

**PHASE II COMPREHENSIVE SITE ASSESSMENT
SCOPE OF WORK
RTN 4-26179**

*Former Barnstable County Fire & Rescue Training Academy,
Barnstable, MA*

March 2022



B E T A

701 George Washington Hwy
Lincoln, Rhode Island 02865
401.333.2382
www.BETA-Inc.com

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Prepared by: BETA GROUP, INC.
Prepared for: Barnstable County

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PHASE II COMPREHENSIVE SITE ASSESSMENT (CSA)

SCOPE OF WORK

1.0 INTRODUCTION

On behalf of Barnstable County, BETA Group, Inc. (BETA) submits this Scope of Work (SOW) for the Phase II Comprehensive Site Assessment (CSA) of the Barnstable County Former Fire and Rescue Training Academy (FTA) PFAS release Site. The PFAS release Site is associated with the former FTA facility located at 155 South Flint Rock Road in Barnstable, Massachusetts. The Massachusetts Department of Environmental Protection (MassDEP) Bureau of Waste Site Cleanup (BWSC) Release Tracking Number (RTN) for the Site is 4-26179. This RTN was assigned in response to the detection of elevated concentrations of per- and polyfluoroalkyl substances (PFAS), including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), in soil and groundwater at the facility and in adjacent areas, in particular to the east, southeast of the facility.

For the purposes of this MCP submittal, the property on which the former Barnstable County Fire and Rescue Training Academy FTA is located will be referred to as the former FTA or facility. The former FTA or facility will also refer to the structures, land and former or current limited functions of the FTA. In accordance with the MCP definition, where contamination attributable to the PFAS Release associated with historic training with firefighting foams at the former FTA have come to be located will be referred to as the Disposal Site or Site.

The Massachusetts Contingency Plan requires the preparation of a Phase II SOW following the submission of the Phase I Initial Site Investigation (ISI). A conceptual Phase II SOW was included with the MCP Phase I ISI and Tier Classification submitted to DEP in May 2018. MassDEP indicated in email correspondence that a formal, full Phase II CSA SOW submittal was required for the RTN 4-26179 Site. This document presents the formal proposed Phase II CSA SOW. This document is being submitted as the final Phase II CSA scope of work following distribution of and comment on the Public Comment Draft Phase II CSA Scope of Work.

This document is being submitted as an attachment the completed BWSC107 Tier Classification Transmittal Form being submitted to the Massachusetts Department of Environmental Protection (MassDEP) electronically via the eDEP system. A copy of the BWSC 107 form prior to electronic signature is included as **Appendix A**.

Site Owner and Site Contacts

As current owners of the former FTA, Barnstable County, as represented by the Barnstable County Commissioners, have been named as the Potentially Responsible Party (PRP) for this release. The contact person for the Disposal Site and release is:

Barnstable County Commissioners – Point of Contact: Stephen Tebo

Barnstable County Asset and Infrastructure Manager

Barnstable County

3195 Main Street

Barnstable, MA 02630

Telephone: 508-375-6643

Email: stebo@barnstablecounty.org

The Licensed Site Professional (LSP) of Record for this Site is:

Roger Thibault, P.E., LSP No. 1443
BETA Group Inc.
701 George Washington Highway
Lincoln, RI 02865
Phone: (401) 333-2382

2.0 RELEASE BACKGROUND

In November 2013, soil and groundwater samples were collected from the FTA property and submitted for laboratory analysis of PFAS. Groundwater analytical results revealed that groundwater at the FTA was impacted by PFOS and MassDEP was subsequently notified. RTN 4-26179 was assigned to the Site in August 2016. PFOS was also detected in soil at the former FTA and in surface water and sediment within the adjacent Flintrock Pond.

As a voluntary measure, Barnstable County refurbished a decommissioned perchlorate pumping and treatment system to help remediate and contain the PFOS apparently migrating from the facility. The groundwater pumping and treatment system (GWPTS) was re-started using granular activated carbon (GAC) for treatment in July 2015. The system utilizes a groundwater recovery well, PRW-4, located approximately 925 feet southeast of the FTA. At that time groundwater was pumped from PRW-4 through two, small diameter force mains to the groundwater treatment system (GWTS) located in a structure on the facility.

In August 2015, Barnstable County funded a more detailed hydrogeological assessment and continued implementation of groundwater pumping and treatment. The soil results indicated a broad area of PFOS contamination throughout the subsurface. The highest PFOS concentrations were detected near the southwestern corner of the FTA, a location subsequently referred to as the "Hot Spot". Groundwater analytical results from the 2015 assessment revealed PFOS contamination ranging from less than 0.070 µg/L (the current US EPA HA)¹ to greater than 300 µg/L. Like the soil results, the highest PFOS concentrations were detected near the southwestern corner of the FTA.

On August 4, 2016, MassDEP issued a Notice of Responsibility (NOR) to Barnstable County. As summarized in the NOR, based on the detected PFAS concentrations in soil and groundwater at the FTA and the inferred groundwater flow direction being to the southeast, MassDEP determined that the releases of PFAS from the historic use of AFFF (for training) at the FTA is a source of PFAS detected in public water supply wells to the east of the FTA. The NOR required submittal of an Immediate Response Action (IRA) Plan no later than September 15, 2016. MassDEP requested that the Site owner evaluate potential Imminent Hazards relative to downgradient public and private water supply wells. MassDEP stated that the IRA Plan should include measures to prevent, eliminate, and/or abate any hazards associated with the consumption of drinking water impacted by PFAS above the HA level of 0.070 µg/L.

The former FTA is situated to the west and most likely upgradient of the Mary Dunn public water supply wells under pumping conditions. Mary Dunn Wells 1, 2, and 3, owned by the Town of Barnstable through the Hyannis Water Supply Division (HWSD) of the Barnstable Department of Public Works (DPW), are located within the preliminary Disposal Site boundary due to the detections of PFAS in the

¹ Prior to June 11, 2018, the USEPA established the EPA Health Advisory for two PFAS chemicals, PFOA and PFOS, which was 70 ng/L. Subsequently, MassDEP's Office of Research and Standards (ORS) expanded on this Health Advisory and created the ORS Guideline that applies to the total summed of five PFAS chemicals, PFOS, PFOA, PFNA, PFHxS, and PFHpA, effective June 11, 2018. MassDEP released drafted Method 1 groundwater risk standards for PFAS on April 19, 2019 that applies to the total sum and individual concentrations of six PFAS compounds (PFOS, PFOA, PFNA, PFHxS, PFHpA, and PFDA), which is 20 ng/L. These drafted groundwater standards were finalized and became effective on December 27, 2019.

groundwater at those wells. Refer to **Figures 1 and 2** for depiction of the Site vicinity and its sensitive environmental receptors.

On September 27, 2016, on behalf of Barnstable County, the Cape Cod Commission (acting as LSP for the Site on behalf of the County) submitted an IRA Plan to MassDEP to address the PFOS/PFOA impacts. Key elements of the IRA Plan included a proposed soil removal action at the Hot Spot, evaluation of expansion of the groundwater pumping and treatment system and addressing other possible groundwater receptors.

Approximately 200 tons of heavily impacted soil were removed from the Hot Spot area in January 2017, reducing the primary source of PFOS contamination leaching into groundwater. However, post-removal grading and settling of the backfill in the Hot Spot area left it prone to infiltration of runoff from the southern portion of the FTA.

In May 2018, a Phase I Initial Site Investigation (ISI) Report and Tier Classification Submittal was submitted to MassDEP by Nover-Armstrong Associates (now BETA) on behalf of Barnstable County. The Phase I ISI confirmed that the primary contaminant of concern is PFOS and, to a lesser extent, PFOA. A Tier Classification was submitted to MassDEP concurrently with the Phase I Report. The RTN 4-26179 release was classified as Tier I.

From December 2018 through February 2019, Barnstable County implemented the regrading and temporary capping of the southwest corner of the FTA, including the former Hot Spot area, with related stormwater controls as an IRA Plan Modification at the direction of MassDEP. An approximate 4,000 square foot area was regraded with clean sand and capped with polyethylene sheeting and stone to prevent infiltration. Additional stormwater diversions were installed. These improvements were designated as the Phase I Stormwater Management Improvements. .

Groundwater monitoring of PFAS compounds across the Site has been ongoing since November 2013. BETA, formerly Nover-Armstrong Associates, has conducted groundwater monitoring activities since June 2018. Elevated PFAS concentrations (relative to MCP risk standards and the MassDEP drinking water Maximum Contaminant Levels) remain in Site groundwater, as they have been documented to be since the onset of monitoring. However, concentrations have trended downward significantly, with some exceptions, especially in the Hot Spot area since PFAS assessment and partial remediation started at the Site in 2015. Groundwater flow direction has been calculated by the Cape Cod Commission and BETA to be primarily in a southeasterly direction from the FTA Site towards the Mary Dunn No. 1 and No. 2 wells.

As noted above, response actions to address PFAS included the renovation of a GWPTS in July 2015. The operational GWPTS was later noted in the NOR issued by MassDEP in August 2016 as part of the ongoing IRAs. As noted, the NOR also requested that Barnstable County install additional recovery wells or increase the groundwater recovery rate to increase PFAS removal. In November 2019, a temporary supplemental treatment system was installed, designated as GWTS#2, to treat water from the existing recovery well. One of the force mains was re-piped and connected via hose and hard piping to temporary treatment system GWTS#2. The system is contained in a temporary structure and is designed to treat PFAS-impacted groundwater (via adsorption technology with liquid phase granular activated carbon) at a target flow rate of approximately 30 gpm.

In response to the *Request for Expedited Immediate Response Action Plan Modification/Interim Deadline-Enforcement Document Number 6694*, dated May 1, 2019 issued by MassDEP and amended by email correspondence, BETA (on behalf of the County) submitted a Draft IRA Plan Modification to DEP detailing preliminary plans for the expansion of the groundwater recovery and treatment system and

capping measures to prevent infiltration of precipitation through the soils at the Site. Following the receipt of public comment, the IRA Plan Modification was finalized in December 2019 and design plans for Sitewide capping were submitted for approval to the Town of Barnstable via a Notice of Intent in February 2020. Final design approval and an Order of Conditions was obtained in November 2020 and January 2021, respectively.

The construction of the cap and stormwater improvements is being funded via the Clean Water Trust State Revolving Fund (CWTSRF); the County received Bids for the project in April 2021. The project was awarded in July 2021. Construction began in August 2021 and was substantially completed in November 2021.

As detailed in the IRA Status Reports that document quarterly, Site-wide groundwater monitoring, elevated PFAS concentrations remain in Site groundwater.

Public Involvement

In January 2019, a petition from a group of residents of Barnstable and Hyannis, MA was received requesting that the Site be designated a Public Involvement Plan (PIP) Site. In response to the request from the local petitioners, Barnstable County designated the Site as a PIP site, prepared Draft and Final Public Involvement Plans, and conducts all relevant MCP response actions under public involvement procedures. As stated in the Final PIP, prior to the completion of a major regulatory milestone, public comment will be solicited, and comments received will potentially be incorporated prior to the implementation of the milestone/response action.

On July 16, 2021, a Public Comment Draft Phase II Comprehensive Site Assessment (CSA) Scope of Work was submitted to MassDEP and was made available for public comment on July 20, 2021 via distribution to the PIP mailing list of the notice of availability of the draft document. The Draft Phase II CSA SOW document described the methodical assessment activities proposed to meet the objectives as stated in the MCP at 310 CMR 40.0833. A Public Information Meeting was held virtually on August 18, 2021. Per Section 4.23 of the Final PIP, public comments were accepted on the Draft Phase II CSA SOW until August 26, 2021. Several sets of public comment were received. The public comments received have been incorporated into this Phase II CSA SOW to the extent feasible and relevant to the Phase II work. Public comments will also be addressed in a formal response document to be submitted to MassDEP and made available to the public through the public notification process.

3.0 PHASE II SCOPE OF WORK - OVERVIEW

3.1 INTRODUCTION

BETA stated in the Phase I Initial Site Investigation report that continuation of the IRA activities, additional assessment, and additional remedial Response Actions are warranted at the Disposal Site. Continuing IRA assessment, in particular groundwater monitoring, confirmed the Phase I ISI conclusions. The Site does not currently meet the criteria for a Permanent Solution and requires additional Comprehensive Response Actions (CRAs).

A Phase II Conceptual Scope of Work (SOW) was submitted with the Phase I ISI outlining the scope, nature of investigation, and sample programs proposed to characterize the risk of harm posed to health, safety, public welfare, and the environment. As noted, MassDEP indicated in email correspondence that a formal Phase II CSA SOW submittal was required for the RTN 4-26179 Site. Accordingly, pursuant to 310 CMR 40.0832 – Phase II Scope of Work, the scope and nature of proposed investigation and sampling programs are described herein.

3.2 OBJECTIVES

In accordance with MCP 310 CMR 40.0833, the Phase II CSA will focus on achieving the following objectives:

1. Assessing and determining to the extent feasible, the nature and extent of the MCP-regulated PFAS contamination at the Site.
2. Evaluating the fate and transport of MassDEP-regulated PFAS at the Site as supported by the currently available science and research.
3. Evaluating potential exposures and risk of adverse impacts to human health and the environment as a result of the PFAS release to the environment.
4. Develop a conceptual site model (CSM).
5. Derive conclusions based on the data obtained to support the evaluation and selection of Comprehensive Remedial Response Actions during the MCP Phase III process, which will follow the Phase II comprehensive assessment work described in this document.

The PFAS Release associated with RTN 4-26179 has already been the subject of extensive assessment with over 55 monitoring wells installed and greater than 25 additional soil borings advanced to date. Assessment conducted to date also included numerous test pits, subsurface and surficial soil sampling, and analytical testing, and testing of surface water and numerous sediment samples from the adjacent Flintrock Pond. The Site is currently subject to IRA quarterly groundwater monitoring. The current monitoring locations are depicted in **Figure 3** and **4**.

In addition, pumping and treatment of impacted groundwater from a recovery well located approximately 925 feet downgradient of the FTA is on-going as an IRA; this remedial action continues to provide empirical hydrogeologic and groundwater quality data for the Site.

Therefore, the media sampling components of the Phase II CSA SOW presented herein are specifically focused on identifying and then addressing data gaps regarding: i) groundwater impacts at large distances from the source area, ii) soil impacts at and in close proximity to the FTA itself, and iii) contaminant conditions in relevant surface water bodies.

3.3 PHASE II COMPREHENSIVE GROUNDWATER ASSESSMENT

Groundwater assessment is a major component of the Phase II Comprehensive Site Assessment. Phase II comprehensive groundwater assessment will include:

- groundwater monitoring using existing monitoring well installations,
- expanded groundwater assessment to the south and southeast of the former FTA facility and the currently identified PFAS plume,
- groundwater assessment to the south and west of Flintrock Pond,
- evaluation of the interactions of surface water in Flintrock Pond and Mary Dunn Pond with groundwater, and
- numerical modeling of groundwater flow and fate and transport of PFAS.

The planned assessment is described in detail in Sections 4.0 and 5.0 of this Scope of Work. Highlights of the proposed approach are presented in sections 3.3.1 and 3.3.2 below.

3.3.1 EXPANDED GROUNDWATER ASSESSMENT

The Phase II CSA SOW includes multiple tasks to methodically assess the extent of the PFAS impacts to groundwater south of Flintrock Pond and Mary Dunn Pond and southeast of the currently identified PFAS plume. This expanded groundwater assessment will be based on initial groundwater screening followed by installation of permanent monitoring wells where screening indicates that significant PFAS concentrations are most likely present in the aquifer. The work will be conducted in phases and organized into zones.

Major tasks to assess potential PFAS in groundwater south of the currently assessed locations to the Hyannis Water District's Airport Well will include:

- Initial groundwater screening for PFAS using direct push drilling methods - vertical screening of the groundwater will also be conducted at selected locations, as feasible and efficient.
- Installation of permanent monitoring wells where screening indicates that significant PFAS concentrations are most likely present.
- At selected permanent sampling locations, installation of multiple wells screened at different depths throughout the aquifer, as appropriate in response to screening data and as relevant to delineate the PFAS plume.
- Precision mapping of all new monitoring locations.
- Gauging of groundwater depths, calculation of groundwater elevations, survey and gauging of pond water elevations and evaluation of interactions of groundwater with pond waters.
- Multiple rounds of sampling of groundwater in the downgradient areas, coordinated with Site-wide sampling.

Groundwater assessment in the vicinity of the Airport Well will most likely be limited by the security zone around Barnstable Municipal Airport. The first round of expanded Phase II CSA groundwater assessment described in detail in this SOW includes assessment south to the northern extent of the airport security zone north of runway 6/24, including the area around the Airport Well to the extent feasible. Assessment will be expanded to the south and southeast of that area if warranted based on the results of the groundwater assessment north of the airport. It is assumed that access for new groundwater assessment along runway 6/24 and the related aprons is not feasible. Therefore, to avoid duplication of effort and additional disruptive activities on the airport, extending the FTA Phase II groundwater assessment further south will first be based on use of the data developed for the Airport PFAS releases by their consultants. In addition, monitoring wells already installed to assess the Airport PFAS release will be utilized for gauging and sampling, as authorized by airport officials and as feasible. Suitable access has been assumed, see Section 3.5 below.

If groundwater assessment within the Airport property reveals significant PFAS impacts to groundwater that are likely associated with the Release at the former FTA, a supplemental program to assess groundwater further downgradient will be developed and implemented. Access to the monitoring wells located south of the Airport that are currently used for assessment of the Airport PFAS Release will be requested. Beyond that request, given the uncertainties involved, it is not feasible to define a groundwater assessment program further downgradient at this time. Such supplemental Phase II assessment will be developed at the appropriate time to address expanded groundwater assessment

further south and/or east, as warranted. Supplemental Phase II assessment will be conducted using methods and installations similar to those described in Sections 4.0 and 5.0 to define the extent of the FTA-related PFAS plume, as required by the MCP and relevant MCP policies and guidelines.

3.3.2 REGIONAL GROUNDWATER FLOW MODEL

As part of the Phase II comprehensive groundwater assessment, a numerical model of groundwater flow conditions from west of Flint Rock Pond to the Hyannis Water District's Maher Wells will be developed and calibrated. The model will be used to confirm, interpret, and interpolate groundwater gradients, flow directions and rates across the modeled area. In addition, it will be used to evaluate the fate and transport of PFAS across the study area.

3.4 ASSESSMENT OF PONDS

Assessment at Flintrock Pond will consist of:

- bathymetry survey and mapping;
- surface water sampling and extensive sediment sampling along transects across the pond;
- pore water sampling
- gauging or monitoring of surface water elevations;
- evaluation of pond water interactions with adjacent groundwater; and
- ecological risk assessment.

Assessment at Mary Dunn Pond will consist of:

- bathymetry survey and mapping;
- surface water and sediment sampling;
- evaluation of water elevations in relationship to elevations of adjacent groundwater; and
- ecological risk assessment.

The assessment of Mary Dunn Pond will be limited in comparison to that of Flintrock Pond because the only mechanism for PFAS from the former FTA to have impacted Mary Dunn Pond is via groundwater migration. There are no direct mechanisms by which AFFF used at the former FTA, residues from AFFF training on the former FTA, or runoff from the former FTA could have migrated to Mary Dunn Pond.

3.5 ASSUMPTIONS AND LIMITATIONS

The extended groundwater and surface water assessment activities and installations will require access to multiple parcels owned by the Town of Barnstable. Access and cooperation have been assumed based on the public comments received from the town. The FTA Site Phase II assessment will include evaluation of all data related to the Barnstable Airport PFAS releases.

As noted in 3.3.1, to avoid duplication of effort and intrusive/disruptive activities on the airport, FTA Phase II extended groundwater assessment will be based on use of the data developed for the Airport PFAS releases by their consultants. In addition, relevant monitoring wells already installed to assess the Airport PFAS releases will be utilized for FTA Phase II assessment, as feasible and appropriate. Access to all existing and viable monitoring wells on the Airport property related to the Airport PFAS releases for survey, gauging, and potential sampling has been assumed.

Access to the monitoring wells located south of the Airport that are currently used for assessment of the Airport PFAS Release will also be requested.

As noted above, if groundwater assessment north of, and within the Airport property reveals significant PFAS impacts to groundwater that are likely associated with the former FTA, groundwater further downgradient will be assessed. Given the magnitude of the uncertainties, it is not feasible to define the next phase of groundwater assessment at this time. Such supplemental Phase II assessment will be developed at the appropriate time to address and extend the results of the initial rounds of extended assessment.

3.6 ORGANIZATION OF PROPOSED PHASE II SCOPE OF WORK

Sections 4.0 through 11.0 of this document present the proposed tasks that comprise the Phase II CSA SOW. The sections are organized into major categories of assessment of environmental media or Site features (such as soil, groundwater, and surface water bodies), evaluations of exposures and risks, and evaluation of hydrogeologic conditions. The major categories selected were chosen to delineate the nature and extent of the PFAS Release at the FTA and assess the fate and transport of the FTA plume. Assessment is primarily based on the MCP regulatory requirements (as set forth in MCP 310 CMR 40.0833) and incorporation of public comment.

Proposed tasks are numbered sequentially across all sections.

4.0 PHASE II CSA SURFICIAL AND SUBSURFACE ASSESSMENT

4.1 SOIL ASSESSMENT

Recent and historic subsurface assessment revealed elevated concentrations of PFAS in soils, specifically within the vadose zone and/or at the water table interface, dominated at most locations by the PFOS, PFHxS, and PFDA compounds (PFAS compounds typical of a PFAS release from the use of AFFF). PFAS concentrations decrease with increasing depth below the vadose zone and are typically below the MCP Method 1 S-1 Soil Standards from 12 to 14 feet below ground surface (bgs).

The Cape Cod Commission and BETA have advanced a total of 37 soil borings and 5 test pits throughout the FTA property, including recent IRA assessment borings (January 2021). These activities have significantly increased the data on PFAS concentrations in soils on the facility. However, data gaps are identified for subsurface soils in limited locations on the former FTA itself and for shallow soils near the perimeter of the facility. Based on the existing PFAS data and historic fire training activities, only groundwater is believed to be significantly impacted downgradient of and away from the former FTA.

TASK 1.0 SUPPLEMENTAL SOIL BORINGS

Task 1 will focus primarily on further assessing PFAS impacts to vadose zone soils. BETA will conduct additional assessment in limited locations on the former FTA and at multiple locations in close proximity to it to further assess the nature and extent of the PFAS in soil and its influence on the groundwater PFAS contaminant plume.

Up to twelve (12) soil borings will be advanced on and immediately to the east and south of the former FTA property, with up to four (4) finished as monitoring wells (see Task 4 for additional discussion of monitoring well installations). **Figure 5** depicts the proposed boring locations. Soil borings will be advanced to a maximum depth of 15 feet with the exception of borings to be finished as monitoring wells, which will be advanced to depths of 15 to 20 feet bgs depending on drilling location and depth of groundwater.

Direct push drilling methods (Geoprobe) will be used; soil samples will be collected continuously via polyacetate sleeves and/or split spoon samplers.



During the Phase II soil boring assessment:

- a) Soil samples will be field screened and geologic descriptions will be logged.
- b) Soil samples will be collected at each borehole within the vadose zone at selected depths based on previous assessment data and Site history. Soil samples collected will be submitted for laboratory analysis of PFAS via ASTM Method 6978-17m, Total Organic Carbon, Total Iron, Total Manganese, pH, Conductivity, and ORP.
- c) All displaced soils will be placed back in the borehole.
- d) Horizontal GPS coordinates of each boring location will be logged.

TASK 2.0 SURFICIAL AND SHALLOW SOIL SAMPLING

To assess for PFAS impacts from possible aerial transport of AFFF or related aerosols during historic fire training exercises, Task 2.0 will include manual sampling of shallow soils along up to six 50 foot (approximate) long transects extending to the south or east from the existing fence line of the FTA. Approximate proposed locations of the transects are shown on **Figure 5**. Along each transect soil samples will be collected at zero, 10, 25 and 50 feet from the fence line of the FTA and from two depths at each location: from approximately 0 - 4 inches below grade (in the A horizon/topsoil below the forest mat, where present) and in the B horizon subsoil, approximately 12 to 20 inches bg. In addition, forest mat will be sampled for PFAS analysis at selected locations. Samples will be submitted for laboratory analysis of PFAS via ASTM Method 6978-17m², Total Organic Carbon, Total Iron, Total Manganese, pH, Conductivity, and ORP.

TASK 3.0 EXPLORATION OF HISTORIC AND CURRENT SUBSURFACE SITE FEATURES

In an effort to determine potential additional PFAS sources on the FTA property, BETA will oversee ground penetrating radar surveys at several locations in the central and northern portions of the former FTA facility to locate and potentially delineate: the septic system, existing basins reportedly used historically for recharge of treated groundwater, and potential locations of the historic burn pits. The results of the surveys will be documented and located via GPS surveying methods.

Depending on the results and observations of the survey and the nature of the feature, additional soil borings will be advanced through the locations to collect soil samples for observation, logging, and laboratory analysis of PFAS via ASTM Method 6978-17m, Extractable Petroleum Hydrocarbons by MassDEP Method EPH 2.1, Total Organic Carbon, Total Iron, Total Manganese, pH, Conductivity, and/or ORP.

4.2 GROUNDWATER MONITORING AND SUBSURFACE ASSESSMENT

During the Phase II CSA, groundwater monitoring will continue via the updated Site-wide, quarterly rounds of groundwater sampling and analyses featuring 12 or 20 monitoring wells depending on the quarter. Currently, quarterly sampling follows the 2018 MassDEP-approved plan (at a minimum): quarterly sampling of 12 selected monitoring wells (others may be added), and annual sampling of an

² The ASTM Method 6978-17m will be utilized for PFAS analysis in soil, sediment, solid media until US EPA Method 1633 becomes certified and available at certified commercial laboratories.

additional 8 monitoring wells (others may be added). The current groundwater monitoring program is included in **Appendix B** for informational purposes.

As new Phase II CSA monitoring wells are installed, they will be sampled by zone; see Tasks 4.0 and 5.0. Later in the Phase II program, a large, Site-wide sampling program will be conducted using new and existing monitoring wells across the study area; see Task 6.0.

The Phase II CSA will include a major expanded groundwater monitoring program. It will be conducted to:

- Spatially and geographically supplement the Site groundwater data, including west and south of Flintrock Pond, south of Mary Dunn Pond, and southeast of existing monitoring points PC-38 and PC-39 to the northern limits of the Airport property.
- Sample newly or recently installed monitoring wells.

BETA will review the existing available groundwater data to refine the current understanding of the nature and extent of the PFAS contamination that has been detected in Site groundwater and make final determinations regarding the number and specific locations of additional monitoring wells to be installed under Tasks 4.0 and 5.0 below.

Attached **Figure 5- Site Plan Detail Phase II CSA Proposed Sampling Plan** and attached **Figure 6- Site Plan Phase II CSA Proposed Sampling Plan** depict the limited number of proposed new monitoring well/boring locations within and in the vicinity of the former Fire Training Academy Facility that have been defined at this time; these planned installations are described in Tasks 4.1 and 4.3 below. A limited number of new wells will be installed west of Flintrock Pond; see subtask 4.3. The majority of new monitoring points will be installed under Task 5.0 at significant distances to the south and southeast of the former FTA. New monitoring wells will be installed south and southeast of the existing extensive monitoring wellfield, which currently extends approximately 1500 to 1900 feet southeast and east of the former FTA. See Task 5.0 for a description of the methodology.

TASK 4.0 MONITORING WELL INSTALLATIONS – VICINITY OF FORMER FIRE TRAINING ACADEMY FACILITY

Figure 5 - depicts the proposed new monitoring well/boring locations within and in the vicinity of the former FTA Facility that have been defined at this time; these installations are described in subtasks 4.1 and 4.3 below.

Wells will be installed using direct drive or hollow stem auger drilling methods. Monitoring wells will typically consist of the following construction details:

- Monitoring wells will be constructed as 2.0" diameter, schedule 40, Poly Vinyl Chloride (PVC) pipe; well sections are connected with a flush threaded joint;
- In shallow wells, well screens (slot size of 0.010) will typically be 10 feet in length and installed across the water table;
- In wells installed to sample deeper groundwater, well screens (slot size of 0.010) will typically be 5 feet in length installed at the desired depth in the saturated zone and sealed above the well screen .
- Well screens will be backfilled with washed silica sand and a bentonite pellet seal above the well screen. Well casings (steel standpipes) will be installed above at each monitoring well.

- The standpipes will be secured with keyed locks.

TASK 4.1 MONITORING WELL INSTALLATIONS -FORMER FTA FACILITY

As noted in Task 1.0, up to four (4) new borings installed for soil assessment purposes will be finished as monitoring wells on or near the FTA facility specifically adjacent to the septic system leaching field, on the northern portion of the facility, and south and east adjacent to the FTA facility. Drilling will be by direct push drilling methods. **Figure 5** depicts the proposed monitoring well/boring locations. The depicted proposed locations are subject to change.

TASK 4.2 MONITORING WELL INSTALLATIONS - WEST OF FLINTROCK POND

Up to four (4) standard, 2-inch PVC monitoring wells will be installed west of Flintrock Pond, including at least one couplet. General proposed locations are depicted on **Figure 6**. Final locations will be coordinated with the Barnstable Fire District.

TASK 4.3 REPLACEMENT AND IN-FILL WELLS – EXISTING WELL FIELD

One existing, key monitoring well, which is no longer functional, will be replaced. A couplet with one well screened at least 20 feet into the saturated zone will be installed at that location.

One couplet of new monitoring wells will be installed east of Mary Dunn Well #3 to improve spatial coverage around the well. **Figure 6** depicts the proposed monitoring well/boring locations.

TASK 5.0 EXPANDED GROUNDWATER MONITORING – SOUTHEAST OF FORMER FIRE TRAINING ACADEMY FACILITY

The Phase II CSA will include a major groundwater monitoring program conducted to the south and southeast of the former FTA, Flintrock Pond, and the existing extensive monitoring wellfield. The program will be based on methodically screening groundwater for PFAS, using those data in conjunction with groundwater gauging to select locations for permanent wells, followed by installation and sampling of permanent monitoring wells.

As noted in Section 3.5, the extended groundwater and surface water assessment activities and installations will require access to multiple parcels owned by the Town of Barnstable. Access and cooperation have been assumed. Task 5.0 includes coordination of such access. The extended groundwater assessment will also require access to multiple parcels that are privately owned. Task 5.0 includes communications, coordination, and negotiations to obtain access to privately-owned parcels, which will ultimately be dependent on the owners of those parcels.

Groundwater Sampling, Screening and Vertical Profiling

Use of groundwater screening and direct push drilling methods for sample collection to develop wide-area groundwater data and guide plume assessment has been noted by US EPA as cost effective and efficient, offering numerous advantages [US EPA, 2005 and US EPA, 2016]. Groundwater screening will be performed by direct push drilling methods primarily using small to medium-sized track-mounted rigs. In addition to overall efficiencies, the direct push drilling equipment will allow access to remote wooded locations with the least amount of disruption, thus lowering the environmental impacts of the Phase II assessment. Direct push tooling will be used to collect discrete groundwater samples from the saturated zone for laboratory analysis for PFAS. At selected locations, vertical profiling of the groundwater will be attempted with precautions taken to mitigate cross-contamination. Where possible, depth to groundwater will be gauge prior to sampling; groundwater depths will be considered approximate.

At each screening location, the drill stem and sampling tool will be driven to the approximate, anticipated depth of groundwater and the presence of groundwater will be checked. Depending on location, a groundwater sample will be withdrawn from within approximately five (5) feet of the piezometric surface of the groundwater using a newly exposed screen at the end of the drill stem. At selected locations, the probe will then be withdrawn for decontamination and driven again to point at least 15 to 20 deeper in the aquifer, from which another sample will be taken.

Screening borings/sampling points will be surveyed in the field using precision GPS measurements. Horizontal and vertical locations of the screening points and preliminary groundwater gauging will be used to initially calculate groundwater elevations and infer groundwater flow directions.

Groundwater screening will be organized into several large zones across the proposed expanded assessment area. The initially proposed zones are shown on Figures 7 and 8. The zones and their boundaries are shown for organizational and informational purposes only; they will be adjusted and revised according to property boundaries, access agreements, physical conditions, and the results of the screening. At this time, it is assumed that screening will progress approximately sequentially across the zones from northwest to southeast; however, screening may be conducted in several zones simultaneously.

Following the collection and analysis of screening groundwater samples in one or more zones, the data will be compiled, mapped, and evaluated. Based on these results, appropriate locations will be selected for installation of permanent wells. At most locations a couplet set of wells will be installed. Direct push or hollow-stem auger drilling methods will be used, depending on the required depths to reach groundwater and drilling and soil conditions. Monitoring wells will be installed as described in Task 4.

TASK 5.1 ACCESS COORDINATION

This task will include coordination of access with the town and related agencies, e.g., the Hyannis Water District. Preliminary screening locations and proposed access points will be developed and depicted on figures to inform the town of the requested access. Communications and coordination will then proceed to obtain access to the town-owned parcels. Task 5.1 also includes communications, coordination, and negotiations to obtain access to privately-owned parcels, which will ultimately be dependent on the owners of those parcels.

TASK 5.2 SOUTH AND SOUTHEAST OF FLINT ROCK POND AND EXISTING MONITORING WELLFIELD – ZONES 1, 2 & 3

The three zones within this approximately 30-acre area will be the initial focus of groundwater screening and permanent monitoring well installations. The area is mostly wooded with restricted access, but it is interrupted by industrial buildings with related parking areas and power lines with related easements.

Depending on access conditions, access agreements, topography, and spatial coverage, 20 to 25 locations will be selected for screening sampling. At each screening location, groundwater will be field screened for the standard field parameters; see Task 6.0. One or more groundwater samples will then be collected into appropriate laboratory supplied containers for submittal for analysis for PFAS via EPA Method 537 modified, Total and Dissolved Iron, Total Dissolved Solids, and/or Total Organic Carbon (TOC). As described in the introduction to Task 5.0, the analytical results, with the

preliminary groundwater elevation and flow inferences, will be used to locate permanent well installations.

Although the number and location of permanent wells to be installed in this area will be highly dependent on the results of the screening program, it is anticipated that eight (8) to ten (10) monitoring well installations (single or couplets depending on the location) will be installed. Immediately following installation, these permanent wells will be developed in accordance with standard practice and MassDEP protocols.

Sampling of all new monitoring wells in these zones will then be conducted using the protocols and analytical methods described in Task 6.0. This sampling will partially guide the groundwater screening and well installations in Zones 4 and 5 – see Task 5.3. Sampling of the new wells in Zones 1 through 3 will also be conducted later as described in Task 6.0.

TASK 5.3 AIRPORT WAY AND SOUTH/SOUTHEAST OF MARY DUNN POND – ZONES 4, 5 & 6

The three zones within this approximately 45-acre area will be subject to the groundwater screening and permanent well installation programs as discussed in Task 5.2. Assessment of Zone 4 will be dependent on the assessment of Zones 1 to 3; if PFAS impacts to groundwater related to the former FTA are detected in one or all of those zones, then a full screening program with related permanent well installations will be executed in Zone 4. Assessment of Zones 5 and 6 will be proceed somewhat independently.

Zones 4, 5 and 6 are heavily wooded with restricted access. Several sets of existing monitoring wells are present in Zone 5, including nested wells immediately south of Mary Dunn Pond and in the vicinity of the Airport Well. To avoid duplication of effort, access to those wells for gauging and sampling has been assumed.

Depending on access conditions, access agreements, topography, and spatial coverage, up to 25 locations (in total) will be selected for screening sampling in Zones 4, 5 & 6. At each screening location, groundwater will also be field screened for the standard field parameters as described in Task 6.0. One or more groundwater samples will then be collected into appropriate laboratory supplied containers for submittal for analysis for PFAS via EPA Method 537 modified, Dissolved Iron, Total Dissolved Solids, and Total Organic Carbon (TOC).

As described in the previous sections, the analytical results, with the preliminary groundwater elevation and flow inferences, will be used to locate permanent well installations. The number and location of permanent wells to be installed in this area will be highly dependent on the results of the screening program. At this time, it is anticipated that six (6) to eight (8) monitoring well installations (one or more wells per location) will be installed. As noted, there are three existing sets of monitoring wells in these zones. Immediately following installation, permanent wells will be developed in accordance with standard practice and MassDEP protocols.

Sampling of all new monitoring wells in these zones will then be conducted using the protocols and analytical methods described in Task 6.0. This sampling will establish baseline PFAS data that meets data quality objectives and will inform the evaluation of the need for additional groundwater assessment south and southeast of the airport. Sampling of the new wells in these zones will also be included in at least one Site-wide round of sampling described in Task 6.0.

TASK 5.4 BARNSTABLE AIRPORT GROUNDWATER MONITORING

As noted in Sections 3.3 and 3.5, monitoring groundwater via the existing monitoring wells in and near the identified PFAS release areas on the Barnstable Municipal Airport is proposed in this scope of work. Initial work will involve coordination of access with the airport authorities and their consultants. After obtaining access, selected existing airport monitoring wells will be gauged and sampled. If surveyed locations and elevations on the proper datum are not available for the selected wells, they will be located using precision GPS measurements.

- Sampling of up to 12 wells will be conducted via EPA Low Flow Method Rev. 4, a reference to this method is included in Appendix C. The standard groundwater quality field parameters (pH, dissolved oxygen, oxidation- reduction potential (ORP), specific conductivity , temperature, and turbidity) will be recorded in-situ during purging and sampling and specific PFAS sampling methods and protocols will be employed.
- Groundwater samples will be submitted for laboratory analysis for PFAS via EPA Method 537 modified, Total Dissolved Solids, Dissolved Iron, and Total Organic Carbon (TOC). Samples from selected monitoring locations will also be analyzed using EPA Method 533 to increase the list of PFAS compounds and precursor analytes. If Draft EPA Method 1633 is finalized and becomes commercially available, selected representative samples will analyzed by Method 1633, rather than Method 533. Additional parameters (through various methods) may be added as necessary to help in assessing the fate and transport of the contaminant plume.

TASK 6.0 PHASE II CSA SITE-WIDE GROUNDWATER MONITORING

As noted in Task 5.0, newly installed monitoring wells will be sampled after they are completed and developed across an assessment zone. Following that sampling, a minimum of one full round of the expanded, Site-wide Phase II CSA groundwater monitoring program will be conducted. BETA will sample the wells listed as annual monitoring points and the newly installed monitoring wells, in order to more accurately delineate and monitor the groundwater contaminant plume. If time allows, a second expanded Site-wide round of groundwater monitoring will be conducted during a different groundwater season.

Groundwater monitoring as part of this Phase II CSA will include:

- a) Gauging of all wells to be sampled prior to purging for sampling.
- b) Groundwater sampling conducted via EPA Low Flow Method Rev. 4, a reference to this method is included in Appendix C. The standard groundwater quality field parameters (pH, dissolved oxygen, oxidation- reduction potential (ORP), specific conductivity , temperature, and turbidity) will be recorded in-situ during purging and sampling.
- c) Collection of samples for PFAS and other parameters directly into laboratory-prepared containers employing specific PFAS sampling methods and protocols.
- d) Submitting groundwater samples from approximately 45 to 50 monitoring wells for laboratory analysis for PFAS via EPA Method 537 modified, Total Dissolved Solids, Dissolved Iron, and Total Organic Carbon (TOC). If Draft EPA Method 1633 is finalized and becomes commercially available, selected representative samples will analyzed by Method 1633, rather than Method 537 M.

Additional parameters (through various methods) will be added as necessary to help in assessing the fate and transport of the contaminant plume.

- e) Analyzing selected, representative samples using EPA Method 533 analytical method (in addition to 537 M) to assess for the presence of a larger number of PFAS compounds.
- f) Analyzing a limited set of representative samples using a commercially available Total Oxidizable Precursor analytical method to assess for the presence of fluorotelomer precursors that have been documented to degrade and/or transform to other PFAS compounds³.

As noted, primary PFAS analysis of groundwater will be by US EPA Method 537 as modified for groundwater to provide continuity to the large data set already generated for the Site. In addition, samples from selected monitoring locations will also be analyzed using EPA Method 533 to increase the list of PFAS compounds and precursor analytes while relying on nationally accepted and approved laboratory methods. If, during the conduct of the Phase II CSA, the newly released Draft EPA Method 1633 is finalized and commercially available, selected representative samples will also be analyzed by Method 1633, rather than Method 533.

TASK 7.0 COMPREHENSIVE COMPILATION AND EVALUATION OF GROUNDWATER ANALYTICAL DATA

All groundwater analytical data will be collected, compiled into expanded tables, and reviewed for data usability and representativeness, data quality control, and Phase II CSA data objectives. Contaminant plume maps will be prepared and updated based on new data.

Selected data from across the study area will be compiled, graphed, and evaluated using a larger set of analytical parameter results than the PFAS 6 compounds. GHD Inc. will provide expertise and guidance in evaluating the collected groundwater data with respect to PFAS profiling and forensics. The probable origins and potential fate and transport of PFAS will be evaluated based on published scientific research. As warranted, forensic data and libraries of PFAS profiles from national and international research organizations will be utilized to evaluate the differences/similarities of the PFAS detected in samples across the study area, the probable origins/product sources of the PFAS, and the potential effects of transport and transformation on the PFAS across the study area.

These data and evaluations will be utilized in Task 10.0 to model the fate and transport of PFAS across the study area.

5.0 HYDROGEOLOGICAL ASSESSMENT

BETA in conjunction with Bristol Engineering will conduct a Site-wide hydrogeologic assessment with focuses on addressing the following concerns:

- potential PFAS migration: from the FTA and Flintrock Pond to the east, southeast, south and west towards the Barnstable Fire District (BFD) public water supply wells;
- the interactions and potential migration between the water in Flintrock Pond and the underlying and adjacent groundwater; and

³ [PFAS Total Oxidizable Precursor Assay \(TOP Assay\) - Eurofins Scientific](#)

- the fate and transport of the current PFAS plume as it relates to the municipal wells to the east and southeast of the FTA and Mary Dunn Pond.

This hydrogeologic assessment will be conducted in conjunction with and in support of numerical groundwater modelling of the aquifer throughout the study area. The model will improve the estimation of key hydrogeologic parameters throughout the aquifer.

The model will support later evaluation of increased groundwater pumping from the Site as part of the design alternatives for the expansion of the current groundwater pumping and treatment system. Such pumping evaluations will be conducted during later phases of the project and are not included in the Phase II CSA scope of work.

All collected data will be compiled and reviewed in conjunction with Bristol Engineering.

The hydrogeologic assessment described in this section, in particular, the modelling efforts, will be partially dependent on obtaining reasonably detailed pumping records for the municipal wells in question.

TASK 8.0 SITE-WIDE HYDROGEOLOGICAL ASSESSMENT

- a) Update the hydrogeologic evaluation of Site conditions by collecting groundwater gauging data from new and existing monitoring wells, calculating elevations, developing groundwater contour plots, and inferring groundwater flow direction from elevation data.
- b) Review available USGS data, studies, and reports, including Zone II Study reports. Review hydrogeologic characteristics, history, components, design capacity and actual flow rates of existing groundwater pumping systems (if data are available and if operation will continue in the future). This review will focus on Mary Dunn Wells 1, 2 and 3, the Airport Well, and Barnstable Fire District Well #5.
- c) Conduct hydraulic testing at new and/or existing monitoring wells with appropriate evaluation of overall hydrogeology and aquifer characteristics. The aquifer response and estimated yields, groundwater flow directions and rates, and PFAS concentrations in the groundwater will be important factors in the later evaluation of IRA expanded groundwater recovery and comprehensive remedial response actions.
- d) Obtain horizontal GPS coordinates and elevations of all identified relevant existing monitoring wells (not already surveyed) and all new monitoring wells using precision GPS methods. Precision land survey will be conducted of the horizontal and vertical locations of a selected number of existing and new monitoring wells in representative locations across the study area. These data will be used to verify the results of the precision GPS survey.
- e) Up to four (4) piezometers will be installed beneath the sediment layer of Flintrock Pond; this work will be conducted in conjunction with the overall pond assessment (Task 11.0.) The piezometers will be gauged during quarterly groundwater gauging (groundwater sampling rounds.) A semi-permanent transducer installation will be implemented in Flintrock Pond to provide for continuous monitoring of pond elevation and evaluating vertical component of

groundwater flow. Groundwater elevations and inferred flow from the pond to the underlying and adjacent groundwater will be calculated.

TASK 9.0 HYDROGEOLOGICAL ASSESSMENT WEST OF FLINTROCK POND

BETA in conjunction with Bristol Engineering recently conducted a preliminary assessment of groundwater conditions west of Flintrock Pond. As the next step in this assessment, Phase II CSA monitoring wells will be installed west of Flintrock Pond on BFD property under Task 4.2. The preliminary proposed locations (approximate only) are depicted in **Figure 5**. Specific locations will be determined following additional research. Following the installation of new monitoring wells, the following work will be conducted under Task 9.0.

- a) Groundwater will be sampled from the new monitoring wells and several existing monitoring wells (if they are judged to be suitable) via EPA Low Flow Method Rev. 4. Standard groundwater quality parameters will be monitored in-situ during purging and sampling.
- b) Groundwater samples will be collected into appropriate containers using specific PFAS sampling methods and protocols.
- c) Collected groundwater samples will be submitted for laboratory analysis for PFAS via EPA Method 537 modified, Dissolved Iron, Total Organic Carbon (TOC). Additional parameters will be added as necessary to help in assessing the fate and transport of the contaminant plume.
- d) Horizontal and vertical locations of the new and several existing monitoring wells will be determined using precision GPS measurements.
- e) The hydrogeologic evaluation of groundwater conditions west of the Site will be updated by collecting groundwater gauging data and calculating groundwater elevation contours, flow direction and gradients. These data will also be used in the study-area numerical model of the aquifer under Task 10.0.

TASK 10.0 NUMERICAL MODELING OF PFAS PLUME FATE AND TRANSPORT

The USGS and others have developed and updated several numerical groundwater flow models of various geographic regions of Barnstable. Versions of these models have been used by various parties to depict the flow and fate of groundwater and various groundwater contaminants in recent years. Using site-specific data gathered in the Phase II CSA, the USGS model will be refined to better depict the local groundwater flow patterns in the vicinity of the former FTA, Mary Dunn wells, Mary Dunn Pond, Flintrock Pond and downgradient. The intent of this modeling is to update previous modeling performed by prior representatives of the County and to assess the limit and extent of the FTA PFAS release plume.

The accuracy of the modeling effort will depend greatly on the availability of the detailed pumping records for all municipal wells within the study area. The Hyannis Water District has provided monthly pumping data for certain wells. We anticipate obtaining and using similar updated data as the study proceeds.

Research into the fate of PFAS in groundwater, i.e., retardation factors, dispersion, etc., is ongoing. In conjunction with Task 7.0, the project team will continue to evaluate the state of the research on these factors and will incorporate the available and peer-reviewed information on the relevant fate and

transport parameters into the Task 10.0 model to assess the potential extent of PFAS migration across the study area.

6.0 FLINTROCK POND ASSESSMENT

Flintrock Pond is a typical, small shallow Cape Cod kettle pond with no inlet or outlet streams and no man-made controls. There is no known public access to the pond. It is approximately 6.5 acres in area. Water depths have yet to be studied methodically; available information indicates shallow slopes along the perimeter with maximum depths of 8 to 10 feet at high water.

The Phase II CSA assessment of Flintrock Pond will include:

- sediment, porewater, and surface water sampling and analyses,
- hydrogeologic evaluations, bathymetry survey and mapping on the same datum as the Site; and
- ecological risk characterization to meet Phase II objectives and MCP requirements.

Extensive sediment sampling will be performed to more comprehensively assess the nature, extent, fate, and transport (as feasible) of PFAS contamination in the pond to meet Phase II requirements, support environmental risk characterization, and support Phase III remedial alternative evaluations. This assessment will also support compliance with the Order of Conditions: Special Conditions of Approval (SE3-5606) issued by the Barnstable Conservation Commission in October 2018.

The Pond's hydrogeological interaction with the underlying and adjacent groundwater and/or role in the fate and transport of the PFAS will be evaluated. The potential interactions and transport of PFAS between the pond sediment, sediment porewater, and underlying groundwater are extremely complex, not conclusively understood or defined by the scientific community, and the subject of current academic and government research. The Phase II CSA will attempt to assess and define these interactions within the pond based on the current PFAS research and available recognized published scientific data.

PFAS are "emerging contaminants" and scientific data are continuously evolving. Currently, significant scientific information indicates that PFAS are highly stable compounds that are persistent in the environment due to the chemical composition of the PFAS compounds, specifically the carbon-fluorine bond. These characteristics indicate that frequently repeated sediment sampling in similar locations may be of limited utility. The historic and most recent sediment sampling data obtained from Flintrock Pond support this hypothesis; PFAS concentrations have not significantly changed between sampling rounds. However, spatial data on sediment concentrations as well as thickness of sediment, PFAS concentrations in granular soil below the pond sediment, and other related data are identified as data gaps for the Site. Therefore, additional sampling, especially spatially, will be conducted (Task 11.1) to complete the overall conceptual site model and evaluate remedial alternatives for the pond component of the Disposal Site during later phases of the project.

Sediment porewater is a major route of exposure to contaminants for many benthic organisms. Contaminants in porewater can be transported to the water column by a variety of processes, thus also potentially exposing fish or other aquatic species in the water column. Therefore, in addition to the laboratory analysis of whole sediment samples, selected sediment samples will be processed by the laboratory using established laboratory techniques to separate the porewater from the solids. A standard analytical method for PFAS will then be run on the separated porewater. See Task 11.2.

TASK 11.1 BATHYMETRY SURVEY

BETA will coordinate with a specialty subconsultant to conduct bathymetric survey and mapping of Flintrock Pond. The survey will be conducted using appropriate scanning technology and will result in a map of the pond bottom with elevations and horizontal locations presented based on the standard datum for Site mapping.

TASK 11.2 SEDIMENT ASSESSMENT

Sediment data collected to date from Flintrock Pond has been from 40 to 60 ft. long transects off the eastern shoreline and 10 to 25 feet from the northeastern bank. The proposed Phase II assessment includes collecting samples across the pond from north to south and east to west, to the extent feasible. Sediment samples will be primarily collected from the top 0-6 inches of sediment where contaminants are most readily bioavailable.

BETA will coordinate with Barnstable County on the means to conduct the transect sampling; cable crossings or similar means to move a small float or a boat systematically across the pond from which samples will be obtained from documented semi-permanent locations across the Pond. Two (2) transects, one crossing from the north to the south (approximately 700 feet) and the other from east to west (approximately 450 feet) will be used. See attached **Figure 5** Phase II CSA Sampling Plan for the proposed transects/crossings. Sediment sampling is proposed on a 50 linear foot spacing. BETA will collect a total of approximately 25 sediment samples, including at up to 3 locations where an attempt will be made to penetrate the sediment layer and sample the sediment as well as the granular soil below it.

The samples will be collected for laboratory analysis of PFAS6 via ASTM Method 6978-17m, Total Organic Carbon, and Total Iron. If the draft EPA Method 1633 is finalized and commercially available prior to the sediment sampling effort, sediment samples will be analyzed using that method. pH, Conductivity, and ORP will be measured in the field. The total solids content will also be measured as a standard part of the laboratory analysis.

TASK 11.3 POREWATER ASSESSMENT

During the sediment assessment, porewater will also be assessed separately using sediment collected from some of the same locations described in Task 11.2. Porewater samples will be prepared from selected sediment samples in the laboratory. Up to 12 porewater samples will be prepared. The sediment porewater samples will laboratory extracted/separated and analyzed for PFAS6 via USEPA Method 537 modified. Select porewater samples may also be submitted for the laboratory analysis of Total Organic Carbon and Total Iron. Analytical results will be used to support the ecological risk assessment by developing a better understanding of the bioavailability of the PFAS6.

TASK 11.4 SURFACE WATER ASSESSMENT

Surface water will be collected along the proposed transects. Surface water samples collected in October 2020 were collected approximately 100 feet from the shoreline and at approximately 6 inches and 36 inches below the surface of the Pond. The results from these samples were not significantly different from one another; however, this is a small data set. Due to the hydrophobic and hydrophilic nature of PFAS, BETA is proposing to assess the Pond's water column by collecting water samples at various depths within the Pond for the laboratory analysis of PFAS. A total of six

(6) surface water samples will be collected and submitted for PFAS analysis via EPA Method 537M; the samples will be collected from multiple depths in the pond.

TASK 11.5 FISH TISSUE SAMPLING AND ASSESSMENT

In conjunction with the sampling of the environmental media of Flintrock Pond, evaluation of the presence and species of fish in Flintrock Pond will be performed by a qualified zoologist. If fish are present and can be caught, up to 10 fish will be collected and submitted to a laboratory for fish tissue analysis. The samples will be analyzed for the presence of PFAS using currently available and certified analytical methods.

TASK 12.0 ASSESSMENT OF UNNAMED WATER BODY NORTH OF FTA

A very small water body with associated bordering vegetated wetlands is present approximately 100 feet north of the entrance to the FTA, north of Flint Rock Road. Concerns have been raised regarding possible runoff migration from the FTA to the water body, although direct drainage patterns are not definitive. Phase II CSA environmental assessment of the water body will include collection of up to 3 sediment samples and one water sample. Sediment samples will be submitted for laboratory analysis of PFAS6 via ASTM Method 6978-17m, Total Organic Carbon, and Total Iron. pH, Conductivity, and ORP will be measured in the field.

7.0 MARY DUNN POND ASSESSMENT

Mary Dunn Pond is also a typical, shallow Cape Cod kettle pond with no inlet or outlet streams and no man-made controls. It is approximately 10 acres in area. Water depths are not known to have been studied methodically.

The Phase II assessment of Mary Dunn will include:

- sediment, sediment porewater, and surface water sampling and analyses;
- hydrogeologic evaluations, bathymetry survey and mapping; and
- ecological risk characterization (to meet Phase II objectives and MCP requirements).

Sediment and water column sampling will be performed to generally characterize the extent of PFAS contamination in the pond and support environmental risk characterization. The Pond's hydrogeological interaction with adjacent groundwater will be evaluated. The assessment of Mary Dunn Pond will be similar to the assessment conducted at Flintrock Pond. However, it will be limited in comparison to Flintrock Pond due to lack of direct mechanisms by which AFFF used on the former FTA could have migrated to Mary Dunn Pond. The only route for PFAS migrating from the former FTA to have impacted Mary Dunn Pond is via groundwater.

TASK 13.1 BATHYMETRY SURVEY

BETA will coordinate with a specialty subconsultant to conduct bathymetric survey and mapping of Mary Dunn Pond. The survey will be conducted using appropriate scanning technology and will result in a map of the pond bottom with elevations and horizontal locations presented on the standard datum for Site mapping.

TASK 13.2 SEDIMENT ASSESSMENT

The proposed Phase II assessment includes collecting samples across the entire width of the pond.

Sediment samples will be primarily collected from the top 0-6 inches of sediment. BETA will collect sediment samples from a small boat or float along one east to west (approximately 450 feet) transect across the pond. Sediment sample locations will be documented via precision GPS measurements. Sediment sampling will be conducted on 50 linear foot spacing.

The samples will be collected for laboratory analysis of PFAS6 via ASTM Method 6978-17m, Total Organic Carbon, and Total Iron. If the draft EPA Method 1633 is finalized prior to the sediment sampling effort, sediment samples will be analyzed using that method. pH, Conductivity, and ORP will be measured in the field. The total solids content will also be measured as standard part of the laboratory analysis.

TASK 13.3 POREWATER ASSESSMENT

During the sediment assessment, porewater samples will be prepared from selected sediment samples collected from the transect locations across the pond. Up to three (3) porewater samples will be prepared. The sediment porewater samples will laboratory extracted/separated and analyzed for PFAS6 via USEPA Method 537 modified. Select porewater samples may also be submitted for the laboratory analysis of Total Organic Carbon, and Total Iron.

TASK 13.4 SURFACE WATER ASSESSMENT

In conjunction with the sediment assessment, surface water will be collected along the proposed transect. Due to the hydrophobic and hydrophilic nature of PFAS, the assessment of the pond's water column will be performed by collecting water samples at the surface and one or two depths at specific sampling locations. Up to four (4) surface water samples will be submitted for PFAS analysis via EPA Method 537M.

8.0 ECOLOGICAL RISK ASSESSMENT

The CSA scope of work will comply with the environmental risk characterization requirements of the Phase II including at CMR 310 40.0830 and particularly at 40.0995. Both Stage I and II environmental risk screening are included in the proposed scope of work if needed. However, in accordance with the MCP and based on Site-specific criteria, a stepwise approach is proposed that may obviate the need for the Stage II risk screening. If substantial harm is detected during the Stage I screening and/or if hydrogeologic and groundwater quality assessment indicate that the surface water, sediment, or sediment porewater is substantially contributing significant PFAS impacts to the underlying or adjacent groundwater (thus indicating the need for remedial actions), the Stage II environmental risk screening may not be conducted or may be truncated.

TASK 14.0 ECOLOGICAL RISK ASSESSMENT

In accordance with 310 CMR 40.0995, a Stage I and Stage II ecological risk assessment (ERA) will be conducted at the Site. The risk assessment will be undertaken in stepwise/iterative fashion to rapidly identify if readily apparent harm and unacceptable ecological risk from exposure to environmental media (i.e., surface water, sediment, and soil) are present.

The risk analysis phase of the ecological risk assessment (ERA) will be conducted by GHD Services, Inc. . The risk analysis will incorporate the Phase II CSA pond media assessments and will characterize the potential ecological exposure and effects (if any) from detected contamination. The ecological exposure assessment involves the identification of potential exposure pathways and the evaluation of the magnitude of exposure of potential ecological receptors. The ecological effects assessment evaluates

the potential adverse effects associated with exposure to chemicals of potential ecological concern (COPEC)s by ecological receptors and reflects specific assessment endpoints. The risk assessment will incorporate and summarize the surface water, sediment, sediment porewater, and fish tissue data (if fish are present in Flintrock Pond) collected throughout the Phase II CSA.

The results of the ecological risk analysis will be analyzed and interpreted to determine the likelihood of adverse environmental effects, and to determine whether a conclusion of no significant risk can be reached for each assessment endpoint evaluated.

The ERA will integrate a variety of methodologies to assess potential ecological risks. The conclusions regarding overall risk(s) to ecological receptors will be based on a weight-of-evidence approach, which will consider the results of all components of the assessment methodology (i.e., an approach that integrates results of physical, biological, toxicological, and field measurement endpoints to draw risk-based conclusions). The weight-of-evidence components will be designed to provide measures of potential risks for different ecological receptors and exposure pathways. Details outlining the methodology and reasoning behind the ecological risk assessment are included in the full proposed ecological risk assessment scope of work in **Appendix C**.

9.0 CONCEPTUAL SITE MODEL

TASK 15 DEVELOP PHASE II CSA CONCEPTUAL SITE MODEL

In accordance with 310 CMR 40.0830, the Phase II CSA is developed and evaluated to support conclusions and opinions regarding: the source, nature, extent, migration pathways and potential impacts of releases of oil and/or hazardous material for the development of the Disposal Site Conceptual Site Model (CSM). As part of the Phase II CSA, BETA will thoroughly evaluate the results and provide reasoning to support the development of the CSM for the Site. The CSM will be documented and evaluated as part of the conclusions of the Phase II CSA report

10.0 METHOD 3 RISK CHARACTERIZATION – HUMAN HEALTH, SAFETY AND PUBLIC WELFARE

TASK 16 COORDINATE AND PREPARE METHOD 3 RISK CHARACTERIZATION

A Method 3 risk characterization (M3RC) will be conducted in accordance with 310 CMR 40.0900 and will characterize the risk associated with the current identified PFAS contamination at the Site to all human receptors. The M3RC will also address risks to safety and public welfare. Environmental risk will be characterized under tasks described in Section 6.0. This risk characterization will be the first iterative characterization at the Site that will aid in determining the comprehensive remedial actions as part of the subsequent Phase III Remedial Action Plan. BETA will coordinate with a selected subconsultant who will conduct the risk characterization. The risk characterization will also include an updated Imminent Hazard evaluation in accordance with MCP requirements.

11.0 REPORT PREPARATION

TASK 17 PREPARE PHASE II CSA REPORT

Following the completion of the Phase II SOW/Assessment activities, BETA and the County will review and evaluate the collected data and prepare a comprehensive report detailing the results and



conclusions of the Phase II CSA. Per the requirements of 310 CMR 40.0835, the report will present all relevant information (maps, graphs, tables, and appendices), findings, and opinions related to the CSA. Additionally, the Phase II CSA report will present the environmental fate and transport, nature and extent, and exposure assessment, as appropriate and present the risk characterization.

Public Involvement

The Phase II CSA report will initially be submitted as a Public Comment Draft document subject to public comment per the requirements of the final Public Involvement Plan for the Site. In accordance with the finalized *Public Involvement Plan*, dated June 2019, this drafted document will be subject to the following process:

1. Notification will be provided to those listed on the Site's public involvement mailing list of the Phase II CSA reports availability.
2. Being made available for public review via the Barnstable County's website and placement at the Hyannis Public Library.
3. Conducting a public involvement meeting (virtual if required by continuing public health concerns) to present findings and conclusions documented in the Draft Phase II CSA.
4. Solicitation of public comments for a minimum 20 calendar day period. Public comments will be incorporated into the final Phase II CSA as appropriate and feasible.

12.0 SCHEDULE OF IMPLEMENTATION

Phase II Site assessment work will proceed after the receipt of any comments and/or approval or conditional approval of this Phase II CSA SOW by MassDEP. Initial assessment work to be conducted will focus on soil and groundwater assessment and monitoring as well as Flintrock Pond. In addition to the Phase II CSA, BETA (on behalf of the County) will continue to conduct quarterly groundwater sampling, oversee the operation of the groundwater treatment systems, submit MCP IRA Status and RMR Reports to MassDEP.

Following the submission of this final Phase II CSA SOW BETA anticipates the Phase II CSA will proceed as follows:

Task or Component	Public Comment Period or MassDEP Review	Implementation: Anticipated start – anticipated completion
Submit final Phase II CSA Scope of Work		March 2022
Approved Phase II CSA Scope of Work – Project Start	21 days	Early April 2022
Soil Assessment – Tasks 1.0 to 3.0 (Section 4.1)	NA	April and May 2022 ⁽¹⁾
Section 4.2 – Groundwater Monitoring and Assessment – Tasks 4.0 through 7.0 (Section 4.2)	NA	May through October 2022 ⁽²⁾
Hydrogeological Assessment – Tasks 8.0 to 10.0 (Section 5.0)	NA –	September through December 2022 ⁽³⁾
Surface Water Assessments—Tasks 11.0, 12.0 and 13.0 (Sections 6.0 & 7.0)	NA	April through June 2022 ⁽⁴⁾
Ecological Assessment – Task 14.0 (Section 8.0)	NA	May through August 2022 ⁽⁴⁾
Method 3 Human Health Risk Characterization – Task 16 (Section 10)	NA	November and December 2022
Public Comment Draft Phase II CSA Report – Tasks 15.0 & 17.0 (Sections 9.0 & 11.0)	NA	November 2022 through January 2023 ⁽⁵⁾
Final Phase II CSA	30-day public comment period	March through April 2023 ⁽⁵⁾

Notes:

1. Dependent on weather conditions and access approvals for off-property locations.
2. Approximate period for conducting extended groundwater assessment to the northern extent of the Barnstable Municipal Airport property. Dependent on obtaining access to municipal and private properties. Additional assessment south or east of the Airport, if needed, will most likely require additional time to conduct beyond the schedule shown here.
3. Dependent on completion of key components of groundwater assessment and obtaining municipal well pumping records.
4. Dependent on weather conditions (general weather) and access approvals for off-property locations.
5. Assumes that assessment south or east of Barnstable Airport is not required.

REFERENCES

Groundwater Sampling and Monitoring with Direct Push Technologies: US EPA Office of Solid Waste and Emergency Response, August 2005/OSWER No. 9200.1-51/EPA 540/R-04/005

Expedited Site Assessment Tools for Underground Storage Tank Sites, A Guide for Regulators: US EPA Land and Emergency Management, October 2016/EPA 510-B-16-004

FIGURES

Figure 1: Site Locus Map

Figure 2: Key Plan

Figure 3: Massachusetts GIS Priority Resource Map

Figure 4: Site Plan



Figure 1

Site Location

Barnstable County Fire & Rescue
 Training Academy
 155 South Flint Rock Road
 Hyannis, Massachusetts

MassDEP - Bureau of Waste Site Cleanup

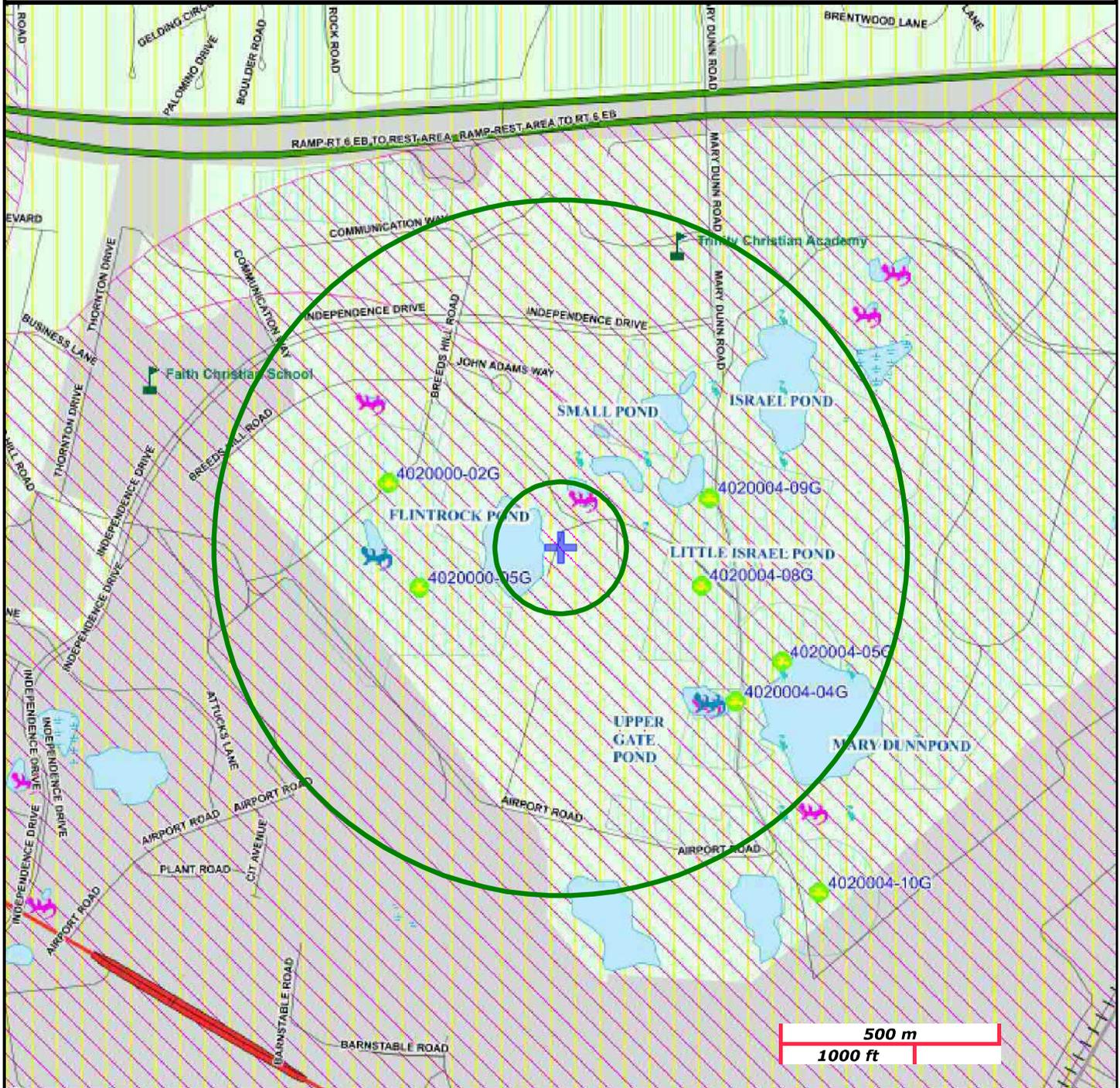
Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

FIGURE 2

Site Information:

BARNSTABLE COUNTY FIRE & RESCUE TRAINING ACADEMY
155 SOUTH FLINT ROCK ROAD BARNSTABLE, MA
4-000026179
NAD83 UTM Meters:
4614868mN , 393038mE (Zone: 19)
April 23, 2021

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>.



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail	PWS Protection Areas: Zone II, IWPA, Zone A		
Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct	Hydrography: Open Water, PWS Reservoir, Tidal Flat		
Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam	Wetlands: Freshwater, Saltwater, Cranberry Bog		
Aquifers: Medium Yield, High Yield, EPA Sole Source	FEMA 100yr Floodplain; Protected Open Space; ACEC		
Non Potential Drinking Water Source Area: Medium, High (Yield)	Est. Rare Wetland Wildlife Hab; Vernal Pool: Cert., Potential		
	Solid Waste Landfill; PWS: Com. GW, SW, Emerg., Non-Com		

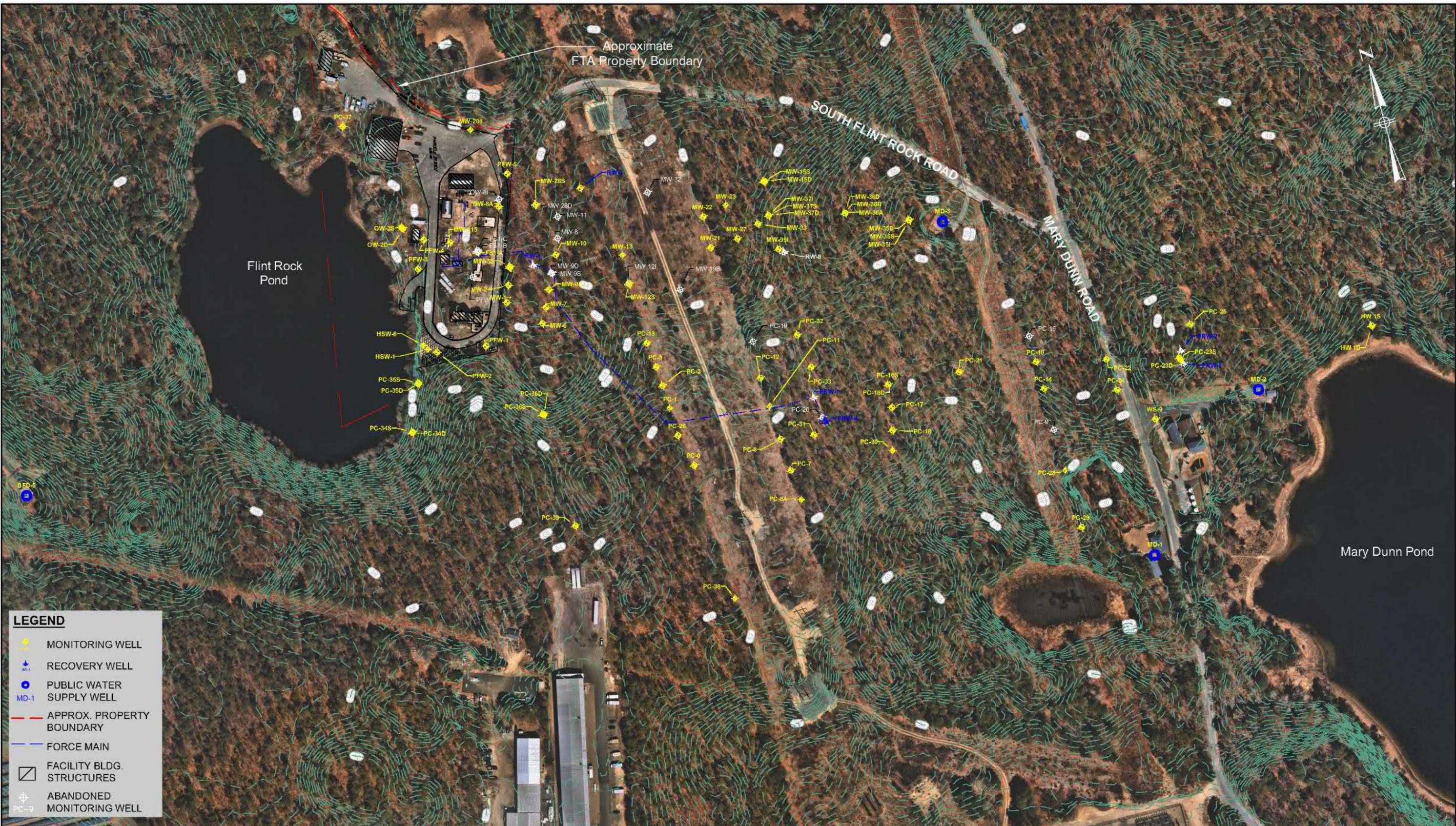


www.BETA-Inc.com

FORMER BARNSTABLE COUNTY
FIRE & RESCUE TRAINING ACADEMY
BARNSTABLE, MA
RTN 4-26179

FIGURE 3
SITE PLAN DETAIL

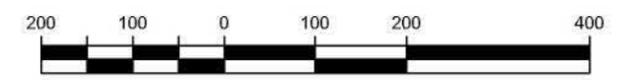
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LEGEND

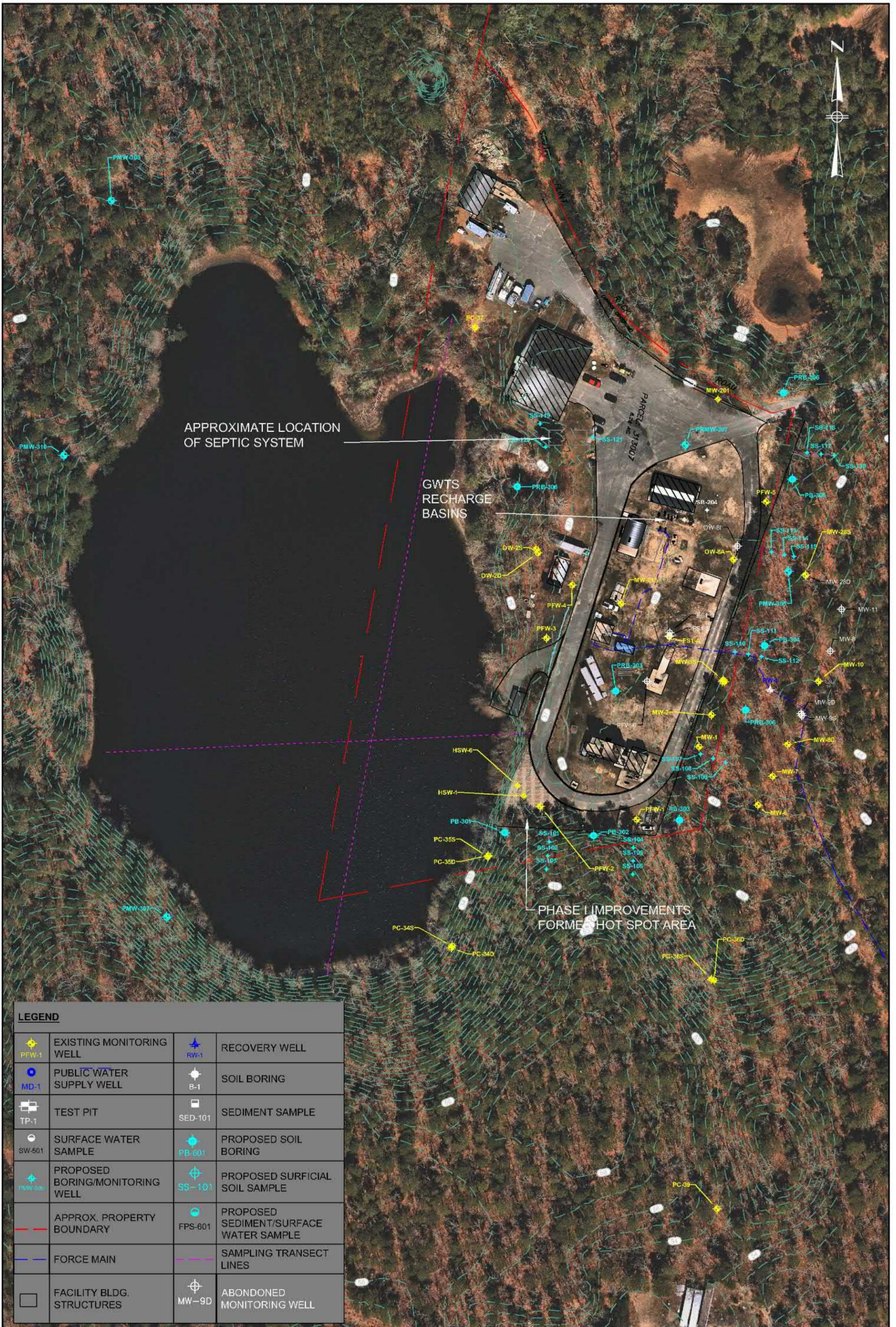
	MONITORING WELL
	RECOVERY WELL
	PUBLIC WATER SUPPLY WELL
	APPROX. PROPERTY BOUNDARY
	FORCE MAIN
	FACILITY BLDG. STRUCTURES
	ABANDONED MONITORING WELL

FIGURE 4 - SITE PLAN
 Former Barnstable County Fire & Rescue Training Academy
 155 South Flint Rock Road, Barnstable, MA



(IN FEET)
 1 inch = 200 ft.





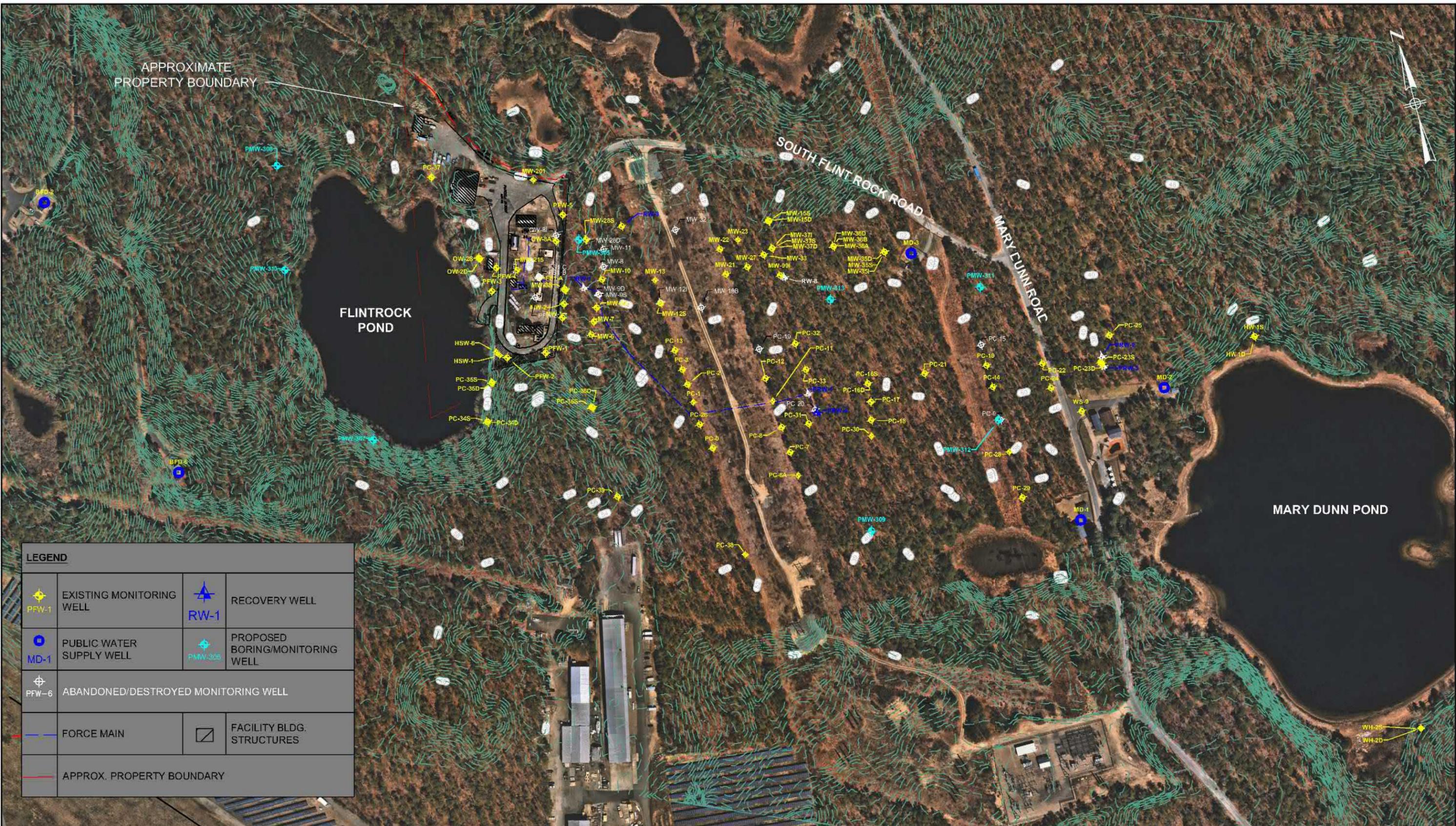
LEGEND			
PFW-1	EXISTING MONITORING WELL	RW-1	RECOVERY WELL
MD-1	PUBLIC WATER SUPPLY WELL	B-1	SOIL BORING
TP-1	TEST PIT	SED-101	SEDIMENT SAMPLE
SW-501	SURFACE WATER SAMPLE	PB-601	PROPOSED SOIL BORING
MW-300	PROPOSED BORING/MONITORING WELL	SS-101	PROPOSED SURFICIAL SOIL SAMPLE
	APPROX. PROPERTY BOUNDARY	FPS-601	PROPOSED SEDIMENT/SURFACE WATER SAMPLE
	FORCE MAIN		SAMPLING TRANSECT LINES
	FACILITY BLDG. STRUCTURES	MW-9D	ABANDONED MONITORING WELL



FORMER BARNSTABLE COUNTY
 FIRE & RESCUE TRAINING ACADEMY
 BARNSTABLE, MA
 RTN 4-26179

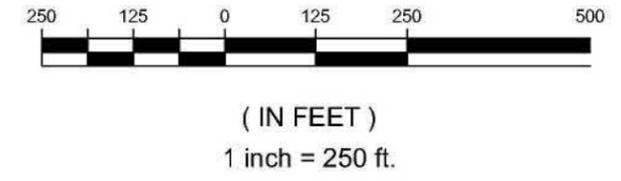
FIGURE 5
 SITE PLAN DETAIL
 PHASE II CSA PROPOSED
 SAMPLING PLAN

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LEGEND			
	EXISTING MONITORING WELL PFW-1		RECOVERY WELL RW-1
	PUBLIC WATER SUPPLY WELL MD-1		PROPOSED BORING/MONITORING WELL PMW-305
	ABANDONED/DESTROYED MONITORING WELL PFW-6		
	FORCE MAIN		FACILITY BLDG. STRUCTURES
	APPROX. PROPERTY BOUNDARY		

FIGURE 6 - SITE PLAN
PHASE II CSA PROPOSED SAMPLING PLAN
 Former Barnstable County Fire & Rescue Training Academy



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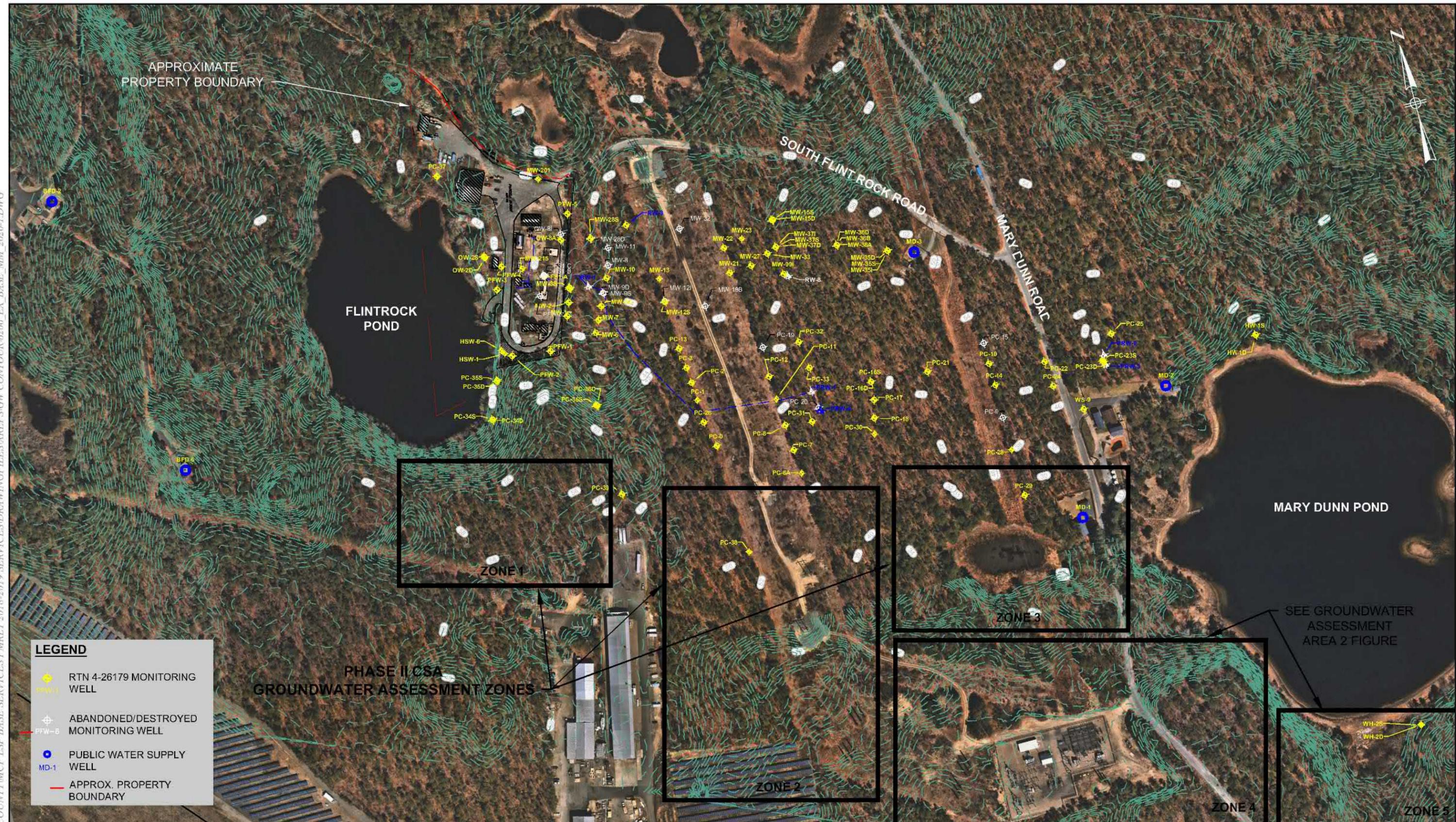
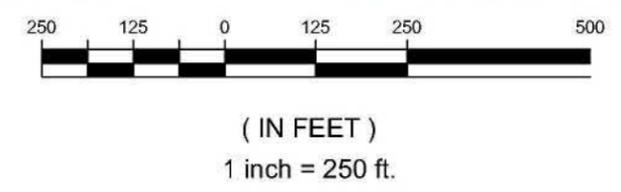
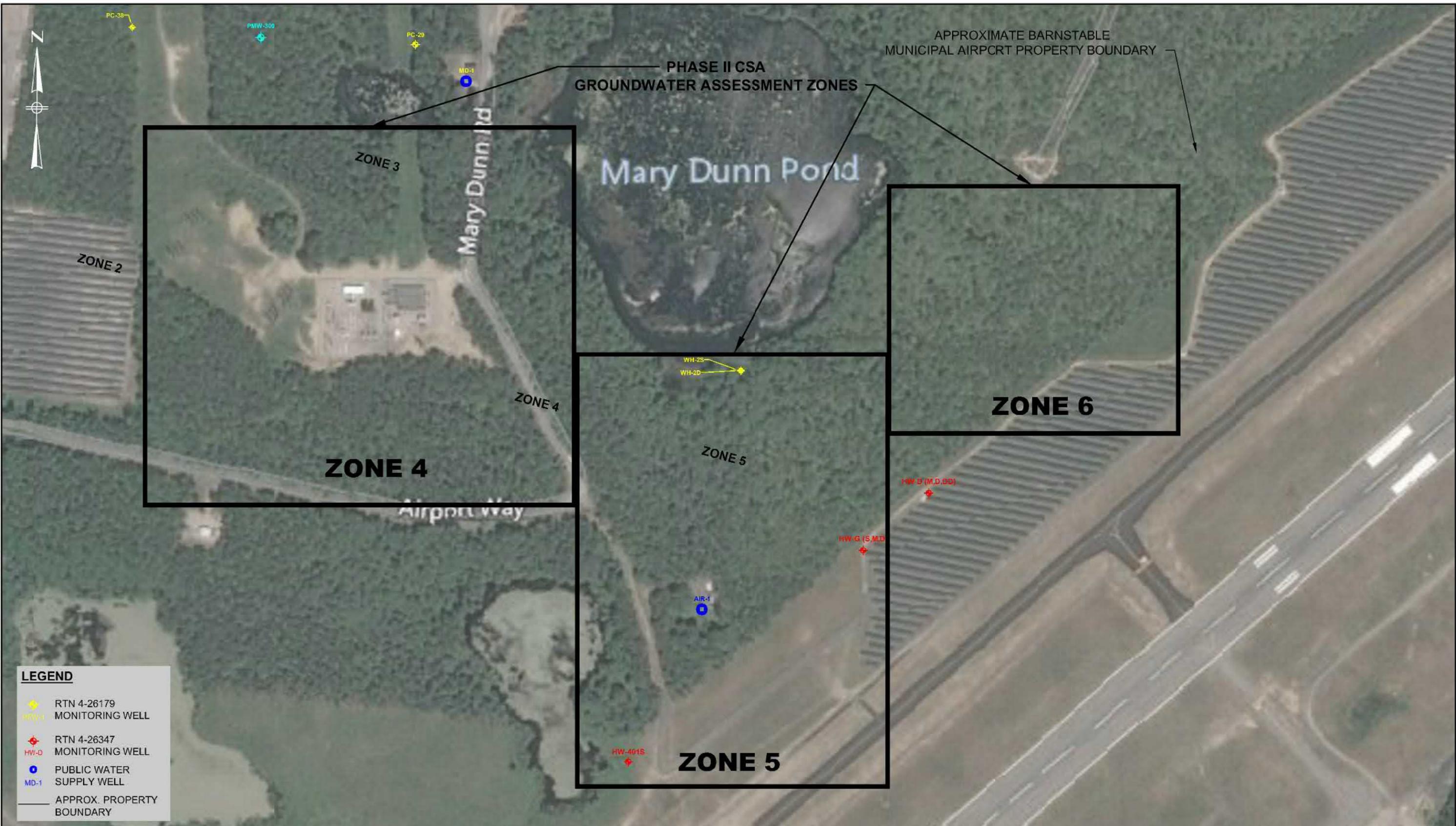


FIGURE 7
PHASE II CSA SCOPE OF WORK
GROUNDWATER ASSESSMENT AREA 1 MAP
 Former Barnstable County Fire & Rescue Training Academy
 RTN 4-26179



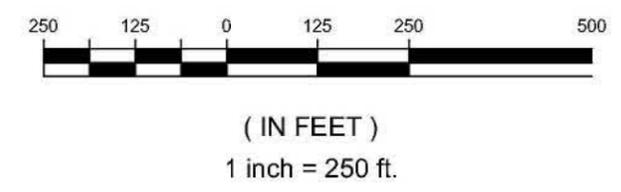
K:\0206 BARNSTABLE COUNTY\MCP LSP BASE SERVICES FMRLY 2018-2019 SERVICES\DRAWINGFILES\XREFS\GW CONTOUR\0206_EX_BASE_MM_2020-1.DWG



LEGEND

- ◆ RTN 4-26179 MONITORING WELL
- ◆ RTN 4-26347 MONITORING WELL
- PUBLIC WATER SUPPLY WELL
- APPROX. PROPERTY BOUNDARY

FIGURE 8
PHASE II CSA SCOPE OF WORK
GROUNDWATER ASSESSMENT AREA 2 MAP
 Former Barnstable County Fire & Rescue Training Academy
 RTN 4-26179



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APPENDIX A



TIER CLASSIFICATION TRANSMITTAL FORM
Pursuant to 310 CMR 40.0500 (Subpart E)

Release Tracking Number

4 - 26179

A. DISPOSAL SITE LOCATION:

1. Disposal Site Name: BARNSTABLE COUNTY FIRE TRAINING ACADEMY

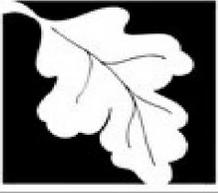
2. Street Address: 155 SOUTH FLINT ROCK ROAD

3. City/Town: BARNSTABLE 4. ZIP Code: 026300000

5. Coordinates: Latitude: N _____ Longitude: W _____

B. THIS FORM IS BEING USED TO: (check all that apply)

1. Submit a new **Tier Classification Submittal**, including a **Tier Classification Compliance History** (BWSC107B).
Check the tier classification category:
- a. Tier I b. Tier II
- c. Check all Tier I criteria that apply, pursuant to 310 CMR 40.0520(2):
- i. Groundwater is located within an Interim Wellhead Protection Area, Zone II, or within 500 feet of a Private Water Supply Well, and there is evidence of groundwater contamination by an Oil or Hazardous Material at the time of Tier Classification at concentrations equal to or exceeding the applicable RCGW-1 Reportable Concentration set forth in 310 CMR 40.0360.
 - ii. An Imminent Hazard is present at the time of Tier Classification.
 - iii. One or more remedial actions are required as part of an Immediate Response Action pursuant to 310 CMR 40.0414(2).
 - iv. One or more response actions are required as part of an Immediate Response Action to eliminate or mitigate a Critical Exposure Pathway pursuant to 310 CMR 40.0414(3).
- d. Check here if including an **Eligible Person, Eligible Tenant, or Other Person Certification** (BWSC107D)
2. Submit a **Phase I Completion Statement** as per 310 CMR 40.0480.
If previously submitted, provide date _____
mm/dd/yyyy
3. Submit a **Phase II Scope of Work** as per 310 CMR 40.0834.
If previously submitted, provide date 7/16/2021
mm/dd/yyyy
4. Submit a **Phase II Conceptual Scope of Work supporting a Tier Classification Submittal**.
5. Submit a **Tier Classification Extension Submittal** for Response Actions at a Tier Classified Site including the **Tier Classification Compliance History** (BWSC107B).
6. Submit a Tier Classification Transfer Submittal for a change in person(s) undertaking Response Actions at a Tier Classified Site including the **Tier Classification Compliance History** (BWSC107B) and the **Tier Classification Transferor Certification** (BWSC107C).
Proposed effective date of transfer : _____
mm/dd/yyyy



TIER CLASSIFICATION TRANSMITTAL FORM

Pursuant to 310 CMR 40.0500 (Subpart E)

Release Tracking Number

4 - 26179

B. THIS FORM IS BEING USED TO: (cont.)

7. Submit a **Revised Tier Classification Submittal**.

Check the revised Tier Classification Category. If the Tier Classification Category is not changing, indicate the current classification.

- a. Tier I
- b. Tier II

c. Check all Tier I criteria that apply, pursuant to 310 CMR 40.0520(2):

- i. Groundwater is located within an Interim Wellhead Protection Area, Zone II, or within 500 feet of a Private Water Supply Well, and there is evidence of groundwater contamination by an Oil or Hazardous Material at the time of Tier Classification at concentrations equal to or exceeding the applicable RCGW-1 Reportable Concentration set forth in 310 CMR 40.0360.
- ii. An Imminent Hazard is present at the time of Tier Classification.
- iii. One or more remedial actions are required as part of an Immediate Response Action pursuant to 310 CMR 40.0414(2).
- iv. One or more response actions are required as part of an Immediate Response Action to eliminate or mitigate a Critical Exposure Pathway pursuant to 310 CMR 40.0414(3).

d. Check here if including an **Eligible Person, Eligible Tenant, or Other Person Certification** (BWSC107D)

8. Provide a **Notice that an additional Release Tracking Number(s) is (are) being linked to this Tier Classified Site** (Primary RTN). Future response actions addressing the Release or Threat of Release notification condition associated with additional Release Tracking Numbers (RTNs) will be conducted as part of the Response Actions planned or ongoing at the Primary Site listed above. For a previously Tier Classified Primary Site, if there is a reasonable likelihood that the addition of the new secondary RTN(s) would change the classification of the site, a **Revised Tier Classification Submittal** must also be made.

Provide Release Tracking Number(s): a. - b. -

All future Response Actions must occur according to the deadlines applicable to the Primary RTN. Use only the Primary RTN when making future submittals for this site unless specifically relating to response actions started before the linking occurred.



TIER CLASSIFICATION TRANSMITTAL FORM

Pursuant to 310 CMR 40.0500 (Subpart E)

Release Tracking Number

4 - 26179

C. LSP SIGNATURE AND STAMP:

I attest under the pains and penalties of perjury that I have personally examined and am familiar with this transmittal form, including any and all documents accompanying this submittal. In my professional opinion and judgment based upon application of (i) the standard of care in 309 CMR 4.02(1), (ii) the applicable provisions of 309 CMR 4.02(2) and (3), and 309 CMR 4.03(2), and (iii) the provisions of 309 CMR 4.03(3), to the best of my knowledge, information and belief,

> if Section B of this form indicates that a **Tier Classification Submittal** is being submitted, this Tier Classification Submittal has been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a **Phase I Completion Statement** is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed and implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a **Phase II Scope of Work** is being submitted, the response action(s) that is (are) the subject of this submittal (i) has (have) been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal;

> if Section B of this form indicates that a **Tier Classification Extension Submittal** or a **Tier Classification Transfer Submittal** is being submitted, the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) complies(y) with the identified provisions of all orders, permits, and approvals identified in this submittal.

I am aware that significant penalties may result, including, but not limited to, possible fines and imprisonment, if I submit information which I know to be false, inaccurate or materially incomplete.

1. LSP#: 1443

2. First Name: ROGERP

3. Last Name: THIBALT

4. Telephone: 508-331-2700

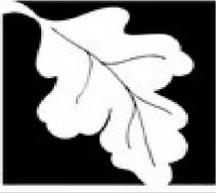
5. Ext.: _____

6. Email: _____

7. Signature: _____

8. Date: _____
mm/dd/yyyy

9. LSP Stamp:



TIER CLASSIFICATION TRANSMITTAL FORM

Pursuant to 310 CMR 40.0500 (Subpart E)

Release Tracking Number

4 - 26179

G. CERTIFICATION OF PERSON MAKING SUBMITTAL:

1. I, _____, attest under the pains and penalties of perjury (i) that I have personally examined and am familiar with the information contained in this submittal, including any and all documents accompanying this transmittal form, (ii) that, based on my inquiry of those individuals immediately responsible for obtaining the information, the material information contained in this submittal is, to the best of my knowledge and belief, true, accurate and complete, and (iii) that I am fully authorized to make this attestation on behalf of the entity legally responsible for this submittal. I/the person or entity on whose behalf this submittal is made am/is aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate, or incomplete information.

If submitting a Tier II Classification, Extension or Transfer, I also attest under the pains and penalties of perjury that (i) I/the person(s) or entity(ies) on whose behalf this submittal is made has/have personally examined and am/is familiar with the requirements of M.G.L. c. 21E and 310 CMR 40.0000; (ii) based upon my inquiry of the/those Licensed Site Professional(s) employed or engaged to render Professional Services for the disposal site which is the subject of this Transmittal Form and of the person(s) or entity(ies) on whose behalf this submittal is made, and my/that person's(s') or entity's(ies') understanding as to the estimated costs of necessary response actions, that/those person(s) or entity(ies) has/have the technical, financial and legal ability to proceed with response actions for such site in accordance with M.G.L. c. 21E, 310 CMR 40.0000 and other applicable requirements; and (iii) that I am fully authorized to make this attestation on behalf of the person(s) or entity(ies) legally responsible for this submittal. I/the person(s) or entity(ies) on whose behalf this submittal is made is aware of the requirements in 310 CMR 40.0172 for notifying the Department in the event that I/the person(s) or entity(ies) on whose behalf this submittal is made learn(s) that it/they is/are unable to proceed with the necessary response actions.

2. By: _____ 3. Title: _____
Signature

4. For: BARNSTABLE COUNTY COMMISSIONERS 5. Date: _____
(Name of person or entity recorded in Section D) mm/dd/yyyy

6. Check here if the address of the person providing certification is different from address recorded in Section D.

7. Street: _____

8. City/Town: _____ 9. State: _____ 10. ZIP Code: _____

11. Telephone: _____ 12. Ext.: _____ 13. Email: _____

YOU ARE SUBJECT TO AN ANNUAL COMPLIANCE ASSURANCE FEE OF UP TO \$10,000 PER BILLABLE YEAR FOR THIS DISPOSAL SITE. YOU MUST LEGIBLY COMPLETE ALL RELEVANT SECTIONS OF THIS FORM OR DEP MAY RETURN THE DOCUMENT AS INCOMPLETE. IF YOU SUBMIT AN INCOMPLETE FORM, YOU MAY BE PENALIZED FOR MISSING A REQUIRED DEADLINE.

Date Stamp (DEP USE ONLY):



**Statement of Provisions
Attachment To:**

BWSC 107 – Tier Classification Transmittal Form:

RTN 4-26179

**Barnstable County Fire & Rescue Training Academy
(FTA)
155 South Flint Rock Road
Hyannis, MA 02630**

Section F, Item 1

The FTA facility was donated to the Town of Barnstable by the Cobb Trust in 1955, when it began to be used as a fire training area. The current owner-of-record is the County of Barnstable, which acquired the Site from the Town in 1983. The FTA has been used for public safety training since the 1950's. Fires (for training purposes) were ignited and then extinguished with water CO₂, and/or aqueous film-forming foam (AFFF). The FTA has been used and continues to be used for public safety training by fire departments and fire districts from throughout Barnstable County, fire departments outside of Barnstable County, and other public and private institutions.

Under the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) for "emerging contaminants" in public water supplies, samples collected from three of the Town of Barnstable Mary Dunn public water supply wells were analyzed for PFAS (PFOS and PFOA) in November 2013. Analytical results revealed evidence of PFOS contamination in all three wells sampled. Subsequently, Barnstable County collected soils and groundwater samples from the FTA, which is located west and likely upgradient of the Mary Dunn wells. Groundwater analytical results revealed that FTA groundwater was impacted by PFOS and MassDEP was notified.

In 2015, Barnstable County funded an initial hydrogeological assessment, implementation of a groundwater pump and treat system to capture PFOS upgradient of the Mary Dunn wells, and additional assessment and immediate response actions.

Massachusetts Department of Environmental Protection (MassDEP) issued a Notice of Responsibility (NOR) to Barnstable County on August 4, 2016. MassDEP determined that the releases of PFAS from the use of AFFF at the FTA is a source of PFAS affecting the water supply of the Mary Dunn wells.

MassDEP requested Immediate Response Action (IRA) response actions to include:

- Evaluation of potential Imminent Hazards.
- Assessment and monitoring of nearby public and private water supply wells.
- Prevention, elimination, and/or abate of any hazards associated with the
- consumption of drinking water impacted by PFAS above the USEPA Health Advisory (HA) level of 0.07 µg/L¹.
- Excavation and off-site removal of impacted soils located in a "hot spot" area; and/or expansion of the existing groundwater recovery and treatment system.

¹ Since MassDEP finalization of the MCP Method 1 groundwater standards for PFAS and Maximum Contaminant Limit (MCL) for PFAS in drinking water in December 2019 and October 2020 respectively, current and future IRA response actions implemented at the Site will address the groundwater and drinking water impacted by PFAS above the Method 1 groundwater standards and drinking water MCL. The Method 1 groundwater standards and MCL supersede the USEPA HA.

MassDEP issued a *Notice of Audit Findings - Immediate Response Action Field Inspection and Request For IRA Modification/Interim Deadline* on June 1, 2018 (NOAF/Request For IRA Modification). In the NOAF/Request For IRA Modification MassDEP indicated that the IRAs currently being conducted at the Site are in compliance with the relevant regulations and the IRA.

Plan previously submitted. However, the NOAF/Request For IRA Modification indicated that MassDEP had determined that additional IRA response actions are necessary at the Site to minimize continued mobilization of contaminants.

MassDEP required the submittal of an IRA Plan Modification that incorporates the installation of drainage controls and/or construction of berms, dikes or impoundments at the Site to prevent stormwater and/or water from fire training activities from entering the Hot Spot area. The IRA Plan Modification was to be submitted to MassDEP on or before June 29, 2018. The IRA Plan was submitted on June 29, 2018 and subsequently executed in December 2018 through March 2019 following local permitting by the Town of Barnstable Conservation Commission.

MassDEP issued a *Notice of Audit Findings/Compliance and Technical Assistance /Interim Deadline* dated November 21, 2018 (NOAF/Interim Deadline). The evaluations and additional information required by the NOAF/Interim Deadline document were presented in Immediate Response Action (IRA) Status and Remedial Monitoring Report (RMR) No. 27, submitted on February 28, 2019. In the February Status report, planned actions to address breakthrough of PFAS from the activated carbon were described, as was a long-term groundwater monitoring plan.

The November 21, 2018 NOAF/Interim Deadline required the evaluation of the feasibility of an expansion of groundwater pumping and treatment, and, if an expansion is feasible, a definitive IRA Plan Modification for such expansion must be presented in the next full IRA Status Report scheduled for August 2019. Expanding the existing groundwater recovery and treatment system, both in terms of pumping rate and locations, was evaluated and judged to be feasible. Based on limited funds available, a short-term expansion of groundwater pumping and treatment, was judged to likely be financially feasible to implement within the required time frame dictated by the November 21, 2018 NOAF/Interim Deadline.

The NOAF/Interim Deadline also required the evaluation of the feasibility of placing a more robust cap over the former Hot Spot area and the Fire Training Area. If such capping measures are feasible, a definitive IRA Plan Modification for such capping must be presented in the next full IRA Status Report scheduled for August 2019. The implementation of a more robust cap system in the Hot Spot area was considered not feasible, in the opinion of Barnstable County or BETA, based on the very recent implementation of a cap system in the Hot Spot area. The implementation of a more robust cap system over portions of or most of the FTA training area was considered not feasible within the time frame specified in the NOAF/Interim Deadline, in the opinion of Barnstable County or BETA, based on multiple factors.

MassDEP issued a *Request For Expedited IRA Plan Modification/Interim Deadline Enforcement Document No. 00006694* on May 1, 2019. In this document, MassDEP requested that the County submit an expedited IRA Plan Modification by June 28, 2019 including detailed plans to expand the groundwater recovery and treatment system and for capping measures to prevent infiltration of precipitation through PFAS-contaminated soil at the Site. On June 3, 2019, the County submitted a formal request to restore the original IRA Plan Modification Deadline to August 28, 2019, indicating that it was not technically feasible to meet the expedited deadline and that the Public Involvement Plan for the Site required that the document be a public comment draft only. The letter was submitted to MassDEP via the eDEP system. The County later received email response by MassDEP indicating that the County's request was accepted and the deadline for the IRA Plan Modification was restored to August 28, 2019.

Following the receipt of public comment, the IRA Plan Modification was finalized and submitted to DEP on December 20, 2019 and DEP contingently approved of the capping design. On November 10, 2020 following the submission of a *Notice of Intent* to The Barnstable Conservation Commission in February 2020, the Conservation approved of the capping design and the public hearing was closed. On December 30, 2020, The Barnstable Conservation Commission approved the design with the implementation of the *Order of Conditions: Special Conditions of Approval (SE3-5772)*. This December 2019 IRA Plan Modification was the second IRA Plan modification proposed and approved for the Disposal Site and will therefore be described as IRA Plan Modification No. 2.

Final design and local permitting proceeded for the capping component of the IRA Plan Modification. However, based on the public comment received during the Town of Barnstable Conservation Commission approval process and the decision by the County to permanently end live-fire training at the FTA, the County opted to include the demolition of the two former, live-fire training buildings at the FTA as part of the capping project. Based on the decision to upgrade the project by including select building demolition, MassDEP requested the filing of an IRA Plan Modification. Therefore, following the receipt of public comment, the IRA Plan Modification No. 3 was finalized and submitted to DEP on June 22, 2021 as an amendment to both the original (September 2016) IRA Plan and the December 2019 IRA Plan Modification. IRA Plan Modification No. 3 presents the select building demolition design revisions to the capping IRA plan. In addition, several minor additions to the capping project, added during the local approval process, are included in this IRA Plan Modification. Construction for the capping and select demolition project is started in late August 2021 and completed at the end of October 2021.

APPENDIX B

Table 1 - Long-Term Groundwater Monitoring Locations
 Barnstable County Fire Training Academy PFAS Release Site - RTN 4-26179
 Proposed Long-Term Monitoring Locations

As of February 2019										
Mon. Wells Sampled - February & June 2018 ⁽²⁾								Proposed Long-Term Quarterly Monitoring Locations		
Well ID	Location	Feb-18			Jun-18			Proposed Long-Term Quarterly Mon. Wells	Proposed Additional Mon. Wells for Annual Rd. ⁽⁴⁾⁽⁵⁾	Rationale
		PFOS [ng/L]	PFOA [ng/L]	Total Five PFAs [ng/L]	PFOS [ng/L]	PFOA [ng/L]	Total Five PFAs [ng/L]			
HSW-6/HS-2(a)	FTA	25,000	160	25,160	950	15	1,006	X*		* Either, or for Quarterly Mon. - HS-1(a) is approx. 15 ft. away
HSW-1/HS-1(a)	FTA	13000	320	13320	--	--	--		X*	* Either, or for Quarterly Mon. - HS-2(a) is approx. 15 feet away.
PFW-1	FTA	8100	470	8570	76000	1500	89410	X		Downgradient of fmr. hot spot - key location.
PFW-2	FTA	32000	400	32400	--	--	--		X	[within 25 ft. of HS-2(a)]
OW-8A	FTA	--	--	--	2800	65	3468	X		General coverage (FTA) & downgradient of recharge galleries
PFW-5	FTA	--	--	--	--	--	--	X		General coverage (FTA) & previous detections
PFW-6	FTA	--	--	--	--	--	--		X	Centrally located in FTA.
"Primary" PFAS Plume:										
PC-1	West of PTLE ⁽³⁾	9000	370	9370	10000	190	11380	X		Central plume monitoring.
PC-6A	East of PTLE ⁽³⁾	--	--	--	1300	60	1790	X		Central plume monitoring.
PC-11	East of PTLE ⁽³⁾	4000	180	4180	9600	250	11780	X		Central plume monitoring.
PC-36	SE of FTA	--	--	--	--	--	--		X	Central plume monitoring.
Downgradient of Recovery Well:										
PC-16d	East of PRW-4	980	64	1044	1900	150	2990	X		Plume and recovery monitoring.
PC-18	East of PRW-4	890	70	960	--	--	--		X	Plume and recovery monitoring.
PC-30	East of PRW-4	1900	98	1998	1600	99	2419	X		Plume and recovery monitoring.
PC-28	East of PRW-4	--	--	--	--	--	--	X		Plume and recovery monitoring.
PC-9	East of PRW-4	--	--	--	--	--	--		X	Plume and recovery monitoring.
Other:										
MW-12	northerly	--	--	--	3000	280	4666	X		Monitor in direction of MD-3
MW-22	northerly	--	--	--	320	30	502	X		Monitor in direction of MD-3
MW-35	northeasterly close to Mary Dunn Pond								X	Monitor in direction of MD-3
HW-1D or 1S									X	groundwater reported to be upgradient of Mary Dunn Pond
								Total = 12	Total = 8 ⁽⁴⁾	Quarterly monitoring - 12 mon. wells. Annual monitoring - 20 mon. wells. See note 4.

Notes:

1. FTA = within the Barnstable County Fire Training Academy facility.
2. Not all wells sampled on these dates are listed or were selected for future monitoring; see February 2018 and June 2018 Status Reports for details.
3. PTLE = Power Transmission Line Easement (the larger easement with central access road.)
4. Eight additional monitoring wells to be included in annual sampling round. Optional additional wells (greater than 8) may be included for specific monitoring purposes.
5. Additional monitoring wells do NOT include wells required for Petroleum Hydrocarbon Release (RTN 4-190) annual monitoring.

APPENDIX C

Ecological Risk Assessment Scope of Work, prepared by GHD



Ecological Risk Assessment Scope of Work

Barnstable County Fire and Rescue
Training Academy
Barnstable, MA

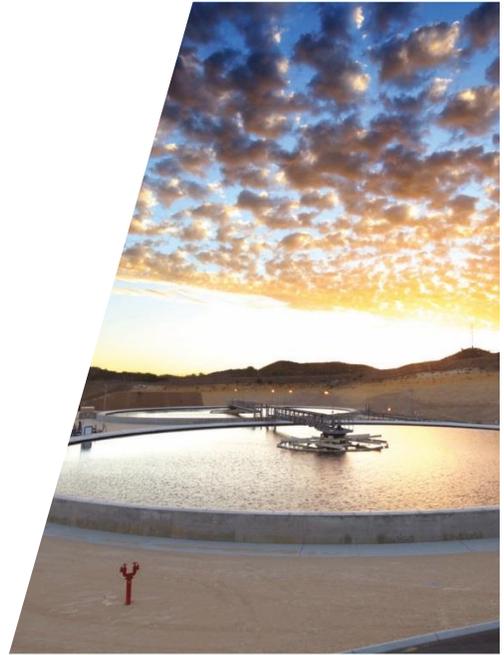




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1. Introduction

1.1 Purpose

This document presents the Baseline Ecological Risk Assessment (BERA) Scope of Work as part of the Phase II Comprehensive Site Assessment (CSA) Scope of Work related to known poly- and perfluoroalkyl substances (PFAS) contamination at the Barnstable County Fire and Rescue Training Academy (BCFRTA or “the Site”) located at 155 South Flint Rock Road in Barnstable, Massachusetts. This release has been assigned Release Tracking Number (RTN) 4-26179.

An Imminent Hazard (IH) condition and Condition of Substantial Release Migration for human health were identified previously for the Site and include PFAS, commonly referred to as the PFAS 6. These include perfluorooctane sulfonic acid (PFOS); perfluorooctanoic acid (PFOA); perfluorohexane sulfonic acid (PFHxS); perfluorononanoic acid (PFNA); perfluoroheptanoic acid (PFHpA), and perfluorodecanoic acid (PFDA).

This ecological risk assessment will be undertaken in stepwise fashion to rapidly identify unacceptable ecological risk from exposure to environmental media (i.e., surface water, sediment, and soil), should it exist. Each stage will be used to inform the Site investigation and remediation strategy, and ultimately, the remediation itself, as necessary.

2. Stage I Ecological Screening

As prescribed in 310 CMR 40.0995, the risk of harm to the site biota and habitats will be characterized by evaluating ecological parameters using a two-stage approach. A Stage I ecological screening will be undertaken to determine if a potentially significant exposure pathway is indicated by the available information per 310 CMR 40.0995(3)(a) and (c). If so, a Stage II Environmental Risk Characterization will be required to characterize the risks posed by those exposures.

As part of the Stage I ecological screening, a qualified biologist will characterize the site biota and habitats and use available evidence to determine whether there is current or potential future exposure of Environmental Receptors to contamination at site. The biologist will evaluate historical records, available site data, field observations, statements by present and past residents or employees, and any other relevant source. Evidence of current or potential exposure will be evaluated per 310 CMR 40.0995(3)(a). If any current or potential future exposure is identified through this process, then for each such exposure, site conditions will be evaluated to determine whether significant environmental harm is “readily apparent” based on the requirements under CMR 310 40.099(3)(b).

If readily apparent harm is not determined, each current and potential future exposure Pathway identified in 310 CMR 40.0995(3)(a) will be evaluated to determine whether it could result in potentially significant exposure. 310 CMR 40.00995(3)(c)(1) provides screening criteria that can be used identify a ‘potentially significant exposure.’ None of these screening sources contain criteria for the assessment of environmental impacts of PFAS. As such, GHD will research available screening criteria adopted by other states or countries for PFAS. These criteria will be then used to evaluate whether there are potential exposures. If current or potential future exposures to contaminants in



any media are not ruled out in this Stage I Screening, those exposures will be considered to be “potentially significant exposures” and a Stage II Environmental Risk Characterization will be undertaken to determine whether a condition of “no significant risk of harm” exists.

3. Stage II Ecological Risk Assessment

It is anticipated that the Stage I ecological screening will necessitate the initiation of a Stage II risk assessment and characterization of ecological risk. The Stage II risk assessment will be conducted in close coordination with the investigation activities being undertaken as part of the Phase II CSA. Those activities will be used to inform the Stage II risk assessment and assist in determining whether specific tasks are necessary.

However, in accordance with the MCP and based on Site-specific criteria, a stepwise approach is proposed that may obviate the need to complete a Stage II study. If hydrogeologic and groundwater quality assessment indicate that the surface water, sediment or sediment pore water is substantially contributing significant PFAS impacts to the underlying or adjacent groundwater, thus indicating the need for remedial actions, some aspects of the Stage II risk assessment may not be conducted.

The following sections provide an outline for the Stage II ecological risk assessment.

3.1 Problem Formulation

3.1.1 Ecological Conceptual Site Model

As noted above, a Site visit will be conducted by a qualified biologist. As part of this visit, the biologist will use available information to develop an ecological conceptual site model (CSM), which is needed to identify the ecological assessment endpoints. Assessment endpoints are “an explicit expression of the environmental value to be protected, operationally defined as an ecological entity and its attributes” (USEPA 1998a). A representation of the links between the following will be developed:

- Contaminants and sources
- Fate and transport of chemicals of potential ecological concern (COPECs)
- Potential ecological receptors
- Exposure pathways

Based on the Phase I Initial Site Investigation Report and Tier Classification Submittal (Nover-Armstrong, 2018), PFAS are the COPECs. In addition, surface water and sediment in Flintrock Pond and site soils contaminated with PFAS as well as surface water and sediment in Mary Dunn Pond are the media of concern that will be evaluated in the BERA. A more robust ecological CSM will be developed as part of the Phase II CSA.

3.1.2 Selection of Assessment and Measurement Endpoints

Once the ecological CSM is developed, assessment and measurement endpoints will be selected. Assessment endpoints are used to evaluate the potential ecological effects associated with



exposure the COPECs. Measurement endpoints are measurable responses to a stressor that are related to the valued characteristics chosen as the assessment endpoints (Suter, 1990).

Assessment endpoints are the ultimate focus in risk characterization and link the measurement endpoints to the risk management process (USEPA 1998a). However, because assessment endpoints often cannot be measured directly, measurement endpoints (measures of effect) are selected that relate to the assessment endpoints and have measurable attributes (e.g., comparison of media concentrations to effects levels, results of food web models, etc.) (USEPA, 1997, 1998). These measures of effect provide a metric for evaluating potential effects of contaminants on the ecosystem components potentially at risk.

The preliminary assessment endpoints identified for the BERA based on the preliminary ecological CSM include:

Assessment Endpoint 1 – Protection and maintenance of benthic macroinvertebrate communities in Flintrock Pond and Mary Dunn Pond.

Assessment Endpoint 2 – Protection and maintenance of fish communities in Flintrock Pond and Mary Dunn Pond (if present).

Assessment Endpoint 3 – Protection and maintenance of soil invertebrate communities.

Assessment Endpoint 4 – Protection and maintenance of piscivorous (fish eating) bird populations.

Assessment Endpoint 5 – Protection and maintenance of invertivorous (invertebrate eating) bird populations.

Assessment Endpoint 6 – Protection and maintenance of carnivorous bird populations.

Assessment Endpoint 7 – Protection and maintenance of invertivorous mammal populations.

Assessment Endpoint 8 – Protection and maintenance of carnivorous mammal populations

To support the measure of effects associated with the proposed assessment endpoints, bulk sediment, sediment pore water (interstitial water), and fish tissue will be collected as discussed in the Phase II CSA Scope of Work.

3.2 Study Design

This section describes the details of the site investigation activities that will be used to support the BERA. The following subsections present the environmental sampling that will be conducted to support the measures of effect for the BERA and quantitative methods that will be used to evaluate potential ecological risks.

3.2.1 Terrestrial Assessment

Risks posed to terrestrial receptors will be assessed based on results of the surficial (0 – 6 inches) soil sampling proposed as part of the Phase II CSA. These analytical data will be compiled for statistical analysis and evaluated against available soil toxicity benchmarks. Soil concentrations will also be used to assess direct exposure to terrestrial invertebrates and indirect exposure to higher-trophic level organisms through food chain exposure.



3.2.2 Aquatic Assessment

Assessment of ecological risks associated with Flintrock Pond and Mary Dunn Pond will be made using a variety of environmental media (sediment, surface water, and pore water) and biota concentrations. A benthic community analysis is not being proposed. The ecology of kettle ponds is unique and dependent on pH, depth, temperature, sediment grain size, plant community, and a variety of natural processes. It is unlikely that a suitable control or “background” location can be found without extensive research into these factors. The following sections summarize the media that will be used to evaluate ecological risks associated with Flintrock Pond and Mary Dunn Pond.

3.2.2.1 Surface Water

Up to six (6) surface water samples from Flintrock Pond and up to four (4) surface water samples will be collected from Mary Dunn Pond. These analytical data will be compiled for statistical analysis and evaluated against available aquatic toxicity benchmarks.

3.2.2.2 Sediment Data

Surficial sediment samples (0 – 6 inches) will be collected as part of the Phase II CSA. The analytical results from these samples will be used to support the assessment of potential risk pose to ecological receptors. These analytical data will be compiled for statistical analysis and evaluated against available sediment toxicity benchmarks. However, there is a severe paucity of ecologically based sediment toxicity benchmarks. As such, this assessment may not be very informative. The sediment pore water described below presents a much better approach to assessing the ecological impacts to benthic invertebrates. However, an attempt will be made to assess if there is a significant risk of environmental harm using sediment analytical results.

3.2.2.3 Pore Water Data

Sediment pore water is a major route of exposure to contaminants for many benthic organisms (Doe et al., 2003). Contaminants in pore water can be transported to groundwater or to overlying water by a variety of processes, thus potentially exposing benthic invertebrates.

In conjunction with the bulk sediment collected as part of the Phase II CSA, eight (8) samples will be used to for interstitial pore water sampling for Flintrock Pond and three (3) will be evaluated for pre water for Mary Dunn Pond. The sediment pore water will be collected via laboratory extraction to support the BERA analysis and to develop a better understanding of bioavailability of the PFAS 6. The analytical results will be used to evaluate whether direct exposures to sediment pore water has the potential to cause toxicity to benthic invertebrates by comparison to toxicity benchmarks.

3.2.2.4 Sediment Toxicity

The MADEP recommends that sediment toxicity tests should be included as a measure of effects in all quantitative site-specific risk assessments that are conducted to evaluate the effects of sediment contaminants on benthic invertebrates. However, in the case of PFAS, the drivers for ecological risk are almost always associated with bioaccumulation and not related to toxicity of sediment dwelling invertebrates (Arblaster, et al., 2019, SERDP 2020). In addition, toxicity to benthic organisms is generally a result of exposure to chemicals in the sediment pore water, and not to sediment particles. Therefore, the potential impacts to sediment-dwelling organisms can be assessed based



on a comparison of pore water sample results to benthic invertebrate toxicity benchmarks, as discussed above in Section 3.2.2.3.

3.2.2.5 Fish Tissue

To support the assessment of risk posed to fish as well as piscivorous birds, fish tissue samples from Flintrock Pond will be collected if the pond supports a sufficient fish population. The overall goal of the fish tissue sampling and analysis is to collect fish and analyze the samples for the presence of the PFAS 6 to support the risk characterization for the fish community and for piscivorous birds through food chain exposure. Because individual fish of sufficient body mass may be difficult to collect, either larger whole fish or composite samples of smaller fish will be targeted for this effort. If possible, ten (10) whole or composite fish samples weighing 250 grams or more will be collected throughout Flintrock Pond and whole fish body burdens will be analyzed for the PFAS 6 using a certified proprietary method developed by Bureau Veritas.

Fish will be collected from Flintrock Pond using a variety of methods. These may include:

- Electrofishing
- Rod and reel
- Minnow traps
- Seine/cast nets
- Gill nets
- Trotlines

3.3 Stage II Risk Analysis

The risk analysis phase of the BERA is based on the ecological CSM and includes the characterization of potential ecological exposure and effects. The ecological exposure assessment involves the identification of potential exposure pathways and the evaluation of the magnitude of exposure of potential ecological receptors. The ecological effects assessment evaluates the potential adverse effects associated with exposure to COPECs by ecological receptors and reflects specific assessment endpoints. The data and methods that will be used to identify and characterize ecological exposure and effects are described below.

3.3.1 Media Concentrations

3.3.1.1 Data Treatment

Analytical data for each medium will be compiled and tabulated in a database for statistical analysis. Data for samples and their duplicates will be averaged before summary statistics are calculated, such that a sample and its duplicate will be treated as one sample for calculation of summary statistics. Where both the sample and the duplicate are not detected, the resulting values are the average of the sample-specific quantitation limits (SSQLs). Where both the sample and the duplicate are detected, the resulting values are the average of the detected results. Where one of the pair is reported as not detected and the other is detected, the detected concentration is used.



3.3.1.2 Terrestrial Risk Analysis

The analytical results from surface soil samples collected as part of the Phase II CSA will be used to support the assessment of potential risk posed to ecological receptors. These analytical data will be compiled for statistical analysis and the average concentration will be compared to soil benchmarks protective of soil invertebrates. In addition, food chain modeling will be conducted, and modeled doses will be compared to toxicity reference values (TRVs) for higher trophic level receptors.

3.3.1.3 Benthic and Aquatic Risk Analysis

3.3.1.3.1 Macroinvertebrate Risk Analysis

The protection and maintenance of freshwater benthic invertebrate communities in Flintrock Pond is one of the assessment endpoints identified in Section 3.1.2. To assess potential risks to these receptors, sediment, and sediment pore water data, will be evaluated with respect to protection of the benthic invertebrate community as described in the sections below.

3.3.1.3.1.1 Surficial Sediment

Surficial sediment samples collected as part of the Phase II CSA will be evaluated. These analytical data will be compiled for statistical analysis and the average concentration will be compared to sediment quality benchmarks protective of benthic invertebrates.

3.3.1.3.1.2 Pore Water

As noted in Section 3.2.2.3, sediment for interstitial pore water analysis will be collected via laboratory extraction from samples collected as part of the Phase II CSA. Surficial pore water provides a direct measure of the bioavailable fraction of COPECs in sediment. The theory of equilibrium partitioning (EqP) has been the basis for the study of sediment toxicity for decades and has been the basis for sediment guidelines since the early 1990s (e.g., USEPA, 1993; 2005). EqP theory maintains that certain chemicals, such as PFAS, may be present in sediment but partitioned to binding factors, such as organic carbon and black carbon, and are generally not bioavailable. Only the freely dissolved fraction of pollutants, therefore, is available for partitioning and bio-uptake (Reichenberg and Mayer 2006).

The surficial sediment pore water data will be used in conjunction with the whole sediment concentration data to evaluate potential COPEC risk drivers. Pore water analytical data will be compiled for statistical analysis and the average concentration will be compared to water quality benchmarks protective of benthic invertebrates.

3.3.1.4 Aquatic Receptor Risk Analysis

The aquatic risk analysis will assess risk to the fish community and higher trophic level receptors that feed on fish in Flintrock Pond.



3.3.1.4.1 Surface Water

Comparison of surface water data to surface water quality benchmarks protective of aquatic life will be used to assess the potential risk posed to the fish communities in Flintrock Pond and Mary Dunn Pond.

3.3.1.4.2 Fish Tissue

As detailed in Section 3.2.2.5, fish tissue samples will be to support the assessment of risk posed to fish directly (direct exposure) and to piscivorous birds through food chain exposure. The analytical results from the fish tissue samples will be compiled for statistical analysis and the average concentration will be compared to tissue benchmarks protective of freshwater fish. In addition, food chain modeling will be conducted, and modeled doses will be compared to TRVs for piscivorous birds.

3.4 Stage II Risk Characterization

The results of the ecological risk analysis will be analyzed and interpreted to determine the likelihood of adverse environmental effects, and to determine whether a conclusion of no significant risk can be reached for each assessment endpoint evaluated. The ecological risk characterization will summarize the results of the risk analysis phase of work and will provide interpretation of the ecological significance of findings. Aspects of ecological significance that will be considered to help place the Site into a broader ecological context include the nature and magnitude of effects and the spatial and temporal patterns of effects.

The BERA will integrate a variety of methodologies to assess potential ecological risks. The conclusions regarding overall risk(s) to ecological receptors will be based on a weight-of-evidence approach, which will consider the results of all components of the assessment methodology (i.e., an approach that integrates results of physical, biological, toxicological, and field measurement endpoints to draw risk-based conclusions). The weight-of-evidence components will be designed to provide measures of potential risks for different ecological receptors and exposure pathways.

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