimination or control. No limitations and/or significant qualifications on the use of the laboratory data used to support this Permanent Solution Statement were identified. All laboratory method detection limits were sufficient in determining Anthropogenetic Background.

Laboratory analytical data collected throughout the investigation and remediation of the Disposal Site has been evaluated and determined to be usable for the purpose of supporting this Permanent Solution Statement.

10.2 Representativeness Evaluation

According to Section 6.0 of MassDEP Policy #WSC-07-350, the Representativeness Evaluation determines whether the data set sufficiently characterizes conditions at the Disposal Site and supports a Conceptual Site Model. The Representativeness Evaluation determined whether there is enough information from the right locations, both spatially and temporally, to support the Permanent Solution, and should:

- Demonstrate the adequacy of cumulative data to characterize the nature and extent of contamination at the Disposal Site, the risk to health, safety, public welfare and the environment and the elimination/control of contaminant source areas; and Identify inconsistent and incomplete information and sources of uncertainty, and justify why such inconsistent information, data gaps, or uncertainty are not sufficient to undermine the Permanent Solution opinion.

10.2.1 Use of Field Screening Data

Field screening data was not necessary for this investigation. Sediment sample locations were determined based on stormwater discharge locations and were collected spatially to determine the extent of impact. Sediment samples were submitted to a Massachusetts certified laboratory using CAM methods for analysis of contaminants of concern.

10.2.2 Sampling Rationale

The media and locations sampled during the investigation of the Disposal Site were appropriate to support the conclusions of the Permanent Solution and satisfy the requirements of Table 1 of WSC-07-350. Samples were collected from both sediment areas in the ponds impacted by stormwater run-off from paved and unpaved areas. The sampling locations were sufficient to delineate the boundaries of the Disposal Site, identify background conditions, calculate EPCs, identify any potential Hot Spots, identify potential exposure pathways and receptors, and demonstrate source elimination or control.

10.2.3 Number, Spatial Distribution, and Handling of Samples

More than 61 sediment samples and 21 groundwater samples were collected for laboratory analysis. The sampling targeted locations that received stormwater run-off from paved and unpaved areas. Field samples were collected in accordance with standardized and accepted protocols. The receiving laboratory reported that samples were received in acceptable condition, appropriately preserved, and that no holding times were exceeded.

10.2.4 Temporal Distribution of Samples

Based upon the release conditions at the Disposal Site, the temporal distribution of soil samples is suitable for providing representative data of the Disposal Site conditions.

10.2.5 Critical Samples

Consistent with WSC-07-350, a critical sample is a sample for which a usable result is necessary to support a conclusion that the response action objectives have been met (i.e., absent a usable result for such sample, it cannot otherwise be demonstrated that the objective has been achieved). No critical samples were identified or are necessary to support the Permanent Solution with No Conditions.

10.2.6 Completeness

Based on a review of the analytical data generated, verification that all surrogate recoveries were within the appropriate quality control limits, and that presumptive certainty has been achieved for all laboratory analytical data, the completeness of this project is 100 percent.

10.2.7 Inconsistency and Uncertainty

No inconsistent or uncertain information was identified or disregarded in reaching a conclusion that site investigation and remedial activities were sufficient to support a Permanent Solution with No Conditions for the Disposal Site.

10.2.8 Representativeness Summary

In summary, the field screening and analytical data collated at the Disposal Site are considered representative of Disposal Site conditions and are suitable for assessing risk in support of the PSS-NC.

11.0 EVALUATION OF THE PERMANENT SOLUTION CRITERIA

Pursuant to 310 CMR 40.1040(1), a Permanent Solutions shall apply where the following conditions exist.

(a) A level of No Significant Risk, as specified in 310 CMR 40.0900, exists or has been achieved.

As set forth in Section 3.3, a level of NSR has been achieved at the Disposal Site.

(b) All sources of OHM impacts have been eliminated or controlled, as specified in 310 CMR 40.1003(5)(a) and (b).

As indicated above, the OHM detected in sediment at the Airport is consist with Anthropogenic Background. Since 2011, 100% of the stormwater discharging to the ponds has been treated by Vortechs® hydrodynamic separators. Calculated TSS removal rates for these water quality units range from 81% to 87% with TPH removal at 67%.

(c) Control of plumes of dissolved OHM in groundwater and vapor-phase OHM in the vadose zone has been achieved as specified in 310 CMR 40.1003(6)(a).

As indicated above, groundwater has not been impacted by the release and conditions are consist with Anthropogenic Background.

(d) NAPL, if present, has been addressed as specified in 310 CMR 40.1003(6)(a).

NAPL has not been identified at the Disposal Site.

(e) All threats of release have been eliminated.

No threats of release, pursuant to 310 CMR 40.0006, have been identified within the Disposal Site boundary.

(f) The level of OHM concentrations in the environment have been reduced to as close to background levels as feasible, as specified at 310 CMR 40.1020.

As indicated above, the OHM detected in sediment at the Airport is consist with Anthropogenic Background.

Pursuant to 310 CMR 40.1041(1), a Permanent Solution with No Conditions shall apply where the following conditions exist.

(a) Disposal Sites or portions of a Disposal Site where the requirements of 310 CMR 40.1040(1) have been achieved;

As set forth above, the requirements of 310 CMR 40.1040(1) have been achieved within the Disposal Site, which is subject to the PSS-NC.

(b) Concentrations of OHM do not exceed an applicable UCL in soil or groundwater listed at 310 CMR 40.0996(6);

As set forth above, sediment and groundwater do not exceed UCLs, and OHM detections are consist with Anthropogenic Background conditions.

(c) Disposal Sites or portions of a disposal Site where a level of NSR exists and will be maintained for all current and foreseeable future use of the Site, without relying upon:

1. assumed limitations on current or future Site activities, uses or conditions, that require an Activity and Use Limitation, as specified in 310 CMR 40.1012(2); or

2. assumed limitations on current or future Site activities, uses or conditions, that do not require an Activity and Use Limitations pursuant to 310 CMR 40.1013; and

Pursuant to 310 CMR 40.1013(1)(d), the Permanent Solution does not require an AUL and no assumed limitations on current or future activities at the Disposal Site have been made.

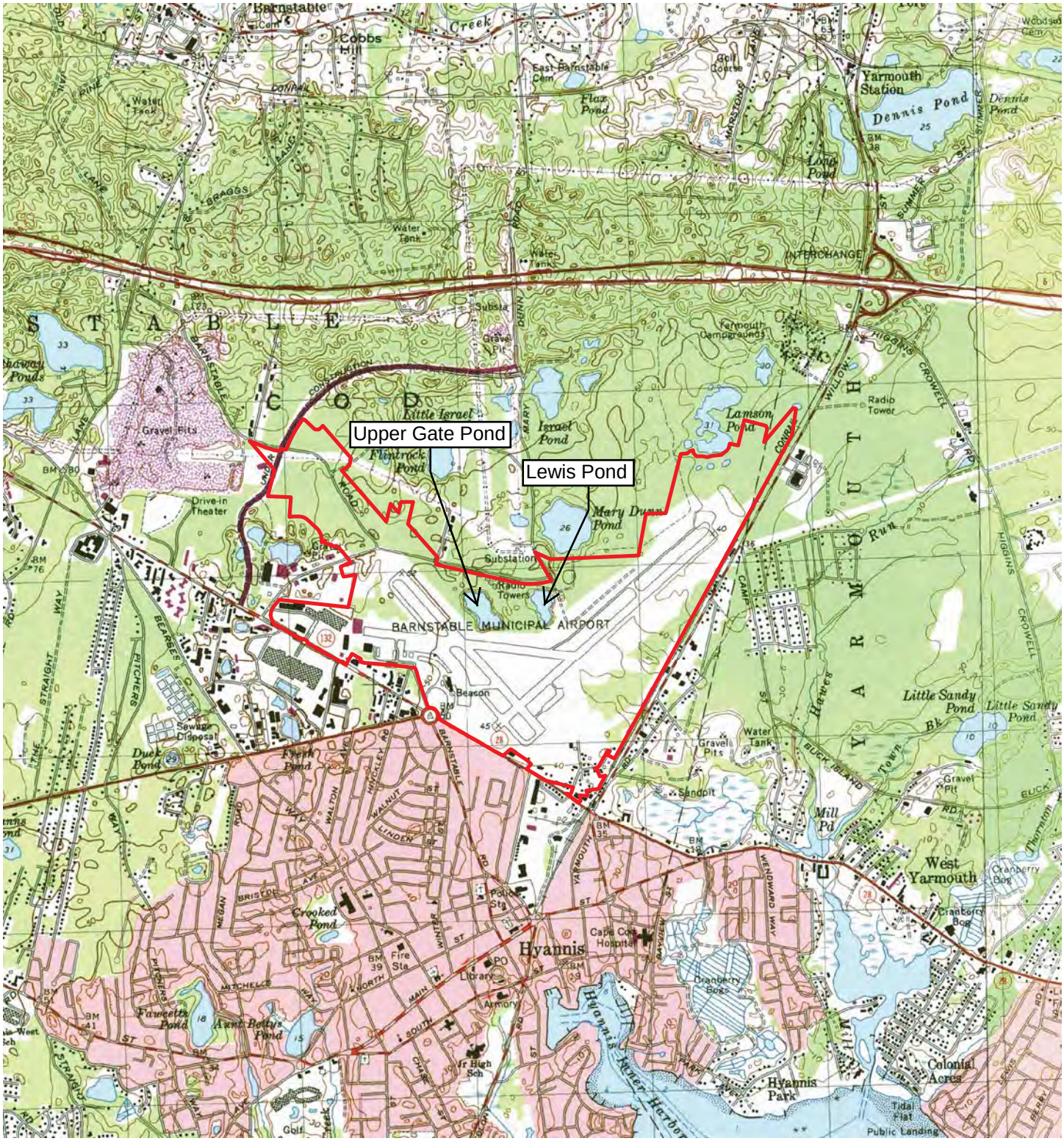
(d) Sites where response actions have eliminated all threats of release and no release of OHM to the environment has occurred.

As set forth above, no threats of release were identified within the Disposal Site.

12.0 PUBLIC INVOLVEMENT

Pursuant to 310 CMR 40.1403 (3)(f), the Chief Municipal Officer and the Board of Health of the Town of Barnstable have been notified of the availability of the PSS-NC. A copy of the notification is provided at Appendix C.

FIGURES



Document Path: H:\Projects\HYA\11072 (697 Barnstable Airport)\GIS_Maps\Maps\USGS_Locus_20130815.mxd

Legend

Airport Property Line

*Hyannis Topographic Quadrangle

N

0.5 Miles

Horsley Witten Group
Sustainable Environmental Solutions
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Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

USGS Locus Map
Cape Cod Gateway Airport
Hyannis, MA

Date: 4/17/2018

Figure 1

Document Path: H:\Projects\HYA\11024 BMA Risk Assessment\GIS\Maps\ERC\20150515_MonWellLocs.mxd

Legend

*MassGIS, April 2014

- Disposal Site Boundary

N

0 600

1" = 600 feet

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Disposal Site Map
Cape Cod Gateway Airport
Hyannis, MA

Date: 5/15/2014

Figure2

DRAINAGE AREA A

DRAINAGE AREA E

DRAINAGE AREA F

DRAINAGE AREA G

DRAINAGE AREA O

DRAINAGE AREA N

DRAINAGE AREA C

DRAINAGE AREA D

DRAINAGE AREA B

DRAINAGE AREA M

DRAINAGE AREA H

DRAINAGE AREA I

DRAINAGE AREA J

DRAINAGE AREA K

DRAINAGE AREA L

Outfall Plaza
(Outfall F)
Sediment Sample

Outfall J Sediment Sample

VORTECHS WATER QUALITY UNIT

VORTECHS WATER QUALITY UNITS

INFILTRATION BASIN

UNDERGROUND RECHARGE STRUCTURES

DISCHARGE CONTROL VALVES

O/WS AND PUMP STATION

MAIN TERMINAL APRON

EAST RAMP APRON

RUNWAY 15/33

RUNWAY 6/24

TAXIWAY A

TAXIWAY B

TAXIWAY C

TAXIWAY D

MARY DUNN POND

LEWIS POND

UPPER GATE POND

LEGEND

RW1533-29 CB: Catchbasin
RW1533-29 LCB: Leaching Catchbasin
RW1533-29 LCB/RD: Leaching Catchbasin / Roof Drain
RW1533-29 LCB/UGDC: Leaching Catchbasin with Underground Discharge Chamber
RW1533-29 LB: Leaching Basin with No Catchment
O/WS: Oil Water Separator
Airport Property Line
BIO: Bioretention Basin
T31 VORTECH: CONTECH Water Quality Structure

NOTE:

All locations of buildings, utilities, and surface features derived from Town of Barnstable, Massachusetts, Geographic Information System. Location and nature of stormwater utilities based upon data provided by Edwards and Kelcey Barnstable Municipal Airport Drainage Plan (07/07), and field inspection of select utilities by Horsley Witten on July 15, 2008.

AIRPORT BUILDINGS/AREAS TABLE

NO.	BUILDING
1	RECTRIX AERODOME CENTER HANGAR
2	CAPE AIR/NANTUCKET AIR HANGAR
3	GRIFFIN AVIONICS
4	GRIFFIN AVIONICS FUEL STATION
5	SPECIALIZED AUTOMOTIVE
6	HANGAR 2 – CAPE AIR / AIRPORT MAINTENANCE
7	GATE F FUEL FARM
8	HANGAR BUILDING (VACANT)
9	ALLIES AIR
10	MAIN TERMINAL BUILDING
11	MAIN TERMINAL GENERATOR
12	AIR TRAFFIC CONTROL TOWER (ATCT)
13	SOUTH RAMP DEICING PAD
14	AIRPORT ARFF/SRE FACILITY
15	RECTRIX/AIR CAPE COD
16	RECTRIX/AIR CAPE COD FUEL FARM
17	AIRPORT LIGHTING VAULT
18	BMA T-HANGAR
19	AMA NANTUCKET INC.
20	CAPEFLIGHT INSTRUCTION
21	HYANNIS HANGAR LLC
22	HEXAGON HANGAR
23	KINGSBURY AVIATION (BUILDING 1)
24	KINGSBURY AVIATION (BUILDING 2)
25	STEAMSHIP AUTH. PARKING LOT
26	HERTZ CAR WASH
27	AVIS CAR WASH
28	BUDGET TRUCK RENTAL

GRAPHIC SCALE

250 0 125 250 500 1000

(IN FEET)

Horsley Witten Group
Sustainable Environmental Solutions
www.horsleywitten.com
90 Route 6A
Sandwich, MA 02563
508-833-6600 voice
508-833-3150 fax

Date: 12/29/2015
Designed By: GWTH
Drawn By: GWTH
Checked By: JEL

Plan Title:

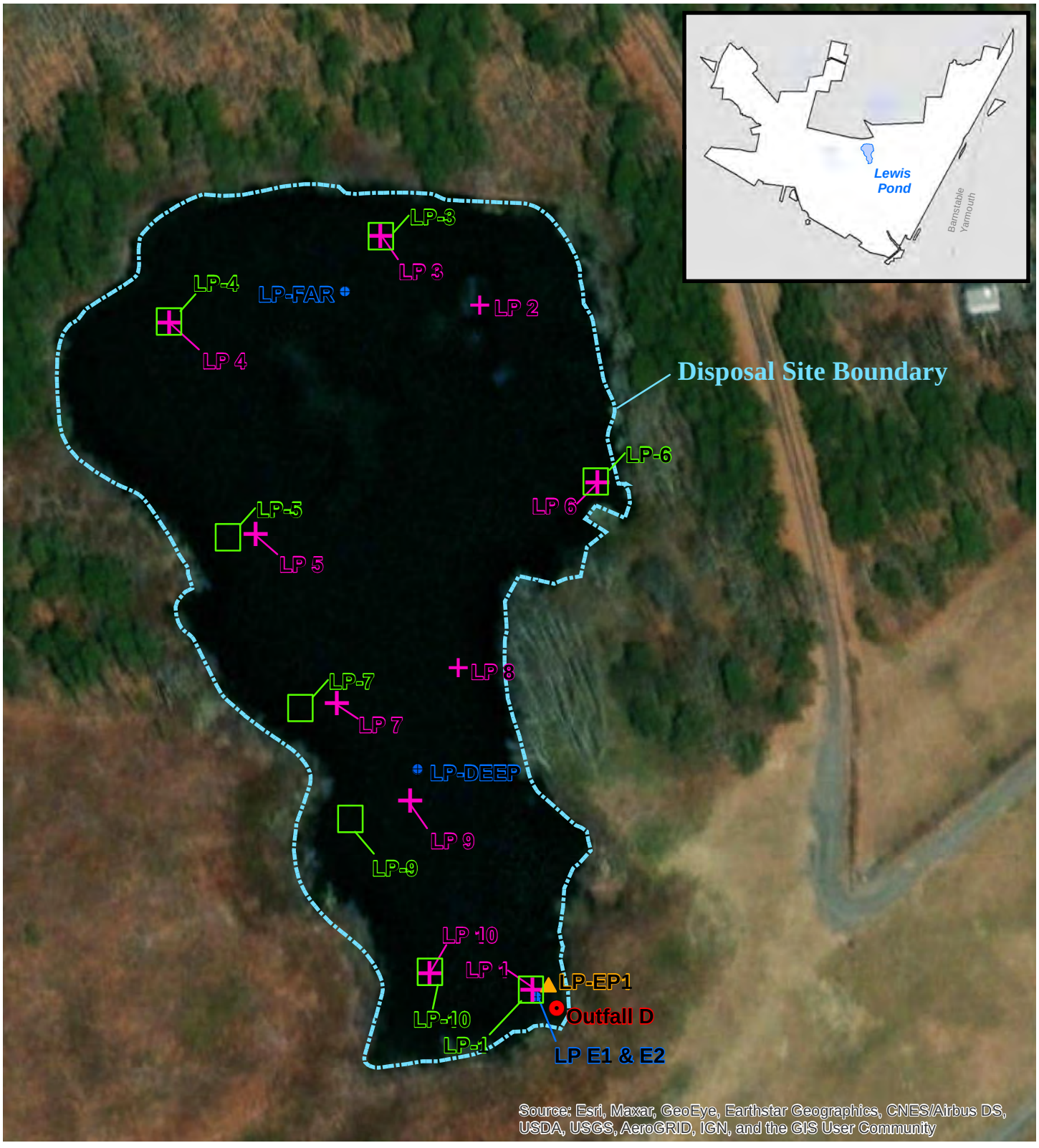
Prepared For:

Revisions

1	12-27-11	ERK	JEL Update to Drainage Plan
2	4-13-12	GH	JEL Update to Drainage Plan
3	4-27-12	GH	JEL Update to Drainage Plan
4	1-25-13	GH	JEL Update to Drainage Plan
5	7-28-13	GH	JEL SWPPP Figure 3
6	9-30-15	GH	JEL SWPPP Figure 3
7	12-29-15	GH	JEL SWPPP Figure 3
8	12-31-19	LEN	PAC Update to Drainage Plan

Project Number: 14105

Figure: Figure 3



Legend

- Cape Cod Gateway Airport Property Boundary
- Surface Water and Disposal Site Boundry
- Stormwater Outfalls
- 05/04/2004 Sediment Sampling Location
- 10/20/2005 Sediment Sampling Locations
- 02/16/2011 Sediment Sampling Locations
- 08/02/2021 Sediment Sampling Locations

N

0 40 80
Feet

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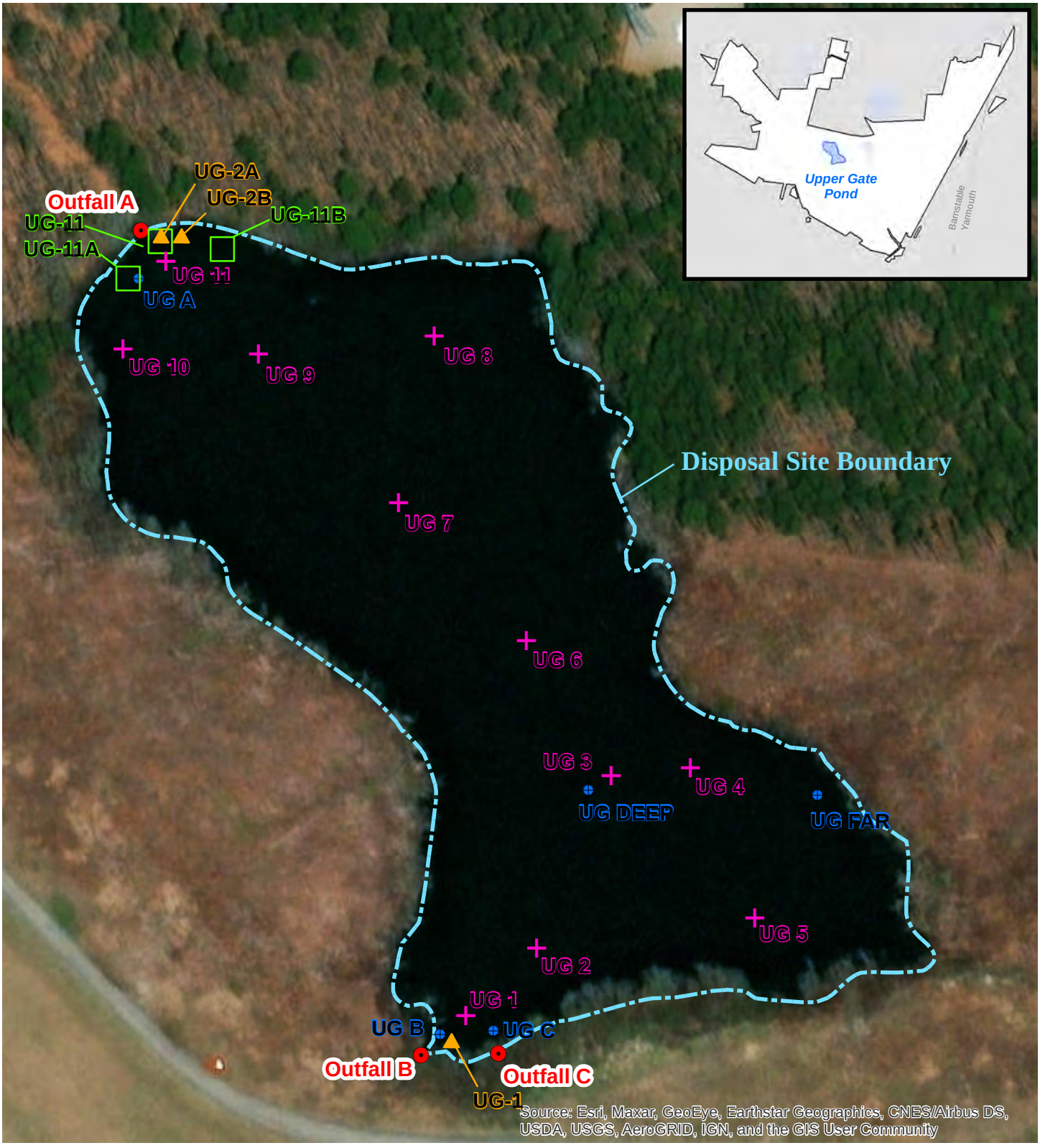
Sediment Sampling Locations
Lewis Pond
Cape Cod Gateway Airport
Hyannis, MA

Date: 6/8/2023 Figure 4

Path: K:\Projects\HYA\21083 FY22 On-Call Services\GIS\Maps\211004_LewisPond_SamplingLocations.mxd



Legend

- Cape Cod Gateway Airport Property Boundary
- Surface Water and Disposal Site Boundry
- Stormwater Outfalls
- 05/04/2004 Sediment Sampling Location
- 10/20/2005 Sediment Sampling Locations
- 02/16/2011 Sediment Sampling Locations
- 08/02/2021 Sediment Sampling Locations

N

0 40 80

Feet

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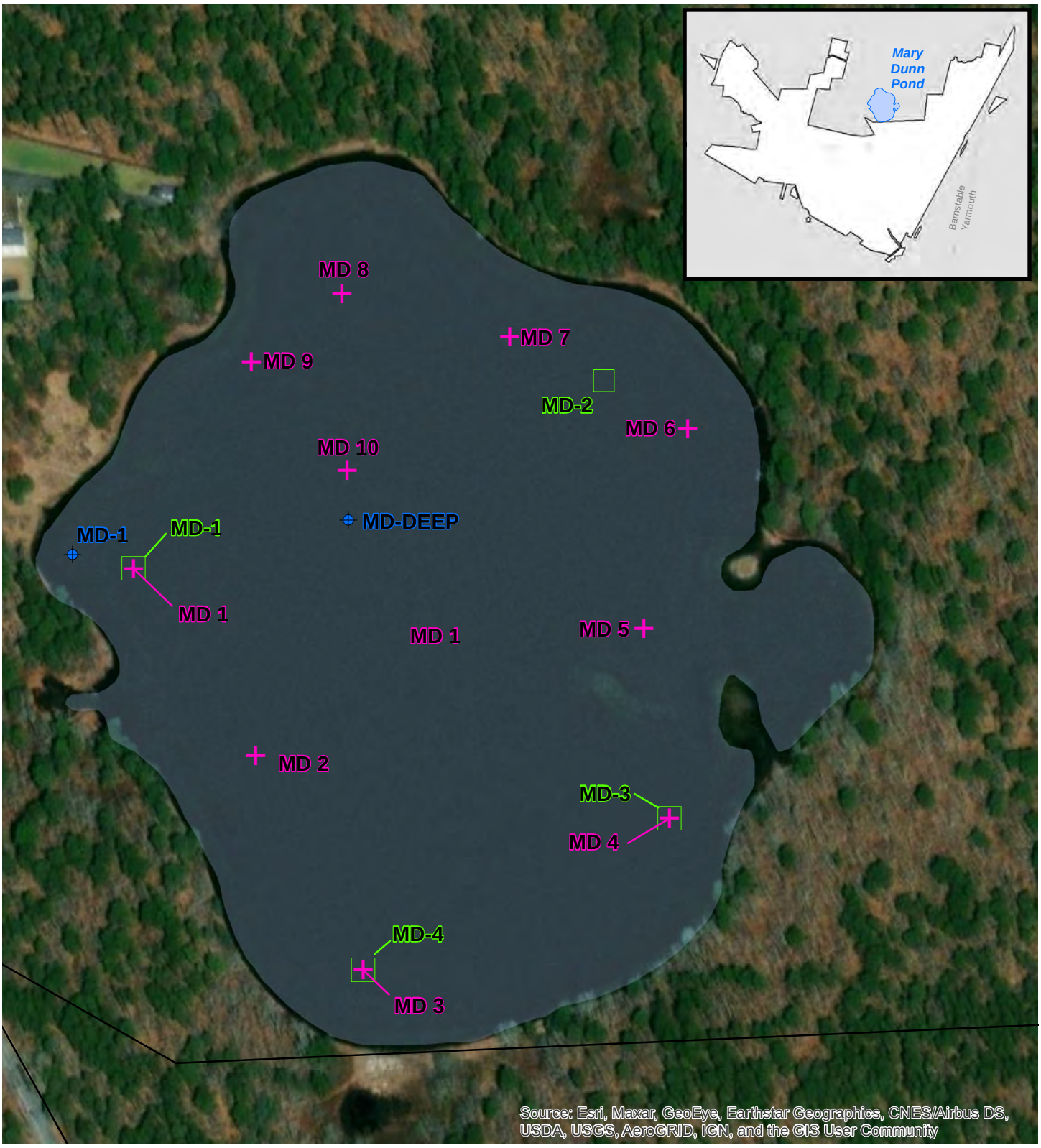
Sediment Sampling Locations
Upper Gate Pond
Cape Cod Gateway Airport
Hyannis, MA

Date: 6/8/2023

Figure 5

Path: K:\Projects\HYA\21083 FY22 On-Call Services\GIS\Maps\211004_UpperGate_SamplingLocations.mxd



Legend

- Cape Cod Gateway Airport Property Boundary
- Surface Water
- 10/20/2005 Sediment Sampling Locations
- 2/16/2011 Sediment Sampling Locations
- 08/02/2021 Sediment Sampling Locations

N

0 85 170

Feet

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Sediment Sampling Locations
Mary Dunn Pond
Cape Cod Gateway Airport
Hyannis, MA

Date: 6/8/2023

Figure 6

Path: K:\Projects\HYA\21083 FY22 On-Call Services\GIS\Maps\211004_MaryDunn_SamplingLocations.mxd

Legend

- Drinking Water Wells
- Barnstable Municipal Airport Property Boundary
- Groundwater Contours
- Disposal Site Boundary

N

0 750

1 in = 750 feet

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

Estimated Groundwater Flow Direction
Cape Cod Gateway Airport
Hyannis, MA

Date: 10/30/23

Figure 1

** Cape Cod Commission (CCC) Groundwater Contours*

Document Path: H:\Projects\HYA\11024 BMA Risk Assessment\GIS\Maps\ERC\20150515_MonWellLocs.mxd

Legend

**MassGIS, April 2014*

- Monitoring Wells Installed by HW on March 31, 2011
- Public Water Supplies*

N

0 600

1" = 600 feet

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Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

Monitoring Well Locations
Barnstable Municipal Airport
Hyannis, MA

Date: 5/15/2014

Figure 8

MassDEP - Bureau of Waste Site Cleanup

Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

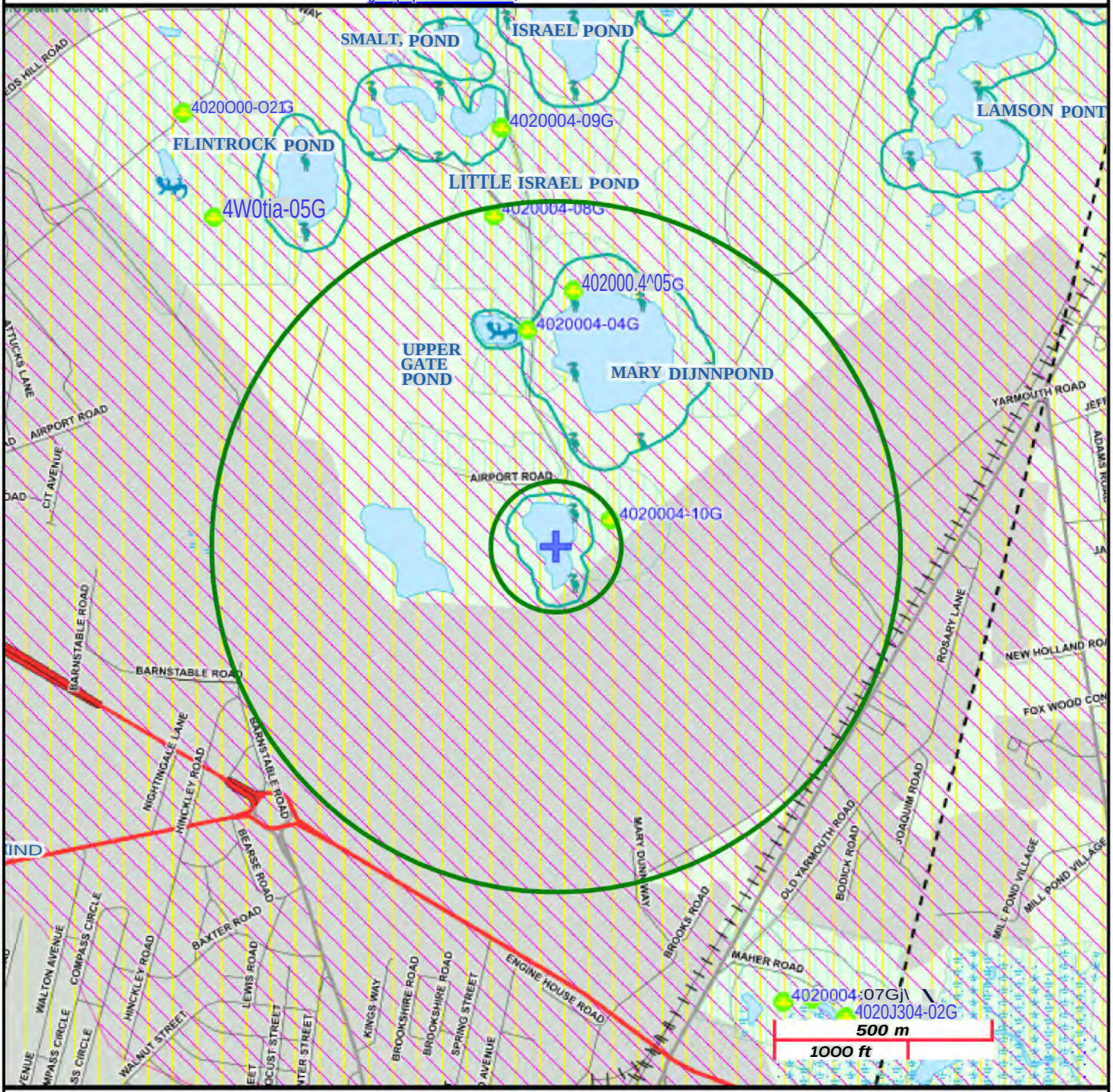
Site Information:

AIRPORT ROAD BARNSTABLE, MA

NAD83 UTM Meters:
4613999mN , 393497mE (Zone: 19)
October 27, 2023

The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at: https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail

Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct

Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam

Aquifers: Medium Yield, High Yield, EPA Sole Source

Non Potential Drinking Water Source Area: Medium, High (Yield)...

PWS Protection Areas: Zone II, IWPA, Zone A

Hydrography: Open Water, PWS Reservoir, Tidal Flat

Wetlands: Freshwater, Saltwater, Cranberry Bog

FEMAIOOyr Floodplain; Protected Open Space; ACEC

NHESP Pri-Hab of Rare Species: Vernal Pnnh Cert , Potential

Solid Waste Landfill; PWS: Com. GW,SW.Emerg.,Non-Com.

Figure 9

MassDEP - Bureau of Waste Site Cleanup

Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

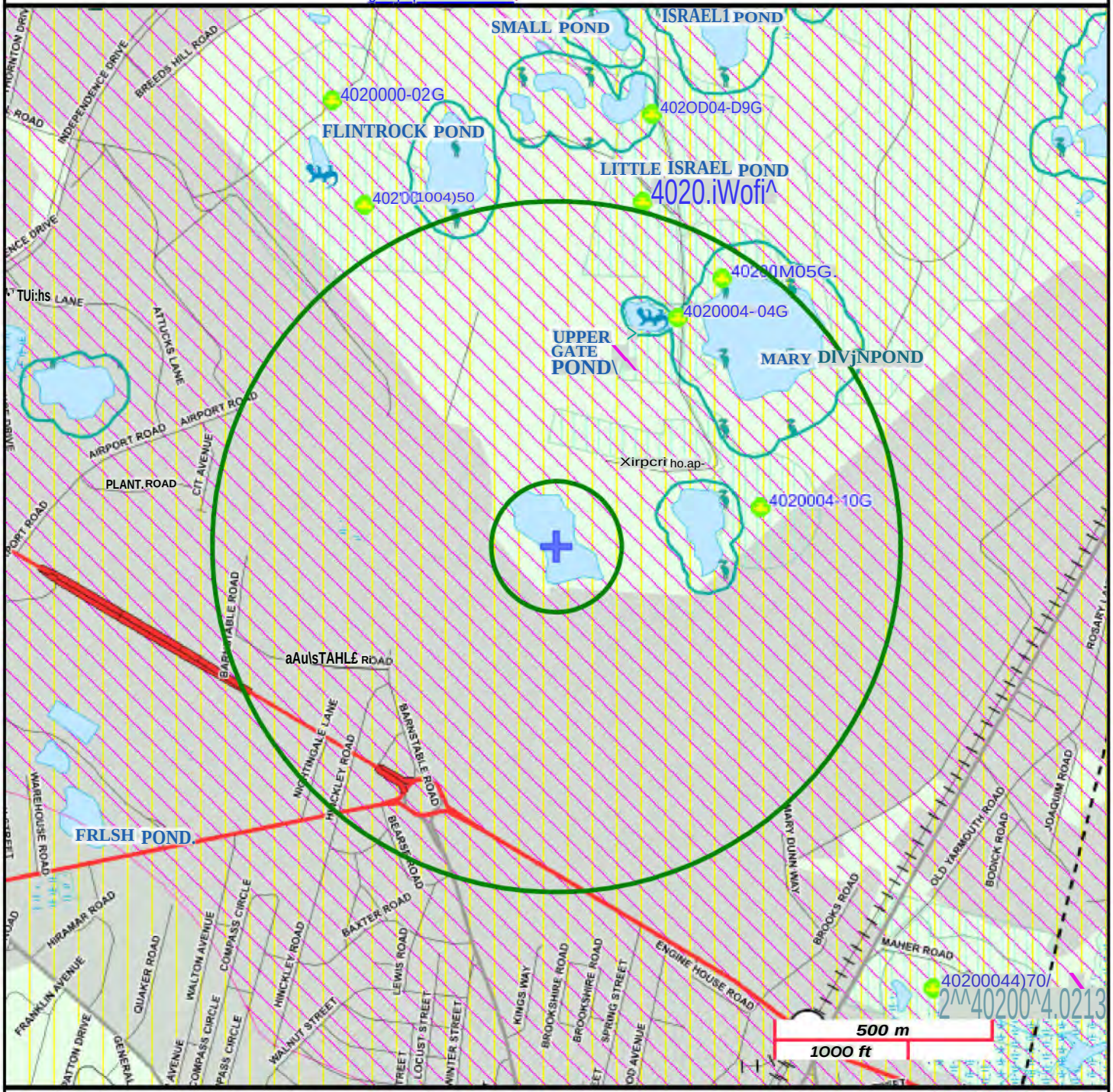
Site Information:

BARNSTABLE ROAD BARNSTABLE, MA

NAD83 UTM Meters:
4613974mN , 393147mE (Zone: 19)
October 27, 2023

The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at: https://www.mass.gov/orgs/massgis-bureau-of-geographic-information.

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail
Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct
Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore. Dam
Aquifers: Medium Yield, High Yield, EPA Sole Source
Non Potential Drinking Water Source Area: Medium, High (Yield)...
PWS Protection Areas: Zone II, IWPA, Zone A
Hydrography: Open Water, PWS Reservoir, Tidal Flat
Wetlands: Freshwater, Saltwater, Cranberry Bog
FEMAIOOyr Floodplain; Protected Open Space; ACEC
NHESP Pri-Hab of Rare Species: Vernal Pnnh Cert , Potential
Solid Waste Landfill; PWS: Com. GW,SW.Emerg., Non-Com.

Figure 10

Table 1 - Lewis Pond Sediment Data (Lead and PAHs Only)

ANALYTE	SAMPLE ID:				HYAS1**	LP-EP1	LP-EP1	LP-EP2	LP-DEEP	LP-FAR
	COLLECTION DATE:				10/1/2001	5/4/04	10/20/05	10/20/05	10/20/05	10/20/05
	SAMPLE DEPTH:				Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)					
Polycyclic Aromatic Hydrocarbons										
2-Methylnaphthalene	NA	700	300,000	5,000,000	ND	2,000 U	46 U	48 U	478 U	80 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	ND	2,000 U	46 U	48 U	478 U	80 U
Acenaphthylene	NA	1,000	10,000	10,000,000	ND	2,000 U	46 U	48 U	478 U	80 U
Anthracene	57	1,000,000	1,000,000	10,000,000	ND	2,000 U	*89*	*85*	478 U	80 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	ND	2,000 U	*633*	*726*	478 U	*169*
Benzo(a)pyrene	150	2,000	2,000	300,000	ND	2,000 U	*1,070*	*1,150*	478 U	*197*
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	ND	2,000 U*	1,210	1,210	478 U	196
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	ND	2,000 U	661	528	478 U	80 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	ND	2,000 U	1,200	1,280	478 U	193
Chrysene	170	70,000	70,000	10,000,000	ND	2,000 U*	*1,020*	*1,170*	478 U	*201*
Dibenzo(a,h)anthracene	33	700	700	300,000	ND	2,000 U	*247*	*204*	478 U	80 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	270	3,400 J	*2,180*	*2,130*	478 U	329
Fluorene	77	1,000,000	1,000,000	10,000,000	ND	2,000 U	46	48	478 U	80 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	ND	2,000 U	745 J	611	478 U	80 U
Naphthalene	180	4,000	500,000	10,000,000	ND	2,000 U	46 U	48 U	478 U	80 U
Phenanthrene	200	10,000	500,000	10,000,000	ND	2,000 U*	*770*	*938*	478 U	80 U
Pyrene	200	1,000,000	1,000,000	10,000,000	*250*	*2,590 J*	*1,670*	*1,720*	478U	*257*
Total Lead										
Lead, Total	130,000	200,000	200,000	6,000,000	85,000	***333,000***	162,000	121,000	***223,000***	104,000

Table 1 - Lewis Pond Sediment Data (Lead and PAHs Only) Continued

ANALYTE	SAMPLE ID:				LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9	LP10
	COLLECTION DATE:				2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11
	SAMPLE DEPTH:				0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)									
Polycyclic Aromatic Hydrocarbons														
2-Methylnaphthalene	NA	700	300,000	5,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Acenaphthylene	NA	1,000	10,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Anthracene	57	1,000,000	1,000,000	10,000,000	806 U	2,990 U	3,650U	3,600 U	4,130 U	3,540U	4,160 U	3,750 U	2,950 U	921 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Benzo(a)pyrene	150	2,000	2,000	300,000	404 U	1,500 U	1,830 U	1,810 U	2,070 U	1,770U	2,090 U	1,880 U	1,480 U	462 U
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Chrysene	170	70,000	70,000	10,000,000	404 U	1,500 U	1,830 U	1,810 U	2,070 U	1,770 U	2,090 U	1,880 U	1,480 U	462 U
Dibenzo(a,h)anthracene	33	700	700	300,000	404 U	1,500 U	1,830 U	1,810 U	2,070 U	1,770 U	2,090 U	1,880 U	1,480 U	462 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Fluorene	77	1,000,000	1,000,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Naphthalene	180	4,000	500,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Phenanthrene	200	10,000	500,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Pyrene	200	1,000,000	1,000,000	10,000,000	806 U	2,990 U	3,650 U	3,600 U	4,130 U	3,540 U	4,160 U	3,750 U	2,950 U	921 U
Total Lead														
Lead, Total	130,000	200,000	200,000	6,000,000	***325,000***	95,600	49,000 U	52,600	51,000 U	106,000	58,200 U	46,500 U	41,500 U	14,200 U

Table 1 - Lewis Pond Sediment Data (Lead and PAHs Only) Continued

ANALYTE	SAMPLE ID:				LP-1	LP-COMP 1[9]	LP-COMP 2[10]	LP-3	LP-4	LP-5	LP-6	LP-7	LP-9	LP-10
	COLLECTION DATE:				8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021	8/2/2021
	SAMPLE DEPTH:				0-2'	0-2'	0-2'	0-2'	0-2'	0-2'	0-2'	0-2'	0-2'	0-2'
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)									
Polycyclic Aromatic Hydrocarbons														
2-Methylnaphthalene	NA	700	300,000	5,000,000	30 U	21 U	200 U	150 U	230 U	180 U	320 U	120 U	300 U	86 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	30	21 U	200 U	150 U	230 U	180 U	320 U	120 U	300 U	86 U
Acenaphthylene	NA	1,000	10,000	10,000,000	74	57	200 U	150 U	230 U	180 U	320 U	120 U	300 U	86 U
Anthracene	57	1,000,000	1,000,000	10,000,000	*1,300*	*65*	200 U	150 U	230 U	180 U	320 U	120 U	300 U	86 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	*920*	*440*	*320*	*230*	230 U	*230*	320 U	*320*	*410*	*300*
Benzo(a)pyrene	150	2,000	2,000	300,000	*1,300*	*600*	*320*	*300*	230 U	*280*	320 U	*430*	*750*	*510*
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	2,200	1,000	500	600	360	490	520	750	1,600	990
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	1,200	490	220	270	230 U	240	320 U	350	800	470
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	660	350	200 U	150	230 U	180 U	320 U	220	400	260
Chrysene	170	70,000	70,000	10,000,000	*1,400*	*660*	*360*	*350*	*250*	*340*	*350*	*490*	*980*	*610*
Dibenzo(a,h)anthracene	33	700	700	300,000	*230*	*100*	200 U	150 U	230 U	180 U	320 U	120 U	300 U	*96*
Fluoranthene	420	1,000,000	1,000,000	10,000,000	*2,800*	*1,200*	*550*	*630*	*580*	*600*	*790*	*860*	*2,100*	*1,200*
Fluorene	77	1,000,000	1,000,000	10,000,000	46	32	200 U	150 U	230 U	180 U	320 U	120 U	*300*	*90*
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	1,400	550	240	330	230 U	290	330	430	940	580
Naphthalene	180	4,000	500,000	10,000,000	30 U	21 U	200 U	150 U	230 U	*400*	320 U	120 U	300 U	86 U
Phenanthrene	200	10,000	500,000	10,000,000	*1,200*	*500*	*240*	*280*	*350*	*300*	*410*	*380*	*980*	*550*
Pyrene	200	1,000,000	1,000,000	10,000,000	*2,400*	*910*	*470*	*500*	*460*	*500*	*600*	*700*	*1,600*	*930*
Polycyclic Aromatic Hydrocarbons Ratios[11]														
Fluoranthane to Pyrene Ratio (diesel exhaust particles is 0.25 to 1.38, diesel fuel is 0.38, urban runoff is 0.23 to 1.07 and gasoline exhaust particles is 0.90)					1.17	1.32	1.17	1.26	1.26	1.20	1.32	1.23	1.31	1.29
Phenanthrene to Anthracene Ratio (diesel exhaust particles is 1.3 to 78, diesel fuel is >800, urban runoff is 0.56 to 1.47, and gasoline exhaust particles is 1.79)					0.92	7.69	2.40	3.73	3.04	3.33	2.56	6.33	6.53	12.79
Total Lead														
Lead, Total	130,000	200,000	200,000	6,000,000	14,800	107,000	*196,000*	*198,000*	*184,000*	***241,000***	119,000	***371,000***	108,000	*240,000*

1. Italic indicates analyte exceeds Revised Sediment Screening Values, Massachusetts Department of Environmental Protection, 2005.
2. Bold Indicates analyte exceeds Method 1 Soil Standards, 2019 Massachusetts Contingency Plan.
3. J indicates value is estimated and is above the laboratory method detection limit and below the laboratory reporting limit.
4. U indicated result is less than the laboratories reporting limit
5. * indicates estimated value due to laboratory quality control issues
6. ug/kg indicated microgram per kilogram
7. ND indicates not detected, laboratory detection limit unknown
8. ** indicates sample locaiton is unknown.
9. LP-COMP 1 is a composite of LP-1, LP-10, LP9, and LP7.
10. LP-COMP 2 is a composite of LP-3, LP-4, LP5, and LP6.
11. PAH ratios obtained from Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediment: Identifying Sources and Ecological Hazard, Neff etal, 2004

Table 2 - Upper Gate Pond Sediment Data (Lead and PAHs only)

ANALYTE	SAMPLE ID:				HYAS2**	UG-1	UG-2A	UG-2B	UG-A	UG-B
	COLLECTION DATE:				10/1/2001	5/4/04	5/4/04	5/4/04	10/20/05	10/20/05
	SAMPLE DEPTH:				Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)					
Polycyclic Aromatic Hydrocarbons										
2-Methylnaphthalene	NA	700	300,000	5,000,000	ND	2,790 U	476 U	2,620 U	31 U	31 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	ND	2,790 U	476 U	2,620 U	31 U	31 U
Acenaphthylene	NA	1,000	10,000	10,000,000	ND	2,790 U	476 U	2,620 U	37	31 U
Anthracene	57	1,000,000	1,000,000	10,000,000	*1,000*	2,790 U	476 U	2,620 U	55	31 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	*4,100*	2,790 U	476 U	2,620 U	*428*	*265*
Benzo(a)pyrene	150	2,000	2,000	300,000	*4,700*	2,790 U	476 U	2,620 U	*538*	*343*
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	5,900	3,960 J	476 J	2,620 U*	495	429
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	3,500	2,790 U	476 U	2,620 U	240	171
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	5,300	2,790 U	476 U	2,620 U	508	367
Chrysene	170	70,000	70,000	10,000,000	*6,000*	*3,480 J*	*476 J*	2,620 U*	*612*	*368*
Dibenzo(a,h)anthracene	33	700	700	300,000	***940***	2,790 U	476 U	2,620 U	*94*	*75*
Fluoranthene	420	1,000,000	1,000,000	10,000,000	*13,000*	*7,710 J*	*781 J*	2,830 J	*972*	*630*
Fluorene	77	1,000,000	1,000,000	10,000,000	ND	2,790 U	476 U	2,620 U*	31 U	31 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	3,500	2,790 U	476 U	2,620 U	262	198
Naphthalene	180	4,000	500,000	10,000,000	ND	2,790 U	476 U	2,620 U	31 U	31 U
Phenanthrene	200	10,000	500,000	10,000,000	*7,400*	*2,990 J*	*476 J*	2,620 U	*459*	*364*
Pyrene	200	1,000,000	1,000,000	10,000,000	*10,000*	*5,460 J*	*898 J*	2,620 U*	*1,080*	*512*
Total Lead										
Lead, Total	130,000	200,000	200,000	6,000,000	***360,000***	***442,000***	12,900	***245,000***	14,600	75,500

Table 2 - Upper Gate Pond Sediment Data (Lead and PAHs only) Continued

ANALYTE	SAMPLE ID:				UG-C	UG-DEEP	UG-FAR	UG1	UG2	UG3
	COLLECTION DATE:				10/20/05	10/20/05	10/20/05	2/16/2011	2/16/2011	2/16/2011
	SAMPLE DEPTH:				Unknown	Unknown	Unknown	0-1.5'	0-1.5'	0-1.5'
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)					
Polycyclic Aromatic Hydrocarbons										
2-Methylnaphthalene	NA	700	300,000	5,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Acenaphthylene	NA	1,000	10,000	10,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Anthracene	57	1,000,000	1,000,000	10,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	*832*	316 U	*284*	*1,160*	476 U	6,280 U
Benzo(a)pyrene	150	2,000	2,000	300,000	*1,260*	*518*	*437*	*1,060*	239 U	3,150 U
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	2,010	713	671	1,330	476 U	6,280 U
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	638	316 U	182 U	562	476 U	6,280 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	1,550	650	605	1,370	476 U	6,280 U
Chrysene	170	70,000	70,000	10,000,000	*1,580*	*574*	*587*	*1,560*	239 U	3,150 U
Dibenzo(a,h)anthracene	33	700	700	300,000	*276*	316 U	182 U	*387*	239 U	3,150 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	*2,190*	*1,100*	*1,210*	*3,620*	476 U	6,280 U
Fluorene	77	1,000,000	1,000,000	10,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	759	316 U	211	567	476 U	6,280 U
Naphthalene	180	4,000	500,000	10,000,000	159 U	316 U	182 U	483 U	476 U	6,280 U
Phenanthrene	200	10,000	500,000	10,000,000	*1,000*	*341*	*372*	*2,370*	476 U	6,280 U
Pyrene	200	1,000,000	1,000,000	10,000,000	*1,480*	*726*	*995*	*2,910*	476 U	6,280 U
Total Lead										
Lead, Total	130,000	200,000	200,000	6,000,000	***352,000***	***676,000***	***225,000***	82,500	43,100	*152,000*

Table 2 - Upper Gate Pond Sediment Data (Lead and PAHs only) Continued

ANALYTE	SAMPLE ID:				UG4	UG5	UG6	UG7	UG8	UG9
	COLLECTION DATE:				2/16/2011	2/16/2011	2/16/2011	2/16/2011	2/16/2011	2/16/2011
	SAMPLE DEPTH:				0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)					
Polycyclic Aromatic Hydrocarbons										
2-Methylnaphthalene	NA	700	300,000	5,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Acenaphthylene	NA	1,000	10,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Anthracene	57	1,000,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Benzo(a)pyrene	150	2,000	2,000	300,000	1,970 U	2,780 U	1,800 U	2,090 U	1,970 U	2,350 U
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Chrysene	170	70,000	70,000	10,000,000	1,970 U	2,780 U	1,800 U	2,090 U	1,970 U	2,350 U
Dibenzo(a,h)anthracene	33	700	700	300,000	1,970 U	2,780 U	1,800 U	2,090 U	1,970 U	2,350 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Fluorene	77	1,000,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Naphthalene	180	4,000	500,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Phenanthrene	200	10,000	500,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Pyrene	200	1,000,000	1,000,000	10,000,000	3,930 U	5,550 U	3,580 U	4,160 U	3,930 U	4,690 U
Total Lead										
Lead, Total	130,000	200,000	200,000	6,000,000	60,100 U	78,400	50,300 U	55,800 U	53,700 U	65,300

Table 2 - Upper Gate Pond Sediment Data (Lead and PAHs only) Continued

ANALYTE	SAMPLE ID:				UG10	UG11	UG-11	UG-11A	UG-11B
	COLLECTION DATE:				2/16/2011	2/16/2011	8/6/2021	8/6/2021	8/6/2021
	SAMPLE DEPTH:				0-1.5'	0-1.5'	0-2'	0-2'	0-2'
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)				
Polycyclic Aromatic Hydrocarbons									
2-Methylnaphthalene	NA	700	300,000	5,000,000	3,930 U	3,600 U	62 J	18 J	38
Acenaphthene	NA	4,000	1,000,000	10,000,000	3,930 U	3,600 U	110 J	23 J	46
Acenaphthylene	NA	1,000	10,000	10,000,000	3,930 U	3,600 U	350	91	190
Anthracene	57	1,000,000	1,000,000	10,000,000	3,930 U	3,600 U	*520*	*100*	*260*
Benzo(a)anthracene	110	7,000	7,000	3,000,000	3,930 U	3,600 U	*3,400*	*530*	*820*
Benzo(a)pyrene	150	2,000	2,000	300,000	1,970 U	1,810 U	*4,000*	*710*	*1,100*
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	3,930 U	3,600 U	7,000	1,200	1,800
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	3,930 U	3,600 U	3,400	590	900
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	3,930 U	3,600 U	2,800	400	520
Chrysene	170	70,000	70,000	10,000,000	1,970 U	1,810 U	*5,200*	*820*	*1,400*
Dibenzo(a,h)anthracene	33	700	700	300,000	1,970 U	1,810 U	*690*	120	*210*
Fluoranthene	420	1,000,000	1,000,000	10,000,000	3,930 U	3,600 U	*10,000*	*1,500*	*2,200*
Fluorene	77	1,000,000	1,000,000	10,000,000	3,930 U	3,600 U	*270*	56 J	*88*
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	3,930 U	3,600 U	3,700	650	1,100
Naphthalene	180	4,000	500,000	10,000,000	3,930 U	3,600 U	120 J	38 J	79
Phenanthrene	200	10,000	500,000	10,000,000	3,930 U	3,600 U	*3,300*	*430*	*700*
Pyrene	200	1,000,000	1,000,000	10,000,000	3,930 U	3,600 U	*8,300*	*1,300*	*2,000*
Polycyclic Aromatic Hydrocarbons Ratios[9]									
Fluoranthane to Pyrene Ratio (diesel exhaust is 0.25 to 1.38, diesel fuel is 0.38, urban runoff is 0.23 to 1.07, gasoline exhaust is 0.90)							1.20	1.15	1.10
Phenanthrene to Anthracene Ratio (diesel exhaust is 1.3 to 78, diesel fuel is >800, urban runoff is 0.56 to 1.47, gasoline exhaust is 1.79)							6.35	4.30	2.69
Total Lead									
Lead, Total	130,000	200,000	200,000	6,000,000	56,600 U	44,800	***277,000***	***406,000***	***318,000***

1. Italic indicates analyte exceeds Revised Sediment Screening Values, Massachusetts Department of Environmental Protection, 2005.
2. Bold Indicates analyte exceeds Method 1 Soil Standards, 2019 Massachusetts Contingency Plan.
3. J indicates value is estimated and is above the laboratory method detection limit and below the laboratory reporting limit.
4. U indicated result is less than the laboratories reporting limit
5. * indicates estimated value due to laboratory quality control issues
6. ug/kg indicated microgram per kilogram
7. ND indicates not detected, laboratory detection limit unknown
8. ** indicates sample locaiton is unknown.
9. PAH ratios obtained from Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediment: Identifying Sources and Ecological Hazard, Neff et a

Table 3 - Other Permited Outfall Sediment Data (Lead and PAHs Only)

ANALYTE	SAMPLE ID:				OUTFALL_J (East Ramp to Lewis Pond)	OUTFALL_PLAZA (Kmart Plaza, Outfall F)
	COLLECTION DATE:				1/10/2022	1/10/2022
	SAMPLE DEPTH:				0-2'	0-2'
	Sediment Screening Criterion (ug/kg)	**S-1/GW-1 (ug/kg)**	**S-1/GW-3 (ug/kg)**	**Upper Concentration Limit (ug/kg)**	**Sample Results (ug/kg)**	
Polycyclic Aromatic Hydrocarbons						
Acenaphthene	NA	4,000	1,000,000	10,000,000	490 J	100 J
Fluoranthene	420	1,000,000	1,000,000	10,000,000	*41,000*	*9,700*
Naphthalene	180	4,000	500,000	10,000,000	770 U	200 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	***11,000***	*3,000*
Benzo(a)pyrene	150	2,000	2,000	300,000	***14,000***	***3,600***
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	**23,000**	**6,200**
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	7,900	1,800
Chrysene	170	70,000	70,000	10,000,000	*18,000*	*4,200*
Acenaphthylene	NA	1,000	10,000	10,000,000	120 J	38 J
Anthracene	57	1,000,000	1,000,000	10,000,000	*1,600*	*340*
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	12,000	2,600
Fluorene	77	1,000,000	1,000,000	10,000,000	*750 J*	*110 J*
Phenanthrene	200	10,000	500,000	10,000,000	*20,000*	*4,100*
Dibenzo(a,h)anthracene	33	700	700	300,000	***2,300***	*540*
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	**14,000**	3,100
Pyrene	200	1,000,000	1,000,000	10,000,000	*29,000*	*7,200*
2-Methylnaphthalene	NA	700	300,000	5,000,000	770 U	200 U
Polycyclic Aromatic Hydrocarbons Ratios[9]						
Fluoranthane to Pyrene Ratio (diesel exhaust is 0.25 to 1.38, diesel fuel is 0.38, urban runoff is 0.23 to 1.07, gasoline exhaust is 0.90)					1.41	1.35
Phenanthrene to Anthracene Ratio (diesel exhaust is 1.3 to 78, diesel fuel is >800, urban runoff is 0.56 to 1.47, gasoline exhaust is 1.79)					12.50	12.06
Total Lead						
Lead, Total	130,000	200,000	200,000	6,000,000	8,800	71,000

1. Italic indicates analyte exceeds Revised Sediment Screening Values, Massachusetts Department of Environmental Protection, 2005.
2. Bold Indicates analyte exceeds Method 1 Soil Standards, 2019 Massachusetts Contingency Plan.
3. J indicates value is estimated and is above the laboratory method detection limit and below the laboratory reporting limit.
4. U indicated result is less than the laboratories reporting limit
5. * indicates estimated value due to laboratory quality control issues
6. ug/kg indicated microgram per kilogram
7. ND indicates not detected, laboratory detection limit unknown
8. ** indicates sample locaiton is unknown.
9. PAH ratios obtained from Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediment: Identifying Sources and Ecological Hazard, Neff et al., 2004

Table 4: 2011 Groundwater Sampling Results
Cape Cod Gateway Airport
Hyannis, Massachusetts

Sample ID[1]			HW-401S					HW-401D				HW-402				HW-403				HW-404			
Sample Date			4/7/2011	5/12/2011	8/16/2011	10/20/2011	12/14/2011	4/7/2011	8/16/2011	10/20/2011	12/14/2011	4/7/2011	8/16/2011	10/20/2011	12/14/2011	4/7/2011	8/16/2011	10/20/2011	12/14/2011	4/7/2011	8/16/2011	10/20/2011	12/14/2011
	Method 1 GW-1	**Method 1 GW-3**																					
Dissolved Metals[3]																							
Arsenic	10	900	<2.5	NS	<2.5	3.2	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Barium	2,000	50,000	<25	NS	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	36	<25	<25	<25	<25	<25	<25	<25
Cadmium	5	4	<2.5	NS	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Chromium	100	300	<10	NS	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Lead	15	10	<10	NS	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mercury	2	20	<0.2	NS	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Selenium	50	100	<25	NS	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Silver	100	7	<5	NS	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Polynuclear Aromatic Hydrocarbons (PAHs)[3]																							
2-Methylnaphthalene	10	20,000	<0.21	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Acenaphthene	20	10,000	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Acenaphthylene	30	40	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Anthracene	60	30	<0.21	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Benzo(a)anthracene	1	1,000	0.08	<0.05 J	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene	0.2	500	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	1	400	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	50	20	<0.21	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Benzo(k)fluoranthene	1	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chrysene	2	70	0.09	<0.05 J	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Dibenzo(a,h)Anthracene	0.5	40	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoranthene	90	200	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Fluorene	30	40	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Indeno(1,2,3-cd)Pyrene	0.5	100	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Naphthalene	140	20,000	<0.21	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	0.41	<0.2	<0.2	<0.20	0.91
Phenanthrene	40	10,000	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20
Pyrene	60	20	<0.21	<0.2 J	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20	<0.2	<0.2	<0.20	<0.20

NOTES:

1. Wells HW-401S, HW-401D, HW-402, HW-403, and HW-404 were historically referred to as HW-1S and HW-1D, HW-2, HW-3, and HW-4, respecitvely. All samples collected by Horsley Witten Group, Inc.
2. Method 1 values are from the Massachusetts Contingency Plan
3. Dissolved metals analyzed via EPA Method 3005A/3020A/6000/7000 and PAHs analyzed via EPA Method 8270D(SIM) by ESS Laboratory of Cranston, RI.
4. All values reported in micrograms per liter (ug/L).
5. "<" indicates that the sample was not detected above the laboratory reporting limit
6. NS = not sampled
7. "J" flag = concentration is estimated due to laboratory quality control issue

Table 5 - Mary Dunn Pond Sediment Data (Lead and PAHs Only)

ANALYTE	SAMPLE ID:				HYAS3**	MD-1	MD-DEEP	MD1	MD2	MD3	MD4	MD5
	COLLECTION DATE:				10/1/2001	10/20/05	10/20/05	2/16/11	2/16/11	2/16/11	2/16/11	2/16/11
	SAMPLE DEPTH:				Unknown	Unknown	Unknown	0-1.5'	0-1.5	0-1.5'	0-1.5	0-1.5'
	Sediment Screening Values (ug/kg)	**S-1/GW-1 (ug/kg)**	**S-1/GW-3 (ug/kg)**	**Upper Concentration Limit (ug/kg)**	**Sample Results (ug/kg)**							
Polycyclic Aromatic Hydrocarbons												
2-Methylnaphthalene	NA	700	300,000	5,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Acenaphthylene	NA	1,000	10,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Anthracene	57	1,000,000	1,000,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Benzo(a)pyrene	150	2,000	2,000	300,000	ND	34 U	165 U	225 U	195 U	803 U	222 U	512 U
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Chrysene	170	70,000	70,000	10,000,000	ND	34 U	165 U	225 U	195 U	803 U	222 U	512 U
Dibenzo(a,h)anthracene	33	700	700	300,000	ND	34 U	165 U	225 U	195 U	803 U	222 U	512 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	ND	34 U	*224*	449 U	389 U	1,600 U	442 U	1,020 U
Fluorene	77	1,000,000	1,000,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Naphthalene	180	4,000	500,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Phenanthrene	200	10,000	500,000	10,000,000	ND	34 U	165 U	449 U	389 U	1,600 U	442 U	1,020 U
Pyrene	200	1,000,000	1,000,000	10,000,000	ND	34 U	182	449 U	389 U	1,600 U	442 U	1,020 U
Total Lead												
Lead, Total	130,000	200,000	200,000	6,000,000	ND	19,000	***624,000***	56,000	3,700 U	24,900	13,500	13,200 U

Table 5 - Mary Dunn Pond Sediment Data (Lead and PAHs Only) Continued

ANALYTE	SAMPLE ID:				MD6	MD7	MD8	MD9	MD10	MD-COMP[9]
	COLLECTION DATE:				2/16/11	2/16/11	2/16/11	2/16/11	2/16/11	8/2/2021
	SAMPLE DEPTH:				0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-1.5'	0-2
	Sediment Screening Values (ug/kg)	S-1/GW-1 (ug/kg)	S-1/GW-3 (ug/kg)	Upper Concentration Limit (ug/kg)	Sample Results (ug/kg)					
Polycyclic Aromatic Hydrocarbons										
2-Methylnaphthalene	NA	700	300,000	5,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Acenaphthene	NA	4,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Acenaphthylene	NA	1,000	10,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Anthracene	57	1,000,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Benzo(a)anthracene	110	7,000	7,000	3,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Benzo(a)pyrene	150	2,000	2,000	300,000	380 U	1,600 U	1,520 U	1,190 U	1,520 U	38 U
Benzo(b)fluoranthene	NA	7,000	7,000	3,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Benzo(ghi)perylene	NA	1,000,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Benzo(k)fluoranthene	NA	70,000	70,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Chrysene	170	70,000	70,000	10,000,000	380 U	1,600 U	1,520 U	1,190 U	1,520 U	38 U
Dibenzo(a,h)anthracene	33	700	700	300,000	380 U	1,600 U	1,520 U	1,190 U	1,520 U	38 U
Fluoranthene	420	1,000,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Fluorene	77	1,000,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Indeno(1,2,3-cd)pyrene	NA	7,000	7,000	3,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Naphthalene	180	4,000	500,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Phenanthrene	200	10,000	500,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Pyrene	200	1,000,000	1,000,000	10,000,000	757 U	3,180 U	3,030 U	2,380 U	3,030 U	38 U
Total Lead										
Lead, Total	130,000	200,000	200,000	6,000,000	34,200	42,600 U	39,000 U	30,000 U	75,400	66,000

1. Italic indicates analyte exceeds Revised Sediment Screening Values, Massachusetts Department of Environmental Protection, 2005.
2. Bold Indicates analyte exceeds Method 1 Soil Standards, 2019 Massachusetts Contingency Plan.
3. J indicates value is estimated and is above the laboratory method detection limit and below the laboratory reporting limit.
4. U indicated result is less than the laboratories reporting limit
5. * indicates estimated value due to laboratory quality control issues
6. ug/kg indicated microgram per kilogram
7. ND indicates not detected, laboratory detection limit unknown
8. ** indicates sample locaiton is unknown.
9. MD-COMP is a composite of MD-1, MD-2, MD-3, and MD-4

APPENDIX A

ECOLOGICAL RISK ASSESSMENT OF POLYCYCLIC AROMATIC HYDROCARBONS IN SEDIMENT: IDENTIFYING SOURCES AND ECOLOGICAL HAZARD

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Original Research

Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediments: Identifying Sources and Ecological Hazard

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ABSTRACT

Polycyclic aromatic hydrocarbons (PAHs) are nearly ubiquitous contaminants of freshwater and marine sediments. Sediment PAHs are derived from combustion of organic matter, fossil fuels, and biosynthesis by microbes. Pyrogenic PAHs, particularly those associated with combustion particles (soot), have a low accessibility and bioavailability in sediments. Polycyclic aromatic hydrocarbons associated with petroleum, creosote, or coal tar in sediments may have a moderate accessibility/bioavailability, particularly if the PAHs are part of a nonaqueous phase liquid (NAPL) phase that is in contact with sediment pore water. We present a method for estimating the hazard of complex PAH assemblage in sediments to benthic organisms. Concentrations of all PAHs in sediment pore water are estimated by an equilibrium partitioning model relative to concentrations in bulk sediment. Predicted log K_{oc} values can be used for predicting sediment/water partitioning of petrogenic PAH, but empirically derived log K_d values are needed to predict partitioning of pyrogenic PAH. A hazard quotient (HQ) for each PAH is calculated as the ratio of the estimated concentration in pore water to the chronic toxicity of the PAH determined by a log K_{ow}/toxicity model. Hazard quotients for all PAH in a sample are summed to produce a hazard index (HI), which is a measure of the worst-case estimated hazard of the sediment PAH to benthic organisms. The results of this study show that the integration of HI results with PAH source data provides insights into the causes of sediment toxicity that are useful in an ecological risk assessment.

Keywords: Petroleum Combustion PAH toxicity Bioavailability

INTRODUCTION

Polycyclic aromatic hydrocarbons (PAHs) are nearly ubiquitous trace contaminants of freshwater and marine sediments worldwide. They are being recognized with increasing frequency as major contributors to the hazard to aquatic life of contaminated sediments, particularly near areas of intense human activity (Neff 1979, 2002). Polycyclic aromatic hydrocarbons are composed of two or more fused benzene (aromatic) rings (Neff 1979). Aromatic rings are fused when they share two carbon atoms.

Polycyclic aromatic hydrocarbons almost never occur alone in sediments. They usually are present as complex mixtures of hundreds or even thousands of related compounds spanning a wide range of physical/chemical properties and toxicity to aquatic organisms. The composition of PAH assemblages in sediments varies widely depending on the sources of the PAH and the extent of natural degradative processes (called weathering) they have undergone since their release into the environment. A risk assessment for PAH-contaminated sediments requires an estimate of the toxicity to aquatic organisms of the complex PAH assemblage in the sediments. Sediment bioassays alone are often inadequate for identifying the chemicals that pose an ecological risk in sediments. This paper presents an approach to estimating the toxicity of PAH associated with marine and freshwater sediments based on principals of equilibrium partitioning theory (Di Toro and McGrath 2000; Rogers 2002; Hansen et al. 2003). The toxicity of a PAH assemblage in sediments depends on its composition and physical form, both of which depend on the sources of the PAH and on the relative concentrations of different PAH in the sediments. Therefore, an overview of the sources and compositions of the PAH assemblages found in sediments is included.

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SOURCES OF PAH IN SEDIMENTS

Polycyclic aromatic hydrocarbons in the environment may be derived from three sources: fossil fuels (petrogenic PAH), burning of organic matter (pyrogenic PAH), and transformation of natural organic precursors in the environment by relatively rapid chemical/biological (diagenic) processes (biogenic PAH) (Neff 1979, 2002). The biogenic PAH assemblages produced naturally (e.g., perylene, retene) are simple and usually do not contribute much to the total mass of PAH in sediments that have received inputs from anthropogenic sources.

Petrogenic PAH

A typical crude oil may contain from 0.2 to more than 7% total PAH. Most of the PAHs in petroleum are low molecular weight hydrocarbons containing two or three fused aromatic rings. Higher molecular weight PAHs, when present, usually are at low concentrations (usually less than 100 mg/kg ppm) (Kerr et al. 1999). Refined petroleum products contain the same PAHs as in the parent crude oil, as well as small amounts of PAHs produced by catalytic cracking and other refining processes (Neff et al. 1994; Stout et al. 2002a). The PAH assemblage in different refined oils varies depending on the distillation temperature range of the product. Gasoline contains mainly low molecular weight ali-

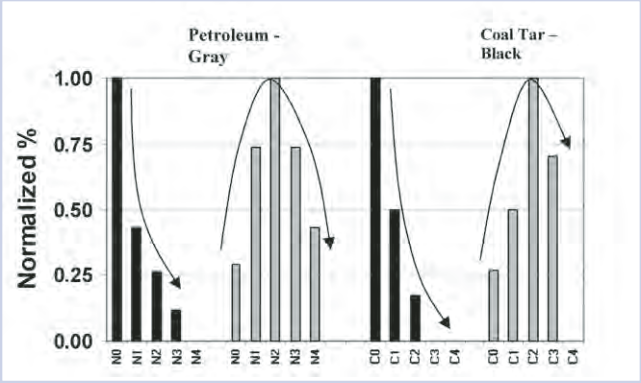

Figure 1. Typical alkyl PAH profiles for naphthalene (N0–N4) and chrysene (C0–C4) in petrogenic (petroleum) and pyrogenic (coal tar) PAH assemblages. From Neff (2002).

phatic, olefinic, and monocyclic aromatic hydrocarbons (e.g., benzene and toluene) and 2-ring PAHs (naphthalene and alkylnaphthalenes). Diesel fuels, home heating oils, and engine oils (crankcase oil; middle distillate fuels) may contain aromatic hydrocarbons from benzene through fluoranthene (four aromatic rings).

Many of the PAHs in petrogenic PAH assemblages contain one or more methyl, ethyl, butyl, or occasionally higher alkyl substituents on one or more of the aromatic carbons (Figure 1). As a general rule, these alkyl PAH are more abundant than the parent compounds in petroleum (Sporstøl et al. 1983; Stout et al. 2002a). Homologues with two to four alkyl carbons usually are more abundant than the less or more highly alkylated homologues (Figure 1).

Pyrogenic PAH

The major source of PAHs containing three or more aromatic rings in the environment is the combustion of organic matter (Neff 1979). During combustion, organic matter is heated to high temperatures, causing it to break up into smaller organic molecules and ultimately into carbon dioxide and water. If combustion is incomplete or the combusted fuel products cool quickly, the small organic chemicals may condense to form new chemicals, including PAH. Polycyclic aromatic hydrocarbons formed during combustion are called pyrogenic PAH, and they often are abundant in the vapor and particulate phases of engine exhaust. Two- and 3-ring PAH are most abundant in the vapor phase; 4- through 6-ringed PAHs often are more abundant in the particulate phase (soot) of engine exhaust or smoke (Neff 2002).

Pyrogenic PAH assemblages are complex, and, unlike the assemblages in petroleum, are dominated by 4-, 5-, and 6-ring PAHs. In pyrogenic PAH assemblages, the dominant compound in each homologous series is the unalkylated parent compound or a homologue with only one or two alkyl substituents (Sporstøl et al. 1983; Stout et al. 2001a). There is an inverse relationship between the temperature of formation and the abundance of alkyl carbons in a pyrogenic PAH assemblage (Neff 1979). The PAH assemblage in coal tar (a product produced by the high-temperature baking of hard coal in a reducing atmosphere to produce coke and manufactured gas) is typical of a high-temperature pyrogenic PAH assemblage (Figure 1). Subsequent distillation of coal (or other) tars alters the composition of the PAH assemblage according to boiling point, sometimes producing pyrogenic mixtures enriched in 2- and 3-ring PAH (e.g., creosote).

SOURCE ALLOCATION

Allocation

Most sediments contain a mixture of PAHs from several petrogenic and pyrogenic sources. It often is desirable or necessary to identify the sources of the PAH in order to identify potentially responsible parties (PRPs) for discharge/spill litigation, to design optimal strategies for source control and remediation, and to aid in characterizing the environmental hazard associated with the sediment contamination. Pyrogenic PAHs in sediments, particularly when they are associated with combustion soot, often are more persistent, less mobile and bioavailable, and less toxic (on a bulk sediment concentration basis) than petrogenic PAHs (Farrington and Westall 1986; Pastorok et al. 1994; Gustafsson et al. 1997). Thus, source identification should be part of any contaminated sediment site assessment.

Historically, the sediment PAHs of primary environmental concern have been the 16 listed on the U.S. Environmental Protection Agency (U.S. EPA) priority pollutant list and similar lists in other countries. However, it has become increasingly evident in recent years that hundreds of PAHs between naphthalene (molecular weight 128.2) and coronene (molecular weight 300.4) are present in environmental matrices that have become contaminated with petrogenic or pyrogenic PAH at concentrations high enough to be of environmental concern (Neff 2002; Barron and Holder 2003). Coronene (log K_{ow}, 6.75, aqueous solubility, 0.14 µg/L) is the highest molecular weight PAH with sufficient environmental mobility to be of potential environmental concern. None of the U.S. EPA priority pollutant PAHs are alkylated; all are unalkylated parent PAHs. However, as discussed above, the most abundant PAH in petrogenic PAH assemblages are alkyl PAHs. Thus, analysis of just 12 to 20 PAHs in sediment samples, as is done for many contaminated site assessments, may be inadequate for providing data needed to identify PAH sources and ecological hazard in the sediments, particularly if they are contaminated primarily with petroleum hydrocarbons.

For source identification, extracts of the nonpolar organic fraction in sediments should be analyzed by a capillary column gas chromatographic method and analyte peaks in the chromatogram identified and quantified by mass spectrometry operated in the selected ion monitoring mode. This analytical method represents a modification of U.S. EPA Method 8270 (Stout et al. 2002a, 2002b). In the modified method, the gas chromatography is operated with a slow oven temperature increase program to optimize separation of target compounds. The mass spectrometer is operated in the selected ion monitoring mode to minimize interferences from nontarget compounds and, when necessary, to improve detection limits for analytes present at low concentrations. The mass spectrometer/selected ion monitoring should target ions of the parent and alkyl PAH analytes of interest. Usually, between 40 and 50 analytes or analyte groups are analyzed, including parent compounds from naphthalene to benzo[*ghi*]perylene and C_1- through C_4-alkyl congener groups for naphthalene, fluorene, phenanthrene/anthracene, fluoranthrene/pryrene, and chrysene. Heterocyclic compounds such as dibenzothiophene (a sulfur-containing heterocyclic compound) and their alkyl homologue groups also may be included on the analyte list, particularly when sediments are suspected to contain a substantial contribution of petrogenic PAHs. It is extremely

Table 1. Ratios of the PAH isomers phenanthrene to anthracene (PH/AN) and fluoranthene to pyrene (FL/PY) in PAH assemblages from several sources

Source	PH/AN	FL/PY	Reference
Primarily pyrogenic sources			
Coke oven emissions	1.27–3.57	0.76–1.31	Maher and Aislabe 1992
Iron/steel plant (soot)	0.24	0.62	Yang et al. 2002
Iron/steel plant (flue gas)	0.06	1.43	Yang et al. 2002
Wood-burning emissions	6.41	1.26	Page et al. 1999
Auto exhaust soot (gasoline)	1.79	0.90	O'Malley et al. 1996
Diesel engine soot	0.06	1.26	Bence et al. 1996
Diesel exhaust particles (n = 22)	1.3–78	0.25–1.38	Sjøgren et al. 1996
Highway dust	4.7	1.4	Christensen et al. 1999
Urban runoff	0.56–1.47	0.23–1.07	Stout et al. 2001a
Creosote	0.11–4.01	1.52–1.70	Neff 2002
Coal tar	3.11	1.29	Neff 2002
Coke	0.24	1.49	S.A. Stout (unpublished data)
Creosote-contaminated sediment in Table 5	0.34	1.59	Stout et al. 2001a
Urban sediment in Table 5	0.22	0.79	Stout et al. 2001a
Primarily petrogenic sources			
60 crude oils (mean)	52.0	0.25	Kerr et al. 1999
Australian crude oil	>370[a]	0.78	Neff et al. 2000
Italian crude oil	>232[a]	0.08	Neff et al. 1998
Alaska crude oil	>262[a]	0.2	Bence et al. 1996
Diesel fuel (No. 2 fuel oil)	>800[a]	0.38	Bence et al. 1996
No. 4 fuel oil	11.8	0.16	S.A. Stout (unpublished data)
Bunker C residual fuel oil	14.8	0.14	S.A. Stout (unpublished data)
Road paving asphalt	20	<0.11[a]	Kriech et al. 2002
West Virginia coal (2 samples)	11.2, 27.9	0.95, 1.03	Neff and Sauer 1993

[a]Anthracene or fluoranthene concentration was below the detection limit.

important that the analyses adhere to strict data quality objectives to assure optimal precision, accuracy, specificity, and sensitivity (Boehm et al. 1997). Poor data quality will hamper the ability to accurately identify PAH sources in sediments. Detailed descriptions of these methods can be found elsewhere (Page et al. 1995; Douglas et al. 1996; Stout et al. 2002a, 2002b).

The differences in ratios of parent to alkyl-substituted PAH congeners can be used to distinguish between petrogenic and various types of pyrogenic PAH assemblages in environmental samples (Bence et al. 1996; Douglas et al. 1996; Zeng and Vista 1997; Stout et al. 2000). If only priority pollutant PAH data are available, ratios of phenanthrene to anthracene (PH/AN) and fluoranthene to pyrene (FL/PY) are useful for differentiating between sediment PAH assemblages containing primarily pyrogenic or petrogenic PAHs (Table 1). Anthracene and fluoranthene are thermodynamically less stable than their isomers, phenanthrene and pyrene, respectively (Baumard et al. 1998). Anthracene and fluoranthene are produced during rapid, high-temperature pyrosynthesis, but are less favored to persist during the slow organic digenesis leading to the generation of fossil fuels. Thus, the PH/AN ratio of pyrogenic PAH assemblages usually is less than 5 and the petrogenic ratio usually is greater than 5 (Table 1). The FL/PY ratio usually approaches or exceeds a value of 1 in pyrogenic assemblages and usually is substantially less than a value of 1 in petrogenic PAH assemblages. Because of the extreme variability in these ratios in PAH assemblages from different sources, and in the absence of additional alkyl PAH and other chemical "fingerprint" data, at a minimum, both ratios should be used to aid in differentiating between petrogenic and pyrogenic PAH in sediments. A plot of PH/AN (y axis) against FL/PY (x axis) for PAH assemblages from different single and mixed sources produces a distribution with a negative slope. Samples containing primarily petrogenic PAHs are clustered in the upper left side of the graph; data points distribute toward the lower right as the fraction of total PAH that is pyrogenic increases.

Several other diagnostic ratios can be used to help distinguish between petrogenic and pyrogenic PAH assemblages in sediments. Because alkyl PAHs are more abundant than the unalkylated parent PAHs in petrogenic PAH assemblages and are less abundant in pyrogenic PAH assemblages, ratios of selected primarily petrogenic alkyl PAHs to selected pri-

Table 2. Fluoranthene plus pyrene to sum of C_2- to C_4-phenanthrenes (FLPY)/(FLPY + C_2- to C_4-phenanthrenes [C24PH]) ratios in different types of petrogenic and pyrogenic PAH assemblages. Most data are from the Battelle PAH Forensics database

Material	No. of samples	Mean ratio	Ratio range
Petrogenic sources			
Crude oils	22	0.015	0–0.044
#2 Fuel oil/diesel	25	0.044	0.008–0.073
#6 Fuel oil/bunker C	43	0.050	0.028–0.143
IBF-380 heavy fuel	17	0.048	0.018–0.057
Gasoline	12	0.105	0–0.174
Coal	21	0.099	0.021–0.320
Pyrogenic sources			
Soot	2	0.821	0.731–0.909
Creosote	9	0.814	0.387–0.975
Coal tar	15	0.922	0.838–0.983

marily pyrogenic parent PAHs provide a good indication of PAH source (Sporstøl et al. 1983). The ratios of methylphenanthrenes to phenanthrene, total methyl-fluoranthenes/pyrenes to fluoranthene/pyrene, and total methylchrysenes to chrysene are the ratios most frequently used (Gustafsson et al. 1997; Zeng and Vista 1997; Pereira et al. 1999; Stout et al. 2001a, 2001b). Although they may be affected by preferential weathering of the parent PAH, these ratios usually are greater than a value of 1 in petrogenic PAH assemblages and less than a value of 1 in pyrogenic assemblages.

The ratio of fluoranthene plus pyrene (FLPY) to the sum of C_2- to C_4-phenanthrenes (C24PH), expressed as FLPY/(FLPY + C24PH) such that values range from 0 to 1, has been effective in differentiating between petrogenic and pyrogenic PAH assemblages in sediments and biological samples from Prince William Sound, (AK, USA) which was the site of the 1989 *Exxon Valdez* oil spill (Neff et al. 2004). Petrogenic PAH assemblages nearly always have a FLPY/(FLPY + C24PH) ratio less than 0.1, whereas the ratio in pyrogenic PAH assemblages usually is more than 0.75 (Table 2). Gasoline may have a higher ratio, because it contains only traces of fluoranthene, pyrene, and more highly alkylated phenanthrenes.

More elaborate fingerprinting methods are required for distinguishing among multiple petrogenic sources in sediments (Boehm et al. 1997; Stout et al. 2002b; Neff et al. 2004). Within each alkyl homologue group, alkyl phenanthrenes, dibenzothiophene, and chrysene tend to weather at the same rates and are fairly persistent in contaminated sediments (Douglas et al. 1996; Boehm et al. 1997). The concentrations and relative abundances of different alkyl-PAHs vary widely in crude and refined petroleum from different sources. Thus, alkyl-PAH ratios are useful for identifying PAH assemblages from different petrogenic sources in sediments (Boehm et al. 1997; Burns et al. 1997; Stout et al. 2002a). For example, ratios of total C_2-dibenzothiophenes to total C_2-phenanthrenes (DT2/PH2) and of the trimethyl homologues (DT3/PH3) were particularly useful for distinguishing among sediment PAH from North Slope crude oil (the oil released in the *Exxon Valdez* oil spill) and from other petrogenic sources (seep oil, weathered petroleum tar, diesel fuel) in spill path areas of Prince William Sound (Page et al. 1996; Boehm et al. 1997). If the sediment PAH data are graphed in double-ratio plots (e.g., DT2/PH2 vs DT3/PH3), the PAH assemblages from different petrogenic sources cluster separately, often allowing clear differentiation among multiple sources (Brown and Boehm 1993; Boehm et al. 1997).

Higher resolution in the source allocation can be obtained by a comprehensive statistical analysis of the complete PAH profile and diagnostic ratios. One such statistical method is principal component analysis (PCA). The principal component analysis is one of several types of ordination techniques, also known as factor analyses, by which multivariate data sets are explored, reduced, interpreted, and/or studied further (Wold et al. 1987). PCA is used in many types of studies and has been applied to PAH fingerprinting and allocation studies (Boehm et al. 1997; Burns et al. 1997; Naes and Oug 1998; Stout et al. 2001a).

Principal component analysis is an exploratory statistical technique that produces a visual comparison among sediment samples and suspected source materials (e.g., petroleum products from suspected sources, pyrogenic emissions from local point and nonpoint sources, coal tar, and creosote). Figure 2 shows a PCA plot for sediments from an urban waterway in which three sources of PAHs were recognized, namely natural background (arising from preindustrial, natural forest fires); urban runoff; and creosote (from a former tar distillation facility on the waterway) (Stout et al. 2001a, 2002b). Many sediment samples from this urban waterway contained PAHs primarily from one of these three end-members. These "single-source" samples tend to plot as clusters at or near the apices of the trends revealed by the PCA factor score plot. Several other sediments tended to plot in locations intermediate between the three end-members, indicating that they contain a mixture of PAHs from two or three of the sources. Spatial relationships among samples on a PCA score plot can be used to estimate or determine the proportions of each end-member in each sediment sample. Additional calculations involving spatial distributions, concentrations, and volumes of PAH-contaminated sediments from each contaminant source in the study can be used to allocate contributions among the three end-member sources.

Sources

Petrogenic PAHs enter freshwater and marine environments from natural oil seeps; erosion of coal, peat, and oil

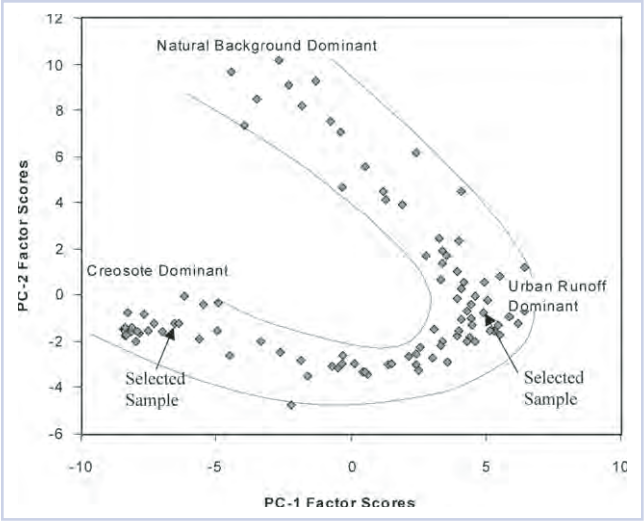

Figure 2. Principal component analysis (PCA) factor score plot for sediment PAH data from a contaminated estuary. The PCA identified three dominant PAH sources (natural background, urban runoff, and creosote). Samples falling between the apices contain a mixture of PAH from these sources. From Stout et al. (2001a, 2002b).

shale deposits; oil and coal spills; discharges of treated and untreated ballast and bilge water from ships; and effluents from oil refineries, oil/water separators on oil production platforms, coal-fired power plants, storm water runoff, and municipal sewage treatment plants (NAS 2002; Neff 2002).

A great many domestic and industrial activities, as well as natural events such as forest fires, produce PAH by pyrolysis/pyrosynthesis. Pyrosynthesized PAH may be released to the environment in airborne particles or in the solid or aqueous byproducts of the pyrolysis process. Burning of fossil fuels is an important source of pyrogenic PAHs in the environment. The particulate fractions of exhaust from gasoline and diesel-powered vehicles contain 16 to 2,300 µg/g total 4- through 6-ringed PAHs (Takada et al. 1991; Oda et al. 1998). Nearly all the PAHs derived from vehicular exhaust are deposited within about 50 m of roads (Harrison and Johnston 1985; Hewitt and Rashed 1990). Much of the deposited PAHs, however, find their way to water bodies in surface runoff from land (Hoffman et al. 1984; Sharma et al. 1994).

Several industrial processes, such as coal coking (Lao et al. 1975); carbonization of coal and oil to produce manufactured gas, coal tars, carbon black, and pitch (Villaume 1984; Merrill and Wade 1985; Mueller et al. 1989); catalytic cracking of petroleum feed stocks to produce refined petroleum products (Stout et al. 2001b); manufacture of iron and steel (Yang et al. 2002); and aluminum smelting (Thrane 1987; Näf et al. 1994) produce airborne particulates and solid wastes containing high concentrations of PAH. Coking of coal produces an estimated emission of about 40 mg of benzo[*a*]pyrene (a carcinogenic PAH) per ton of coke produced (Eisenhut et al. 1990). Polycyclic aromatic hydrocarbon–contaminated wastes and discharges from these industries may reach freshwater and marine environments in wastewater effluents and in deposition of airborne vapor-phase or particulate PAH. For example, an estimated 10 t of PAHs were discharged to the sea from seven Norwegian aluminum smelters in 1992, down from 42 t in 1988 (Knutzen 1995).

ESTIMATION OF THE TOXICITY OF PAH IN SEDIMENTS

Concentration of PAH in sediment pore water

Polycyclic aromatic hydrocarbons in solution in ambient water or pore water of sediments are much more bioavailable and toxic than those adsorbed to particles (particularly combustion soot) (Gustafsson et al. 1997) or associated with a nonaqueous phase liquid (NAPL; e.g., petroleum, creosote, or coal tar) (Pastorok et al. 1994). The dissolved phase of PAHs in sediments can be estimated based on equilibrium partitioning theory (Hansen et al. 2003).

Nonpolar organic chemicals, such as PAHs, have low aqueous solubilities and high affinities for adsorption to sediment and organic particles and absorption (bioconcentration) by living organisms (Neff 2002). Most of the higher molecular weight pyrogenic PAHs entering aquatic environments are sorbed to soot (the particulate fraction of smoke and engine exhaust). Petrogenic lower molecular weight PAHs may enter the water from the vapor phase in rainfall or dry fallout. They quickly adsorb to the organic phase of suspended particles and are deposited with them in sediments (Neff 2002).

Petrogenic PAHs from petroleum and pyrogenic PAHs from creosote and coal tar in sediments may be complexed with the colloidal and particulate organic fraction of sediment or associated with a NAPL, an oil phase, or an oil coating on sediment particles. Because the affinity of hydrocarbons is higher for the oil phase than for the sediment organic matter and sediment porewater phases, partitioning of hydrocarbons into sediment porewater is controlled primarily by the affinity of the hydrocarbons for the NAPL phase (Zemanek et al. 1997). Thus, in estimating the partitioning of PAHs between the NAPL phase (petroleum, coal tar, creosote) and dissolved phase, PAH concentration should be normalized to some measure of total hydrocarbons.

The PAHs in sediments are distributed between the dissolved (porewater) and particulate and NAPL phases of the sediment according to their relative affinities for the three phases. This distribution can be expressed as an organic carbon/water partition coefficient (K_{oc}) or an oil/water partition coefficient (K_{oil}) (Lee et al. 1992a; Neff and Sauer 1995; Di Toro and McGrath 2000; Hansen et al. 2003). Both partition coefficients are similar to the octanol/water partition coefficient (K_{ow}) that is used frequently to model bioconcentration of nonpolar organic compounds from water by aquatic animals (Connell 1993; Neff 2002). The K_{oc} for most nonpolar organic chemicals and colloidal/particulate organic matter in sediments is lower than the K_{ow} (Karickhoff 1981; Di Toro et al. 1991; Neff 2002), whereas the K_{oil} for PAHs in most refined petroleum products and liquid coal tars is about the same as or higher than the K_{ow} and tends to increase with average molecular weight of the NAPL material (Shiu et al. 1990; Lee et al. 1992a, 1992b).

However, high molecular weight, petrogenic PAHs in coal particles and asphalt, pyrogenic PAHs in soot or coal tar, and related viscous liquids often are bound to sediment particles more strongly than predicted by equilibrium partitioning theory. Mitra et al. (1999) reported high, invariant log K_{oc}s for PAHs in sediments from the Elizabeth River (VA, USA), which is heavily contaminated with creosote-contaminated wood particles. Polycyclic aromatic hydrocarbons in sediments of urban estuaries—such as the Tamar River (UK) (Readman et al. 1987); Boston Harbor (MA, USA)

Table 3. Log K_{ow}, freshwater solubility, and estimated acute and chronic toxicity of PAH frequently found in crude and refined petroleum. Solubility and toxicity values are micrograms per liter (µg/L ppb). Log K_{ow} values and solubilities are from Mackay et al. (1992), Neff and Burns (1996), and Ran et al. (2002)

PAH	Log K_{ow}	Freshwater solubility	Acute toxicity	Chronic toxicity
Naphthalene	3.37	33,720	4,870	970
C_1-Naphthalenes	3.87	27,160	1,420	284
C_2-Naphthalenes	4.37	4,725	410	81
C_3-Naphthalenes	4.90	2,100	130	17
C_4-Naphthalenes	5.55	NV[a]	42	4.1
Biphenyl	3.95	7,728	1,420	250
Acenaphthylene	4.07	16,688	1,181	180
Acenaphthene	3.92	16,908	1,360	270
Dibenzofuran	4.12	4,225	860	135
Fluorene	4.18	2,045	730	150
C_1-Fluorenes	4.97	1,090	96	19
C_2-Fluorenes	5.2	NV	56	11
C_3-Fluorenes	5.5	NV	16	5.3
Anthracene	4.54	79.6	300	60
Phenanthrene	4.46	1,100	367	55
C_1-Phenanthrenes	5.14	272	64	13
C_2-Phenanthrenes	5.51	NV	26	5.1
C_3-Phananthrenes	6.0	NV	7.4	1.5
C_4-Phenanthrenes	6.51	NV	2.0	0.40
Dibenzothiophene	4.49	1,136	350	70
C_1-Dibenzothiophenes	4.86	NV	140	28
C_2-Dibenzothiophenes	5.5	NV	27	5.4
C_3-Dibenzothiophenes	5.73	NV	16	3.1
Fluoranthene	5.22	261	55	11
Pyrene	5.18	134	61	12
C_1-Fluoranthenes/pyrenes	5.72	NV	15	3.1
Benz[*a*]anthracene	5.91	14.7	9.8	2.0
Chrysene	5.86	6.0	11	2.2
C_1-Chrysenes	6.42	62.2	2.7	0.53
C_2-Chrysenes	6.88	25.0	0.8	0.16
C_3-chrysenes	7.44	NV	0.2	0.04
C_4-Chrysenes	8.0	NV	0.06	0.01
Benzo[*b*]fluoranthene	5.8	4.1	14	2.9
Benzo[*k*]fluoranthene	6.0	0.8	8.6	1.7
Benzo[e]pyrene	6.04	4.0	7.6	1.5
Benzo[*a*]pyrene	6.04	1.4	7.6	1.5
Perylene	6.25	0.4	4.3	0.86
Indeno[1,2,3-*cd*]pyrene	7.0	6	0.64	0.13
Dibenz[*a*,*h*]anthracene	6.75	0.5	1.3	0.25
Benzo[*ghi*]perylene	6.5	0.3	2.4	0.49

[a] NV = No solubility value could be found.

(McGroddy and Farrington 1995); and San Francisco Bay (CA, USA) (Maruya et al. 1996)—often are more tightly bound to sediment particles (have higher log K_{oc}s) than predicted. The desorption rate of PAHs from sediments decreases with duration of sediment contamination (Kraaij et al. 2002). Polycyclic aromatic hydrocarbons also are tightly bound to coal (Ghosh et al. 2001). These tightly bound PAHs do not partition effectively into the aqueous phase of porewater.

The use of K_{ow} or K_{oc} tends to overestimate concentrations of dissolved PAHs in porewater of sediments contaminated primarily with pyrogenic PAHs but should give a reasonable upper-limit estimate of dissolved-phase PAHs in porewater of petroleum-, creosote-, or coal tar–contaminated sediments if the oil or other NAPL phase is still liquid and in physical contact with sediment porewater. The NAPL, particularly if it is crude oil or coal tar, may develop a surface "skin" of resins-asphalthenes or other high molecular weight polar compounds, decreasing NAPL/water partitioning (Ghoshal et al. 2004). A NAPL or oil-filled pores also may substantially decrease the permeability of the soil or sediment, decreasing the effective NAPL/water interface and limiting accessibility of the PAH to partitioning into sediment porewater. Empirically determined K_d (particle/water partition coefficients) are best for estimating sediment/water partitioning of pyrogenic PAHs or PAHs from weathered crude oil.

Values for the octanol/water partition coefficient (K_{ow}) have been published for a large number of PAHs (Mackay et al. 1992; Durell et al. 2004). The most accurate current values for log K_{ow} for several PAHs of environmental concern are summarized in Table 3. K_{oc} can be estimated from K_{ow} (Karickhoff et al. 1979), but K_d must be determined empirically on a site-specific basis. The concentration of a PAH in sediment porewater in equilibrium with its concentration in the bulk sediment can be estimated by the simple equation

$$C_w = C_s/K_x \quad (1)$$

where C_w is the concentration of the PAH in solution in sediment porewater, C_s is the concentration of the PAH in bulk sediment (measured as concentration per unit mass of sediment organic carbon or concentration per unit mass of total petroleum hydrocarbons [TPH]), and K_x is the sediment organic matter/water partition coefficient (K_{oc}) or sediment particle/water partition coefficient (K_p) for the PAH. The K_p for pyrogenic PAHs associated primarily with combustion soot requires a variation on Equation 1 to account for the high affinity of soot particles for PAHs (Bucheli and Gustafsson 2000; Cornelissen and Gustafsson 2004).

Concentrations of individual PAHs in bulk sediment, expressed as µg/g dry sediment, should be normalized to the concentration of total extractable (C_8+) petroleum hydrocarbons (TPH) in sediments, determined by gas chromatography/flame ionization detection (Sauer and Boehm 1995), if the source of the PAHs in sediments is primarily petroleum. If the PAHs in the sediment are primarily pyrogenic, then concentrations of PAHs should be normalized to sediment total organic carbon if the sediments contain high concentrations (several percent) of particulate organic matter or if a pyrogenic NAPL (e.g., creosote or coal tar) is present. TPH or total extractable organic matter often is the best parameter for normalizing PAH concentrations in urban or industrial sediments, even when the PAHs are primarily from pyrogenic sources because the total extractables analysis quantifies mainly the nonpolar organic fraction in bulk sediment that often is the most important in adsorbing PAHs. This calculation is repeated for all PAHs analyzed in sediment and is the basis for an estimate of the maximum concentration of total PAHs in solution in sediment porewater. Where the estimated concentration of a PAH exceeds its aqueous solubility, the aqueous solubility is used as the water concentration.

Toxicity of dissolved PAH mixtures to aquatic organisms

A search of the U.S. EPA Toxicity Information Retrieval (USEPA 1997) database identified more than 300 values for the acute toxicity (median lethal concentration, LC50) of aromatic hydrocarbons to freshwater and marine invertebrates and fish. The search excluded LC50 concentrations greater than the aqueous solubility of the particular hydrocarbon. Suitable aquatic toxicity data were found for 25 aromatic hydrocarbons, including 14 PAHs (Table 4). Log geometric mean acute toxicity values (in mM/L) for the aromatic hydrocarbons were regressed against log K_{ow}. The regression has a high correlation ($r^2 = 0.885$) and the form

$$\log \mathrm{LC50(mM/L)} = -1.162 \log K_{ow} + 2.496 \quad (2)$$

This equation was used to estimate the acute toxicity of each of the PAHs analyzed in sediment (Table 3). Equation 2 is similar to that developed by McCarty et al. (1992) to estimate the toxicity to freshwater fish of a large number of nonpolar organic compounds. Equation 2 considers toxicity data for freshwater and marine invertebrates and fish and applies only to aromatic hydrocarbons.

The chronic toxicity of each PAH was estimated by dividing the acute value by an acute/chronic ratio of 5. An acute/chronic ratio of 5 represents a conservative estimate of the acute/chronic ratio for aromatic hydrocarbons. For example, Suter and Rosen (1988) evaluated the comparative acute and chronic toxicity of several chemicals to marine fish and crustaceans. Acute/chronic ratios for aromatic hydrocarbons calculated from their data are between 2 and 4.

The estimated concentration of each PAH in solution in sediment porewater was divided by its chronic toxicity value to derive a HQ. Hazard quotients for all of the PAHs detected in sediment were summed to produce a HI for total PAHs:

$$\mathrm{HQ} = (\mathrm{PAH})_{sol}/\text{chronic value} \quad (3)$$

$$\mathrm{HI} = \Sigma \mathrm{HQ} \quad (4)$$

Equations 3 and 4 are based on the reasonable assumptions that the dissolved PAHs are much more bioavailable and toxic than adsorbed PAHs (Neff 2002) and the toxicities of individual PAHs in a mixture in solution are additive (Warne et al. 1989; Di Toro and McGrath 2000; Hansen et al. 2003; Landrum et al. 2003).

Toxicity of PAH assemblages in sediments

Log K_{ow} values for the PAHs most frequently analyzed in freshwater and marine sediments increase with molecular weight from 3.37 for naphthalene to 8.0 for C_4-chrysenes (Table 3). Log K_{oc} values estimated by the log K_{oc}/log K_{ow} regression of Karickhoff (1981) are slightly lower than the log K_{ow} values in Table 3, ranging from 2.94 for naphthalene to 6.68 for benzo[*ghi*]peylene. Values for log K_{oil}, based on the regression of Lee et al. (1992a) for diesel fuel PAHs, are slightly higher than the log K_{ow} values, ranging from 3.81

Table 4. Geometric mean toxicity (LC50 with 48-h or longer exposure) for PAH, based on available data from the AQUIRE database (USEPA 1997)

Chemical	Geomean LC50 (µg/L)	Chemical	Geomean LC50 (µg/L)
Naphthalene	2,140	Phenanthrene	166
1-Methylnaphthalene	4,220	Anthracene	36
2-Methylnaphthalene	1,130	9-Methylanthracene	125
1,3-Dimethylnaphthalene	1,700	Fluoranthene	69
Acenaphthene	1,640	Pyrene	91
Biphenyl	2,110	Benz[*a*]anthracene	10
Fluorene	818	Benzo[*a*]pyrene	5

for naphthalene to 6.72 for benzo[*ghi*]perylene. The actual value of log K_{oil} varies with the "average molecular weight" of the oil and, therefore, is different for different crude and refined petroleum products and changes with oil weathering (Lee et al. 1992a, 1992b; Shiu et al. 1990). The value of log K_{oil} for a particular PAH decreases as the average molecular weight and density of the bulk oil increases, in agreement with Raoult's Law (Lane and Loehr 1995). Thus, K_{ow} is a reasonable, conservative coefficient to use for estimating the dissolved concentrations of PAHs associated with sediments, most of which contain both weathered petrogenic and pyrogenic PAHs. The use of log K_{ow} may result in approximately 2-fold under- or overestimation of the true concentration of a PAH in solution in equilibrium with the NAPL phase (Shiu et al. 1988).

Polycyclic aromatic hydrocarbon solubility in freshwater decreases with increasing PAH molecular weight (Table 3). The solubility of some alkyl-PAHs is greater than that of the parent PAH, possibly reflecting steric effects of the alkyl carbons. Solubility tends to decrease with increasing seawater salinity and decreasing water temperature (Neff 2002). For example, the solubility of phenanthrene in fresh and salt water at 25°C is 1,080 and 644 µg/L, respectively (Eastcott et al. 1988). The solubility of anthracene in freshwater decreases from 56.5 µg/L at 29.1°C to 15.5 µg/L at 8.9°C (Reza et al. 2002). At all salinities and temperatures, anthracene is much less soluble than its isomer, phenanthrene. These physical properties of PAH affect their bioavailability and toxicity to freshwater and marine organisms.

The measured acute toxicity of aromatic hydrocarbons increases (LC50 decreases) with increasing PAH molecular weight and log K_{ow} (Table 4; Hansen et al. 2003) The estimated acute toxicity values follow the same trend (Table 3). Estimated chronic values for PAHs range from 970 µg/L (ppb) for naphthalene to 0.01 ppb for C_4-chrysenes (Table 3). For anthracene and PAHs with molecular weights of 228.3 (chrysene and benz[*a*]anthracene) or higher, the acutely lethal concentration approaches, or is higher than, the single phase aqueous solubility. Saturated solutions of these highly nonpolar PAHs are not acutely toxic to aquatic organisms.

We selected sediment PAH data from a recent study of the sources of PAHs in sediments of the Wycoff/Eagle Harbor Superfund site in the state of Washington, USA, to demonstrate the method described above for estimating the aquatic toxicity, measured as HI, of sediment-bound PAHs (Table 5). Two sediment samples from Eagle Harbor in Puget Sound were used, one heavily contaminated with creosote and the other contaminated with PAHs from urban runoff and deposition of pyrogenic PAHs from combustion sources. The PAH data for the two sediment samples used in this example are plotted in the PCA plot for the site data (Figure 2) and show that one sample has a clear creosote signature and the other has a clear urban runoff signature.

The creosote-contaminated sediment contained 27,441 µg/g (ppm) of TPH and 17,283 ppm of total PAH. The urban runoff sediment contained 212 ppm of TPH and 25 ppm of total PAH. Total PAH concentrations were much higher than the "high" value reported in the National Status and Trends database of 2.18 ppm of total PAH (24 parent PAH and alkyl homologue groups in sediments) (Daskalakis and O'Connor 1995), indicating that sediments from Eagle Harbor were highly contaminated with PAHs. Daskalakis and O'Connor (1995) identified Eagle Harbor as the location of some of the most heavily contaminated sediments in Puget Sound.

The sediment PAH concentrations were normalized to TPH concentration for calculation of HIs. TPH-normalized PAH concentrations were 629,808 µg PAH/g TPH and 115,655 µg/g in the creosote-contaminated and urban runoff–contaminated sediments, respectively. Estimated concentrations of total PAH in solution in sediment porewater in equilibrium with the two sediments were 17,190 µg/L (ppb) and 10,216 µg/L, respectively (Table 5). However, estimated concentrations of several PAHs in solution in water in equilibrium with the creosote-contaminated sediment were in excess of their single-phase aqueous solubilities (Table 3). Actual concentrations of these PAHs in solution in sediment pore water would not exceed their aqueous solubilities. Therefore, the aqueous solubilities of these PAHs were used as the exposure concentrations.

The estimated concentration of each PAH in solution was divided by its chronic toxicity value (Table 3) to obtain an HQ. The HQs for the PAHs in the creosote-contaminated sediment pore water ranged from 0.1 to 32.1 (C_4-phenanthrenes). The sum of HQs (the HI) for this sediment was 250.

The estimated concentration of only benzo[*a*]pyrene in solution exceeded its water solubility for the urban runoff sediment sample. The difference was small, so no adjustment was necessary. Estimated HQs for PAH in the urban runoff–contaminated sediment porewater ranged from 0.1 to 6.9 (naphthalene), and the estimated HI was 64.

An HI value greater than 1 indicates that the porewater contains in solution a concentration of total PAHs in excess of its estimated chronic toxicity to aquatic animals (Ozretich et al. 2000). Both sediments had HIs substantially greater than 1, suggesting that both sediments would be toxic to the benthic fauna of Eagle Harbor.

Table 5. Hazard quotients (HQ) and hazard indices (HI) for two sediment samples collected from Eagle Harbor, Washington, USA. The weathered creosote-contaminated sediment contained 17,283 μg/g dry wt (ppm) total polycyclic aromatic hydrocarbons (PAH) and 27,441 ppm total petroleum hydrocarbons (TPH). The sediment sample contaminated with urban runoff/fallout PAH contained 25 ppm total PAH and 212 ppm TPH. Concentrations in parentheses are freshwater solubilities. PAH data from Stout et al. (2001a)

	Creosote-contaminated sediment (27,441 μg TPH/g sediment)			Sediment contaminated with urban runoff PAH (212 μg TPH/g sediment)		
PAH	Sediment (μg/g TPH)	Water (μg/L)	HQ	Sediment (μg/g TPH)	Water (μg/L)	HQ
Naphthalene	2,931	1,250	1.3	15,762	6,720	6.9
C_1-Naphthalenes	4,712	636	2.2	6,629	890	3.2
C_2-Naphthalenes	13,135	560	6.9	3,527	150	1.9
C_3-Naphthalenes	11,212	112	6.6	1,506	15	0.9
C_4-Naphthalenes	4,684	13	3.2	423	1	0.3
Biphenyl	689	77	0.3	1,763	200	0.8
Acenaphthylene	495	42	0.2	459	39	0.2
Acenaphthene	41,226	4,960	18.3	6,615	800	2.9
Dibenzofuran	20,988	1,290	9.6	6,487	400	3.0
Fluorene	48,290	3,190	21.8	6,438	420	2.9
C_1-Fluorenes	11,249	120	6.3	1,254	13	6.8
C_2-Fluorenes	7,294	46	4.2	603	4	0.4
C_3-Fluorenes	3,637	12	2.2	650	2	0.4
Anthracene	11,280	325 (80)	(1.3)	1,480	43	0.7
Phenanthrene	3,888	100	1.9	327	9	0.2
C_1-Phenanthrenes	2,506	18	1.4	240	2	0.1
C_2-Phenanthrenes	630	2	0.4	161	0.5	0.1
C_3-Phenanthrenes	187	0.2	0.1	95	0.1	0.1
C_4-Phenanthrenes	41,597	13	32.1	4,556	1	2.5
Dibenzothiophene	86,458	2,800 (1,140)	(16.3)	10,442	340	4.8
C_1-Dibenzothiophenes	29,735	410	14.7	2,736	38	1.4
C_2-Dibenzothiophenes	16,779	53	9.8	1,351	4	0.8
C_3-Dibenzothiophenes	5,736	11	3.5	629	1	0.4
Fluoranthene	101,012	609 (260)	(23.6)	6,168	37	3.4
Pyrene	63,521	420 (130)	(10.8)	7,808	52	4.3
C_1-Fluoranthenes/pyrenes	25,471	49	15.7	3,725	7	2.3
Benz[*a*]anthracene	14,934	18 (15)	(7.5)	1,996	2	1.3
Chrysene	15,693	22 (6)	(2.7)	4,022	6	2.5
C_1-Chrysenes	6,826	3	4.9	1,725	0.7	1.2
C_2-Chrysenes	1,842	0.2	1.5	489	0.1	0.6
C_3-Chrysenes	295	0.01	0.3	197	0	0
Benzo[*b*]fluoranthene	4,474	7	2.4	2,972	5	1.6
Benzo[*k*]fluoranthene	5,233	5	3.1	2,596	3	1.8
Benzo[e]pyrene	3,002	3	1.8	1,974	2	1.2
Benzo[*a*]pyrene	4,210	4 (1)	(0.7)	1,867	2 (1)	(0.7)
Perylene	863	0.5	0.6	1,369	0.8	0.1
Indeno[1,2,3-*cd*]pyrene	857	0.1	0.7	928	0.1	0.7
Dibenzo[*a,h*]anthracene	590	0.1	0.4	253	0.04	0.2
Benzo[*ghi*]perylene	809	0.3	0.5	847	0.3	0.6
Total PAH	629,808	17,190		115,655	10,216	
HI			250			64

Sediment quality guidelines, based on toxicity to sediment-dwelling marine animals, have been developed for total PAH in marine sediments (Long et al. 1995). The effects range low (ERL) and effects range median (ERM) concentrations for total PAH are 4.022 µg/g dry wt and 44.792 µg/g, respectively. The ERL is the concentration in bulk sediment below which toxicity to benthic organisms is unlikely; the ERM is the concentration above which effects are likely. Concentrations between the ERL and ERM may be toxic and may require additional evaluation. At Eagle Harbor, the creosote-contaminated sediment contained more than 17,000 µg/g of total PAHs, more than 384 times higher than the ERM concentration. The high HI value and substantial exceedence of the ERM value for this sediment indicates that it is likely to be highly toxic to benthic fauna.

Approximately 34% of the HI for the creosote-contaminated sediment at Eagle Harbor was attributable to 4-ring+ (fluoranthene and higher) PAHs, most of which are pyrogenic (Table 5). Other predominantly pyrogenic PAHs also contributed to the HI, including acenaphthene, dibenzofuran, and anthracene. Dibenzothiophenes, which usually are considered primarily petrogenic, make a substantial contribution to the HI. Some of the creosote from the Wycoff wood treatment facility may have been distilled from a high-sulfur petroleum tar, which would contain high concentrations of dibenzothiophenes. These creosote-associated PAHs, particularly the higher molecular weight ones, have much higher log K_{oc}s than predicted (Mitra et al. 1999), indicating a low accessibility and bioavailability. Thus, it is likely that the sediments are much less toxic to benthic animals than predicted by the high HI value and exceedence of the ERM value.

The urban runoff sediment contained 25 ppm of total PAHs, about 55% of the ERM concentration and about 6 times the ERL concentration. The HI of the PAH assemblage in this sediment was 64, indicating a hazard (risk of toxicity) to benthic organisms if the PAH are accessible and bioavailable. This sediment would be toxic to benthic animals if the PAH associated with the sediment particles are accessible. As indicated in Table 5, this sediment sample was enriched in parent PAHs and several 4-ring+ PAHs characteristic of pyrogenic sources. There also is evidence of some petrogenic PAH contributions, particularly the dibenzothiophenes (DBT) that are much more abundant in petrogenic than pyrogenic PAH assemblages (Neff 2002). More than 40% of the HI for this sediment was attributable to 4-ring and higher PAHs (mostly pyrogenic) that tend to sorb to sediment particles much more strongly than predicted (Neff 2002). However, there may be enough alkyl naphthalenes, phenanthrenes, and dibenzothiophenes (mostly petrogenic) in the sediments to elicit effects in some sensitive benthic organisms.

The toxicity of two heavily contaminated Eagle Harbor sediments was evaluated with a sensitive sand dollar embryo test (Meador et al. 1990). The sediment samples contained 33.6 and 37.0 µg/g total PAH. There was 100% mortality of the echinoderm embryos during exposure to both sediments. Ozretich et al. (2000) evaluated the toxicity of 30 creosote-contaminated sediments from nearby Elliott Bay (WA, USA) with two amphipod species. Mean amphipod mortality was less than 10% (sediments were not toxic) in seven sediments containing 12 to 140 µg/g total PAH (34 parent and alkyl PAH groups). There was 100% mortality in eight sediments containing 500 to 25,000 µg/g PAH. Mean amphipod mortality ranged from 13 to 78% in the remaining sediments, containing 19 to 480 µg/g PAH. Thus, the creosote-contaminated sediment used in the present investigation, containing 17,000 µg/g total PAH, probably also would be toxic. The urban runoff sediment containing 25 µg/g PAH probably were either nontoxic or moderately toxic to benthic animals.

SUMMARY

The analysis of PAHs in sediments from Eagle Harbor shows how the source and composition of the PAH assemblage in sediment can affect its estimated hazard to aquatic animals. The HI approach to estimating the hazard of a complex mixture, like PAH, in sediments provides more information than the ERL/ERM or sediment toxicity approaches and can be used to aid in interpreting the significance of the hazard estimates and the causes of any risk identified. A combination of HI assessment and sediment toxicity probably would provide the largest amount of useful information upon which to base estimates of ecological risk of PAH-contaminated sediments.

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APPENDIX B

TRESPASSER IMMINENT HAZARD SHORT FORM

Trespasser - Soil: Table TSIH-1
Exposure Point Concentration (EPC)
Based on Trespasser Ages 11-16 (Cancer) and 11-12 (Non-Cancer)

ShortForm Version 10-12
Vlookup Version v0315

ELCR (all chemicals) = 1.5E-06
HI (all chemicals) = 1.7E-01

****Do not insert or delete any rows****
Click on empty cell below and select OHM using arrow.

Oil or Hazardous Material	EPC (mg/kg)	$ELCR_{ingestion}$	$ELCR_{dermal}$	$ELCR_{total}$	Subchronic HQ_{ing}	Subchronic HQ_{derm}	HQ_{total}
METHYLNAPHTHALENE, 2-	1.4E+00				3.7E-05	8.6E-05	1.2E-04
ACENAPHTHENE	4.1E+01				2.2E-05	5.0E-05	7.2E-05
ACENAPHTHYLENE	1.4E+00				5.0E-07	1.1E-06	1.6E-06
ANTHRACENE	1.1E+01				1.2E-06	2.7E-06	3.9E-06
BENZO(a)ANTHRACENE	1.4E+01	3.7E-08	1.9E-08	5.7E-08	5.0E-06	2.3E-06	7.3E-06
BENZO(a)PYRENE	2.3E+01	6.1E-07	3.2E-07	9.3E-07	8.2E-06	3.8E-06	1.2E-05
BENZO(b)FLUORANTHENE	7.9E+00	2.1E-08	1.1E-08	3.2E-08	2.8E-06	1.3E-06	4.1E-06
BENZO(g,h,i)PERYLENE	1.8E+01				6.4E-06	1.5E-05	2.1E-05
BENZO(k)FLUORANTHENE	5.3E+00	1.4E-09	7.4E-10	2.2E-09	1.9E-06	8.7E-07	2.7E-06
CHRYSENE	6.0E+00	1.6E-09	8.4E-10	2.4E-09	2.1E-06	9.8E-07	3.1E-06
DIBENZO(a,h)ANTHRACENE	1.2E+01	3.2E-07	1.7E-07	4.9E-07	4.3E-06	2.0E-06	6.2E-06
FLUORANTHENE	1.3E+01				1.4E-05	3.2E-05	4.6E-05
FLUORENE	2.0E+01				5.3E-06	1.2E-05	1.8E-05
INDENO(1,2,3-cd)PYRENE	3.7E+00	9.9E-09	5.1E-09	1.5E-08	1.3E-06	6.1E-07	1.9E-06
NAPHTHALENE	1.4E+01				7.4E-06	1.7E-05	2.5E-05
PHENANTHRENE	2.9E+01				1.0E-05	2.4E-05	3.4E-05
PYRENE	1.0E+01				3.5E-06	8.2E-06	1.2E-05
LEAD	6.8E+02				1.6E-01	1.3E-02	1.7E-01

Note! Lead IH HQ limit is 1, not 10.

MassDEP ORS
Contact: Lydia Thompson
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Trespasser - Soil: Table TSIH-2
Equations to Calculate Cancer Risk for a Trespasser (Age 11-16 years)

Vlookup Version v0315

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF$$

$$LADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{c\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP_{lifetime}}$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{c\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM specific	$(mg/kg\text{-}day)^{-1}$
LADD	OHM specific	mg/kg-day
$[OHM]_{soil}$	OHM specific	mg/kg
IR	50	mg/day
$RAF_{c\text{-}ing}$	OHM specific	dimensionless
$RAF_{c\text{-}derm}$	OHM specific	dimensionless
$EF_{ing,derm}$	0.164	event/day
ED	1	day/event
EP	5	years
C	0.000001	kg/mg
BW	48.2	kg
$AP_{(lifetime)}$	70	years
SA	2796	cm^2 / day
SAF	0.14	mg/cm^2

MassDEP ORS
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617-556-1165

Trespasser - Soil: Table TSIH-3

Equations to Calculate Subchronic Noncancer Risk for a Trespasser (Age 11-12 years)

Vlookup Version v0315

Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

Parameter	Value	Units
RfD	OHM specific	mg/kg-day
ADD	OHM specific	mg/kg-day
$[OHM]_{soil}$	OHM specific	mg/kg
IR	50	mg/day
$RAF_{nc\text{-}ing}$	OHM specific	dimensionless
$RAF_{nc\text{-}derm}$	OHM specific	dimensionless
$EF_{ing,derm}$	0.286	event/day
ED	1	day/event
EP	0.577	years
C	0.000001	kg/mg
BW	40.3	kg
AP	0.577	year
SA	2477	cm^2 / day
SAF	0.14	mg/cm^2

MassDEP ORS
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Trespasser - Soil: Table TSIH-4
Definitions and Exposure Factors

Vlookup Version v0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
CSF - Cancer Slope Factor	chemical specific	$(mg/kg\text{-}day)^{-1}$	see Table RS-7
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific
HQ - Hazard Quotient	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
RfD - Reference Dose	chemical specific	mg/kg-day	see Table RS-7
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific
EPC - Exposure Point Concentration	chemical specific	mg/kg	
IR - Soil Ingestion Rate	50	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate. (http://www.mass.gov/dep/ors/orspubs.htm)
RAF_c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	
$EF_{subchronic}$ - Exposure Frequency for subchronic ingestion or dermal exposure	0.286	event/day	2 days/week
EF_{cancer} - Exposure Frequency for cancer, ingestion or dermal exposure	0.164	event/day	2 days/week, 30 weeks/year
ED - Exposure Duration	1	day/event	
$EP_{(11\text{-}12)}$ - Exposure Period for age group 11-12	0.577	years	30 weeks
$EP_{(11\text{-}16)}$ - Exposure Period for age group 11-16	5	years	
$BW_{(11\text{-}12)}$ - Body Weight for age group 11-12	40.3	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7
$BW_{(11\text{-}16)}$ - Body Weight for age group 11-16	48.2	kg	Ibid
$AP_{subchronic}$ - Averaging Period for subchronic noncancer	0.577	years	30 weeks
AP_{cancer} - Averaging Period for lifetime	70	years	
$SA_{(11\text{-}12)}$ - Surface Area for age group 11-12	2477	cm^2 / day	50th percentile of forearms, hands, and feet for females. MADEP 1995 Guidance for Disposal Site Risk Characterization, Table B-2.
$SA_{(11\text{-}16)}$ - Surface Area for age group 11-16	2796.1	cm^2 / day	Ibid
SAF - Surface Adherence Factor, Trespasser	0.14	mg/cm^2	SAF developed for ShortForm according to procedure outlined in MA DEP Technical Update: Weighted Skin-Soil Adherence Factors, April 2002.

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Trespasser - Soil: Table TSIH-5
Chemical-Specific Data

Vlookup Version v0315

Oil or Hazardous Material	CSF $(mg/kg\text{-}day)^{-1}$	$RAF_{c\text{-}ing}$	$RAF_{c\text{-}derm}$	Subchronic RfD mg/kg-day	Subchronic $RAF_{nc\text{-}ing}$	Subchronic $RAF_{nc\text{-}derm}$
METHYLNAPHTHALENE, 2-				4.0E-03	0.3	0.1
ACENAPHTHENE				2.0E-01	0.3	0.1
ACENAPHTHYLENE				3.0E-01	0.3	0.1
ANTHRACENE				1.0E+00	0.3	0.1
BENZO(a)ANTHRACENE				3.0E-01	0.3	0.02
BENZO(a)PYRENE				3.0E-01	0.3	0.02
BENZO(b)FLUORANTHENE				3.0E-01	0.3	0.02
BENZO(g,h,i)PERYLENE				3.0E-01	0.3	0.1
BENZO(k)FLUORANTHENE				3.0E-01	0.3	0.02
CHRYSENE				3.0E-01	0.3	0.02
DIBENZO(a,h)ANTHRACENI				3.0E-01	0.3	0.02
FLUORANTHENE				1.0E-01	0.3	0.1
FLUORENE				4.0E-01	0.3	0.1
INDENO(1,2,3-cd)PYRENE				3.0E-01	0.3	0.02
NAPHTHALENE				2.0E-01	0.3	0.1
PHENANTHRENE				3.0E-01	0.3	0.1
PYRENE				3.0E-01	0.3	0.1
LEAD				7.5E-04	0.5	0.006

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Trespasser - Soil: Table TSIH-6
Cyanide Calculations

The soil cyanide concentration limit set to protect a trespasser against an acute, potentially lethal one-time dose of cyanide from incidental ingestion of contaminated soil is 8,000 mg/kg_{soil}. This is the concentration of available cyanide in soil below which acute human health effects would not be expected following a one-time exposure. This soil concentration is calculated using the equation below with a one-time soil ingestion estimate of 50 mg_{soil} and an available cyanide dose limit of 0.01 $mg/kg_{body\ weight}$.

MassDEP's guidance on evaluating the risk from a one-time cyanide dose considers cyanide's potentially lethal effects as well as information on cyanide metabolism:

> Cyanides are detoxified rapidly by the body, and a large acute dose which overwhelms the detoxification mechanism is potentially more toxic than the same dose distributed over a period of hours. (MassDEP *Background Documentation for the Development of an Available Cyanide Benchmark Concentration,* originally dated October 1992, Modified August 1998)

Assessment of a potential one-time dose requires an estimate of the maximum soil concentration the trespasser could contact at any one time. The average soil concentration within a typical exposure area will underestimate the potential one-time dose. Therefore, to assess the acute risk of a one-time potentially lethal dose, the EPC for cyanide should be a conservative estimate of the maximum soil concentration.

The trespasser soil concentration limit to protect against adverse effects from an acute (one-time) exposure to cyanide is 8000 mg/kg.

Concentration Calculation for Cyanide

$$\text{Concentration} = \frac{\text{HQ x Acute Dose Limit x BW}}{\text{IR x RAF x Conversion Factor}}$$

Parameter	Value	Units
HQ (Hazard Quotient)	1	(unitless)
Acute Dose Limit	0.01	mg avail. CN/ kg BW
BW (Body Weight) 11-12	40.3	kg
IR (1-time reasonable max)	50	mg
Conversion Factor	1.0E-06	kg soil / mg soil
RAF	1	(unitless)

The toxicological basis for estimating an allowable one-time is documented in MassDEP's 1992 *Background Documentation for the Development of an "Available Cyanide" Benchmark Concentration,* which is published at: http://www.mass.gov/eea/docs/dep/toxics/stypes/dscyanide.pdf

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Trespasser - Soil: Table TSIH-6
Cyanide Calculations

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Assessment of a potential one-time dose requires an estimate of the maximum soil concentration the trespasser could contact at any one time. The average soil concentration within a typical exposure area will underestimate the potential one-time dose. Therefore, to assess the acute risk of a one-time potentially lethal dose, the EPC for cyanide should be a conservative estimate of the maximum soil concentration.

The trespasser soil concentration limit to protect against adverse effects from an acute (one-time) exposure to cyanide is 8000 mg/kg.

APPENDIX C

LABORATORY REPORTS 2021 AND 2022

ANALYTICAL REPORT

Lab Number:	L2141856
Client:	Horseley & Witten, Inc. Sextant Hill Office Park 90 Route 6A Sandwich, MA 02563
ATTN:	Brian Massa
Phone:	(508) 833-6600
Project Name:	CAPE COD GATEWAY AIRPORT
Project Number:	Not Specified
Report Date:	08/19/21

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2141856-01	LP-1	SOIL	HYANNIS, MA	08/02/21 11:25	08/05/21
L2141856-02	LP-10	SOIL	HYANNIS, MA	08/02/21 11:35	08/05/21
L2141856-03	LP-9	SOIL	HYANNIS, MA	08/02/21 11:45	08/05/21
L2141856-04	LP-7	SOIL	HYANNIS, MA	08/02/21 11:55	08/05/21
L2141856-05	LP-COMP 1	SOIL	HYANNIS, MA	08/02/21 11:25	08/05/21
L2141856-06	LP-5	SOIL	HYANNIS, MA	08/02/21 12:10	08/05/21
L2141856-07	LP-4	SOIL	HYANNIS, MA	08/02/21 12:20	08/05/21
L2141856-08	LP-3	SOIL	HYANNIS, MA	08/02/21 12:32	08/05/21
L2141856-09	LP-6	SOIL	HYANNIS, MA	08/02/21 12:43	08/05/21
L2141856-10	LP-COMP 2	SOIL	HYANNIS, MA	08/02/21 12:10	08/05/21
L2141856-11	MD-1	SOIL	HYANNIS, MA	08/02/21 16:20	08/05/21
L2141856-12	MD-2	SOIL	HYANNIS, MA	08/02/21 16:42	08/05/21
L2141856-13	MD-3	SOIL	HYANNIS, MA	08/02/21 16:57	08/05/21
L2141856-14	MD-4	SOIL	HYANNIS, MA	08/02/21 17:10	08/05/21
L2141856-15	MD-COMP	SOIL	HYANNIS, MA	08/02/21 16:20	08/05/21

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

MADEP MCP Response Action Analytical Report Certification

This form provides certifications for all samples performed by MCP methods. Please refer to the Sample Results and Container Information sections of this report for specification of MCP methods used for each analysis. The following questions pertain only to MCP Analytical Methods.

An affirmative response to questions A through F is required for "Presumptive Certainty" status		
A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	YES
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	YES
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	YES
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data?"	YES
E a.	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	N/A
E b.	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	N/A
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	YES

A response to questions G, H and I is required for "Presumptive Certainty" status		
G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	NO
H	Were all QC performance standards specified in the CAM protocol(s) achieved?	NO
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	NO

For any questions answered "No", please refer to the case narrative section on the following page(s).

Please note that sample matrix information is located in the Sample Results section of this report.

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2141856
Project Number:	Not Specified	**Report Date:**	08/19/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856
Project Number: Not Specified **Report Date:** 08/19/21

Case Narrative (continued)

Report Submission

August 19, 2021: This final report includes the results of all requested analyses.

August 12, 2021: This is a preliminary report.

MCP Related Narratives

Sample Receipt

The analyses performed were specified by the client.

In reference to question H:

A Matrix Spike was not submitted for the analysis of Total Metals.

PAHs by SIM

L2141856-01, -02, -03, -04, -06, -07, -08, -09, -10, and -15: The sample has elevated detection limits due to the limited sample volume utilized during extraction, as required by the sample matrix.

In reference to question G:

L2141856-01, -02, -03, -04, -06, -07, -08, -09, -10, and -15: One or more of the target analytes did not achieve the requested CAM reporting limits.

In reference to question I:

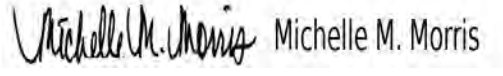
All samples were analyzed for a subset of MCP analytes per client request.

Total Metals

In reference to question I:

All samples were analyzed for a subset of MCP analytes per client request.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:  Michelle M. Morris

Title: Technical Director/Representative Date: 08/19/21

QC OUTLIER SUMMARY REPORT

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
MCP Semivolatile Organics by SIM - Westborough Lab								
8270D-SIM	Batch QC	WG1533821-2	Nitrobenzene-d5	Surrogate	135	30-130	-	potential high bias

ORGANICS

SEMIVOLATILES

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-01
Client ID: LP-1
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 20:24
Analyst: DV
Percent Solids: 63%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	30		ug/kg	30	--	1
Fluoranthene	3100	E	ug/kg	30	--	1
Naphthalene	ND		ug/kg	30	--	1
Benzo(a)anthracene	920		ug/kg	30	--	1
Benzo(a)pyrene	1300		ug/kg	30	--	1
Benzo(b)fluoranthene	2200		ug/kg	30	--	1
Benzo(k)fluoranthene	660		ug/kg	30	--	1
Chrysene	1400		ug/kg	30	--	1
Acenaphthylene	74		ug/kg	30	--	1
Anthracene	1300		ug/kg	30	--	1
Benzo(ghi)perylene	1200		ug/kg	30	--	1
Fluorene	46		ug/kg	30	--	1
Phenanthrene	1200		ug/kg	30	--	1
Dibenzo(a,h)anthracene	230		ug/kg	30	--	1
Indeno(1,2,3-cd)pyrene	1400		ug/kg	30	--	1
Pyrene	2400		ug/kg	30	--	1
2-Methylnaphthalene	ND		ug/kg	30	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	111		30-130
2-Fluorobiphenyl	85		30-130
4-Terphenyl-d14	85		30-130

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-01 D
Client ID: LP-1
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/18/21 16:25
Analyst: DV
Percent Solids: 63%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Fluoranthene	2800		ug/kg	60	--	2

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-02
Client ID: LP-10
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:35
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 20:41
Analyst: DV
Percent Solids: 22%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	86	--	1
Fluoranthene	1200		ug/kg	86	--	1
Naphthalene	ND		ug/kg	86	--	1
Benzo(a)anthracene	300		ug/kg	86	--	1
Benzo(a)pyrene	510		ug/kg	86	--	1
Benzo(b)fluoranthene	990		ug/kg	86	--	1
Benzo(k)fluoranthene	260		ug/kg	86	--	1
Chrysene	610		ug/kg	86	--	1
Acenaphthylene	ND		ug/kg	86	--	1
Anthracene	ND		ug/kg	86	--	1
Benzo(ghi)perylene	470		ug/kg	86	--	1
Fluorene	90		ug/kg	86	--	1
Phenanthrene	550		ug/kg	86	--	1
Dibenzo(a,h)anthracene	96		ug/kg	86	--	1
Indeno(1,2,3-cd)pyrene	580		ug/kg	86	--	1
Pyrene	930		ug/kg	86	--	1
2-Methylnaphthalene	ND		ug/kg	86	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	104		30-130
2-Fluorobiphenyl	68		30-130
4-Terphenyl-d14	65		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-03
Client ID: LP-9
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:45
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 20:57
Analyst: DV
Percent Solids: 6%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	300	--	1
Fluoranthene	2100		ug/kg	300	--	1
Naphthalene	ND		ug/kg	300	--	1
Benzo(a)anthracene	410		ug/kg	300	--	1
Benzo(a)pyrene	750		ug/kg	300	--	1
Benzo(b)fluoranthene	1600		ug/kg	300	--	1
Benzo(k)fluoranthene	400		ug/kg	300	--	1
Chrysene	980		ug/kg	300	--	1
Acenaphthylene	ND		ug/kg	300	--	1
Anthracene	ND		ug/kg	300	--	1
Benzo(ghi)perylene	800		ug/kg	300	--	1
Fluorene	300		ug/kg	300	--	1
Phenanthrene	980		ug/kg	300	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	300	--	1
Indeno(1,2,3-cd)pyrene	940		ug/kg	300	--	1
Pyrene	1600		ug/kg	300	--	1
2-Methylnaphthalene	ND		ug/kg	300	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	55		30-130
2-Fluorobiphenyl	31		30-130
4-Terphenyl-d14	36		30-130

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-04
Client ID: LP-7
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:55
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 21:13
Analyst: DV
Percent Solids: 16%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	120	--	1
Fluoranthene	860		ug/kg	120	--	1
Naphthalene	ND		ug/kg	120	--	1
Benzo(a)anthracene	320		ug/kg	120	--	1
Benzo(a)pyrene	430		ug/kg	120	--	1
Benzo(b)fluoranthene	750		ug/kg	120	--	1
Benzo(k)fluoranthene	220		ug/kg	120	--	1
Chrysene	490		ug/kg	120	--	1
Acenaphthylene	ND		ug/kg	120	--	1
Anthracene	ND		ug/kg	120	--	1
Benzo(ghi)perylene	350		ug/kg	120	--	1
Fluorene	ND		ug/kg	120	--	1
Phenanthrene	380		ug/kg	120	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	120	--	1
Indeno(1,2,3-cd)pyrene	430		ug/kg	120	--	1
Pyrene	700		ug/kg	120	--	1
2-Methylnaphthalene	ND		ug/kg	120	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	104		30-130
2-Fluorobiphenyl	65		30-130
4-Terphenyl-d14	55		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-05
Client ID: LP-COMP 1
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/12/21 15:05
Analyst: DV
Percent Solids: 31%

Extraction Method: EPA 3546
Extraction Date: 08/11/21 09:36

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	21	--	1
Fluoranthene	1200		ug/kg	21	--	1
Naphthalene	ND		ug/kg	21	--	1
Benzo(a)anthracene	440		ug/kg	21	--	1
Benzo(a)pyrene	600		ug/kg	21	--	1
Benzo(b)fluoranthene	1000		ug/kg	21	--	1
Benzo(k)fluoranthene	350		ug/kg	21	--	1
Chrysene	660		ug/kg	21	--	1
Acenaphthylene	57		ug/kg	21	--	1
Anthracene	65		ug/kg	21	--	1
Benzo(ghi)perylene	490		ug/kg	21	--	1
Fluorene	32		ug/kg	21	--	1
Phenanthrene	500		ug/kg	21	--	1
Dibenzo(a,h)anthracene	100		ug/kg	21	--	1
Indeno(1,2,3-cd)pyrene	550		ug/kg	21	--	1
Pyrene	910		ug/kg	21	--	1
2-Methylnaphthalene	ND		ug/kg	21	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	106		30-130
2-Fluorobiphenyl	61		30-130
4-Terphenyl-d14	52		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-06
Client ID: LP-5
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 21:30
Analyst: DV
Percent Solids: 11%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	180	--	1
Fluoranthene	600		ug/kg	180	--	1
Naphthalene	400		ug/kg	180	--	1
Benzo(a)anthracene	230		ug/kg	180	--	1
Benzo(a)pyrene	280		ug/kg	180	--	1
Benzo(b)fluoranthene	490		ug/kg	180	--	1
Benzo(k)fluoranthene	ND		ug/kg	180	--	1
Chrysene	340		ug/kg	180	--	1
Acenaphthylene	ND		ug/kg	180	--	1
Anthracene	ND		ug/kg	180	--	1
Benzo(ghi)perylene	240		ug/kg	180	--	1
Fluorene	ND		ug/kg	180	--	1
Phenanthrene	300		ug/kg	180	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	180	--	1
Indeno(1,2,3-cd)pyrene	290		ug/kg	180	--	1
Pyrene	500		ug/kg	180	--	1
2-Methylnaphthalene	ND		ug/kg	180	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	100		30-130
2-Fluorobiphenyl	60		30-130
4-Terphenyl-d14	45		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-07
Client ID: LP-4
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 21:46
Analyst: DV
Percent Solids: 9%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	230	--	1
Fluoranthene	580		ug/kg	230	--	1
Naphthalene	ND		ug/kg	230	--	1
Benzo(a)anthracene	ND		ug/kg	230	--	1
Benzo(a)pyrene	ND		ug/kg	230	--	1
Benzo(b)fluoranthene	360		ug/kg	230	--	1
Benzo(k)fluoranthene	ND		ug/kg	230	--	1
Chrysene	250		ug/kg	230	--	1
Acenaphthylene	ND		ug/kg	230	--	1
Anthracene	ND		ug/kg	230	--	1
Benzo(ghi)perylene	ND		ug/kg	230	--	1
Fluorene	ND		ug/kg	230	--	1
Phenanthrene	350		ug/kg	230	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	230	--	1
Indeno(1,2,3-cd)pyrene	ND		ug/kg	230	--	1
Pyrene	460		ug/kg	230	--	1
2-Methylnaphthalene	ND		ug/kg	230	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	109		30-130
2-Fluorobiphenyl	63		30-130
4-Terphenyl-d14	39		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-08
Client ID: LP-3
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:32
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 22:02
Analyst: DV
Percent Solids: 12%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	150	--	1
Fluoranthene	630		ug/kg	150	--	1
Naphthalene	ND		ug/kg	150	--	1
Benzo(a)anthracene	230		ug/kg	150	--	1
Benzo(a)pyrene	300		ug/kg	150	--	1
Benzo(b)fluoranthene	600		ug/kg	150	--	1
Benzo(k)fluoranthene	150		ug/kg	150	--	1
Chrysene	350		ug/kg	150	--	1
Acenaphthylene	ND		ug/kg	150	--	1
Anthracene	ND		ug/kg	150	--	1
Benzo(ghi)perylene	270		ug/kg	150	--	1
Fluorene	ND		ug/kg	150	--	1
Phenanthrene	280		ug/kg	150	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	150	--	1
Indeno(1,2,3-cd)pyrene	330		ug/kg	150	--	1
Pyrene	500		ug/kg	150	--	1
2-Methylnaphthalene	ND		ug/kg	150	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	73		30-130
2-Fluorobiphenyl	45		30-130
4-Terphenyl-d14	56		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-09
Client ID: LP-6
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:43
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 22:18
Analyst: DV
Percent Solids: 6%

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	320	--	1
Fluoranthene	790		ug/kg	320	--	1
Naphthalene	ND		ug/kg	320	--	1
Benzo(a)anthracene	ND		ug/kg	320	--	1
Benzo(a)pyrene	ND		ug/kg	320	--	1
Benzo(b)fluoranthene	520		ug/kg	320	--	1
Benzo(k)fluoranthene	ND		ug/kg	320	--	1
Chrysene	350		ug/kg	320	--	1
Acenaphthylene	ND		ug/kg	320	--	1
Anthracene	ND		ug/kg	320	--	1
Benzo(ghi)perylene	ND		ug/kg	320	--	1
Fluorene	ND		ug/kg	320	--	1
Phenanthrene	410		ug/kg	320	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	320	--	1
Indeno(1,2,3-cd)pyrene	330		ug/kg	320	--	1
Pyrene	600		ug/kg	320	--	1
2-Methylnaphthalene	ND		ug/kg	320	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	124		30-130
2-Fluorobiphenyl	85		30-130
4-Terphenyl-d14	71		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-10
Client ID: LP-COMP 2
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/09/21 14:10
Analyst: DV
Percent Solids: 10%

Extraction Method: EPA 3546
Extraction Date: 08/07/21 22:10

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	200	--	1
Fluoranthene	550		ug/kg	200	--	1
Naphthalene	ND		ug/kg	200	--	1
Benzo(a)anthracene	320		ug/kg	200	--	1
Benzo(a)pyrene	320		ug/kg	200	--	1
Benzo(b)fluoranthene	500		ug/kg	200	--	1
Benzo(k)fluoranthene	ND		ug/kg	200	--	1
Chrysene	360		ug/kg	200	--	1
Acenaphthylene	ND		ug/kg	200	--	1
Anthracene	ND		ug/kg	200	--	1
Benzo(ghi)perylene	220		ug/kg	200	--	1
Fluorene	ND		ug/kg	200	--	1
Phenanthrene	240		ug/kg	200	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	200	--	1
Indeno(1,2,3-cd)pyrene	240		ug/kg	200	--	1
Pyrene	470		ug/kg	200	--	1
2-Methylnaphthalene	ND		ug/kg	200	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	81		30-130
2-Fluorobiphenyl	61		30-130
4-Terphenyl-d14	53		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-15
Client ID: MD-COMP
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 16:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/12/21 15:21
Analyst: DV
Percent Solids: 51%

Extraction Method: EPA 3546
Extraction Date: 08/07/21 22:12

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	ND		ug/kg	38	--	1
Fluoranthene	ND		ug/kg	38	--	1
Naphthalene	ND		ug/kg	38	--	1
Benzo(a)anthracene	ND		ug/kg	38	--	1
Benzo(a)pyrene	ND		ug/kg	38	--	1
Benzo(b)fluoranthene	ND		ug/kg	38	--	1
Benzo(k)fluoranthene	ND		ug/kg	38	--	1
Chrysene	ND		ug/kg	38	--	1
Acenaphthylene	ND		ug/kg	38	--	1
Anthracene	ND		ug/kg	38	--	1
Benzo(ghi)perylene	ND		ug/kg	38	--	1
Fluorene	ND		ug/kg	38	--	1
Phenanthrene	ND		ug/kg	38	--	1
Dibenzo(a,h)anthracene	ND		ug/kg	38	--	1
Indeno(1,2,3-cd)pyrene	ND		ug/kg	38	--	1
Pyrene	ND		ug/kg	38	--	1
2-Methylnaphthalene	ND		ug/kg	38	--	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	104		30-130
2-Fluorobiphenyl	85		30-130
4-Terphenyl-d14	69		30-130

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified
Lab Number: L2141856
Report Date: 08/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 08/09/21 10:25
Analyst: DV

Extraction Method: EPA 3546
Extraction Date: 08/07/21 22:10

Parameter	Result	Qualifier	Units	RL	MDL
MCP Semivolatile Organics by SIM - Westborough Lab for sample(s): 10,15 Batch: WG1532685-1					
Acenaphthene	ND		ug/kg	6.5	--
Fluoranthene	ND		ug/kg	6.5	--
Naphthalene	ND		ug/kg	6.5	--
Benzo(a)anthracene	ND		ug/kg	6.5	--
Benzo(a)pyrene	ND		ug/kg	6.5	--
Benzo(b)fluoranthene	ND		ug/kg	6.5	--
Benzo(k)fluoranthene	ND		ug/kg	6.5	--
Chrysene	ND		ug/kg	6.5	--
Acenaphthylene	ND		ug/kg	6.5	--
Anthracene	ND		ug/kg	6.5	--
Benzo(ghi)perylene	ND		ug/kg	6.5	--
Fluorene	ND		ug/kg	6.5	--
Phenanthrene	ND		ug/kg	6.5	--
Dibenzo(a,h)anthracene	ND		ug/kg	6.5	--
Indeno(1,2,3-cd)pyrene	ND		ug/kg	6.5	--
Pyrene	ND		ug/kg	6.5	--
2-Methylnaphthalene	ND		ug/kg	6.5	--

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	47		30-130
2-Fluorobiphenyl	45		30-130
4-Terphenyl-d14	51		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 08/12/21 14:48
Analyst: DV

Extraction Method: EPA 3546
Extraction Date: 08/11/21 09:36

Parameter	Result	Qualifier	Units	RL	MDL
MCP Semivolatile Organics by SIM - Westborough Lab for sample(s): 05 Batch: WG1533821-1					
Acenaphthene	ND		ug/kg	6.6	--
Fluoranthene	ND		ug/kg	6.6	--
Naphthalene	ND		ug/kg	6.6	--
Benzo(a)anthracene	ND		ug/kg	6.6	--
Benzo(a)pyrene	ND		ug/kg	6.6	--
Benzo(b)fluoranthene	ND		ug/kg	6.6	--
Benzo(k)fluoranthene	ND		ug/kg	6.6	--
Chrysene	ND		ug/kg	6.6	--
Acenaphthylene	ND		ug/kg	6.6	--
Anthracene	ND		ug/kg	6.6	--
Benzo(ghi)perylene	ND		ug/kg	6.6	--
Fluorene	ND		ug/kg	6.6	--
Phenanthrene	ND		ug/kg	6.6	--
Dibenzo(a,h)anthracene	ND		ug/kg	6.6	--
Indeno(1,2,3-cd)pyrene	ND		ug/kg	6.6	--
Pyrene	ND		ug/kg	6.6	--
2-Methylnaphthalene	ND		ug/kg	6.6	--

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	110		30-130
2-Fluorobiphenyl	89		30-130
4-Terphenyl-d14	98		30-130

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified
Lab Number: L2141856
Report Date: 08/19/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 08/15/21 20:08
Analyst: DV

Extraction Method: EPA 3546
Extraction Date: 08/14/21 16:23

Parameter	Result	Qualifier	Units	RL	MDL
MCP Semivolatile Organics by SIM - Westborough Lab for sample(s): 01-04,06-09 Batch: WG1535169-1					
Acenaphthene	ND		ug/kg	19	--
Fluoranthene	ND		ug/kg	19	--
Naphthalene	ND		ug/kg	19	--
Benzo(a)anthracene	ND		ug/kg	19	--
Benzo(a)pyrene	ND		ug/kg	19	--
Benzo(b)fluoranthene	ND		ug/kg	19	--
Benzo(k)fluoranthene	ND		ug/kg	19	--
Chrysene	ND		ug/kg	19	--
Acenaphthylene	ND		ug/kg	19	--
Anthracene	ND		ug/kg	19	--
Benzo(ghi)perylene	ND		ug/kg	19	--
Fluorene	ND		ug/kg	19	--
Phenanthrene	ND		ug/kg	19	--
Dibenzo(a,h)anthracene	ND		ug/kg	19	--
Indeno(1,2,3-cd)pyrene	ND		ug/kg	19	--
Pyrene	ND		ug/kg	19	--
2-Methylnaphthalene	ND		ug/kg	19	--

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	96		30-130
2-Fluorobiphenyl	86		30-130
4-Terphenyl-d14	108		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 10,15 Batch: WG1532685-2 WG1532685-3								
Acenaphthene	67		67		40-140	0		30
Fluoranthene	72		73		40-140	1		30
Naphthalene	66		67		40-140	2		30
Benzo(a)anthracene	68		70		40-140	3		30
Benzo(a)pyrene	76		77		40-140	1		30
Benzo(b)fluoranthene	77		77		40-140	0		30
Benzo(k)fluoranthene	73		75		40-140	3		30
Chrysene	69		71		40-140	3		30
Acenaphthylene	70		71		40-140	1		30
Anthracene	69		70		40-140	1		30
Benzo(ghi)perylene	73		73		40-140	0		30
Fluorene	71		73		40-140	3		30
Phenanthrene	68		69		40-140	1		30
Dibenzo(a,h)anthracene	72		73		40-140	1		30
Indeno(1,2,3-cd)pyrene	76		77		40-140	1		30
Pyrene	71		71		40-140	0		30
2-Methylnaphthalene	65		65		40-140	0		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 10,15 Batch: WG1532685-2 WG1532685-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Nitrobenzene-d5	64		65		30-130
2-Fluorobiphenyl	62		63		30-130
4-Terphenyl-d14	71		71		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 05 Batch: WG1533821-2 WG1533821-3								
Acenaphthene	107		94		40-140	13		30
Fluoranthene	105		100		40-140	5		30
Naphthalene	116		88		40-140	27		30
Benzo(a)anthracene	107		105		40-140	2		30
Benzo(a)pyrene	116		112		40-140	4		30
Benzo(b)fluoranthene	117		112		40-140	4		30
Benzo(k)fluoranthene	112		109		40-140	3		30
Chrysene	103		99		40-140	4		30
Acenaphthylene	126		94		40-140	29		30
Anthracene	105		101		40-140	4		30
Benzo(ghi)perylene	112		108		40-140	4		30
Fluorene	111		96		40-140	14		30
Phenanthrene	103		98		40-140	5		30
Dibenzo(a,h)anthracene	113		111		40-140	2		30
Indeno(1,2,3-cd)pyrene	122		115		40-140	6		30
Pyrene	103		99		40-140	4		30
2-Methylnaphthalene	117		88		40-140	28		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT

Project Number: Not Specified

Lab Number: L2141856

Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 05 Batch: WG1533821-2 WG1533821-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Nitrobenzene-d5	**135**	Q	103		30-130
2-Fluorobiphenyl	112		85		30-130
4-Terphenyl-d14	97		93		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-04,06-09 Batch: WG1535169-2 WG1535169-3								
Acenaphthene	90		100		40-140	11		30
Fluoranthene	96		109		40-140	13		30
Naphthalene	91		100		40-140	9		30
Benzo(a)anthracene	93		102		40-140	9		30
Benzo(a)pyrene	98		110		40-140	12		30
Benzo(b)fluoranthene	92		101		40-140	9		30
Benzo(k)fluoranthene	93		109		40-140	16		30
Chrysene	86		97		40-140	12		30
Acenaphthylene	99		109		40-140	10		30
Anthracene	95		107		40-140	12		30
Benzo(ghi)perylene	93		104		40-140	11		30
Fluorene	92		102		40-140	10		30
Phenanthrene	90		101		40-140	12		30
Dibenzo(a,h)anthracene	104		117		40-140	12		30
Indeno(1,2,3-cd)pyrene	102		114		40-140	11		30
Pyrene	96		109		40-140	13		30
2-Methylnaphthalene	94		103		40-140	9		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT

Project Number: Not Specified

Lab Number: L2141856

Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-04,06-09 Batch: WG1535169-2 WG1535169-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Nitrobenzene-d5	103		111		30-130
2-Fluorobiphenyl	89		98		30-130
4-Terphenyl-d14	108		123		30-130

METALS

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-01
Client ID: LP-1
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 63%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	14.8		mg/kg	3.16	--	1	08/13/21 23:15	08/16/21 18:05	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-02 Date Collected: 08/02/21 11:35

Client ID: LP-10 Date Received: 08/05/21

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 22%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	240		mg/kg	8.82	--	1	08/13/21 23:15	08/16/21 18:10	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-03
Client ID: LP-9
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 11:45
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 6%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	108		mg/kg	30.4	--	1	08/13/21 23:15	08/16/21 18:14	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-04
Client ID: LP-7
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 11:55
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 16%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	371		mg/kg	12.6	--	1	08/13/21 23:15	08/16/21 18:19	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-05
Client ID: LP-COMP 1
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 31%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	107		mg/kg	6.39	--	1	08/19/21 12:19	08/19/21 14:00	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-06
Client ID: LP-5
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 11%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	241		mg/kg	18.5	--	1	08/13/21 23:15	08/16/21 18:41	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-07
Client ID: LP-4
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 12:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 9%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	184		mg/kg	22.5	--	1	08/13/21 23:15	08/16/21 18:46	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-08
Client ID: LP-3
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 12:32
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 12%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	198		mg/kg	16.2	--	1	08/13/21 23:15	08/16/21 17:47	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-09
Client ID: LP-6
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 12:43
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 6%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	119		mg/kg	33.4	--	1	08/13/21 23:15	08/16/21 17:56	EPA 3050B	97,6010D	SV

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-10
Client ID: LP-COMP 2
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 10%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	196		mg/kg	20.0	--	1	08/09/21 14:26	08/09/21 20:24	EPA 3050B	97,6010D	GD

Project Name: CAPE COD GATEWAY AIRPORT
Lab Number: L2141856
Project Number: Not Specified
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-15
Client ID: MD-COMP
Sample Location: HYANNIS, MA
Date Collected: 08/02/21 16:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Percent Solids: 51%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	66.0		mg/kg	3.70	--	1	08/09/21 14:26	08/09/21 21:19	EPA 3050B	97,6010D	GD

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2141856

Project Number: Not Specified **Report Date:** 08/19/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 10,15 Batch: WG1532917-1										
Lead, Total	ND		mg/kg	2.00	--	1	08/09/21 14:26	08/09/21 21:06	97,6010D	GD

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01-04,06-09 Batch: WG1534984-1										
Lead, Total	ND		mg/kg	2.00	--	1	08/13/21 23:15	08/16/21 16:44	97,6010D	SV

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 05 Batch: WG1536945-1										
Lead, Total	ND		mg/kg	2.00	--	1	08/19/21 12:19	08/19/21 13:48	97,6010D	SV

Prep Information

Digestion Method: EPA 3050B

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT

Project Number: Not Specified

Lab Number: L2141856

Report Date: 08/19/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 10,15 Batch: WG1532917-2 WG1532917-3 SRM Lot Number: D109-540								
Lead, Total	85		88		72-128	3		30
MCP Total Metals - Mansfield Lab Associated sample(s): 01-04,06-09 Batch: WG1534984-2 WG1534984-3 SRM Lot Number: D109-540								
Lead, Total	92		95		72-128	3		30
MCP Total Metals - Mansfield Lab Associated sample(s): 05 Batch: WG1536945-2 WG1536945-3 SRM Lot Number: D109-540								
Lead, Total	105		92		72-128	13		30

INORGANICS
&
MISCELLANEOUS

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-01
Client ID: LP-1
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	62.7		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-02
Client ID: LP-10
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:35
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	22.2		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-03
Client ID: LP-9
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:45
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	6.38		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-04
Client ID: LP-7
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:55
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	15.6		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-05
Client ID: LP-COMP 1
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 11:25
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	30.8		%	0.100	NA	1	-	08/10/21 11:12	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-06
Client ID: LP-5
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	10.7		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-07
Client ID: LP-4
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	8.58		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-08
Client ID: LP-3
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:32
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	12.3		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-09
Client ID: LP-6
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:43
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	5.98		%	0.100	NA	1	-	08/14/21 12:08	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-10
Client ID: LP-COMP 2
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 12:10
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	9.62		%	0.100	NA	1	-	08/07/21 09:58	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

SAMPLE RESULTS

Lab ID: L2141856-15
Client ID: MD-COMP
Sample Location: HYANNIS, MA

Date Collected: 08/02/21 16:20
Date Received: 08/05/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	51.4		%	0.100	NA	1	-	08/07/21 09:58	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2141856-01A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-01B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-01C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-01D	Glass 120ml unpreserved split	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-02A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-02B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-02C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-03A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-03B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-03C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-04A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-04B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-04C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-05A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-05B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-05C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-06A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-06B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-06C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-07A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-07B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-07C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-08A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)

*Values in parentheses indicate holding time in days

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: Not Specified

Lab Number: L2141856
Report Date: 08/19/21

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2141856-08B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-08C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-09A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-09B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-09C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-10A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-10B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-10C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)
L2141856-11A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		HOLD-WETCHEM()
L2141856-11B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		HOLD-METAL(180),HOLD-8270(14)
L2141856-11C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		-
L2141856-12A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		HOLD-WETCHEM()
L2141856-12B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		HOLD-8270(14),HOLD-METAL(180)
L2141856-12C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		-
L2141856-13A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		HOLD-WETCHEM()
L2141856-13B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		HOLD-8270(14),HOLD-METAL(180)
L2141856-13C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		-
L2141856-14A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		HOLD-WETCHEM()
L2141856-14B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		HOLD-8270(14),HOLD-METAL(180)
L2141856-14C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		-
L2141856-15A	Plastic 2oz unpreserved for TS	A	NA		4.2	Y	Absent		TS(7)
L2141856-15B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		4.2	Y	Absent		MCP-PB-6010T-10(180)
L2141856-15C	Glass 120ml/4oz unpreserved	A	NA		4.2	Y	Absent		MCP-PAHSIM-10(14)

*Values in parentheses indicate holding time in days

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2141856
Project Number:	Not Specified	**Report Date:**	08/19/21

GLOSSARY

Acronyms

DL - Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EMPC - Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LOD - Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

LOQ - Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

NR - No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TEF - Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.

TEQ - Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: Data Usability Report

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2141856
Project Number:	Not Specified	**Report Date:**	08/19/21

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the reporting limit (RL) for the sample.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where

Report Format: Data Usability Report

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2141856
Project Number:	Not Specified	**Report Date:**	08/19/21

Data Qualifiers

the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

Report Format: Data Usability Report

REFERENCES

97 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA, IIB, IIIA, IIIB, IIIC, IIID, VA, VB, VC, VIA, VIB, VIIIA and VIIIB, July 2010.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625/625.1: alpha-Terpineol
EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D/8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 2

Date Rec'd in Lab: 8/5/21

ALPHA Job #: L2141856

ALPHA ANALYTICAL
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Project Information

Project Name: CAPE COD GATEWAY AIRPORT
Project Location: HYANNIS, MA
Project #: 21083
Project Manager: BRYAN MASSA
ALPHA Quote #:

Report Information - Data Deliverables

☐ ADEx ☒ EMAIL

Billing Information

☐ Same as Client info PO #:

Client Information

Client: HORSLEY WITTEN GROUP
Address: 90 ROUTE 6A
SANDWICH, MA 02563
Phone: 508-833-6600
Email: jibanez@horsleywitten.com

Regulatory Requirements & Project Information Requirements

☒ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

Additional Project Information:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

ANALYSIS

VOC: ☐ 8260 ☐ 624 ☐ 524.2
SVOC: ☐ ABN ☐ PAH
METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15
METALS: ☐ RCRA5 ☐ RCRA8 ☐ PP13
EPH: ☐ Ranges & Targets ☐ Ranges Only
VPH: ☐ Ranges & Targets ☐ Ranges Only
☐ PCB ☐ PEST
TPH: ☐ Quant Only ☐ Fingerprint
Lead
PAH SIM
Total % Solids

SAMPLE INFO

Filtration
☐ Field
☐ Lab to do
Preservation
☐ Lab to do

Sample Comments

TOTAL # BOTTLES

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	TOTAL # BOTTLES
41856-1	LP-1	8/2/21	1125	Sediment	JI	3
-02	LP-10		1135			
-03	LP-9		1145			
-04	LP-7		1155			
-05	LP-COMP1		1125			
-06	LP-5		1210			
-07	LP-4		1220			
-08	LP-3		1232			
-09	LP-6		1243			
-10	LP-COMP2		1240			

Container Type	2oz	4oz	2oz
	P/G	P/G	P
Preservative	A	A	A

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H= $Na_2S_2O_3$
I= Ascorbic Acid
J= NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
MCM	8/5/21 1015	MCM MUTZ AAZ	8/5/21 1015
	8/5/21 1235		8/5/21 1235

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

CHAIN OF CUSTODY

PAGE 2 OF 2

Date Rec'd in Lab: 8/5/21

ALPHA Job #: L2141858

ALPHA Analytical
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Client Information

Client: HORSLEY WITTEN GROUP
Address: 90 ROUTE 6A
SANDWICH, MA 02360
Phone: 508-833-6600
Email: jibanez@horsleywitten.com

Additional Project Information:

Project Information

Project Name: CAPE COD GATEWAY AIRPORT
Project Location: HYANNIS, MA
Project #: 21083
Project Manager: BRYAN MASSA
ALPHA Quote #:

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

Report Information - Data Deliverables

☐ ADEx ☐ EMAIL

Billing Information

☐ Same as Client Info PO #:

Regulatory Requirements & Project Information Requirements

☐ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	ANALYSIS: Lead PATHSIM	ANALYSIS: Total % Solid	SAMPLE INFO: Filtration ☐ Field ☐ Lab to do; Preservation ☐ Lab to do	Sample Comments	TOTAL # BOTTLES
41856-11	MD-1	8/2/21	1620	SEDIMENT	JI	X	X			3
-12	MD-2		1642			X	X			
-13	MD-3		1657			X	X			
-14	MD-4		1710			X	X			
-15	MD-COMP	↓	1620	↓	↓	X	X			↓

Container Type						A	A	A		
Preservative						A	A	A		

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
	8/5/21 1015		8/5/21 1015
	8/5/21 1225		8/5/21 1225

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev 12-Mar-2012)

ANALYTICAL REPORT

Lab Number:	L2144221
Client:	Horseley & Witten, Inc. Sextant Hill Office Park 90 Route 6A Sandwich, MA 02563
ATTN:	Brian Massa
Phone:	(508) 833-6600
Project Name:	CAPE COD GATEWAY AIRPORT
Project Number:	21083
Report Date:	08/24/21

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2144221
Report Date: 08/24/21

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2144221-01	UG-11	SOIL	HYANNIS, MA	08/06/21 09:50	08/09/21
L2144221-02	UG-11A	SOIL	HYANNIS, MA	08/06/21 10:05	08/09/21
L2144221-03	UG-11B	SOIL	HYANNIS, MA	08/06/21 10:20	08/09/21

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

MADEP MCP Response Action Analytical Report Certification

This form provides certifications for all samples performed by MCP methods. Please refer to the Sample Results and Container Information sections of this report for specification of MCP methods used for each analysis. The following questions pertain only to MCP Analytical Methods.

An affirmative response to questions A through F is required for "Presumptive Certainty" status		
A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	YES
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	YES
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	YES
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data?"	YES
E a.	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	N/A
E b.	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	N/A
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	YES

A response to questions G, H and I is required for "Presumptive Certainty" status		
G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	YES
H	Were all QC performance standards specified in the CAM protocol(s) achieved?	NO
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	NO

For any questions answered "No", please refer to the case narrative section on the following page(s).

Please note that sample matrix information is located in the Sample Results section of this report.

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

MCP Related Narratives

Sample Receipt

In reference to question H:

A Matrix Spike was not submitted for the analysis of Total Metals.

Semivolatile Organics

In reference to question I:

All samples were analyzed for a subset of MCP analytes per client request.

Total Metals

In reference to question I:

All samples were analyzed for a subset of MCP analytes per client request.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Jennifer L Clements

Title: Technical Director/Representative Date: 08/24/21

QC OUTLIER SUMMARY REPORT

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2144221
Report Date: 08/24/21

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment

There are no QC Outliers associated with this report.

ORGANICS

SEMIVOLATILES

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-01 D
Client ID: UG-11
Sample Location: HYANNIS, MA

Date Collected: 08/06/21 09:50
Date Received: 08/09/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/24/21 15:21
Analyst: RP
Percent Solids: 21%

Extraction Method: EPA 3546
Extraction Date: 08/19/21 01:05

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	110	J	ug/kg	160	33.	5
Fluoranthene	10000		ug/kg	160	11.	5
Naphthalene	120	J	ug/kg	160	28.	5
Benzo(a)anthracene	3400		ug/kg	160	15.	5
Benzo(a)pyrene	4000		ug/kg	160	19.	5
Benzo(b)fluoranthene	7000		ug/kg	160	15.	5
Benzo(k)fluoranthene	2800		ug/kg	160	14.	5
Chrysene	5200		ug/kg	160	12.	5
Acenaphthylene	350		ug/kg	160	19.	5
Anthracene	520		ug/kg	160	12.	5
Benzo(ghi)perylene	3400		ug/kg	160	13.	5
Fluorene	270		ug/kg	160	19.	5
Phenanthrene	3300		ug/kg	160	13.	5
Dibenzo(a,h)anthracene	690		ug/kg	160	16.	5
Indeno(1,2,3-cd)pyrene	3700		ug/kg	160	19.	5
Pyrene	8300		ug/kg	160	11.	5
2-Methylnaphthalene	62	J	ug/kg	160	44.	5

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	81		30-130
2-Fluorobiphenyl	55		30-130
4-Terphenyl-d14	57		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-02
Client ID: UG-11A
Sample Location: HYANNIS, MA

Date Collected: 08/06/21 10:05
Date Received: 08/09/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/24/21 16:59
Analyst: RP
Percent Solids: 10%

Extraction Method: EPA 3546
Extraction Date: 08/19/21 01:05

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	23	J	ug/kg	64	14.	1
Fluoranthene	1500		ug/kg	64	4.5	1
Naphthalene	38	J	ug/kg	64	12.	1
Benzo(a)anthracene	530		ug/kg	64	6.1	1
Benzo(a)pyrene	710		ug/kg	64	7.8	1
Benzo(b)fluoranthene	1200		ug/kg	64	6.1	1
Benzo(k)fluoranthene	400		ug/kg	64	5.8	1
Chrysene	820		ug/kg	64	4.8	1
Acenaphthylene	91		ug/kg	64	8.1	1
Anthracene	100		ug/kg	64	5.2	1
Benzo(ghi)perylene	590		ug/kg	64	5.5	1
Fluorene	56	J	ug/kg	64	7.8	1
Phenanthrene	430		ug/kg	64	5.5	1
Dibenzo(a,h)anthracene	120		ug/kg	64	6.4	1
Indeno(1,2,3-cd)pyrene	650		ug/kg	64	7.8	1
Pyrene	1300		ug/kg	64	4.5	1
2-Methylnaphthalene	18	J	ug/kg	64	18.	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	97		30-130
2-Fluorobiphenyl	41		30-130
4-Terphenyl-d14	31		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-03
Client ID: UG-11B
Sample Location: HYANNIS, MA

Date Collected: 08/06/21 10:20
Date Received: 08/09/21
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 97,8270D-SIM
Analytical Date: 08/19/21 16:07
Analyst: DV
Percent Solids: 18%

Extraction Method: EPA 3546
Extraction Date: 08/19/21 01:05

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	46		ug/kg	36	7.5	1
Fluoranthene	2200		ug/kg	36	2.5	1
Naphthalene	79		ug/kg	36	6.4	1
Benzo(a)anthracene	820		ug/kg	36	3.4	1
Benzo(a)pyrene	1100		ug/kg	36	4.3	1
Benzo(b)fluoranthene	1800		ug/kg	36	3.4	1
Benzo(k)fluoranthene	520		ug/kg	36	3.2	1
Chrysene	1400		ug/kg	36	2.7	1
Acenaphthylene	190		ug/kg	36	4.4	1
Anthracene	260		ug/kg	36	2.8	1
Benzo(ghi)perylene	900		ug/kg	36	3.0	1
Fluorene	88		ug/kg	36	4.3	1
Phenanthrene	700		ug/kg	36	3.0	1
Dibenzo(a,h)anthracene	210		ug/kg	36	3.6	1
Indeno(1,2,3-cd)pyrene	1100		ug/kg	36	4.3	1
Pyrene	2000		ug/kg	36	2.5	1
2-Methylnaphthalene	38		ug/kg	36	10.	1

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	61		30-130
2-Fluorobiphenyl	34		30-130
4-Terphenyl-d14	42		30-130

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2144221
Report Date: 08/24/21

Method Blank Analysis
Batch Quality Control

Analytical Method: 97,8270D-SIM
Analytical Date: 08/24/21 15:05
Analyst: RP

Extraction Method: EPA 3546
Extraction Date: 08/19/21 01:05

Parameter	Result	Qualifier	Units	RL	MDL
MCP Semivolatile Organics by SIM - Westborough Lab for sample(s): 01-03 Batch: WG1536708-1					
Acenaphthene	ND		ug/kg	6.6	1.4
Fluoranthene	ND		ug/kg	6.6	0.46
Naphthalene	ND		ug/kg	6.6	1.2
Benzo(a)anthracene	ND		ug/kg	6.6	0.63
Benzo(a)pyrene	ND		ug/kg	6.6	0.79
Benzo(b)fluoranthene	ND		ug/kg	6.6	0.63
Benzo(k)fluoranthene	ND		ug/kg	6.6	0.59
Chrysene	ND		ug/kg	6.6	0.49
Acenaphthylene	ND		ug/kg	6.6	0.82
Anthracene	ND		ug/kg	6.6	0.53
Benzo(ghi)perylene	ND		ug/kg	6.6	0.56
Fluorene	ND		ug/kg	6.6	0.79
Phenanthrene	ND		ug/kg	6.6	0.56
Dibenzo(a,h)anthracene	ND		ug/kg	6.6	0.66
Indeno(1,2,3-cd)pyrene	ND		ug/kg	6.6	0.79
Pyrene	ND		ug/kg	6.6	0.46
2-Methylnaphthalene	ND		ug/kg	6.6	1.9

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	74		30-130
2-Fluorobiphenyl	52		30-130
4-Terphenyl-d14	58		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2144221
Report Date: 08/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-03 Batch: WG1536708-2 WG1536708-3								
Acenaphthene	63		69		40-140	9		30
Fluoranthene	69		74		40-140	7		30
Naphthalene	61		65		40-140	6		30
Benzo(a)anthracene	68		72		40-140	6		30
Benzo(a)pyrene	73		80		40-140	9		30
Benzo(b)fluoranthene	73		77		40-140	5		30
Benzo(k)fluoranthene	72		81		40-140	12		30
Chrysene	67		72		40-140	7		30
Acenaphthylene	62		66		40-140	6		30
Anthracene	65		70		40-140	7		30
Benzo(ghi)perylene	68		75		40-140	10		30
Fluorene	64		69		40-140	8		30
Phenanthrene	64		69		40-140	8		30
Dibenzo(a,h)anthracene	70		77		40-140	10		30
Indeno(1,2,3-cd)pyrene	73		81		40-140	10		30
Pyrene	69		74		40-140	7		30
2-Methylnaphthalene	59		63		40-140	7		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2144221
Report Date: 08/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-03 Batch: WG1536708-2 WG1536708-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Nitrobenzene-d5	79		84		30-130
2-Fluorobiphenyl	54		59		30-130
4-Terphenyl-d14	59		63		30-130

METALS

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-01 Date Collected: 08/06/21 09:50

Client ID: UG-11 Date Received: 08/09/21

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 21%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	277		mg/kg	9.04	0.485	1	08/19/21 22:10	08/23/21 23:07	EPA 3050B	97,6010D	DL

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-02 Date Collected: 08/06/21 10:05

Client ID: UG-11A Date Received: 08/09/21

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 10%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	406		mg/kg	18.9	1.02	1	08/19/21 22:10	08/23/21 23:34	EPA 3050B	97,6010D	DL

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-03 Date Collected: 08/06/21 10:20

Client ID: UG-11B Date Received: 08/09/21

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 18%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	318		mg/kg	10.5	0.565	1	08/19/21 22:10	08/23/21 23:38	EPA 3050B	97,6010D	DL

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2144221

Project Number: 21083 **Report Date:** 08/24/21

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01-03 Batch: WG1537019-1										
Lead, Total	ND		mg/kg	2.00	0.107	1	08/19/21 22:10	08/23/21 23:20	97,6010D	DL

Prep Information

Digestion Method: EPA 3050B

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT

Project Number: 21083

Lab Number: L2144221

Report Date: 08/24/21

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01-03 Batch: WG1537019-2 WG1537019-3 SRM Lot Number: D109-540								
Lead, Total	99		105		72-128	6		30

INORGANICS
&
MISCELLANEOUS

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2144221
Report Date: 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-01
Client ID: UG-11
Sample Location: HYANNIS, MA
Sample Depth:
Matrix: Soil

Date Collected: 08/06/21 09:50
Date Received: 08/09/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	21.2		%	0.100	NA	1	-	08/18/21 11:43	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2144221
Report Date: 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-02
Client ID: UG-11A
Sample Location: HYANNIS, MA
Sample Depth:
Matrix: Soil

Date Collected: 08/06/21 10:05
Date Received: 08/09/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	10.1		%	0.100	NA	1	-	08/18/21 11:43	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2144221
Report Date: 08/24/21

SAMPLE RESULTS

Lab ID: L2144221-03
Client ID: UG-11B
Sample Location: HYANNIS, MA
Sample Depth:
Matrix: Soil

Date Collected: 08/06/21 10:20
Date Received: 08/09/21
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	18.2		%	0.100	NA	1	-	08/18/21 11:43	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2144221
Report Date: 08/24/21

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2144221-01B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.0	Y	Absent		MCP-PB-6010T-10(180)
L2144221-01C	Glass 120ml/4oz unpreserved	A	NA		3.0	Y	Absent		TS(7),MCP-PAHSIM-10(14)
L2144221-02B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.0	Y	Absent		MCP-PB-6010T-10(180)
L2144221-02C	Glass 120ml/4oz unpreserved	A	NA		3.0	Y	Absent		TS(7),MCP-PAHSIM-10(14)
L2144221-03B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.0	Y	Absent		MCP-PB-6010T-10(180)
L2144221-03C	Glass 120ml/4oz unpreserved	A	NA		3.0	Y	Absent		TS(7),MCP-PAHSIM-10(14)

*Values in parentheses indicate holding time in days

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

GLOSSARY

Acronyms

DL - Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EMPC - Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LOD - Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

LOQ - Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

NR - No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TEF - Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.

TEQ - Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

Data Qualifiers

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2144221
Project Number:	21083	**Report Date:**	08/24/21

REFERENCES

97 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA, IIB, IIIA, IIIB, IIIC, IIID, VA, VB, VC, VIA, VIB, VIIIA and VIIIB, July 2010.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625/625.1: alpha-Terpineol
EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D/8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 1

L2144221 CF 8/17/21

Date Rec'd in Lab: 8/09/21

ALPHA Job #: ~~L2142562~~

8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9303

Client Information

Client: Horsley Witten Group
Address: 90 Route 6A
Sandwich, MA 02563
Phone: (508) 833-6600
Email: bmassa@horsleywitten.com

Additional Project Information:

Project Information

Project Name: Cape Cod Gateway Airport
Project Location: Hyannis, MA
Project #: 21093
Project Manager: Bryan Massa
ALPHA Quote #:

Turn-Around Time

☑ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

Report Information - Data Deliverables

☐ ADEx ☐ EMAIL

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☑ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☑ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	ANALYSIS: VOC: ☐ 8260 ☐ 624 ☐ 524.2	SVOC: ☐ ABN ~~☐ 8270~~ ☐ EPA 625	METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15	METALS: ☐ RCRA5 ☐ RCRA8 ☐ PP13	EPH: ☐ Ranges & Targets ☐ Ranges Only	VPH: ☐ Ranges & Targets ☐ Ranges Only	☐ PCB ☐ PEST	TPH: ☐ Quant Only ☐ Fingerprint	Total Solids - SM2540	Total Lead - 6010D	PAH - SIM	PB	SAMPLE INFO: Filtration ☐ Field ☐ Lab to do; Preservation ☐ Lab to do	Sample Comments	TOTAL # BOTTLES
~~42562~~-01	VG-11	8/6/21	9:30	Soil	SB		✓						✓	✓	X	X			HOLD	3
44221-02	VG-11A	8/6/21	10:05	Soil	SB		✓						✓	✓	X	X			HOLD	3
-03	VG-11B	8/6/21	10:20	Soil	SB		✓						✓	✓	X	X			HOLD	3
~~-04~~	VG-Comp1	8/6/21	G: 8:50-10:20	Soil	SB		✓						✓	✓						3
Container Type																				
Preservative							/						/	/						

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_3$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	8/9 15:30	[signature]	8/9/21 15:30
[signature]	8/9/21 17:40		8/9/21 17:40

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

ANALYTICAL REPORT

Lab Number:	L2201668
Client:	Horseley & Witten, Inc. Sextant Hill Office Park 90 Route 6A Sandwich, MA 02563
ATTN:	Brian Massa
Phone:	(508) 833-6600
Project Name:	CAPE COD GATEWAY AIRPORT
Project Number:	21083
Report Date:	01/25/22

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2201668
Report Date: 01/25/22

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L2201668-01	OUTFALL_J	SOIL	HYANNIS, MA	01/10/22 12:30	01/12/22
L2201668-02	OUTFALL_PLAZA	SOIL	HYANNIS, MA	01/10/22 13:40	01/12/22

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

MADEP MCP Response Action Analytical Report Certification

This form provides certifications for all samples performed by MCP methods. Please refer to the Sample Results and Container Information sections of this report for specification of MCP methods used for each analysis. The following questions pertain only to MCP Analytical Methods.

An affirmative response to questions A through F is required for "Presumptive Certainty" status		
A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	YES
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	YES
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	YES
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data?"	YES
E a.	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	N/A
E b.	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	N/A
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	YES

A response to questions G, H and I is required for "Presumptive Certainty" status		
G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	NO
H	Were all QC performance standards specified in the CAM protocol(s) achieved?	NO
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	NO

For any questions answered "No", please refer to the case narrative section on the following page(s).

Please note that sample matrix information is located in the Sample Results section of this report.

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively.

When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances, the specific failure is not narrated but noted in the associated QC Outlier Summary Report, located directly after the Case Narrative. QC information is also incorporated in the Data Usability Assessment table (Format 11) of our Data Merger tool, where it can be reviewed in conjunction with the sample result, associated regulatory criteria and any associated data usability implications.

Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

HOLD POLICY - For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Alpha Project Manager and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Project Management at 800-624-9220 with any questions.

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

Case Narrative (continued)

Report Submission

All non-detect (ND) or estimated concentrations (J-qualified) have been quantitated to the limit noted in the MDL column.

MCP Related Narratives

Sample Receipt

In reference to question H:

A Matrix Spike was not submitted for the analysis of Total Metals.

Semivolatile Organics by SIM

L2201668-02D: The sample has elevated detection limits due to the limited sample volume utilized during extraction, as required by the sample matrix, and due to the analytical dilution required by the sample matrix.

In reference to question G:

L2201668-01D and -02D: One or more of the target analytes did not achieve the requested CAM reporting limits.

In reference to question H:

L2201668-01D: The surrogate recoveries are below the acceptance criteria for nitrobenzene-d5 (0%), 2-fluorobiphenyl (0%) and 4-terphenyl-d14 (0%) due to the dilution required to quantitate the sample. Re-extraction was not required; therefore, the results of the original analysis are reported.

In reference to question I:

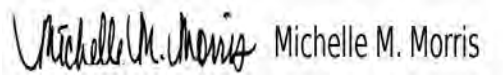
All samples were analyzed for a subset of MCP analytes per client request.

Total Metals

In reference to question I:

All samples were analyzed for a subset of MCP analytes per client request.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:  Michelle M. Morris

Title: Technical Director/Representative Date: 01/25/22

QC OUTLIER SUMMARY REPORT

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2201668
Report Date: 01/25/22

Method	Client ID (Native ID)	Lab ID	Parameter	QC Type	Recovery/RPD (%)	QC Limits (%)	Associated Samples	Data Quality Assessment
MCP PAHs by SIM - Westborough Lab								
8270E-SIM	OUTFALL_J	L2201668-01 D	Nitrobenzene-d5	Surrogate	0	30-130	-	- - not applicable - -
8270E-SIM	OUTFALL_J	L2201668-01 D	2-Fluorobiphenyl	Surrogate	0	30-130	-	- - not applicable - -
8270E-SIM	OUTFALL_J	L2201668-01 D	4-Terphenyl-d14	Surrogate	0	30-130	-	- - not applicable - -

ORGANICS

SEMIVOLATILES

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-01 D
Client ID: OUTFALL_J
Sample Location: HYANNIS, MA

Date Collected: 01/10/22 12:30
Date Received: 01/12/22
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 141,8270E-SIM
Analytical Date: 01/23/22 16:46
Analyst: JJW
Percent Solids: 85%

Extraction Method: EPA 3546
Extraction Date: 01/22/22 10:27

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	490	J	ug/kg	770	160	100
Fluoranthene	41000		ug/kg	770	54.	100
Naphthalene	ND		ug/kg	770	140	100
Benzo(a)anthracene	11000		ug/kg	770	74.	100
Benzo(a)pyrene	14000		ug/kg	770	93.	100
Benzo(b)fluoranthene	23000		ug/kg	770	74.	100
Benzo(k)fluoranthene	7900		ug/kg	770	70.	100
Chrysene	18000		ug/kg	770	58.	100
Acenaphthylene	120	J	ug/kg	770	97.	100
Anthracene	1600		ug/kg	770	62.	100
Benzo(ghi)perylene	12000		ug/kg	770	66.	100
Fluorene	750	J	ug/kg	770	93.	100
Phenanthrene	20000		ug/kg	770	66.	100
Dibenzo(a,h)anthracene	2300		ug/kg	770	77.	100
Indeno(1,2,3-cd)pyrene	14000		ug/kg	770	93.	100
Pyrene	29000		ug/kg	770	54.	100
2-Methylnaphthalene	ND		ug/kg	770	220	100

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	**0**	Q	30-130
2-Fluorobiphenyl	**0**	Q	30-130
4-Terphenyl-d14	**0**	Q	30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-02 D
Client ID: OUTFALL_PLAZA
Sample Location: HYANNIS, MA

Date Collected: 01/10/22 13:40
Date Received: 01/12/22
Field Prep: Not Specified

Sample Depth:
Matrix: Soil
Analytical Method: 141,8270E-SIM
Analytical Date: 01/23/22 16:29
Analyst: JJW
Percent Solids: 50%

Extraction Method: EPA 3546
Extraction Date: 01/22/22 10:27

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor
MCP PAHs by SIM - Westborough Lab						
Acenaphthene	100	J	ug/kg	200	42.	5
Fluoranthene	9700		ug/kg	200	14.	5
Naphthalene	ND		ug/kg	200	36.	5
Benzo(a)anthracene	3000		ug/kg	200	19.	5
Benzo(a)pyrene	3600		ug/kg	200	24.	5
Benzo(b)fluoranthene	6200		ug/kg	200	19.	5
Benzo(k)fluoranthene	1800		ug/kg	200	18.	5
Chrysene	4200		ug/kg	200	15.	5
Acenaphthylene	38	J	ug/kg	200	25.	5
Anthracene	340		ug/kg	200	16.	5
Benzo(ghi)perylene	2600		ug/kg	200	17.	5
Fluorene	110	J	ug/kg	200	24.	5
Phenanthrene	4100		ug/kg	200	17.	5
Dibenzo(a,h)anthracene	540		ug/kg	200	20.	5
Indeno(1,2,3-cd)pyrene	3100		ug/kg	200	24.	5
Pyrene	7200		ug/kg	200	14.	5
2-Methylnaphthalene	ND		ug/kg	200	57.	5

Surrogate	% Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	87		30-130
2-Fluorobiphenyl	64		30-130
4-Terphenyl-d14	46		30-130

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

Method Blank Analysis
Batch Quality Control

Analytical Method: 141,8270E-SIM
Analytical Date: 01/23/22 13:05
Analyst: JJW

Extraction Method: EPA 3546
Extraction Date: 01/22/22 10:27

Parameter	Result	Qualifier	Units	RL	MDL
MCP Semivolatile Organics by SIM - Westborough Lab for sample(s): 01-02 Batch: WG1597001-1					
Acenaphthene	ND		ug/kg	6.6	1.4
Fluoranthene	0.46	J	ug/kg	6.6	0.46
Naphthalene	ND		ug/kg	6.6	1.2
Benzo(a)anthracene	0.69	J	ug/kg	6.6	0.62
Benzo(a)pyrene	ND		ug/kg	6.6	0.79
Benzo(b)fluoranthene	ND		ug/kg	6.6	0.62
Benzo(k)fluoranthene	ND		ug/kg	6.6	0.59
Chrysene	ND		ug/kg	6.6	0.49
Acenaphthylene	ND		ug/kg	6.6	0.82
Anthracene	ND		ug/kg	6.6	0.53
Benzo(ghi)perylene	ND		ug/kg	6.6	0.56
Fluorene	ND		ug/kg	6.6	0.79
Phenanthrene	ND		ug/kg	6.6	0.56
Dibenzo(a,h)anthracene	ND		ug/kg	6.6	0.66
Indeno(1,2,3-cd)pyrene	ND		ug/kg	6.6	0.79
Pyrene	ND		ug/kg	6.6	0.46
2-Methylnaphthalene	ND		ug/kg	6.6	1.9

Surrogate	%Recovery	Qualifier	Acceptance Criteria
Nitrobenzene-d5	82		30-130
2-Fluorobiphenyl	77		30-130
4-Terphenyl-d14	73		30-130

Lab Control Sample Analysis
Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2201668
Report Date: 01/25/22

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-02 Batch: WG1597001-2 WG1597001-3								
Acenaphthene	90		76		40-140	17		30
Fluoranthene	99		82		40-140	19		30
Naphthalene	86		72		40-140	18		30
Benzo(a)anthracene	102		84		40-140	19		30
Benzo(a)pyrene	104		86		40-140	19		30
Benzo(b)fluoranthene	98		81		40-140	19		30
Benzo(k)fluoranthene	104		81		40-140	25		30
Chrysene	91		78		40-140	15		30
Acenaphthylene	94		79		40-140	17		30
Anthracene	98		82		40-140	18		30
Benzo(ghi)perylene	91		71		40-140	25		30
Fluorene	92		77		40-140	18		30
Phenanthrene	92		76		40-140	19		30
Dibenzo(a,h)anthracene	99		79		40-140	22		30
Indeno(1,2,3-cd)pyrene	99		75		40-140	28		30
Pyrene	97		81		40-140	18		30
2-Methylnaphthalene	88		74		40-140	17		30

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2201668
Report Date: 01/25/22

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Semivolatile Organics by SIM - Westborough Lab Associated sample(s): 01-02 Batch: WG1597001-2 WG1597001-3								

Surrogate	LCS %Recovery	Qual	LCSD %Recovery	Qual	Acceptance Criteria
Nitrobenzene-d5	87		72		30-130
2-Fluorobiphenyl	79		67		30-130
4-Terphenyl-d14	72		61		30-130

METALS

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-01 Date Collected: 01/10/22 12:30

Client ID: OUTFALL_J Date Received: 01/12/22

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 85%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	8.80		mg/kg	2.21	0.118	1	01/20/22 15:25	01/20/22 20:38	EPA 3050B	97,6010D	DL

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-02 Date Collected: 01/10/22 13:40

Client ID: OUTFALL_PLAZA Date Received: 01/12/22

Sample Location: HYANNIS, MA Field Prep: Not Specified

Sample Depth:

Matrix: Soil

Percent Solids: 50%

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab											
Lead, Total	71.0		mg/kg	3.81	0.204	1	01/20/22 15:25	01/20/22 20:43	EPA 3050B	97,6010D	DL

Project Name: CAPE COD GATEWAY AIRPORT **Lab Number:** L2201668

Project Number: 21083 **Report Date:** 01/25/22

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
MCP Total Metals - Mansfield Lab for sample(s): 01-02 Batch: WG1595789-1										
Lead, Total	ND		mg/kg	2.00	0.107	1	01/20/22 15:25	01/20/22 22:09	97,6010D	DL

Prep Information

Digestion Method: EPA 3050B

Lab Control Sample Analysis

Batch Quality Control

Project Name: CAPE COD GATEWAY AIRPORT

Project Number: 21083

Lab Number: L2201668

Report Date: 01/25/22

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
MCP Total Metals - Mansfield Lab Associated sample(s): 01-02 Batch: WG1595789-2 WG1595789-3 SRM Lot Number: D113-540								
Lead, Total	89		78		72-128	13		30

INORGANICS
&
MISCELLANEOUS

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2201668
Report Date: 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-01
Client ID: OUTFALL_J
Sample Location: HYANNIS, MA
Sample Depth:
Matrix: Soil

Date Collected: 01/10/22 12:30
Date Received: 01/12/22
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	85.4		%	0.100	NA	1	-	01/13/22 11:58	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083
Lab Number: L2201668
Report Date: 01/25/22

SAMPLE RESULTS

Lab ID: L2201668-02
Client ID: OUTFALL_PLAZA
Sample Location: HYANNIS, MA
Sample Depth:
Matrix: Soil

Date Collected: 01/10/22 13:40
Date Received: 01/12/22
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	49.5		%	0.100	NA	1	-	01/13/22 11:58	121,2540G	RI

Project Name: CAPE COD GATEWAY AIRPORT
Project Number: 21083

Lab Number: L2201668
Report Date: 01/25/22

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Absent

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L2201668-01A	Plastic 2oz unpreserved for TS	A	NA		3.2	Y	Absent		TS(7)
L2201668-01B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.2	Y	Absent		MCP-PB-6010T-10(180)
L2201668-01C	Glass 120ml/4oz unpreserved	A	NA		3.2	Y	Absent		MCP-PAHSIM-21(14)
L2201668-02A	Plastic 2oz unpreserved for TS	A	NA		3.2	Y	Absent		TS(7)
L2201668-02B	Metals Only-Glass 60mL/2oz unpreserved	A	NA		3.2	Y	Absent		MCP-PB-6010T-10(180)
L2201668-02C	Glass 120ml/4oz unpreserved	A	NA		3.2	Y	Absent		MCP-PAHSIM-21(14)

*Values in parentheses indicate holding time in days

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

GLOSSARY

Acronyms

DL - Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the limit of quantitation (LOQ). The DL includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EMPC - Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LOD - Limit of Detection: This value represents the level to which a target analyte can reliably be detected for a specific analyte in a specific matrix by a specific method. The LOD includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

LOQ - Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

Limit of Quantitation: The value at which an instrument can accurately measure an analyte at a specific concentration. The LOQ includes any adjustments from dilutions, concentrations or moisture content, where applicable. (DoD report formats only.)

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. For Method 332.0, the spike recovery is calculated using the native concentration, including estimated values.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NDPA/DPA - N-Nitrosodiphenylamine/Diphenylamine.

NI - Not Ignitable.

NP - Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.

NR - No Results: Term is utilized when 'No Target Compounds Requested' is reported for the analysis of Volatile or Semivolatile Organic TIC only requests.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

STLP - Semi-dynamic Tank Leaching Procedure per EPA Method 1315.

TEF - Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.

TEQ - Toxic Equivalent: The measure of a sample's toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.

TIC - Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Difference: With respect to Total Oxidizable Precursor (TOP) Assay analysis, the difference is defined as the Post-Treatment value minus the Pre-Treatment value.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

PAH Total: With respect to Alkylated PAH analyses, the 'PAHs, Total' result is defined as the summation of results for all or a subset of the following compounds: Naphthalene, C1-C4 Naphthalenes, 2-Methylnaphthalene, 1-Methylnaphthalene, Biphenyl, Acenaphthylene, Acenaphthene, Fluorene, C1-C3 Fluorenes, Phenanthrene, C1-C4 Phenanthrenes/Anthracenes, Anthracene, Fluoranthene, Pyrene, C1-C4 Fluoranthenes/Pyrenes, Benz(a)anthracene, Chrysene, C1-C4 Chrysenes, Benzo(b)fluoranthene, Benzo(j)+(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Indeno(1,2,3-cd)pyrene, Dibenz(ah)+(ac)anthracene, Benzo(g,h,i)perylene. If a 'Total' result is requested, the results of its individual components will also be reported.

PFAS Total: With respect to PFAS analyses, the 'PFAS, Total (5)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA and PFOS. In addition, the 'PFAS, Total (6)' result is defined as the summation of results for: PFHpA, PFHxS, PFOA, PFNA, PFDA and PFOS. For MassDEP DW compliance analysis only, the 'PFAS, Total (6)' result is defined as the summation of results at or above the RL. Note: If a 'Total' result is requested, the results of its individual components will also be reported.

The target compound Chlordane (CAS No. 57-74-9) is reported for GC ECD analyses. Per EPA,this compound "refers to a mixture of chlordane isomers, other chlorinated hydrocarbons and numerous other components." (Reference: USEPA Toxicological Review of Chlordane, In Support of Summary Information on the Integrated Risk Information System (IRIS), December 1997.)

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Data Qualifiers

A - Spectra identified as "Aldol Condensates" are byproducts of the extraction/concentration procedures when acetone is introduced in the process.

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

F - The ratio of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

J - Estimated value. The Target analyte concentration is below the quantitation limit (RL), but above the Method Detection Limit (MDL) or Estimated Detection Limit (EDL) for SPME-related analyses. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

ND - Not detected at the method detection limit (MDL) for the sample, or estimated detection limit (EDL) for SPME-related analyses.

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

Data Qualifiers

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

V - The surrogate associated with this target analyte has a recovery outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Z - The batch matrix spike and/or duplicate associated with this target analyte has a recovery/RPD outside the QC acceptance limits. (Applicable to MassDEP DW Compliance samples only.)

Report Format: DU Report with 'J' Qualifiers

Project Name:	CAPE COD GATEWAY AIRPORT	**Lab Number:**	L2201668
Project Number:	21083	**Report Date:**	01/25/22

REFERENCES

97 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA, IIB, IIIA, IIIB, IIIC, IIID, VA, VB, VC, VIA, VIB, VIIIA and VIIIB, July 2010.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

141 EPA Test Methods (SW-846) with QC Requirements & Performance Standards for the Analysis of EPA SW-846 Methods under the Massachusetts Contingency Plan, WSC-CAM-IIA and IIB, November 2021.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene, Naphthalene
EPA 625/625.1: alpha-Terpineol
EPA 8260C/8260D: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D/8270E: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine, alpha-Terpineol; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.
SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B, SM4500NO2-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603, SM9222D.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522, EPA 537.1.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb**,** As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab: 1/12/22

ALPHA Job #: L2201668

ALPHA ANALYTICAL
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Client Information

Client: Horsley Witten Group
Address: 90 Route 6A #1
Sandwich MA 02563
Phone: (508) 833-6600
Email: Bmassa@horsleywitten.com

Additional Project Information:

Project Information

Project Name: Cape Cod Gateway
Project Location: Hyannis Airport
Project #: 21083
Project Manager: BryanMassa
ALPHA Quote #:

Turn-Around Time

☑ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

Report Information - Data Deliverables

☐ ADEx ☑ EMAIL

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☑ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☑ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	ANALYSIS: Lead	PAH SIM	Total Solids (%)	SAMPLE INFO: Filtration ☐ Field ☐ Lab to do; Preservation ☐ Lab to do	Sample Comments	TOTAL # BOTTLES
01688-01	outfall_J	1/10/22	12:30	soil	SB	✓	✓	✓			3
-02	outfall_plaza	1/10/22	13:40	soil	SB	✓	✓	✓			3
											3

Container Type	A	A	P
Preservative	A	A	A

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H= $Na_2S_2O_3$
I= Ascorbic Acid
J= NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Sarah Bartlett	1/12/22 13:37	Brianna Sousa - ADL	1/12 13:37
Brianna Sousa - ADL	1/12 17:15	[illegible]	1/12 17:15

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

APPENDIX D

PUBLIC NOTIFICATION DOCUMENTATION

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Unit 1 • Sandwich, MA 02563
508-833-6600 • horsleywitten.com

November 6, 2023

Mr. Mark S. Ells
Town of Barnstable Manager
367 Main Street
Hyannis, MA 02601

Re: Availability of a Permanent Solution Statement with No Conditions
Upper Gate and Lewis Pond
Cape Cod Gateway Airport
480 Barnstable Road
Hyannis, Massachusetts
MassDEP RTN 4-298577

Dear Mr. Ellis:

On behalf of the Cape Cod Gateway Airport, the Horsley Witten Group, Inc. (HW) is notifying you as the Chief Municipal Officer for the Town of Barnstable of the completion and availability of a Permanent Solution Statement with No Conditions (PSS-NC). The PSS-NC is related to polycyclic aromatic hydrocarbons (PAHs) and lead detected in sediment samples obtained from Upper Gate and Lewis Ponds located at the Cape Cod Gateway Airport. The concentration of PAHs and lead detected in sediments were determined to be anthropogenic background and consistent with petroleum residuals that are incidental to the normal operation of a vehicle and atmospheric deposition of engine emissions.

Information regarding the release is available for public review at the Commonwealth of Massachusetts Department of Environmental Protection ("MassDEP") Southeastern regional office, located in Lakeville, Massachusetts or at:

https://eeaonline.eea.state.ma.us/portal#!/wastesite/4-0028577 .

This notification is being sent to you to comply with the Public Involvement requirements of the Massachusetts Contingency Plan, 310 CMR 40.1403.

If you have any questions, please contact Bryan Massa at 508-833-6600.

Sincerely,

HORSLEY WITTEN GROUP, INC.

Mark Nelson, P.G.
Principal

cc: Town of Barnstable Health Department

Appendix H

Circulation List

APPENDIX H CIRCULATION LIST

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Office of Environmental Review
EPA New England-Region 1
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Executive Office of Energy and Environmental Affairs
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Boston, MA 02114
MEPA@mass.gov

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100 Cambridge Street, Suite 900
Boston, MA 02144
MEPA-EJ@mass.gov

Department of Environmental Protection
Commissioner's Office
One Winter Street
Boston, MA 02108
helena.boccadoro@mass.gov

Department of Environmental Protection
Southeast Regional Office – Lakeville
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20 Riverside Drive,
Lakeville, MA 02347
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Public/Private Development Unit
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Boston, MA 02116
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Massachusetts Department of
Transportation, District #5
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Cape Cod and Islands
3195 Main Street, P.O. Box 220
Barnstable, MA 02630
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The Massachusetts Historical Commission
The MA Archives Building
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Appendix I

Updated EJ Distribution List

APPENDIX I PROJECT SPECIFIC EJ DISTRIBUTION LIST

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