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CAPE COD COMMISSION

September 27, 2016

Gerard Martin
Site Remediation Section
Southeast Regional Office
Department of Environmental Protection
20 Riverside Drive
Lakeville, MA 02347

Re: WSA-4-26179
Immediate Response Action
PFOS/PFOA in Groundwater

Dear Mr. Martin:

Barnstable County is pleased to submit an Immediate Response Action to the Notice of Responsibility dated, August 4, 2016. The IRA contains a summary of the assessment and interim actions that the County has performed beginning in 2014. The IRA includes and evaluation of imminent hazards to downgradient public and private supplies, specific plans for a hot spot removal action and an interim expansion of the existing groundwater pump and treatment system.

The IRA also contains an evaluation of water supply alternatives and options for partnering with the Town of Barnstable and the Department to prioritize County and Town resources to appropriate comprehensive actions for the long term.

This report and its Appendices are being also submitted through eDEP with an IRA transaction Form and Release Notification Form as required by 310 CMR 40.0336.

Please contact me if you have any questions on this submittal.

Sincerely,

Tom Cambareri
Technical Services Director for Water Resources
LSP #3788

Cc: Jack Yunits, County Administrator
Robert Cox, Counsel for the County
Mark Ells, Barnstable Town Manager
Dan Santos, Barnstable DPW Director
Tom Mckeon, Barnstable Health Department

Immediate Response Action Plan
Barnstable County Fire and Rescue Training Academy
RTN:4-26179
RTN: 4-190

This response is being submitted to the Department to meet the requirements for approval of an Immediate Response Action (IRA) Plan, as outlined in Section 40.0424 of the Massachusetts Contingency Plan (MCP), 310 CMR 40.0000.

Site: Barnstable County Fire and Rescue Training Academy
155 South Flintrock Road
Hyannis, MA

Potential Responsible Party/
Owner/Operator:

Barnstable County
Attn: Jack Yunits, County Administrator
Superior Court House Barnstable, MA 02630
Barnstable, MA 02630
Tel: (508) 375-6641

Contact/LSP: **Thomas C. Cambareri, LSP # 3788**
Cape Cod Commission
3225 Main Street
Barnstable, MA 02630
(508) 744-1234
tcambareri@capecodcommission.org

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Release Description:

Background

The Barnstable County Fire Rescue Training Academy is located on South Flintrock Road in the Village of Hyannis in the Town of Barnstable. ("BCFRTA"). The BCFRTA site consists of approximately 6.2 acres, according to a recorded plan, of which about 4.55 acres is upland and 1.55 acres is pond area ("BCFRTA Site" or "Site"). Located on the BCFRTA Site are four primary buildings: A "fire station" that houses two classrooms, administrative offices, and two apparatus bays, a classroom building, a smokehouse, and a burn building, along with several sheds and outbuildings used in connection with fire and rescue training activities. The owner of the BCFRTA Site is Barnstable County ("County"). The County acquired the Site in 1983 by deed recorded June 3, 1983, Barnstable Registry of Deeds, Book 3759, Page 039. The Site is identified by the Town of Barnstable's Assessor's at Map 313, Parcel 007. The BCFRTA Site is serviced by public water provided by the Town of Barnstable, Department of Public Works, Water Supply Division (a/k/a Hyannis Water System), and an on-site septic system.

The BCFRTA Site is immediately upgradient of and to the west of the Mary Dunn 1, 2 and 3 public water supply wells (Figure 1). The BCFRTA has been used for public safety member training since the 1950's. Firefighting training has included historic use and controlled burning of Number 2 Diesel fuel. Fires would be ignited in concrete pits and then extinguished by firefighters using water, CO2 and foam. The use of Number 2 Diesel for such training activities ceased in the summer of 1986. Petroleum releases were identified at the Site and response actions were conducted under RTN 4-190.

A Phase II assessment was completed in 1992 (Cambareri, 1992). The remediation of the petroleum consisted of soil removal, vapor extraction, perozone sparge system and extensive pump and treat system which was operational from 1994 to 2005. The cleanup of petroleum hydrocarbons is largely accomplished with no substantial hazard to public or environment. Monitoring under a Temporary Solution has been in place since 2001 (Cambareri, 2001). During the course of compliance monitoring, a plume of MTBE was identified in 1998. An Immediate Response Action consisting of a modification of the original pump and treat system was implemented (Cambareri, 1998) and the MTBE cleanup was concluded with a Class A1 Response Action outcome in 2001. (Cambareri,2001). In 2006 a plume of perchlorate was identified. (Cambareri, 2006) An Immediate Response Action consisted of a substantial modification of the pump and treat system to an Ion exchange filtration system with relocated recovery wells (Cambareri, 2007). The perchlorate cleanup was concluded with an IRA Completion Statement in 2010 (Cambareri, 2010).

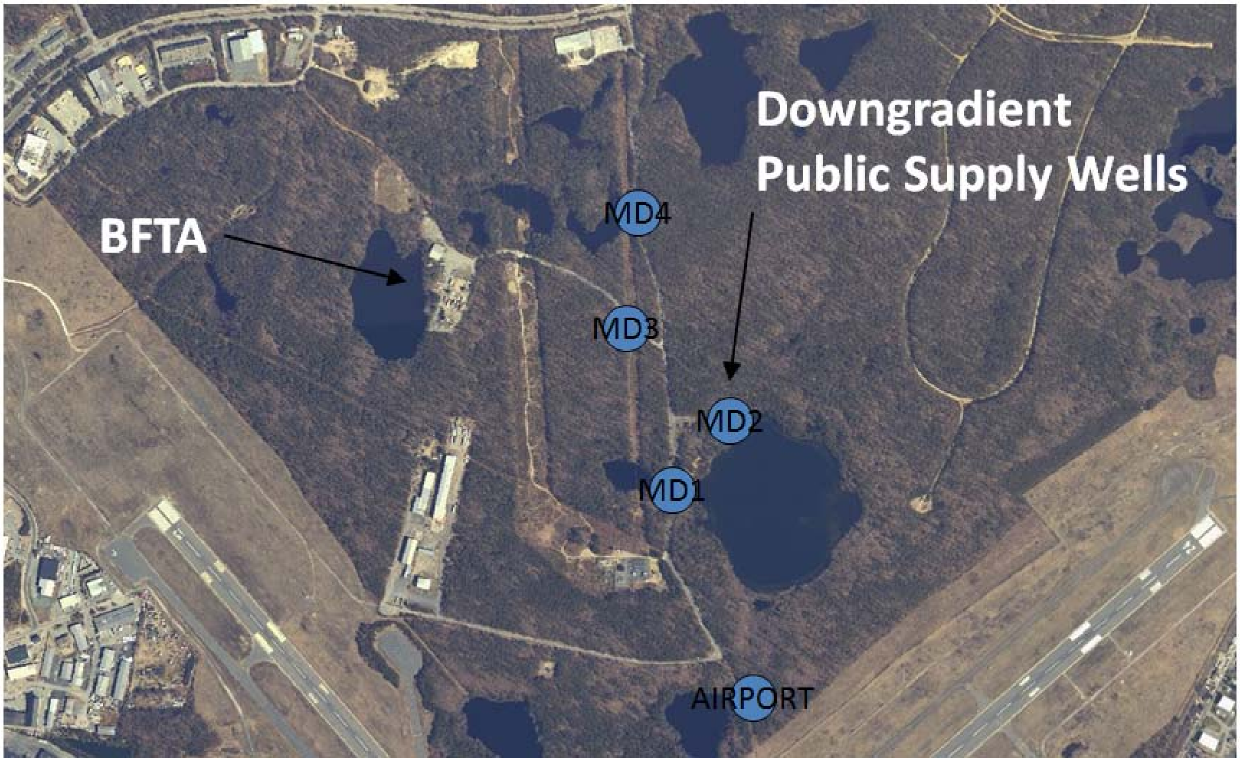

Figure 1 Barnstable County Fire Rescue Training Site and Downgradient Water Supply Wells

Poly and Per Fluorinated Alkyl Substances (PFAS)

Per- and poly fluoroalkyl substances (together, PFASs) are a class of man-made chemicals. They are not found naturally in the environment. PFASs are one group of Perfluorinated chemicals (PFCs). The other group of PFCs are perfluorocarbons, which are distinctly different, not as toxic as PFASs, but a potent greenhouse gas (USEPA Fact Sheet- https://www.epa.gov/pfas). Perfluoro octanolic acid (PFOA) and Perfluoroalkyl sulfonic acid (PFOS) have been the most extensively produced and studied of the PFASs chemicals. Both chemicals are very persistent in the environment and in the human body. Due to their persistence, PFASs can travel long distances through the air; monitoring in the Arctic has shown levels of PFASs in air, water, and living things. Studies have found PFOS and PFOA in blood samples of humans and wildlife nationwide. Using data from CDC's 2003–2004 National Health and Nutrition Examination Survey (NHANES), scientists detected PFASs in over 98% of the thousands of blood samples collected during the survey. PFASs have been used in the manufacture of products that:

- keep food from sticking to cookware,
- make upholstered furniture, carpets and clothing resistant to soil, stains and water,
- make shoes, clothes and mattresses more waterproof,
- keep food packaging from sticking to food, and
- help fight fires at airfields and other places where petroleum-product-based fires are a risk.

In the mid-1960s, the 3M developed aqueous film-forming foam (AFFF) for the United States Navy (Place and Field, 2012). This synthetic foam has a low viscosity and spreads rapidly across the surface of most hydrocarbon fuels. A water film forms beneath the foam, which cools the liquid fuel, which stops the formation of flammable vapors. This provides dramatic fire knockdown, an important factor in crash rescue firefighting. AFFF became a standard tool in the arsenal of firefighting for airport and automobile crashes and smothering spilled hydrocarbons to prevent likely flames. Training in the use of AFFF became a required training experience for firefighting safety officials. The Federal Aviation Administration has requirements under Part 139 Airport Certification Status List (ACSL) that airport fire operations have regular training in the use of foam (Title 14 CFR Part 139). Barnstable Municipal Airport is on the Part 139 ACSL. Whereas local firefighters are likely to provide mutual support services, local fire fighters training with AFFF occurred regularly at the Barnstable Municipal Airport.

The use of AFFF in firefighting training activities occurred at the BCFRTA. The petroleum tanks pits and apparatus, which were discontinued in 1986, were used with both AFFF and water. AFFF and water were used with straw and propane firefighting apparatus after 1986. The most active area for flame extinguishing training is at the southwest corner of the site where the "Flame Prop and Propane Tank Prop" were used. The Flame Prop is located adjacent to Flintrock Pond.

Initial Assessment Actions: PFAS/PFOS

Background

The County's assessment included the broadest array of PFASs that could be commercially analysed by Maxxam Laboratories of Canada. The Assessment description below focusses on the occurrence of PFOS as a surrogate for all other detected PFASs, including PFOA, which will be fully characterized later in the assessment.

In 2010 the Silent Spring Institute released the first study of the occurrence of Compounds of Emerging Concern (CECs) in Cape Cod public water supply wells (Schaider, 2010). Twenty supply wells were sampled for the study in 2009. A detected compound of interest was Perfluorinated sulfonic acid (PFOS) in samples from the Maher Hyannis public supply well and distribution system. The detection of PFOS at half of the EPA Health Advisory of 0.2 ug/l in the Maher wells indicated concern about the use of AFFF at the Municipal Airport and County Fire Training Academy. The Director of the BCFRTA was notified about the potential groundwater risk of using AFFF based on the early findings of the 2010 Silent Spring report by the County's LSP, Tom Cambareri.

In 2013 County staff identified a commercial laboratory to analyse for Perfluorinated compounds including PFOS. Spilt-samples taken as part of the regular Temporary Solution in November 2013, indicated that groundwater at the site was impacted with PFOS. Groundwater samples were taken in June of 2014 further downgradient of the site which confirmed the earlier results. Upon receipt of the lab results, the County contacted was made to both DEP and Hyannis water officials. At the same time water quality results were being released from the first (2013) and second round (2014) of the EPA Unregulated Contaminant Monitoring Rule (UCMR) national sampling mandate for CECs in public water supplies (EPA, 2012). The list of CECs to be tested included PFOS and PFOA. PFOS was detected at the Mary Dunn and Maher Wells. Hyannis water officials and Cape Cod Commission Water staff, of which Tom Cambareri is the Program Director, shared information at a meeting in November 2014 and $30,000 was sought and approved by the County in January 2015 for an initial hydrogeological assessment. In May of 2015 the County appropriated $32,000 for data gap and short term measure. In July 2015, a pump and treat system to capture a defined high concentration level of PFOS in groundwater was implemented. In September 2015, an additional $232,000 was appropriated for operation and maintenance, and additional assessment and immediate response actions. The County has committed at least 1,200 hours of staff time over the last 2 years to the PFOS issue at the BCFRTA.

Notice of Responsibility from DEP

On August 4, 2016 the DEP issued a Notice of Responsibility (NOR) to Barnstable County with a request for an Immediate Response Action (IRA) Plan with an Interim Deadline of September 15, 2016. At the County's request, DEP agreed to extend the deadline for submittal of an IRA Plan to September 22, 2016. When the County recognized the IRA Plan was not yet ready for submittal on September 22, 2016, the County requested a further extension to September 27, 2016. While DEP denied that request for a short extension, the County has used best efforts to complete and submit this IRA Plan as soon as practicable. The NOR is available in Appendix I. The NOR requires the County to perform immediate response actions in response to sudden releases, imminent hazards and condition of substantial release migration.

The NOR requires the County to engage a Licensed Site Professional to manage, supervise or actually perform the necessary response actions. The County's long term LSP for the site is Tom Cambareri, #3788.

The NOR requires that the IRA Plan include measures that the County BCFRTA will conduct to prevent, eliminate, and/or abate any hazards associated with drinking water above the Health Advisory of 0.07 ug/l.

The NOR also states that DEP is "of opinion that reducing the mass of PFAS detected in the soil and groundwater at the BCFRTA is necessary to prevent, eliminate or minimize harm to health, safety, public welfare or the environment and, pursuant to 310 CMR 40.4012(4), requests that the IRA Plan include a proposal designed to reduce the concentration of PFAS in groundwater migrating off the BCFRTA Site including but not limited to:

1. Excavating the soil hot spot soil contaminated with PFAS that is acting as on on-going source of groundwater contamination; and/or

2. Expanding the existing groundwater recovery and treatment system to include additional recovery wells or an increased pumping rate to decrease the mass of PFAS in groundwater at the BFTA."

The IRA Plan request by the DEP requires an evaluation on the source and extent of contamination in order to base the evaluation of Imminent Hazards and appropriate response actions. The following two sections present the assessment findings to date for soil and groundwater, including whether an Imminent Hazard exists relative to public and private water supply wells.

IRA Assessment

<u>Soil</u>

The presence of PFOS in subsurface soil at the BCFRTA was investigated and assessed at locations shown on Figure 2 and described below. In March 2015, 11 continuous core borings were advanced into the subsurface to an approximate depth of 12 feet to the water table. Shallow monitoring wells were placed in 5 borings and an additional well without coring was placed at PFW-5. Soil was sampled at 27 locations as shown on the fence diagrams Figure 4. Flintrock Pond sediment was sampled 3 times in April and an additional 5 times in June to confirm the results. Well logs for soil borings are available in Appendix II.

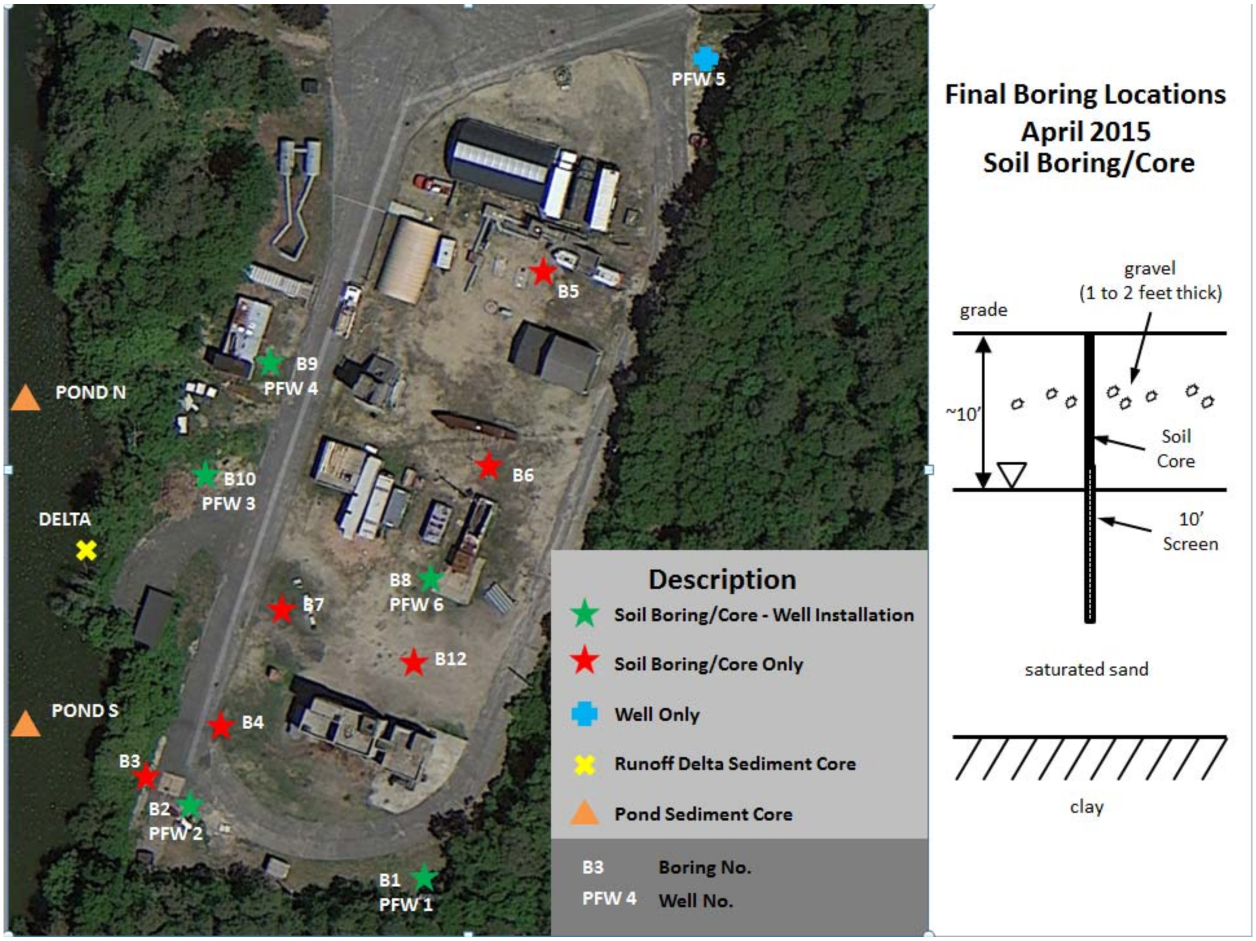

Figure 2 General Soil Data Point Map

The soil samples were kept on ice and shipped over night to Maxxam Laboratory in Canada. Maxxam offers 16 PFAS soil analytes through their modified 537 EPA method. The highest reported PFOS concentration for each boring/sediment location is shown on Figure 3. (Soil laboratory results and chain of custody forms are available in Appendix III.

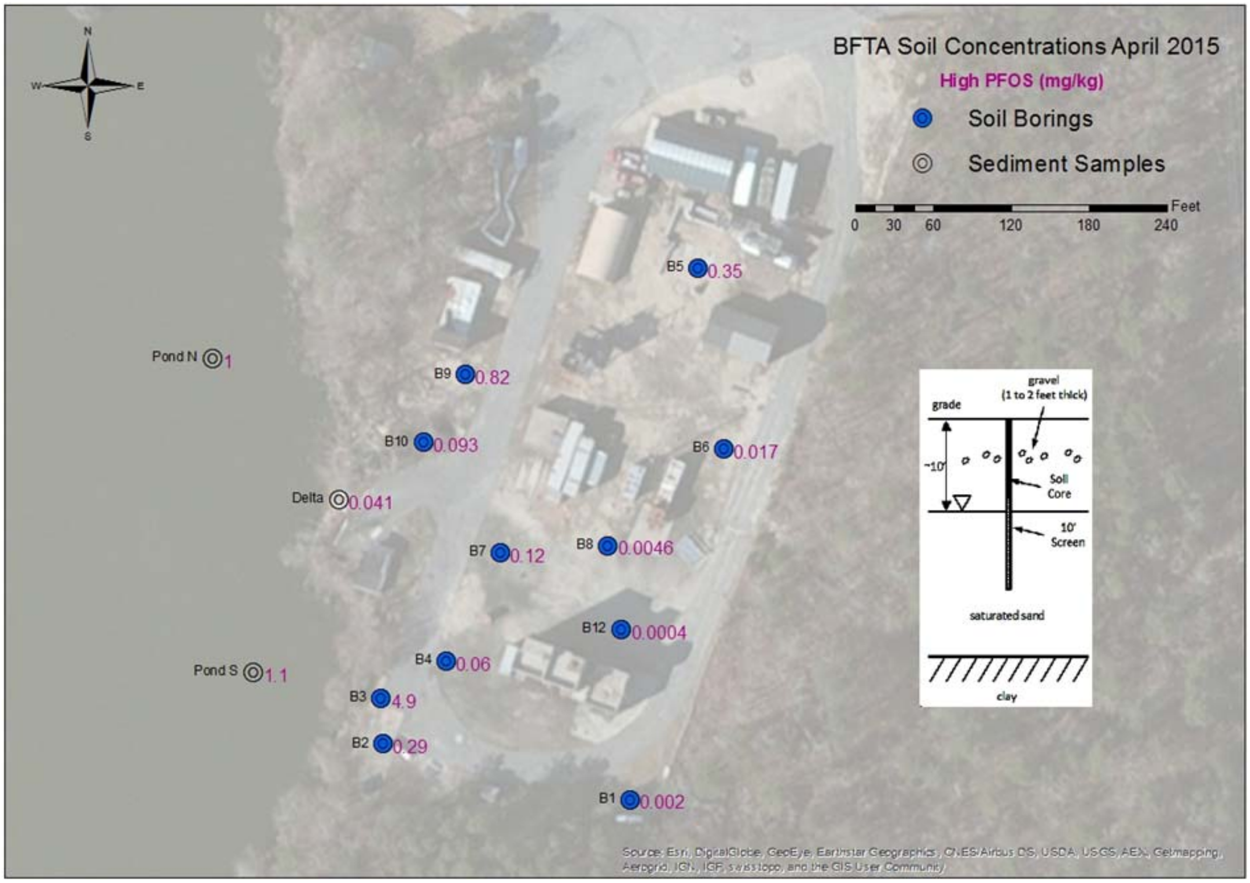

Figure 3 PFOS in Soil and Pond Sediment Map

Of the 16 analytes for 35 samples, PFOS was the only one detected above the method reporting limit, in every sample, with the highest concentration of 4.9 mg/kg at the location we would later refer to, as the Hot Spot (Figure 3 and Table 1). The PFOS concentrations ranged from 4.9 to .002 mg/kg with a median of .034 mg/kg as shown in the fence diagrams (Figure 4). Two of the April 2014 pond sediments samples were at 1 and 1.1 mg/kg of PFOS. In June 2014 several additional pond sediment were analysed and the PFOS concentrations were all appreciably less, ranging from .011 to .041 mg/kg.

Other PFAS Compounds in Soil

Of the 35 samples taken PFOS was detected in each. Perfluorohexane Sulfonate (PFHxS) was detected in 16 or 45% of the samples, Perfluorooctane Sulfonamide (PFOSA) was detected in 13 or 37% of the samples, and Perfluorononanoic Acid (PFNA) and Perfluoroundecanoic Acid (PFUnA) were detected in 12 or 34% of the samples. PFOA was only detected 7 times in soil with the highest concentration of 5 mg/kg at the B12 location. The 7 detections ranged from 5 to .002 mg/kg. Figures 5 and 6 show the relative concentrations of PFOS and other PFASs in soil at the BCFRTA site.

The soil results indicate a broad area of soil contamination with PFOS throughout the subsurface of the site. While PFOS has been identified a Compound of Emerging Concern, it is otherwise unregulated and there are no associated federal or state maximum contaminated levels for soil. The state of Minnesota developed a site specific soil cleanup standard of 6 mg/kg. The PFOS concentrations in soil at the BCFRTA are below that level. The highest PFOS soil concentration detection of 4.9 mg/kg combined with the groundwater results downgradient of the location lead to further evaluation of the Hot Spot, as described in the IRA section of the report.

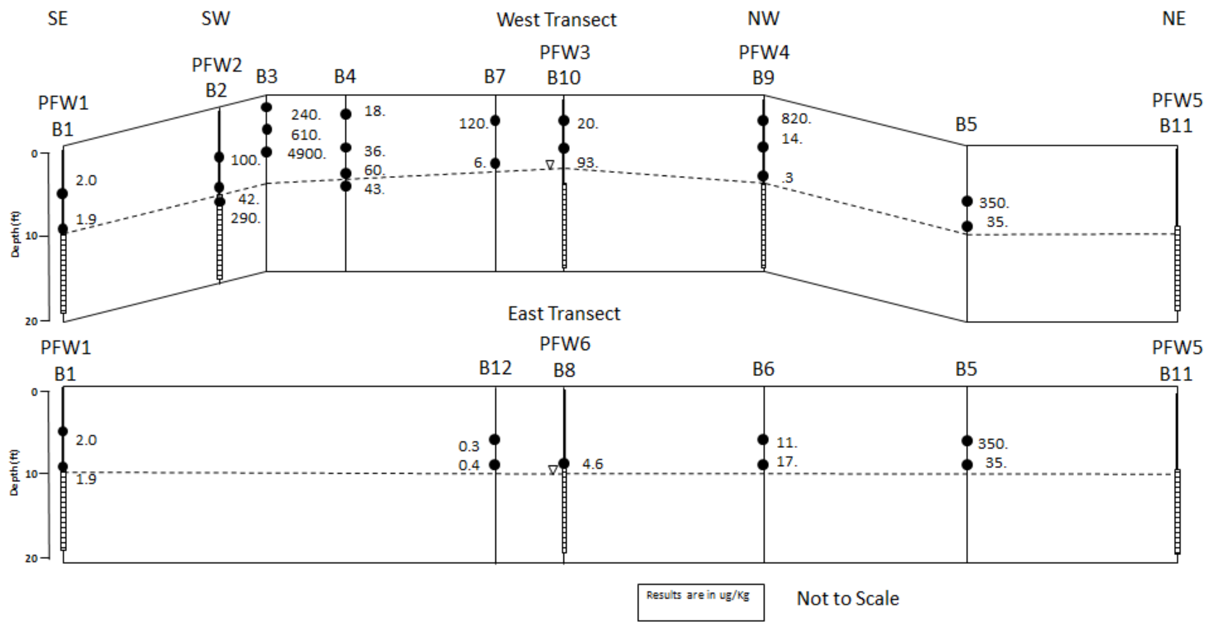

Figure 4 Fence Diagram of PFOS Concentrations in Soil (ug/l)

Table 1 Laboratory Results for March 2015 Soil Analysis (mg/kg)

Analytes	Highest Concentration	# Samples above RDL (out of 35)	% Samples above RDL
Perfluorobutane Sulfonate (PFBS)	5	2	5.7
Perfluorobutanoic acid (PFBA)	5	2	5.7
Perfluorodecane Sulfonate (PFDcS	18	6	17.1
Perfluorodecanoic Acid (PFDA)	21	4	11.4
Perfluorododecanoic Acid (PFDoA)	6	2	5.7
Perfluoroheptanoic Acid (PFHpA)	5	5	14.3
Perfluorohexane Sulfonate (PFHxS	40	16	45.7
Perfluorohexanoic Acid (PFHxA)	11	10	28.6
Perfluoro-n-Octanoic Acid (PFOA)	5	7	20.0
Perfluorononanoic Acid (PFNA)	44	12	34.3
Perfluorooctane Sulfonamide (PFC	57	13	37.1
Perfluorooctane Sulfonate (PFOS)	4900	35	100.0
Perfluoropentanoic Acid (PFPeA)	5	8	22.9
Perfluorotetradecanoic Acid (PFTA	6	2	5.7
Perfluorotridecanoic Acid (PFTrA)	40	7	20.0
Perfluoroundecanoic Acid (PFUnA)	240	12	34.3

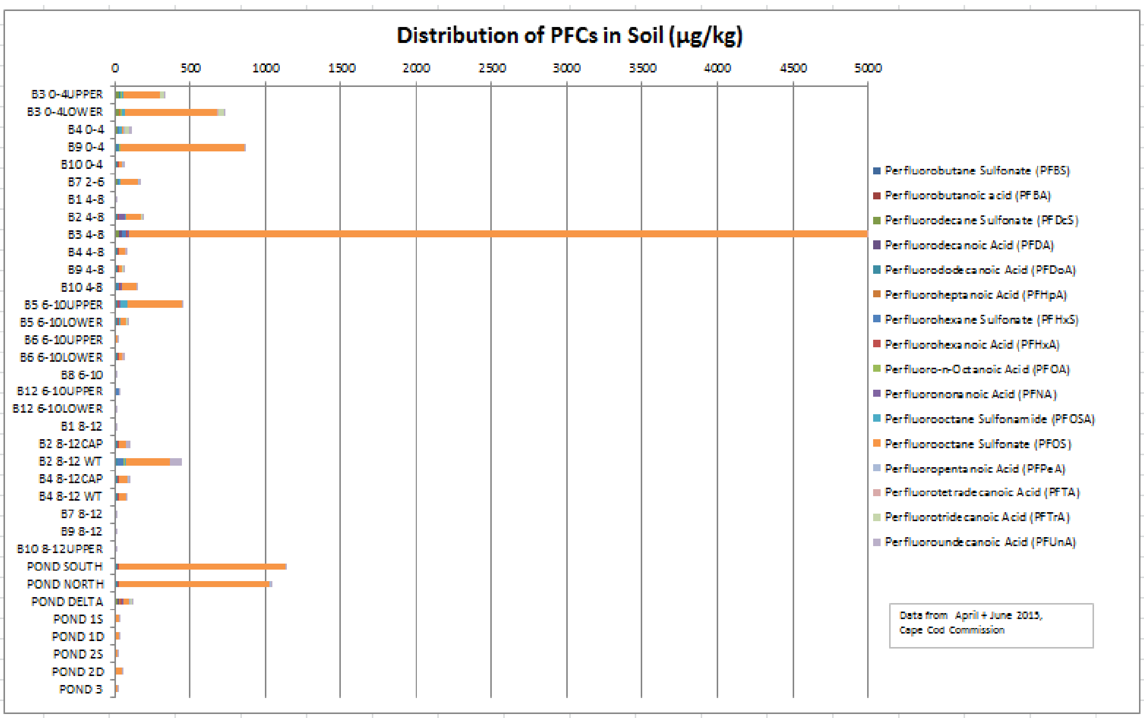

Figure 5 Distribution of PFAS in Soil

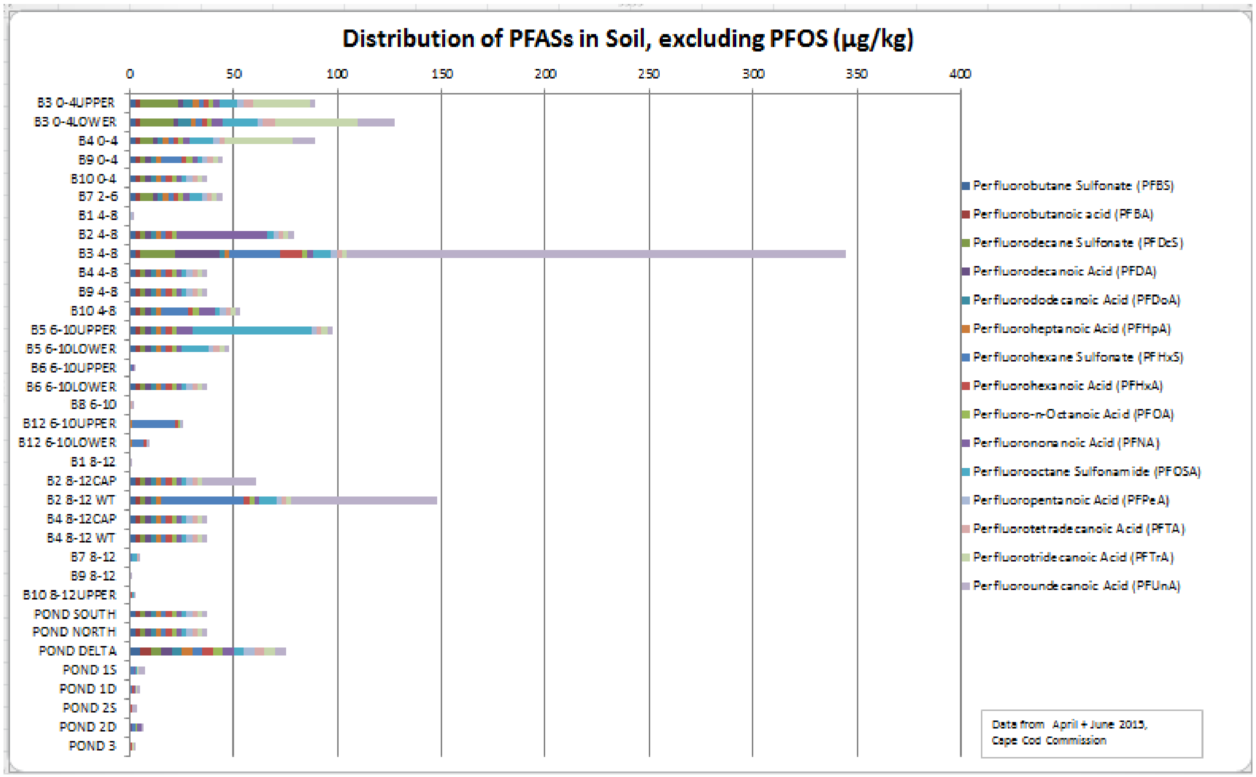

Figure 6 Distribution of PFAS in soil not including PFOS

Groundwater

General

This section describes the County's groundwater assessment beginning in November 2013. Since 2013 there have been 48 sampling events in which 119 wells were sampled. Biweekly operational pump and treat performance samples for raw water (PRW-4) lead and lag vessels, include an additional 100 samples. Overall approximately 3,400 data points have been generated. Laboratory results are available in Appendix V.

Groundwater investigations included sampling from selected locations within the existing monitoring well network from the Phase II Assessment in 1992, MTBE assessment in 1998, and perchlorate assessment in 2007. Fifteen (15) additional locations were incrementally selected for 18 new monitoring wells to assess groundwater beneath the BCFRTA site, the downgradient area near the Mary Dunn Wells, the area of the PFOS recovery well (PRW-4), and downgradient of Flintrock Pond. Monitoring well logs are available Appendix II. Flintrock and Mary Dunn Pond surface water samples and water from the public supply wells and distribution points were also taken, as shown on the data point map (Figure 7).

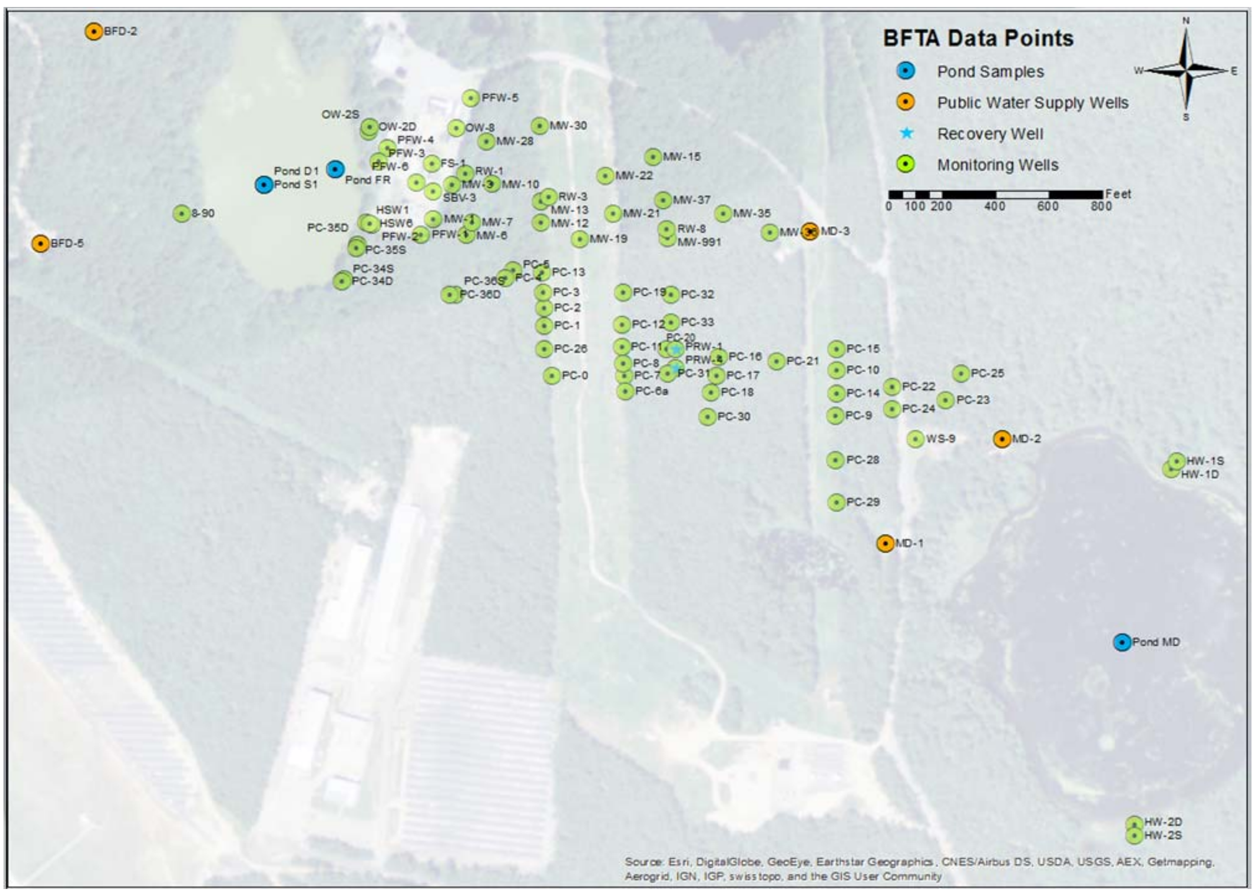

Figure 7 Data Point Map

The Water Table and Groundwater Flow

The watertable at the Site was at 12 ft below the ground surface, when the investigation began in 2014. The watertable has been decreasing since that time due to the lack of precipitation and drought conditions. The depth to groundwater at the site has historically ranged from 12 to 16 ft. Groundwater flow, as determined in the Phase II assessment and delineations of the former plumes of contamination, is to the east-southeast from the Site which accounts for the configuration of the numerous monitoring wells (Figure 7). The bottom of the effected aquifer at the Site is defined by a dense silty-clay at approximately 35 feet below the water table. The aquifer maintains this thickness from the Site downgradient towards MD2 where it dips to approximately 45 ft. The hydraulic conductivity of the aquifer material estimated from USGS groundwater modeling, monitoring well slug-tests, pump tests of the Mary Dunn wells is approximately 250 ft/day. The average hydraulic gradient is .0016 ft/d and the groundwater velocity is approximately 1.3 ft/d.

Flintrock Pond is an 8 ft deep kettle hole pond. There are no inlets or outlets. Groundwater recharges the pond on its west side and surface water discharges to the water table beneath the BCFRTA Site from the Pond's east side.

Sampling Protocol

Groundwater sampling protocol followed Uniform Federal Policy–Quality Assurance Project Plan for PFC sampling at the Joint Base Cape Cod (CH2M Hill, 2014), found in Appendix IV). Water levels and depth of monitoring wells was measured to calculate the volume of water to achieve 3 purge volumes prior to sampling. Each well to be sampled was outfitted with 5/8 inch high density polyethylene and a Waterra D25 foot valve. An electric Waterra actuator was powered by a Honda generator to purge the well water. Field personal wore old clothes and nitrile gloves. The samples were taken in polyethylene bottles provided by the laboratory and kept on ice. Chain of custody forms were completed and samples were shipped to the laboratory by overnight FedEx. In 2015 the County switched labs from Eurofins to Maxxam because of the ability to tests for 23 PFAS compounds. Surface water from ponds were sampled from nearshore, using waders or by kayak. Supply wells were sampled through sampling ports adjacent to the well.

Extent of Groundwater Impact

The 3000+ data points of information on groundwater and surface water monitoring were categorized into 6 concentration levels of PFOS relative to the EPA Health Advisory (HA) of 70 ng/l or parts per trillion (ppt) to illustrate the extent of PFOS. The highest PFOS concentration measured at a monitoring well for the entire assessment was mapped to determine the horizontal and vertical extent of contamination (Figure 8).

The PFOS concentration categories include:

< 70 ng/l below the HA
>70 ng/l above the HA
>700 ng/l (10 times the HA)
>2,100 ng/l (30 times the HA)
>7,000 ng/l (100 times the HA)
>70,000 ng/l (1,000 times the HA)

An additional map showing the actual data from wells sampled in 2016 using the Maxxam lab with historical data is included (Figure 9). Groundwater sampling results are available in Appendix V.

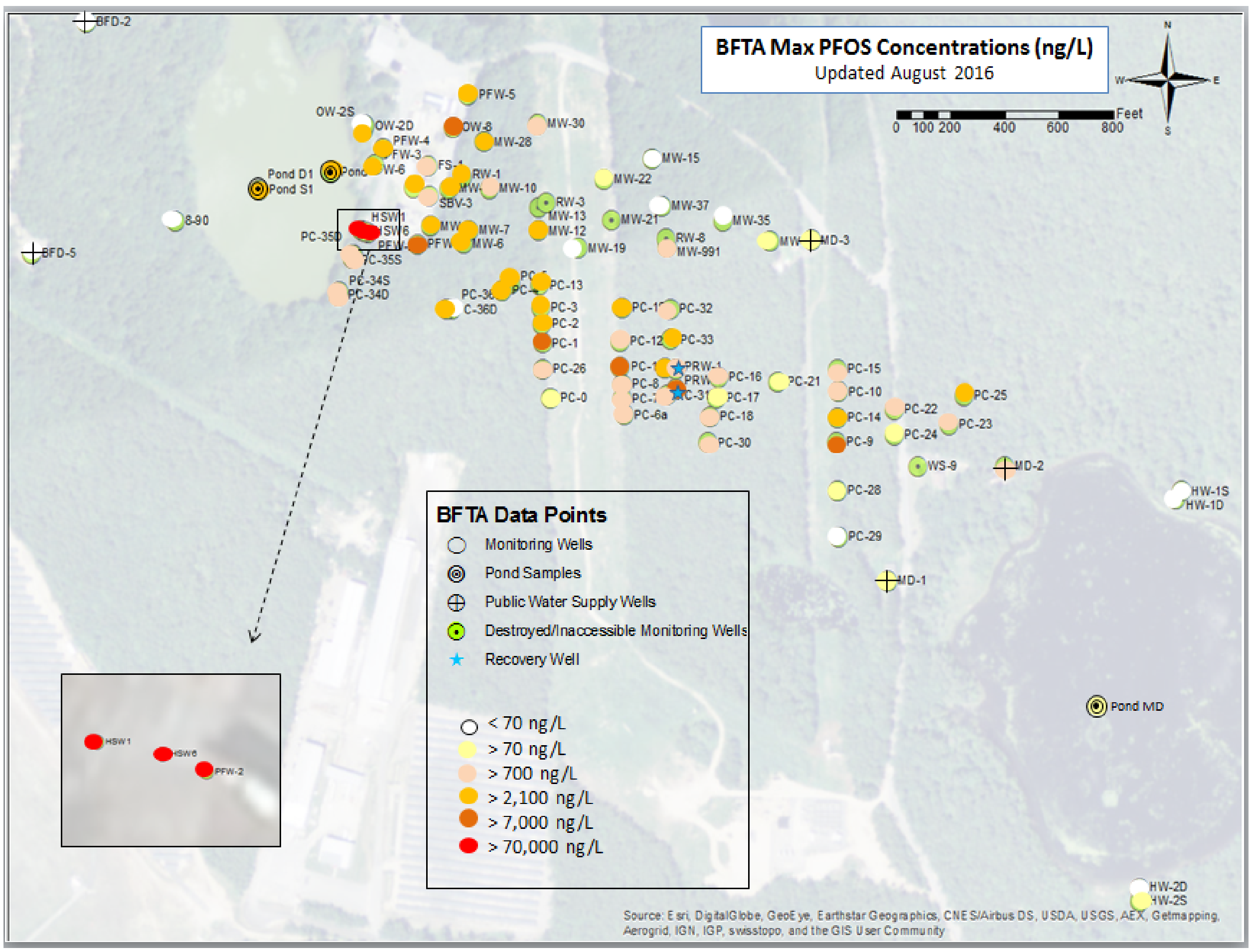

Figure 8 Max PFOS Concentrations in Groundwater

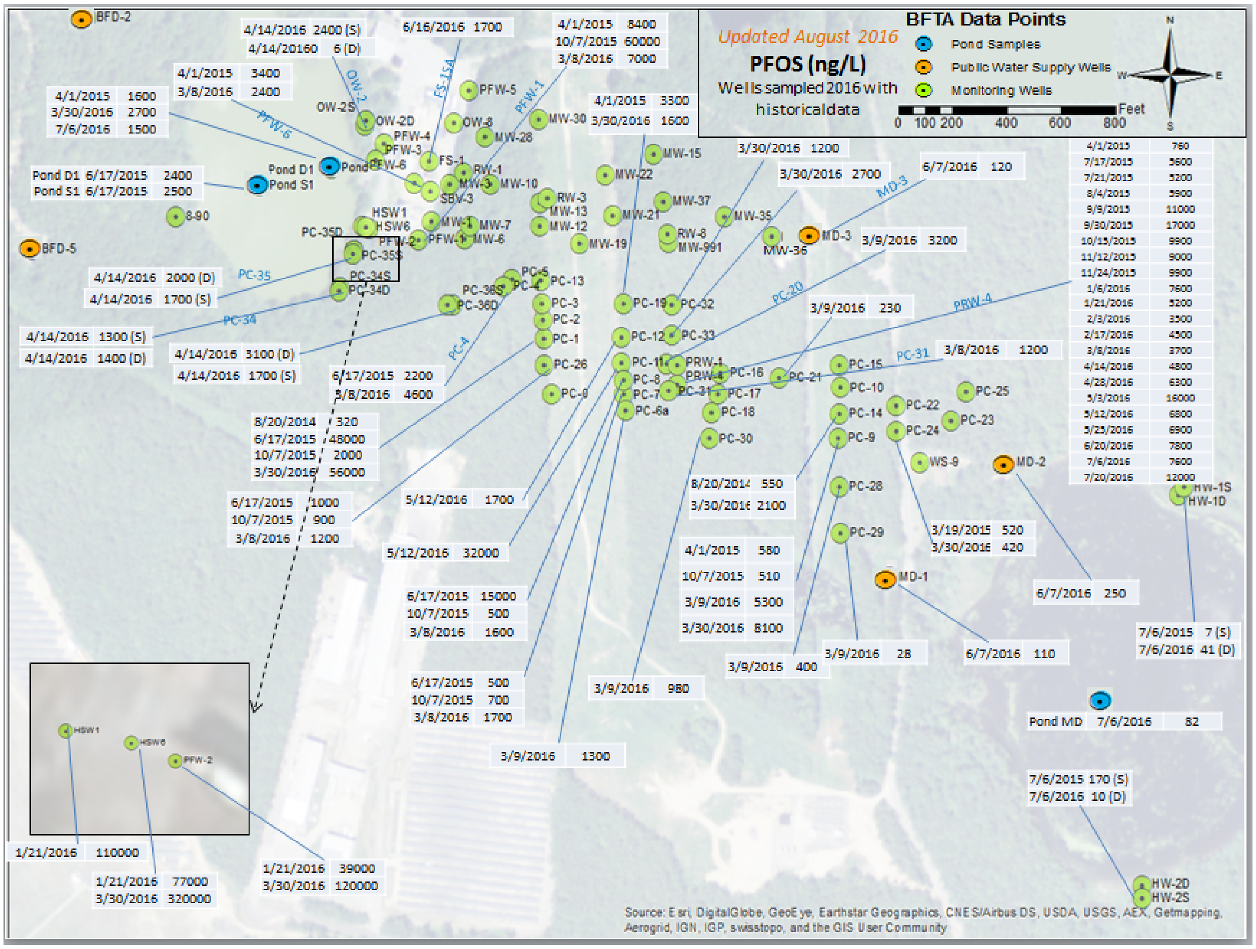

Figure 9 PFOS in Groundwater (ng/l)

The highest PFOS concentrations are from wells at the BCFRTA Hot Spot at a maximum of 320,000 ng/l. Groundwater flow to the east of the Hot Spot maintains a fairly high concentrated plume of 56,000 ng/l at PC-1 and 32,000 ng/l at PC-11. The Hot Spot plume is approximately 200 ft wide. Consistent with the PFOS soil concentrations across the site, the groundwater PFOS concentrations range from 8,600 to 98 ng/l with an average of 3,050 ng/l, beneath a broad portion of the site from north to south and the area downgradient. The northern portion of the site and groundwater downgradient with concentrations from 70 to 700ng/l is less severely contaminated than the southern portion. The "Tank" pit apparatus, described in the 1992 Phase II Assessment, was formally at the location of the high PFOS detection shown at OW-8 (Figure 7).The occurrence and configuration of the PFOS plume is greatly modified by the remedial pump and treat actions that have occurred over the last 30 years. The petroleum and perchlorate pump and treat systems discharged treated water into north and south leaching basins that likely modified and even created dilute PFOS source areas on the Site. The monitoring well PFW-5 (Figure 7) was installed to evaluate the potential of PFOS from the septic system that is located to the west of the well, but it is now in the downgradient area of the north PFOS treatment discharge basin. The pumping schedule of the Mary Dunn wellfield and the supply of PFOS tainted water that was delivered to the site through the Hyannis water supply system are additional complicating sources. This will be discussed in the IRA Pump and Treatment Evaluation section.

Flintrock Pond

The surface water sampled from Flintrock Pond has high PFOS concentrations ranging from 1,500 to 2,700 ng/l. Researchers at JBCC have sampled several background ponds on the Upper Cape and found no detections indicating the concentrations in Flintrock Pond are high for surface water (personal communication, 2016, Amanda Weber). Fire training with foam occurred at the Flare Prop and Propane Prop Hot Spot (Figure 2), adjacent to Flintrock Pond. Due to its proximity, runoff entered the pond. Also ponding of training water occurs to the northeast of the Burn Building and eventually runs off the topographic west pitch of the site into the pond. As a result several mechanisms for PFOS to enter the pond environment are apparent. The high concentration of PFOS in the pond water is consistent with the initially high concentrations in the pond sediments.

Because Flintrock Pond discharges its water to groundwater on the east side, the pond itself is a source of PFOS to groundwater. In order to distinguish groundwater being indirectly impacted from Pond discharge vs directly from site activities, monitoring wells PC34S&D and PC35S&D were installed south of the site's southern boundary. Groundwater sampled from these wells range from 1,300 to 2,000 ng/l PFOS indicating that Flintrock Pond is a source releasing PFOS contaminated surface water into the groundwater along the southern edge of the broad plume configuration. PFOS found in the monitoring well pairs at PC 34 and 35 may also be attributable to fire training activities that directed foam and water across the southern Site boundary, near the location of PC 34 and 35.

Southern and Northern Plume Boundary

PFOS concentrations to the south of the main plume are low to non-detect, suggesting that the southern limit of contamination PFOS from the site is from PC29 and the MD1 supply well to a line drawn to Flintrock Pond. Additional assessment is warranted to confirm a lower boundary condition in the mid-plume area and the southern and northern extent of impact from Flintrock Pond discharge.

Hot Spot Plume Core

The Winter-Spring 2015 groundwater assessment revealed a Hot Spot at the BCFRTA site and a high concentrated PFOS plume core is migrating directly through the main path of the 2007 perchlorate plume with PFOS concentrations of 120,000 ng/l at PFW-2, 60,000 at PC1, 56,000ng/l at PC1, 32,000 ng/l at PC11 and 17,000 ng/l at PRW-4 (Figure 10). The high concentration of PFOS at the former perchlorate recovery well (PRW-4) indicated that it was possible to capture the high concentrations of PFOS by refurbishing the perchlorate pump and treat system. As mentioned in the General section above, the County implemented this as a short term measure in July 2015 as further described in the IRA Groundwater Pump and Treat Evaluation below.

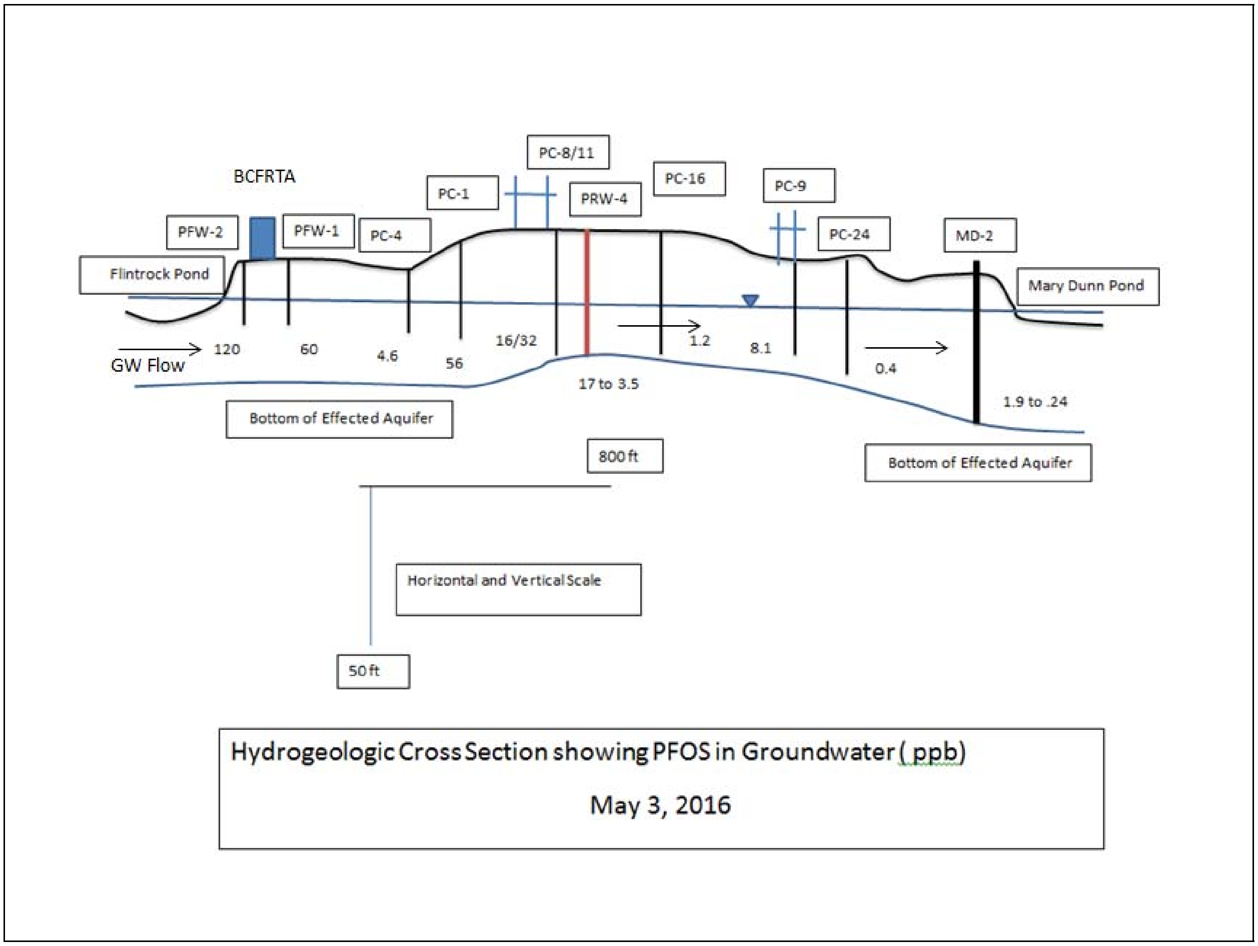

Figure 10 Hydrogeologic Cross Section showing PFOS concentrations in ug/l

Characterization of the other PFAS constituents

PFOS is just one of 23 PFAS analytes that can be detected by the laboratory. The top five PFASs compounds found in groundwater are: 1) PFOS, 2) Perfluorohexane Sulfonate (PFHxS), 3) 6:2 Fluorotelomer sulfonate, 4) 8:2 Fluorotelomer sulfonate and 5) Perfluorohexanoic Acid (PFHxA). PFOS was detected in over 230 samples. There were nearly as many detections of PFOA. The PFOS maximum, average and median concentrations of 320,000 ng/l, 10,126 ng/l and 930 ng/l are significantly higher than PFOA maximum, average and median concentrations of 5,200 ng/l, 249 ng/l and 73 ng/l. The concentration of PFOA in the PFOS plume core is above the HA and ranges from 2100 ng/l at the Hot Spot to 110 ng/l with a concentration below the HA of 22 ng/l upgradient of the MD2 well at PC24 (Figure 10 Table 3). The complete suite of compounds for groundwater in the plume core indicate that the concentrations of PFAS generally decrease with distance from the Hot Spot but that there are slugs of higher concentrations likely due to precipitation events at the source and at PC-9 where higher PFOS concentrations were not caught before the recovery well was re-activated at PRW-4.

Table 2 PFAS Summary Statistics in Groundwater (ng/l)

PFAS Compound	Maximum	Avgerage	Count	StdDev
6:2 Fluorotelomer sulfonate	16000	1200	137	2966
8:2 Fluorotelomer sulfonate	12000	549	137	1805
N-ethylperfluorooctane sulfonamide	0	0	137	0
N-ethylperfluorooctane sulfonamidoe	9	0	137	1
N-methylperfluorooctane sulfonamide	0	0	137	0
N-methylperfluorooctanesulfonamidol	6.5	0	137	1
Perfluorobutane Sulfonate (PFBS)	5100	160	203	486
Perfluorobutanoic acid	890	111	143	172
Perfluorodecane Sulfonate	530	13	143	71
Perfluorodecanoic Acid (PFDA)	540	18	148	75
Perfluorododecanoic Acid (PFDoA)	7.7	0	147	1
Perfluoroheptane sulfonate	5400	252	137	736
Perfluoroheptanoic Acid (PFHpA)	1600	159	204	223
Perfluorohexane Sulfonate (PFHxS)	51000	1750	203	4715
Perfluorohexanoic Acid (PFHxA)	6100	516	151	836
Perfluoro-n-Octanoic Acid (PFOA)	5200	249	229	552
Perfluorononanoic Acid (PFNA)	830	96	203	159
Perfluorooctane Sulfonamide (PFOSA)	240	8	143	23
Perfluorooctane Sulfonate (PFOS)	320000	10126	232	38408
Perfluoropentanoic Acid (PFPeA)	2300	326	143	437
Perfluorotetradecanoic Acid	8.2	0	147	1
Perfluorotridecanoic Acid	440	3	147	36
Perfluoroundecanoic Acid (PFUnA)	5600	220	148	749

Table 3 PFAS in Groundwater along the Plume Core (ng/l)

Date	3/30/2016	10/7/2015	3/8/2016	3/30/2016	3/8/2016	5/12/2016	9/30/2015	6/17/2015	3/30/2016	10/7/2015
	PFW-2	PFW-1	PC-4	PC-1	PC-8	PC-11	PRW-4	PC-18	PC-9	PC-24
6:2 Fluorotelomer sulfonate	16000	700	370	7800	92	2600	3200	460	8,500	32
8:2 Fluorotelomer sulfonate	5500	100	450	3900	63	1100	0	0	450	7
N-ethylperfluorooctane sulfonamide	0	0	0	0	0	0	0	0	0	0
N-ethylperfluorooctane sulfonamidoe	0	0	0	0	0	0	0	0	0	0
N-methylperfluorooctane sulfonamide	0	0	0	0	0	0	0	0	0	0
N-methylperfluorooctanesulfonamidol	0	0	0	0	0	0	0	0	0	0
Perfluorobutane Sulfonate (PFBS)	360	0	73	0	72	350	920	72	3,200	15
Perfluorobutanoic acid	390	0	130	330	46	380	0	71	560	30
Perfluorodecane Sulfonate	240	0	5.1	0	0	0	0	0	0	0
Perfluorodecanoic Acid (PFDA)	230	0	20	0	7.1	0	0	0	0	0
Perfluorododecanoic Acid (PFDoA)	0	0	0	0	0	0	0	0	0	0
Perfluoroheptane sulfonate	2300	200	39	660	73	500	910	23	880	11
Perfluoroheptanoic Acid (PFHpA)	460	0	190	1000	130	470	0	150	1,100	48
Perfluorohexane Sulfonate (PFHxS)	13000	600	1000	5400	540	3300	7300	820	16,000	140
Perfluorohexanoic Acid (PFHxA)	2300	400	440	1600	270	1500	2000	270	4,200	81
Perfluoro-n-Octanoic Acid (PFOA)	2100	800	160	1200	97	430	840	110	1,600	22
Perfluorononanoic Acid (PFNA)	830	100	92	410	86	260	0	71	360	24
Perfluorooctane Sulfonamide (PFOSA)	0	0	24	0	10	0	0	0	0	0
Perfluorooctane Sulfonate (PFOS)	120000	60000	4600	56000	1600	32000	17000	1200	8,100	420
Perfluoropentanoic Acid (PFPeA)	1300	600	430	1500	170	1200	0	220	2,300	91
Perfluorotetradecanoic Acid	0	0	0	0	0	0	0	0	0	0
Perfluorotridecanoic Acid	0	0	0	0	0	0	0	0	0	0
Perfluoroundecanoic Acid (PFUnA)	2500	840	15	990	130	240	0	0	230	0

Upgradient Conditions

The groundwater upgradient of the BCFRTA was evaluated with the assistance of the Barnstable Fire District Water personnel. The supply wells BFD-2 to the north and BFD-5 to the south and a monitoring well 8-90 located on the upgradient side of Flintrock Pond (Figure 7) were sampled on June 17, 2015. All sampled locations indicated Non-detect concentrations of PFOS (Figure 8). A subsequent sampling by the District on January 4, 2016 indicated PFOS concentrations of 13 ng/l in BFD-5 and 8 ng/l in BFD-2. However PFOS was also detected at 23 ng/l at BFD-4, which is west of Hathaway's Pond and not in the groundwater flow of the BCFRTA. These data indicate that low concentrations of PFOS may be present at background conditions. Researchers at JBCC have indicated that PFOS concentrations in atmospheric deposition are less than a couple of ng/l (Amanda Weber, personal communication). The concentration of background PFOS should be further evaluated in order to determine appropriate cleanup concentrations. In addition to upgradient conditions and relative to background, the BCFRTA on-site hydrant and tap water were sampled at on two different occasions. The PFOS concentration at the fire hydrant was 170 ng/l and the PFOS concentration at the tap on November 23, 2015 was 300 ng/l. These results indicate the water delivery from the Town's Hyannis System was also a source of PFOS at the BCFRTA.

Public Water Supply Assessment

The NOR requested a water quality assessment of the downgradient public water supplies. This IRA Plan includes the results of groundwater samples taken from the Mary Dunn Wellfield, the Airport Well, the Barnstable Fire District wells and other Hyannis Water Division wells. These samples were taken either by the Town, DEP or County staff. In most cases the PFOS sampled groundwater concentrations in MD2 are higher than MD1 and MD3 (Table 4). In 2015, the Town decided to only treat the MD1 and MD2 wells because concentrations in these wells exceeded the HA in effect at the time. The Town increased pumping to nearly 400 gpm for each of the two treated wells. The shaded area in Table 4 below shows the period of time when the MD wells were being pumped and treated. PFOS concentrations decreased to non-detect in the MD1 well during this period, but as pumping continued after summer pumping, PFOS concentrations returned (Figure 11). The pumping also resulted in lower PFOS concentrations in MD2. Prior to, and immediately after the 2015 treatment system summer/fall operation, the Town pumped the MD3 well at a high rate of 450 gpm (Figure 11). On May 19, 2016, the EPA revised its Health Advisory for PFOS an order of magnitude lower from 200 to 70 ng/l. The current HA level is now below the groundwater PFOS concentration levels pumped from MD3. The Town provided treatment for this well going into the summer of 2016.

The effect of variable pumping rates on the flow of PFOS from the BCFRTA site and potential impacts from moving the primary pumping center from the Maher wells to the Mary Dunn wellfield are discussed in the section on alternative water in the IRA Plan section below.

Table 4 PFOS/PFOA results from the Mary Dunn and Airport Supply Wells

Year	Month	Day	Constituent	Airport	Mary Dunn No. 1	Mary Dunn No. 2	Mary Dunn No. 3	Mary Dunn No. 4
2009	October	1	PFOS (ug/L)	0.016				
2009	October	1	PFOA (ug/L)					
2009	October	1	Combined (ug/L)					
2013	November	20	PFOS (ug/L)	ND	0.190	0.170	0.110	ND
2013	November	20	PFOA (ug/L)		ND	0.020	ND	
2013	November	20	Combined (ug/L)		0.190	0.190	0.110	
2014	May	22	PFOS (ug/L)	ND	0.098	0.430	0.210	ND
2014	May	22	PFOA (ug/L)		ND	0.062	0.020	
2014	May	22	Combined (ug/L)		0.098	0.492	0.230	
2015	January	9	PFOS (ug/L)		0.330	0.960	0.040	
2015	January	9	PFOA (ug/L)		ND	0.080	ND	
2015	January	9	Combined (ug/L)		0.330	1.040	0.040	
2015	March	19	PFOS (ug/L)	ND	0.280	1.600		
2015	March	19	PFOA (ug/L)		ND	0.130		
2015	March	19	Combined (ug/L)					
2015	April	6	PFOS (ug/L)				0.110	
2015	April	6	PFOA (ug/L)					
2015	April	6	Combined (ug/L)					
2015	July	29	PFOS (ug/L)		ND	0.400		
2015	July	29	PFOA (ug/L)		ND	0.044		
2015	July	29	Combined (ug/L)			0.444		
2015	August	6	PFOS (ug/L)			0.220		
2015	August	6	PFOA (ug/L)			0.040		
2015	August	6	Combined (ug/L)			0.260		
2015	August	12	PFOS (ug/L)		ND	0.220		
2015	August	12	PFOA (ug/L)		ND	0.032		
2015	August	12	Combined (ug/L)			0.252		
2015	August	19	PFOS (ug/L)		ND	0.200		
2015	August	19	PFOA (ug/L)		ND	0.028		
2015	August	19	Combined (ug/L)			0.228		
2015	August	26	PFOS (ug/L)		ND			
2015	August	26	PFOA (ug/L)		ND			
2015	August	26	Combined (ug/L)					
2015	September	9	PFOS (ug/L)					
2015	September	9	PFOA (ug/L)					
2015	September	9	Combined (ug/L)					
2015	October	13	PFOS (ug/L)					
2015	October	13	PFOA (ug/L)					
2015	October	13	Combined (ug/L)					
2015	October	21	PFOS (ug/L)	ND	0.210	0.240	0.099	
2015	October	21	PFOA (ug/L)	ND	0.019	0.026	0.022	
2015	October	21	Combined (ug/L)		0.229	0.266	0.121	
2015	November	4	PFOS (ug/L)					
2015	November	4	PFOA (ug/L)					
2015	November	4	Combined (ug/L)					
2015	November	24	PFOS (ug/L)					
2015	November	24	PFOA (ug/L)					
2015	November	24	Combined (ug/L)					
2016	March	23	PFOS (ug/L)					
2016	March	23	PFOA (ug/L)					
2016	March	23	Combined (ug/L)					
2016	April	20	PFOS (ug/L)	0.006	0.060	0.200	0.200	
2016	April	20	PFOA (ug/L)	ND	ND	0.018	0.027	
2016	April	20	Combined (ug/L)	0.006	0.060	0.218	0.227	
2016	April	27	PFOS (ug/L)					
2016	April	27	PFOA (ug/L)					
2016	April	27	Combined (ug/L)					
2016	May	20	PFOS (ug/L)	0.0033	0.110	0.260	0.170	
2016	May	20	PFOA (ug/L)	ND	0.0054	0.022	0.028	
2016	May	20	Combined (ug/L)	0.003	0.115	0.282	0.198	
2016	May	24	PFOS (ug/L)	ND	0.120	0.210	0.180	ND
2016	May	24	PFOA (ug/L)	ND	0.0047	0.016	0.026	ND
2016	May	24	Combined (ug/L)		0.125	0.226	0.206	
2016	June	1	PFOS (ug/L)					
2016	June	1	PFOA (ug/L)					
2016	June	1	Combined (ug/L)					
2016	June	7	PFOS (ug/L)	0.0029	0.11	0.25	0.12	ND
2016	June	7	PFOA (ug/L)	0.0025	0.0061	0.022	0.024	ND
2016	June	7	Combined (ug/L)	0.0054	0.1161	0.272	0.144	

Red indicates an exceedance of the Health Advisory

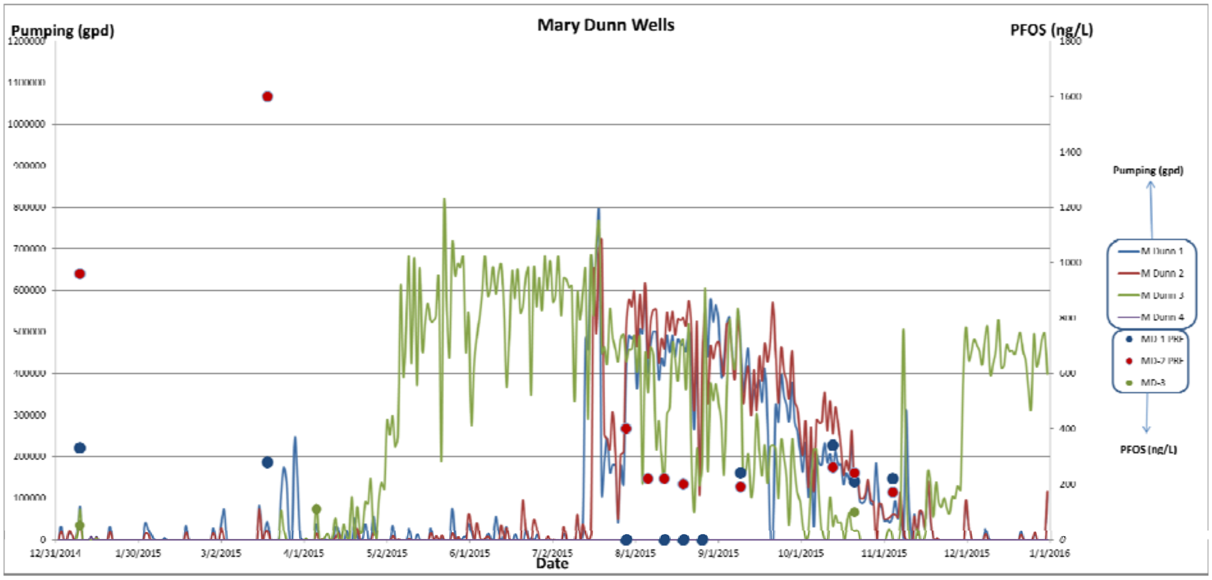

Figure 11 2015 Pumping Operations at the Mary Dunn Wellfield and PFOS Concentrations

Downgradient Supplies

The NOR requires an assessment of other potential downgradient public or private wells. There are no known private wells in the immediate downgradient area between the BCFRTA site and the Mary Dunn Wellfield. The BCFRTA Site is located in a composite Zone II that includes the Mary Dunn Wells, the Airport Well, the Maher 1, 2, & 3 Wells and even Yarmouth wells to the east (Figure 12). Zone IIs are produced to be conservatively protective under extreme pumping conditions of rated capacity pumping for 180 days with no recharge. The Yarmouth wells do not draw from the area affected by the BCFRTA Site. The Zone II delineation also shows internal outlines of zones of contributions (ZOCs) that occur under average pumping conditions to individual wells. The internal ZOC delineations show MD2 not pumping and MD4 pumping. This is not a typical condition because MD4 is not used due to the Water Management Act constraints presented by the nearby wetland and Israel Pond, and because the MD2 well has been used for supply since the completion of the perchlorate cleanup in 2010.

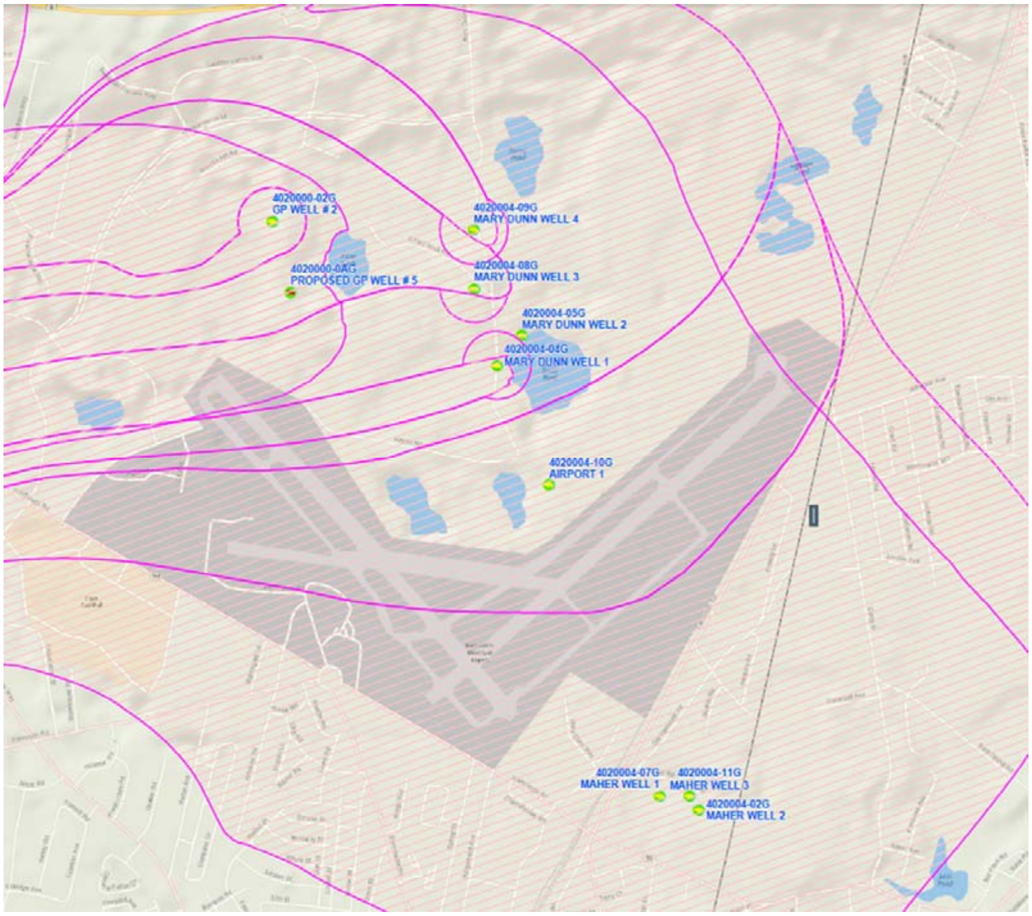

Figure 12 DEP Zone IIs

A draft Zone II delineation produced for the Town by the Cape Cod Commission (2011) shows the most up-to-date concept of the ZOCs to the downgradient wells. The 2011 model indicates that under average conditions the MD1, 2, and 3 ZOCs will capture the entire downgradient area of the BCFRTA (Figure 13). The Airport ZOC is south of the BCFRTA source and samples of its pumped groundwater results have been below reporting limits or single digit ng/l detections consistent with background (Table 4). The Maher ZOC, because it is the Town’s biggest producing wellfield, captures a large area of groundwater primarily west from the Airport (Figure 14). The Maher ZOC also reaches north up to Mary Dunn Pond. The 2011 Model was used to evaluate the percentage of water derived from the Mary Dunn Pond. Under average pumping conditions for Hyannis, the model scenario shows that approximately 15% of the Maher water could be derived from the Mary Dunn Pond area (based on the percentage of reverse particles from the Maher Wells) (Figure 14). However, this average scenario also includes an active Airport well which deflects the reverse tracked particles north toward the pond. The 2011 Model also indicates that the time of travel for a particle to migrate from the BCFRTA to Mary Dunn Pond and then the Maher wells is approximately 10 to 20+ years while the time it takes for a particle to travel from the Airport directly to the Maher wells is less than 5 years.

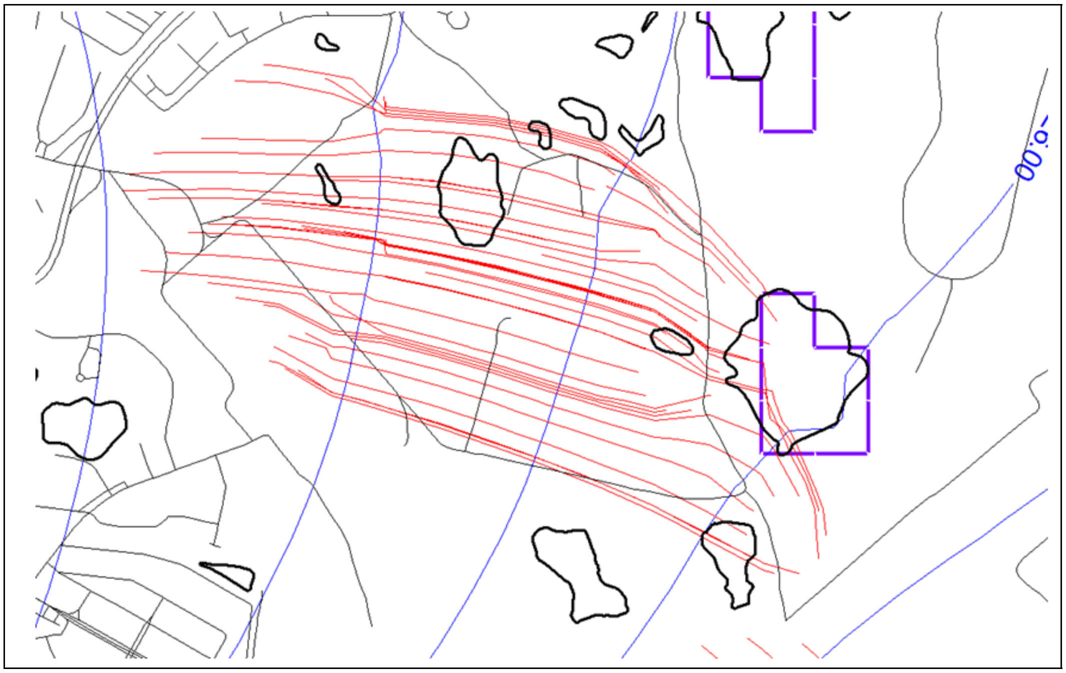

Figure 13 Five Year Reverse Particle Tracks for Average Pumping Conditions

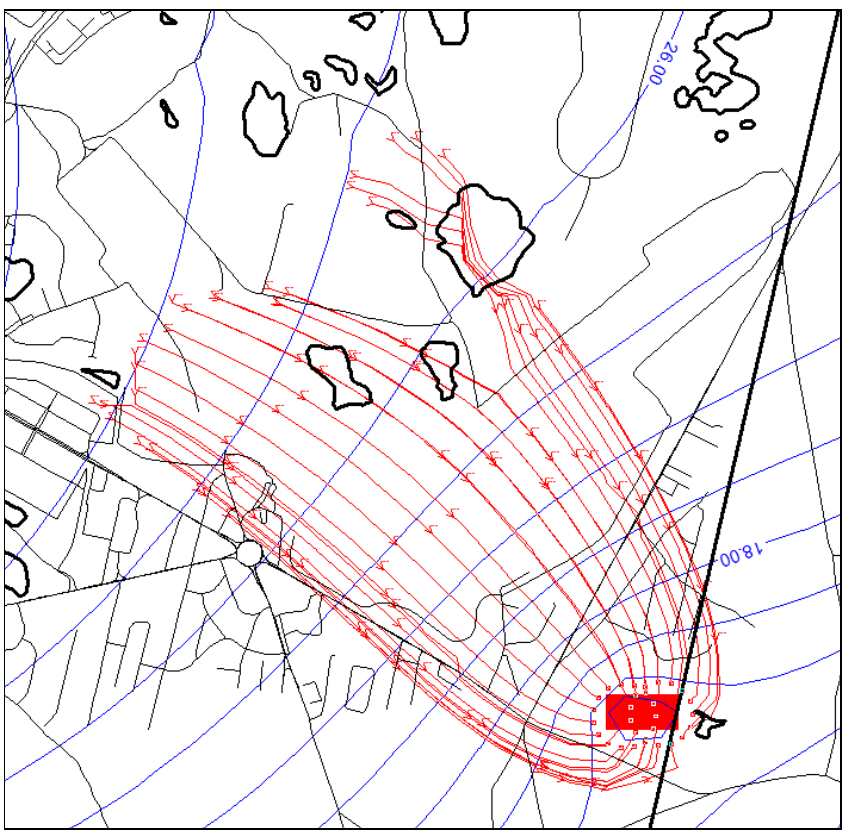

Figure 14 Reverse Particle Tracks for the Maher Wellfield under Average Pumping with 5-Year Markers.

The NOR asked the County to assess downgradient private and public water supplies. In order to address the NOR requirements, the County sampled Mary Dunn Pond and two sets of existing monitoring wells, HW1 and HW2, located north and south of Mary Dunn Pond respectively. These wells were installed in 1992 to address DEP Water Management Act (WMA) concerns that the Mary Dunn Wells can draw down the water level in Mary Dunn Pond. During the 1991 drought Mary Dunn Pond was completely dried up. The April 12, 2007 WMA Permit contains restrictions on the amount of water that the Town can withdrawal from the area to protect surface water dependent ecosystems along with monitoring.

The assessment of groundwater downgradient of the Mary Dunn wells detected PFOS at shallow and deeper depths in the aquifer (Figure 15). The results indicate that when the Mary Dunn wells are not operating that PFOS in groundwater will continue to migrate pass the well locations to 1) discharge into the Pond where 82 ng/l was detected and 2) to flow in groundwater beneath the Pond to the south side where PFOS was detected at 170 and 41 ng/l for the shallow and deep monitoring wells respectively The historic concentrations downgradient of the pond and the amount of attenuation that would occur over a 10-20 year time of travel it takes to get to the Maher wells are not known.

In order to assess downgradient impacts, the 2011 Model was used to track particles from the entire south side of the Mary Dunn Pond. The results indicate that some particles will migrate to the Maher wells to enter the east side of the wellfield (Maher-2) and that the remainder continue to travel southeast to discharge into Mill Creek (Figure 16). The County understands that certain fire training activities have taken place on the Airport's East Ramp by the Airport's Fire squad with mutual participation by local Fire Districts as another, and more proximal, potential PFOS source to the Maher wellfield.

A review of parcel water supply data indicates there are not any private wells in this downgradient area. Groundwater from the Maher wells includes multiple contaminants including VOCs, and 1-4 Dioxane in addition to PFOS with concentrations that are greater in the western (Airport) side of the wellfield (Maher-1 & 3) versus the eastern side of the wellfield (Maher-2) indicating that the primary water quality impacts at the Maher wellfield are from the Airport, not the BCFRTA. The DEP has issued a Request for Information from the Town of Barnstable for information regarding the use of AFFF foam for training at the Airport and potential releases of PFAS. Until the Airport is found not to be a source of the multiple contaminants impacting the Maher Wells, including PFOS, the weight of evidence, based on concentration, distance and lack of multiple contaminants, indicates that the BCFRTA is not the likely source of contaminants at the Maher wells.

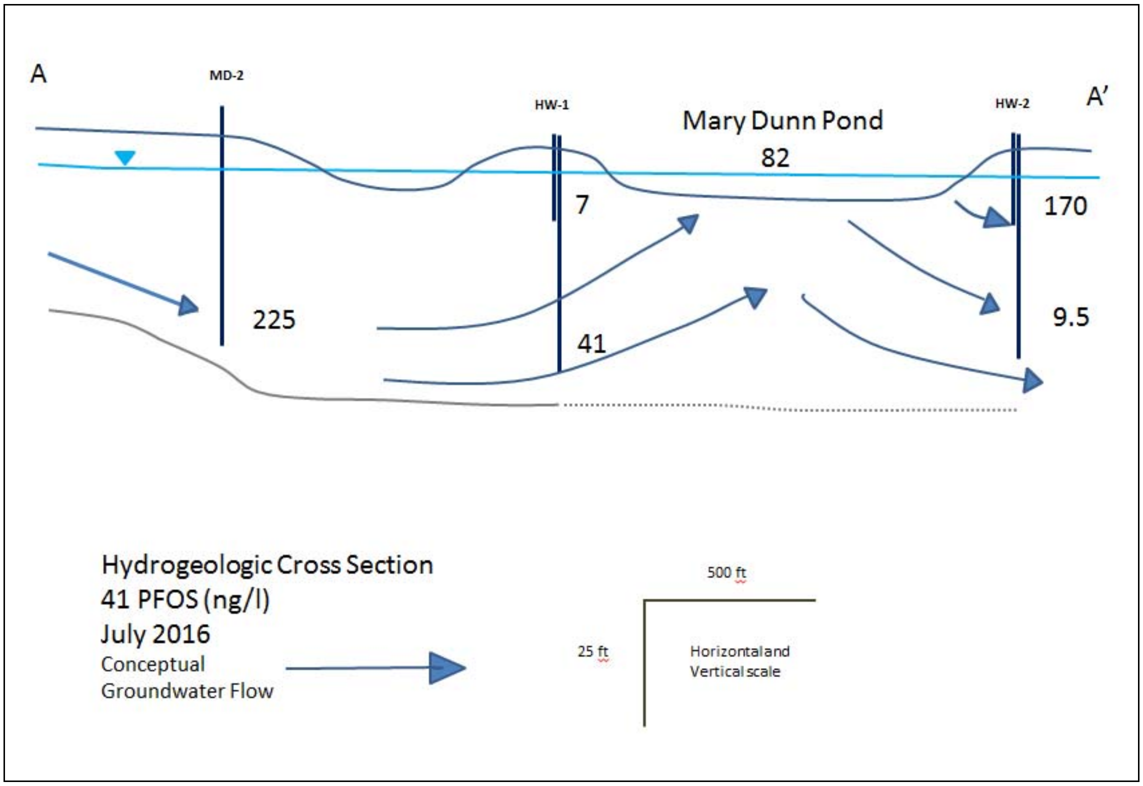

Figure 15 Downgradient Assessment

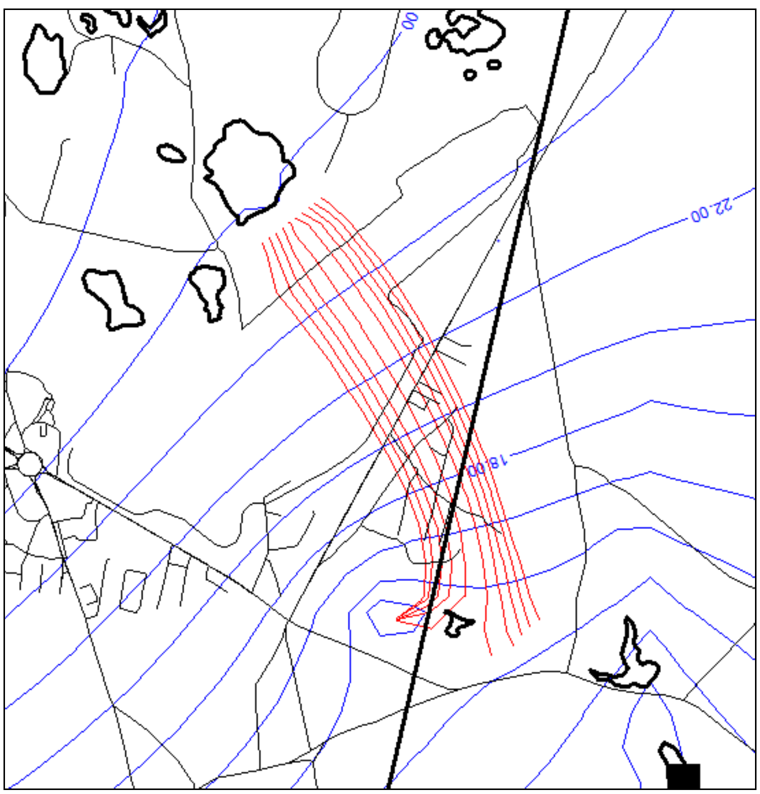

Figure 16 Particle Tracks from the Southeast side of Mary Dunn Pond

Imminent Hazard and Substantial Release Migration

Because the concentrations of PFOS are above the EPA HA, an Imminent Hazard condition as defined under 310 CMR 40.0321 (2) c exists. Furthermore, because PFOS has migrated more than 200ft downgradient and has been detected in a public supply well and a surface water body, a condition of Substantial Release Migration (SRM) 310 CMR 40.0006, also exists.

The NOR asked that the County include in its responses (beyond those containment assessment actions detailed elsewhere), measures that the County will take to prevent, eliminate and/or abate any hazards associated with the consumption of impacted drinking water. Actions so far taken by the County at the BCFRTA site include a moratorium of using foam at the site and abandonment of the use of the Flare, Propane and Pan Props to reduce runoff in the area upgradient to the Hot Spot. The management actions at the BCFRTA have restricted access to the Site to only non-training personnel.

The primary Imminent Hazard condition caused by contamination of an active public or private water supply is addressed through the provision of alternative water supplies and/or treatment of the affected supplies. The NOR asked that the County respond with such measures and a timeline.

Alternative Water

The Town of Barnstable has provided carbon treatment for the Mary Dunn wellfield, starting with MD1 and MD2 in the summer of 2015 and adding MD3 in the summer of 2016. Review of 2015 performance data of the treatment system indicates that the carbon is effectively removing the PFAS compounds including PFOS. The Town also provided short term access to bottled water during the transition periods, prior to system start-up and during a period when the new EPA Health Advisory was lowered from 200 to 70 ng/l.

The Town has provided treatment of the PFOS impacted Mary Dunn wells and has thus addressed the Imminent Hazard.

Due to growing concern about the presence of 1-4 Dioxane at the Maher Well, the Town made an emergency connection to the Yarmouth Water Department to dilute the 1-4 Dioxane. This action also reduced PFOS detected in the Town's water supply system to address the lowered PFOS Health Advisory in 2016.

Long Term Water Supply Alternatives and Constraints

The three wells at the Mary Dunn Wellfield have been used in conjunction with the other nine Hyannis Water System supply wells at the Maher, Straightway and Simmons Pond Hyannisport wells. Several of the other supply wells are impacted with other contaminants, primarily 1-4 Dioxane. The constraints to using the other supply wells, has now increased the Town's reliance on the treated Mary Dunn Wellfield that is producing treated drinking water without any contaminants (Figure 17).

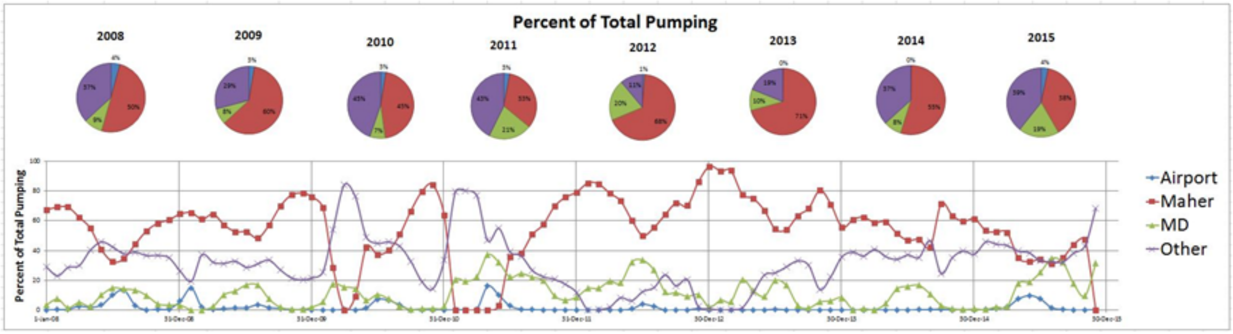

Figure 17 Percent of Water from Hyannis Supply Wells 2008-2016

The Mary Dunn wellfield, as indicated earlier, has ecological constraints on the amount of water that can be withdrawn under the 4/12/2007 WMA Permit. The 2016 year has seen a return to drought type of conditions and falling watertable. This condition has resulted in falling water levels in the sensitive coastal plain ponds complex of the Hyannis area. Measurements of water levels in HW-1s on the north side of Mary Dunn Pond indicate a decrease of 0.68 ft over the course of August 25 to Sept 5, 2016 (Table 5). The water table decrease measured at the Mary Dunn Pond well is 30% more than the water table decrease measured at the USGS index well AIW306 for the same period.

Table 5 Depth to Water Table Measurements

	HW1s	AIW306
8/25/2016	7.65	25.66
8/26/2016	7.70	25.69
8/29/2016	7.75	25.78
9/6/2016	8.12	25.98
9/9/2016	8.19	26.05
9/14/2016	8.33	26.19
WMA Threshold	aug	25.95
WMA Threshold	sept	26.37

While provision of safe drinking water is a paramount concern, over reliance on the Mary Dunn wells can exacerbate the drought conditions with severe ecological consequences. In 1991 Mary Dunn Pond was completely dry under similar extended drought conditions and pumping. The 4/12/2007 WMA Permit constrained pumping at the Mary Dunn Wellfield to 1.85 MGD from June 1 to Aug 31 and to 0.5 MGD for the period September through May. Little Israel Pond is presently dry and Mary Dunn Pond has exposed aquatic plants in September 2016. It is not clear, if the Town can stay within the water withdrawal thresholds of the 4/12/2007 WMA Permit or if the water level monitoring program is being implemented. The status of the DEP's Special Condition requirements of the 4/12/2007 WMA Permit # 3 and # 6 need to be clarified. The draft 4/15/2015 WMA Permit indicates these special conditions are in effect until the final permit is completed. The 4/15/2015 draft WMA Permit makes reference to the AIW306 watertable level as a threshold. Comparison of AIW306 to HW-1s measurements this summer and the water level in the Pond, indicates that ecological conditions at Mary Dunn Pond are impacted prior to the Permit's draft threshold at AIW306. The 4/15/2015 draft WMA Permit's proposed removal of these special conditions was made during a non-drought period and does not reflect the resource protection needed during present drought cycles. The WMA Permits are available in Appendix X.

The Town's efforts to secure connections to other water suppliers (Yarmouth and COMM) are an appropriate response to meeting the long term demands of Hyannis. The Town is also considering a water supply exploration effort to identify and permit new supplies within the Town. Such efforts are typically 3-5 years long and cost at least $5 million dollars. The adjacent DCR land includes several other shallow surface waters that would merit protection/mitigation from new water supply withdrawals.

Another option to consider is the use of the Upper Cape Water Supply Cooperative (UCWSC). The UCWSC was established for supplementing projected upper cape water supply deficits due to contamination at the JBCC. However, the four Districts/Towns of the Upper Cape have continued to secure new supplies or invest in costly treatment to extend the capacity of their own supplies. Therefore the capacity of the UCWSC is barely taxed with an apparent excess Maximum Daily Demand ranging from 3 to 4 MGD over the last 5 years compared to the MDD of the entire Hyannis system which ranges from 4.5 to 5.5 MGD (Figure 18). The UCWSC supply was built by the Department of Defense for the communities of the Sagamore Lens and should be considered by the Town and water supply regulators as potential alternative source (Tata and Howard, 2015). The distance from the Maher station to the JBCC along Willow Street and Route 6 is 13 miles. A typical pipeline installation cost is $180 ft. Thus the estimated cost for Hyannis to hook up to the Upper Cape Reserve is $ 12.5 million dollars. This does not include the whole cost of the supply.

The County and the Cape Cod Commission are ready to work with the Town, State and Federal officials to secure long term water supply options for the Town and region.

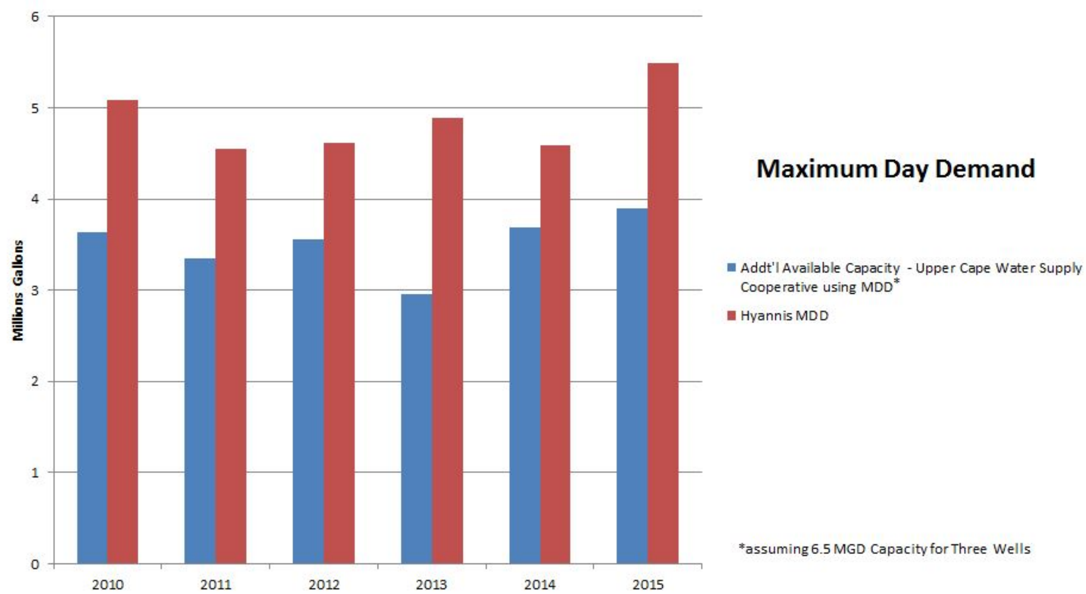

Figure 18 Upper Cape Water Supply

IRA Plan

Hot Spot Soil Removal

Source Area

The general soil and groundwater assessment identified a Hot Spot in the southeast corner of the BCFRTA. Given the high concentrated plume of PFOS that emanates from the area, an immediate response action for removal is proposed. To better define the extent of soil contamination, a Hot Spot soil investigation was conducted.

Detailed assessment

On Jan 21, 2016 seven soil borings were advanced with a DT9500 Power Probe by Desmond Well Drilling/Cape Cod Test Boring (Figure 19). Continuous core samples were retrieved to a depth of 12 ft below ground surface; boring logs were completed and images of the cores were taken. (Boring Logs are available in Appendix II). Twenty soil samples were selected from the cores and placed in polyethylene bottles and placed on ice for shipment to Maxxam laboratory. Two temporary 2 inch PVC monitoring wells with 5 ft screens were installed at the watertable in the boreholes of HS1 and HS2. The Hot Spot area is blacktopped with concrete along the east side. Along the concrete is a sump where there is no blacktop. This area is shown with an ellipse on Figure 19. The initial boring B3 of 2015 detected high soil concentration of 4,900 mg/kg PFOS. The preliminary conceptual model is that the sump serves as a direct path for PFOS in foam to infiltrate to the groundwater. Therefore the borings HS1, 2, and 3 were oriented north to south in the sump area. Borings and samples were then taken along the west side of the edge of pavement. A single shallow boring was placed in the center of the pavement..

Figure 19 Hot Spot Soil Boring Locations

The laboratory results indicate that subsurface soil along the west transect beneath the sump has high PFOS concentrations with a maximum of 830 mg/kg (Figure 20). The East Transect has a maximum PFOS concentration of 500 mg/kg. The result from soil just below the pavement in HS-7 had a high concentration of 2000 mg/kg. At the time of sampling; (January 2016), the soil beneath the pavement was insulated because of the presence of moist soil. The preliminary conceptual model is that PFOS in the Hot Spot area is carried up by water vapor and is trapped beneath the pavement. It is not known if this is an expected transport route for PFOS in subsurface conditions.

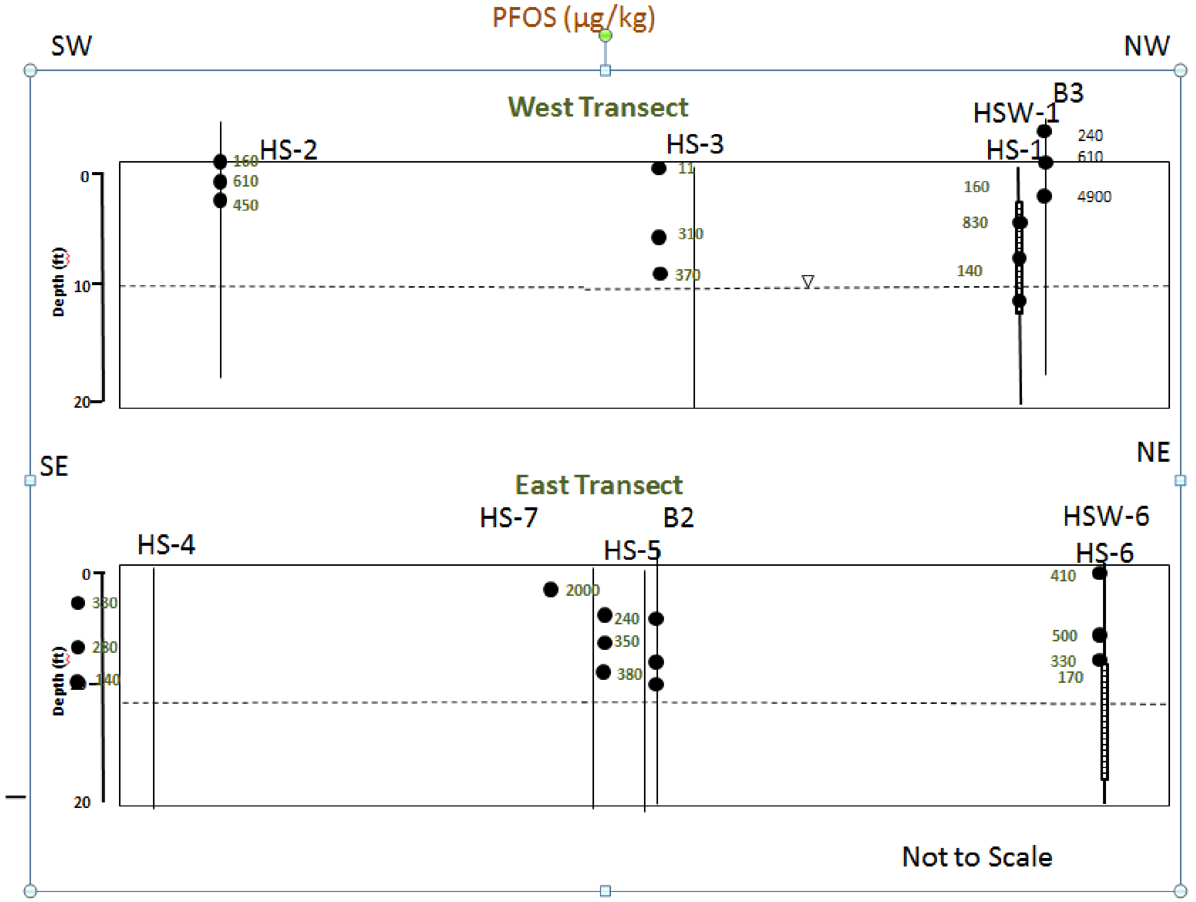

Figure 20 PFOS Concentrations in Hot Spot Soil Samples

Other PFASs in Hot Spot Soil

PFOS was one of five compounds detected in all 20 samples (Table 6). The other compounds in order of maximum concentration are, 8:2 Fluorotelomer sulfonate at 350 ug/kg, Perfluoroundecanoic Acid (PFUnA) at 260 ug/kg, Perfluorodecane Sulfonate at 28 ug/g, 6:2 Fluorotelomer sulfonate at 11 ug/kg, and Perfluorohexane Sulfonate (PFHxS) at 9.2 ug/kg. PFOA was found in 80% of the samples with a maximum of 3.7 ug/l. The low PFOA detections in Hot Spot soil is consistent with the low concentrations in groundwater. The high concentration of the fluorotelomers in soil is consistent with those found in groundwater.

Table 6 Statistical Summary of Hot Spot Soil Tests

	ug/kg					
Statistics:	High	Median	Average	# samples above RDL (20 samples total)	% samples above RDL	Minn Soil Cleanup standard
6:2 Fluorotelomer sulfonate	11.00	1.85	2.68	20	100%	
8:2 Fluorotelomer sulfonate	350.00	22.00	38.58	20	100%	
N-ethylperfluorooctane sulfonamide	0.00	0.00	0.00	0	0%	
N-ethylperfluorooctane sulfonamidoe	0.00	0.00	0.00	0	0%	
N-methylperfluorooctane sulfonamide	0.00	0.00	0.00	0	0%	
N-methylperfluorooctanesulfonamidol	0.00	0.00	0.00	0	0%	
Perfluorobutane Sulfonate (PFBS)	0.54	0.00	0.03	1	5%	
Perfluorobutanoic acid	0.00	0.00	0.00	0	0%	
Perfluorodecane Sulfonate	28.00	1.35	4.05	20	100%	
Perfluorodecanoic Acid (PFDA)	16.00	1.20	2.03	19	95%	
Perfluorododecanoic Acid (PFDoA)	8.00	0.33	1.10	12	60%	
Perfluoroheptane sulfonate	5.50	0.81	1.26	17	85%	
Perfluoroheptanoic Acid (PFHpA)	0.46	0.00	0.08	4	20%	
Perfluorohexane Sulfonate (PFHxS)	9.20	1.70	3.00	20	100%	
Perfluorohexanoic Acid (PFHxA)	3.10	0.36	0.57	19	95%	
Perfluoro-n-Octanoic Acid (PFOA)	3.70	0.32	0.54	16	80%	
Perfluorononanoic Acid (PFNA)	5.70	0.83	1.12	20	100%	
Perfluorooctane Sulfonamide (PFOSA)	11.00	1.10	2.57	19	95%	
Perfluorooctane Sulfonate (PFOS)	2000.00	330.00	408.55	20	100%	6000
Perfluoropentanoic Acid (PFPeA)	0.99	0.00	0.11	4	20%	
Perfluorotetradecanoic Acid	2.70	0.00	0.26	7	35%	
Perfluorotridecanoic Acid	45.00	1.40	6.10	19	95%	
Perfluoroundecanoic Acid (PFUnA)	260.00	16.50	42.11	20	100%	

Immediate Response Action for the Hot Spot

The immediate action for the Hot Spot is to remove the primary soils receiving runoff and soils proximal to the activity area. The area was initially estimated by a 20 x 20 ft area with a 10 ft depth. Upon further review the area was enlarged.

Proposed Activities

The proposed work will entail excavation of a 400 square foot area referred to as the hot spot, approximately 20 feet wide and 20 feet long in the southwest corner of the site as shown on Figure 3. This area contains the highest concentrations of PFOS at the site, which are being mobilized by groundwater and are detected in downgradient, off-site monitoring wells. The County proposes to excavate up to 200 cubic yards from this area. Removal of this contaminated soil will greatly reduce the concentrations of PFOS on-site, and the groundwater plume flowing off-site.

Excavation Area A & Area B: Contaminated soil will be removed at two different depths within this area. Area A is 10 feet wide by 20 feet long (200 sf) and contains the higher concentrations at greater depths, and will be excavated to a depth of 10 to 12 feet. Area B is the remaining 200 sf surrounding Area A, and will be excavated to depth of 5 feet (Figure 21).

Figure 21 Proposed Hot Spot IRA and Temporary Stockpile Area

Stockpile: All excavated soil will be stockpiled immediately northeast of the hot spot in the area designated on Figure 21. This location will allow the excavated soil to be placed on existing hardscape and will require less transport to an alternative stockpile area. Stockpiled soils will be placed on an impermeable plastic liner enclosed by a haybale perimeter to prevent potential rainfall from infiltrating. The stockpile will also be covered with polyethylene sheeting.

Soil Disposal: The stockpile will be removed for disposal at a lined landfill operated by Waste Management of Massachusetts, Inc. within a week of the excavation, depending on schedule. The County has a contract with WMM to receive 200 cubic yards of material.

In-Situ Sampling: Following soil removal to the proposed depths, soil samples will be collected to determine remaining concentrations of PFOS within the soilat the bottom of the excavation. This will enable the County to gauge the success of the clean-up and to inform future planning for more long-term remediation for the site as a whole.

Carbon Soil Amendment: The County will amend the remaining soil at the bottom of the hole with a carbon material amendment commercially available as *Rembind* (See Appendix VII). PFOS will bind to the carbon/*Rembind*, allowing the soil amendment to absorb remaining PFOS in the soil. The amendment will be broadcast with an excavator at the conclusion of the excavation. The *Rembind* will reduce the leaching of PFAS from the soil. *Rembind* is an activated carbon that is supplemented with Alum. Therefore, Compounds that could potentially leach from *Rembind* are aluminium and copper. Standards for aluminium are normally high (i.e. non-stringent) so some leaching is generally acceptable as aluminium is a naturally occurring form in natural clays. A small amount of copper is in the product but again leachability will be low and totals will be within guidelines once mixed with the soil. The amount of leaching is expected to be low.

Backfill: The excavated hole will be filled in with clean fill from Robert B. Our Company, Inc. within one week of the excavation.

Erosion & Sedimentation Controls: The proposed action has been documented and reviewed by the Barnstable Conservation Commission. The ConCom approved the action with a negative determination (DA-16058). Straw wattles will be installed around the hotspot to limit mobilization of sediment within this area. This barrier will be routinely inspected and repaired, as necessary. The wattles will remain in place until all soils have become stabilized.

Hot Spot IRA Monitoring Plan

Shallow PVC drive points will be driven into the bottom of the hole to the water table to monitor PFAS concentrations after the excavation. In addition, PFW-2 will be monitored on a biweekly basis for two months to evaluate the change in PFAS concentrations. PFW-2 has had the highest PFAS concentrations on the site (310,000 ng/l).

Hot Spot IRA Schedule

The local permitting and procurement for various aspects of the Hot Spot IRA are completed or in progress. It will be scheduled immediately after approval of the Hot Spot as an IRA by the DEP.

IRA Groundwater Pump and Treat Evaluation

The County under took what it referred to as a short term measure to refurbish the perchlorate pump and treat system to contain the high concentrations of PFOS emanating from the Hot Spot Area as described above. The NOR requested that the IRA include a response to expand the existing groundwater recovery and treatment system to include additional recovery wells or an increased pumping rate to decrease the mass of PFAS in the groundwater. This section will describe the existing pump and treat system and its performance, the system's interaction with the Mary Dunn Well and an evaluation options to expand or increase pumping to further decrease mass.

Existing Pump and Treatment System

The treatment system is documented in the perchlorate 2007 IRA start-up and status reports. In 2015 the County contractors, Desmond Well Drilling Inc., evaluated the pump in PRW-4 and replaced broken and/or worn parts at the treatment building including electrical connections and the Goulds system pump. A new Variable Frequency Drive (VFD) unit was ordered and installed. The specifications of the two Siemens treatment vessels were evaluated by Calgon and 1500 lbs of activated carbon (Filtrasorb 400 virgin GAC) was installed in each vessel. On July 15 the system became operational. The County staff operated the system until November of 2015 when it contracted with Coastal Engineering Inc. for treatment system operation and maintenance consisting of system check, iron filter bag exchanges and regular backwashing. The initial pumping rate was approximately 38 gpm. The IRA plan for perchlorate indicated a 200 ft wide capture area for PRW-4 at 40 gpm. The electrical use is approximately 400-500 KWH for the Goulds pump in the treatment building and 1200 KWH for the recovery well.

Performance Monitoring

Performance monitoring samples are taken on a biweekly basis, consisting of raw water from PRW-4, mid-point and effluent. After several weeks only PRW-4 and the mid-point samples were taken since no detections in the effluent were expected. The carbon filtration indicates that all 23 analysed compounds by Maxxam are below the reporting limits. The regular performance monitoring of raw water provides information on the PFOS removal. PFOS concentrations in groundwater from the PRW-4 capture well have ranged from 17,000 ng/l to 3,500 ng/l, averaging 7,800 ng/l over the period of operation. (Figure 22). In comparison the highest PFOS concentration at MD2 was 1,600 ng/l.

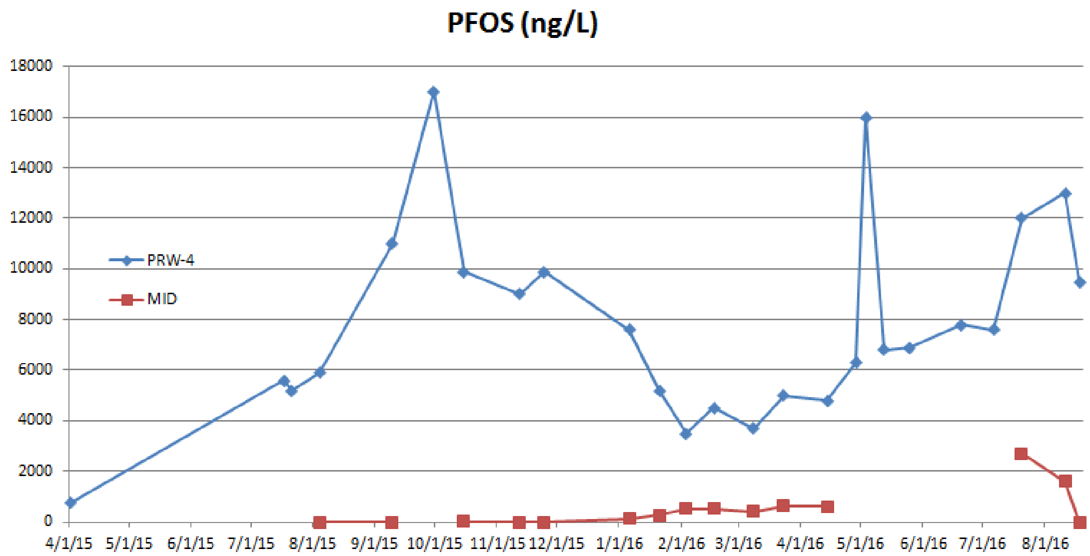

Figure 22 PFOS in PRW-4 Capture Well and Mid-Point (lead) Carbon Vessel

The pumping rate of PRW-4 is affected by iron fouling in the well and force mains. By October 2015 the rate had decreased to 15 gpm. The well and force mains were treated with scaling agent, hydrochloric acid, in December 2015 and the pumping rate increased to 33 gpm. The pumping rate again declined through the spring so that by June of 2016, the pumping rate had decreased to 16 gpm. Several investigations of the force main and another scaling treatment were conducted and the force main was abandoned for another 2 dormant lines. As a result of the new lines, the pumping rate rebounded to approximately 60 gpm in July. The rate has been decreasing to approximately 35 gpm in August 2016 and 30 gpm in September. The lag carbon vessel began to experience a low concentration of PFOS in the effluent in early July after a doubling of the flow rate through the system. The carbon was changed out in late July 2016. The last effluent PFAS sample from the lag vessel before the change out had a concentration of 6.2 ng/l of PFOS and no other detections, on July 20, 2016.

Overall the system has pumped approximately 14 million gallons of the highly concentrated PFOS plume at an average rate of 22 gpm. Using an average concentration of 7800 ng/l, the mass removed from groundwater is approximately 9/10 of a pound for the duration. In comparison the MD2 well in the summer pumped approximately 17 million gallons per month. At a concentration of 200 ng/l the MD2 well removed 0.02 pounds of PFOS. If the single MD2 well operated year round, the amount removed would be 1/3 of a pound.

The concentration of PFOA in the PRW-4 recovery well ranges from 840 ng/l to below the reporting limit with an average of 254 ng/l with a median of 160 ng/l. PFOA is detected in concentrations below the 70 ng/l Health Advisory action level at the Mary Dunn Wells

The County recently received 2016 performance data (PFOS/PFOA concentrations) on the MD1, 2 & 3 wells to evaluate whether the interim action of partial containment has reduced the overall concentrations being pumped by the supply wells. The connection between the County's assessment of PFOS and performance of the Mary Dunn wells is inextricable. As indicated above, the PFOS concentrations in the MD1 raw water in 2015 during summer pumping was reduced to non-detect and then rebounded after pumping (Figure 11).

The 2016 spring and summer PFAS and pumping data provided by the Town was evaluated (Figure 23). The concentration of PFOS steadily increased from April to August from approximately 60 ng/l to 210 ng/l in MD1. The Town pumped over 1 million gallons per day, an extreme amount, from MD3 during the month of June and the PFOS increased from 170 ng/l to a maximum of 390 ng/l in July for MD3. The MD3 PFOS concentration decreased in August. The PFOS concentration in MD2 remained stable around 200 to 260 ng/l. Overall the increased pumping from the wellfield appears to have increased PFOS concentrations in the wells. It is difficult to see the benefit of the containment or mass reduction when only monthly raw samples are taken. The PFOS concentrations in MD 1 increased in 2016 instead of declining in 2015. The heavy amount of pumping from the three supply wells appears to have resulted in a uniform mass combining the uncaptured high plume core and surrounding broader area plume area which gets diluted. The PFOA concentrations are below the Health Advisory with MD1 having the highest levels.

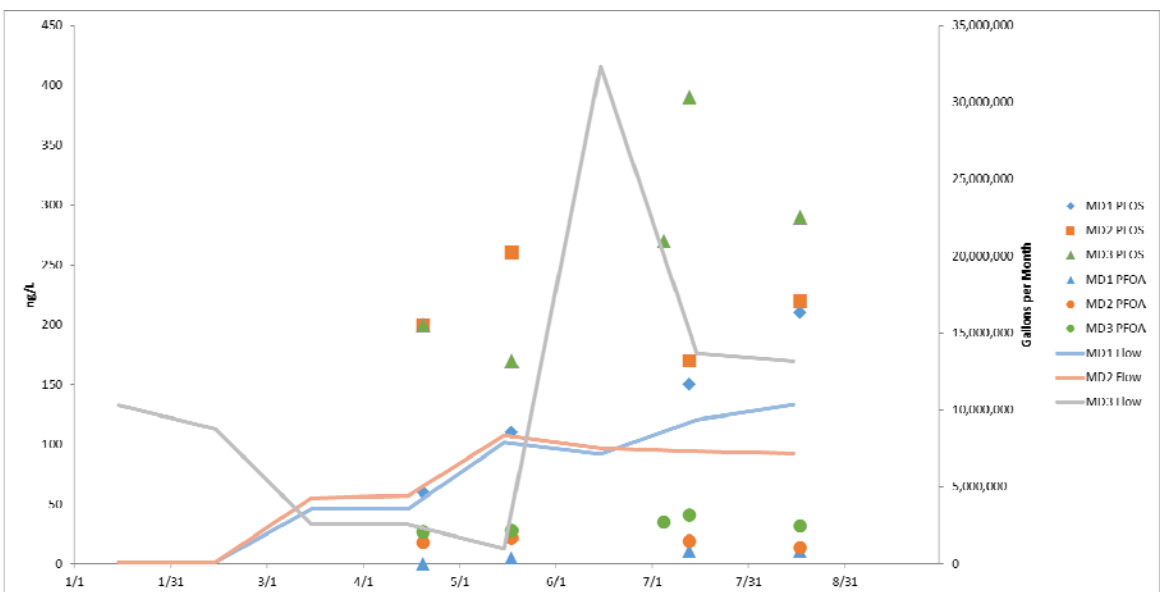

Figure 23 PFOS and PFOA Concentrations and 2016 Monthly Pumping Rates in the Mary Dunn Wells.

Groundwater Modeling of Capture and Interaction with the Mary Dunn Wells

The USGS Model Flow model, as modified by the Cape Cod Commission (2011) for the Town of Barnstable's "Draft Zone II Delineation", was used to evaluate the containment options and interaction with the Mary Dunn wellfield. The 2011 Model was telescoped to the area of the BCFRTA and the Mary Dunn wells. This process uses the boundary conditions and groundwater fluxes from the regional model and inputs them to the Telescoped Model. A series of 15 screen shots of model outputs illustrates the options for expanded containment of PFOS contaminated groundwater. The Telescoped Model performs well with a mass balance error of less than 0.5 %.

The Telescoped Model was used to illustrate the path of particles placed at the Hot Spot under average pumping conditions from 2008 to 2010 Figure 24. The illustration shows the path of particles from the Hot Spot combined with the broader area of lower level contamination that extends from the lower boundary of Flintrock Pond to the northern extent of the activity area of the site which is approximately 570 ft. The Telescoped Model shows that particles from the Hot Spot migrate towards MD2, with some deflection towards MD3, and that the particles from the broader area migrate to MD1, 2 and 3. These results are consistent with the observed concentrations of PFOS in groundwater and also with the configuration of the earlier perchlorate plume.

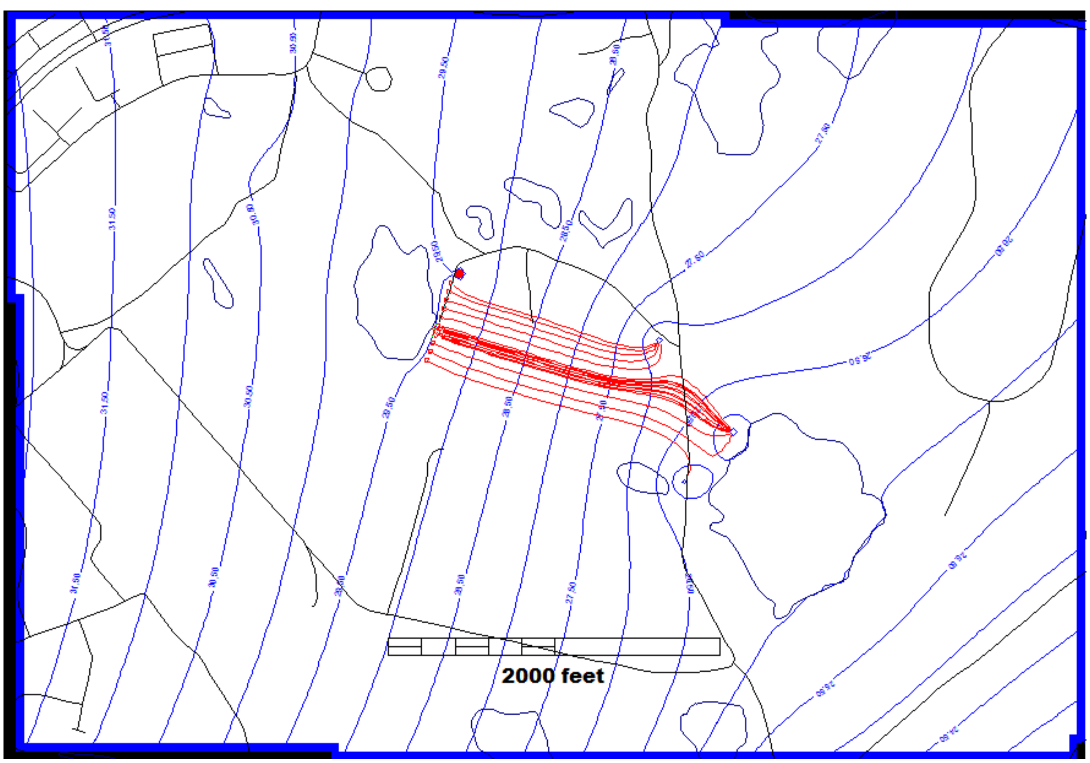

Figure 24 Particle Paths from the Hot Spot and Broader Area under Average Pumping

The Telescoped Model was used to illustrate the capture effect of the interim pump and treat system at an average pumping rate of 25 gpm with the same amount returned as discharge to the northern recharge basin (Figure 25). This is the average condition of the existing I-PT system. The time of travel from the Hot Spot to the recovery well is 2 years. The TM shows containment of the high concentration plume, but not the entire broader area of lower concentrations (Ranging from 1000 to 3000 ng/l).

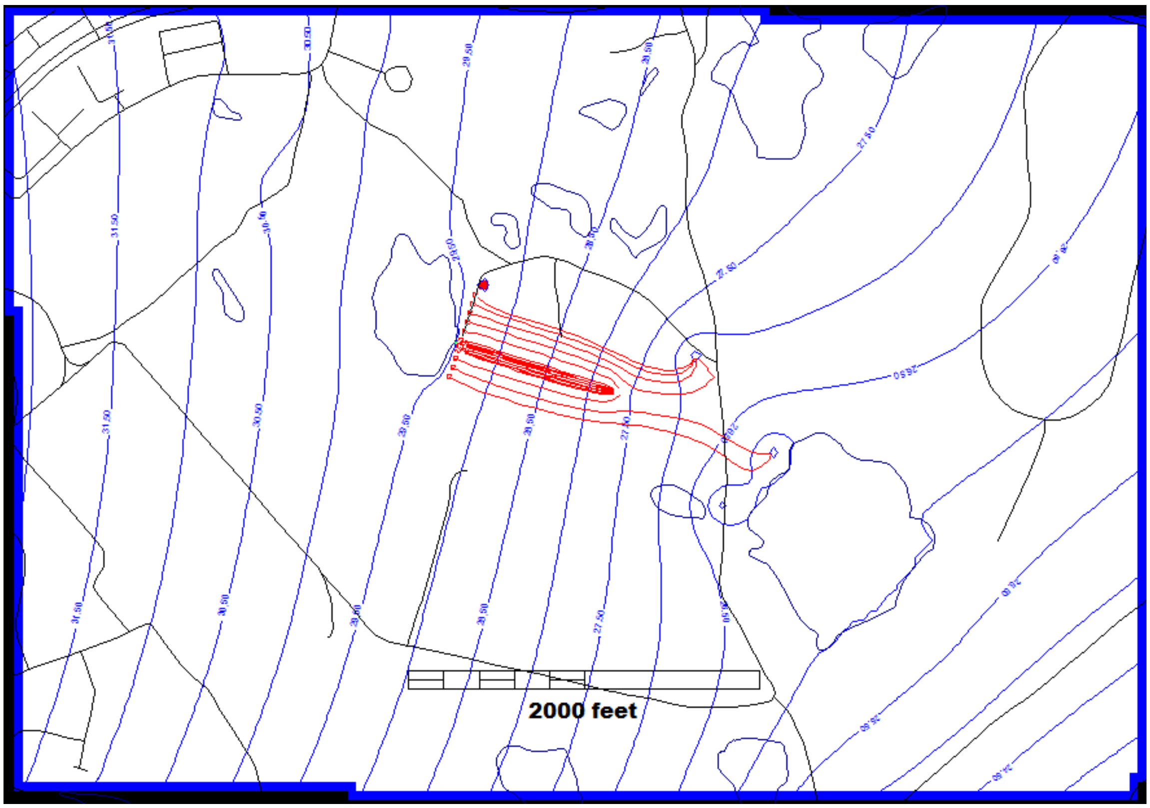

Figure 25 Particle Paths from the Hot Spot and Broader Area with containment at average MD pumping conditions.

The next series of screenshots show the present capture at 25 gpm under: 1) 2015 Summer pumping conditions (this included the treated water from MD1 and MD2 but also a fairly significant volume from MD3 which was below the 200 ng/l Health Advisory at the time) (Figure 26); 2) 2016 winter pumping conditions which was almost entirely from MD3 prior to the lowering of the HA (Figure 27); and 2016 Summer pumping which had 60% higher volume being pumped from MD3 than MD1 and MD2 (Figure 28). The steady state conditions of these pumping regimes indicate that the 25 gpm Recovery Well contains the high concentrated PFOS but that the lower PFOs concentrations are induced to flow towards MD3. This illustration does not include a representation of the high PFOS concentrations downgradient of the PRW-4 recovery well. Water Quality data from the Mary Dunn Wells indicates increasing PFOS concentrations in MD3 (Figure 23).

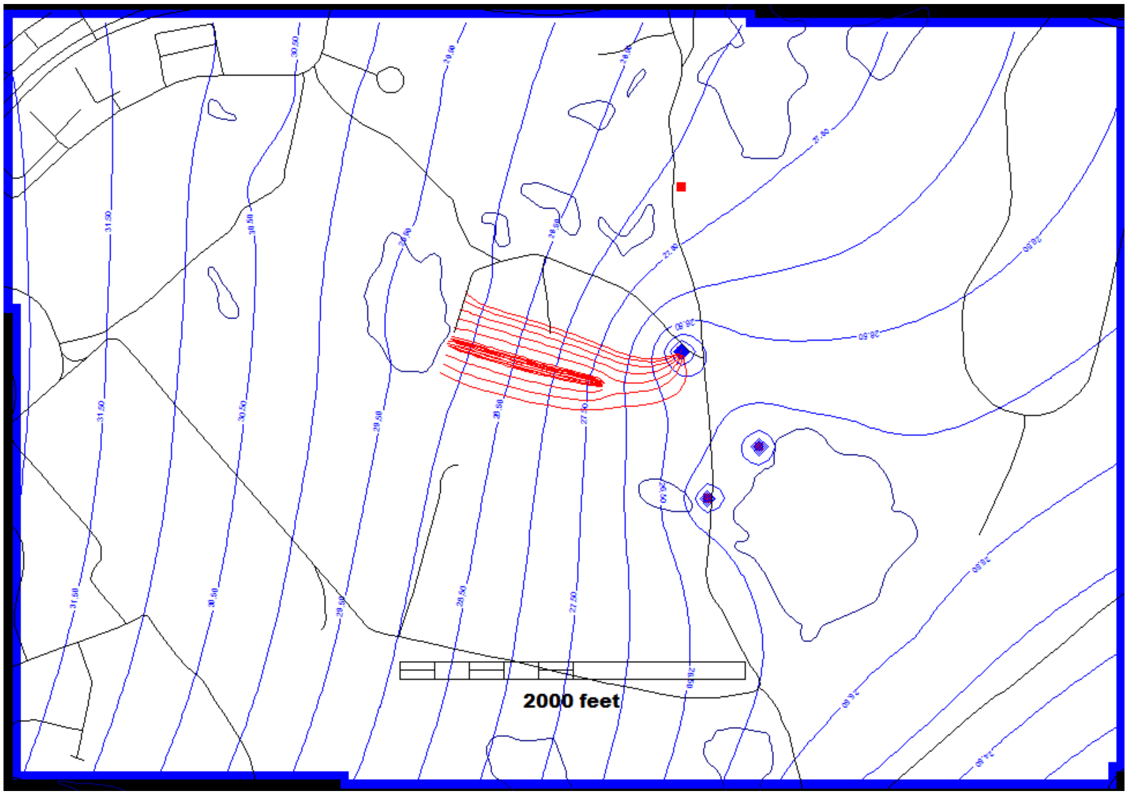

Figure 26 Particle Paths from the Hot Spot and Broader Area Summer 2015 Pumping

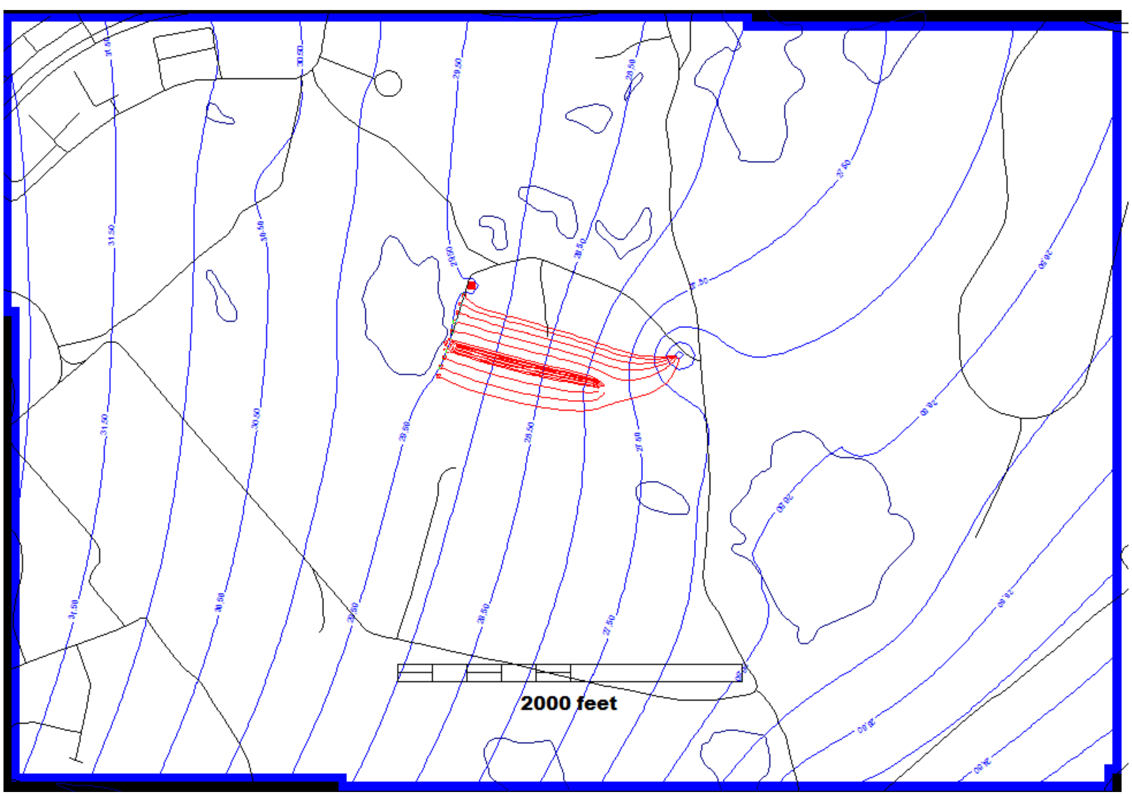

Figure 27 Particle Paths from the Hot Spot and Broader Area Winter 2016 Pumping

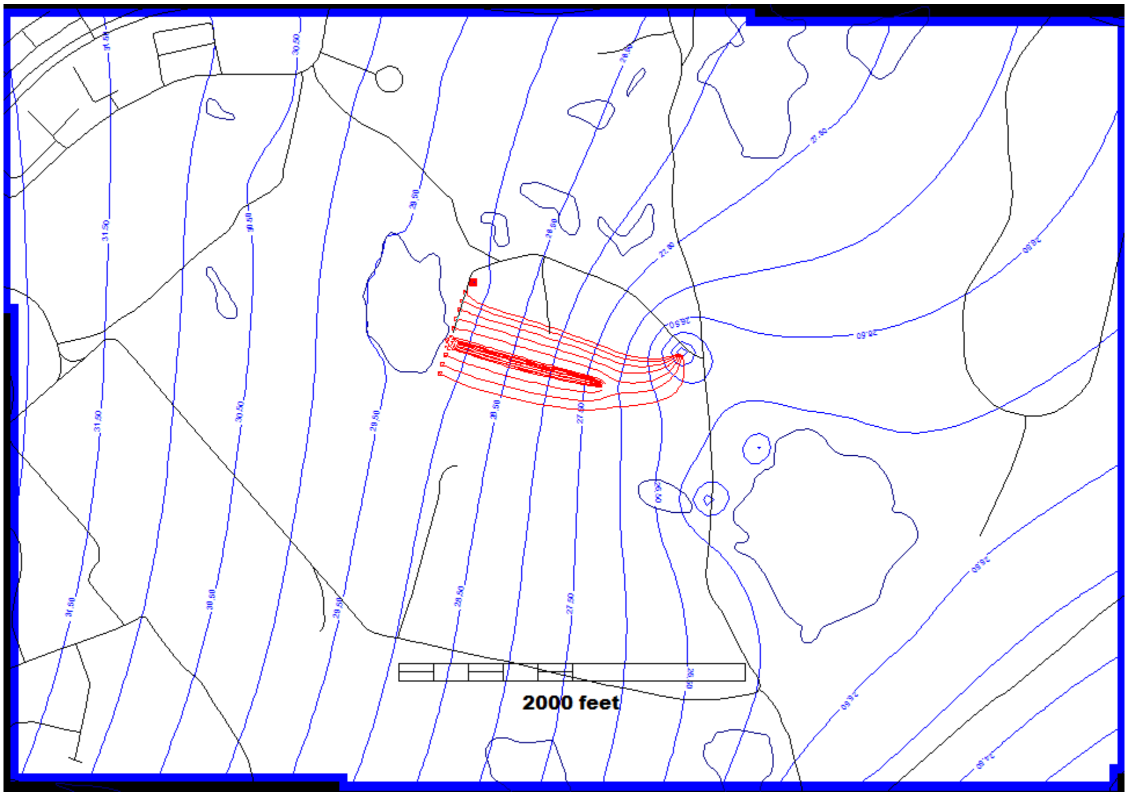

Figure 28 Particle Paths from the Hot Spot and Broader Area Summer 2016 Pumping

The next series of screenshots show increasing rates of pumping from the PRW-4 recovery well with a goal to entirely capture PFOS from the BCFRTA Site. The increase to 40 gpm does not provide complete capture (Figure 29), the 60 gpm rate nearly captures the particles (Figure 30) and the 80 gpm rate appears to achieve complete capture (Figure 31). Discharge at the North Basin was increased for each scenario. An optional capture scenario using two 40 gpm wells in the same vicinity also achieves complete capture of the site particles (Figure 31).

Numerous other computer runs were evaluated including the effect of the north basin on flow from Flintrock Pond and siting of a south basin below the pond to focus potential migrating PFOS from Flintrock Pond towards the capture wells. This worked fairly well but the basins had to preferentially load the north basin to direct the north particles to the capture well. Another benefit of a south basin is to reduce of the likelihood of having the single north basin loaded at 80 gpm fail. The southern basin would need to be located south of Flintrock Pond on Town land.

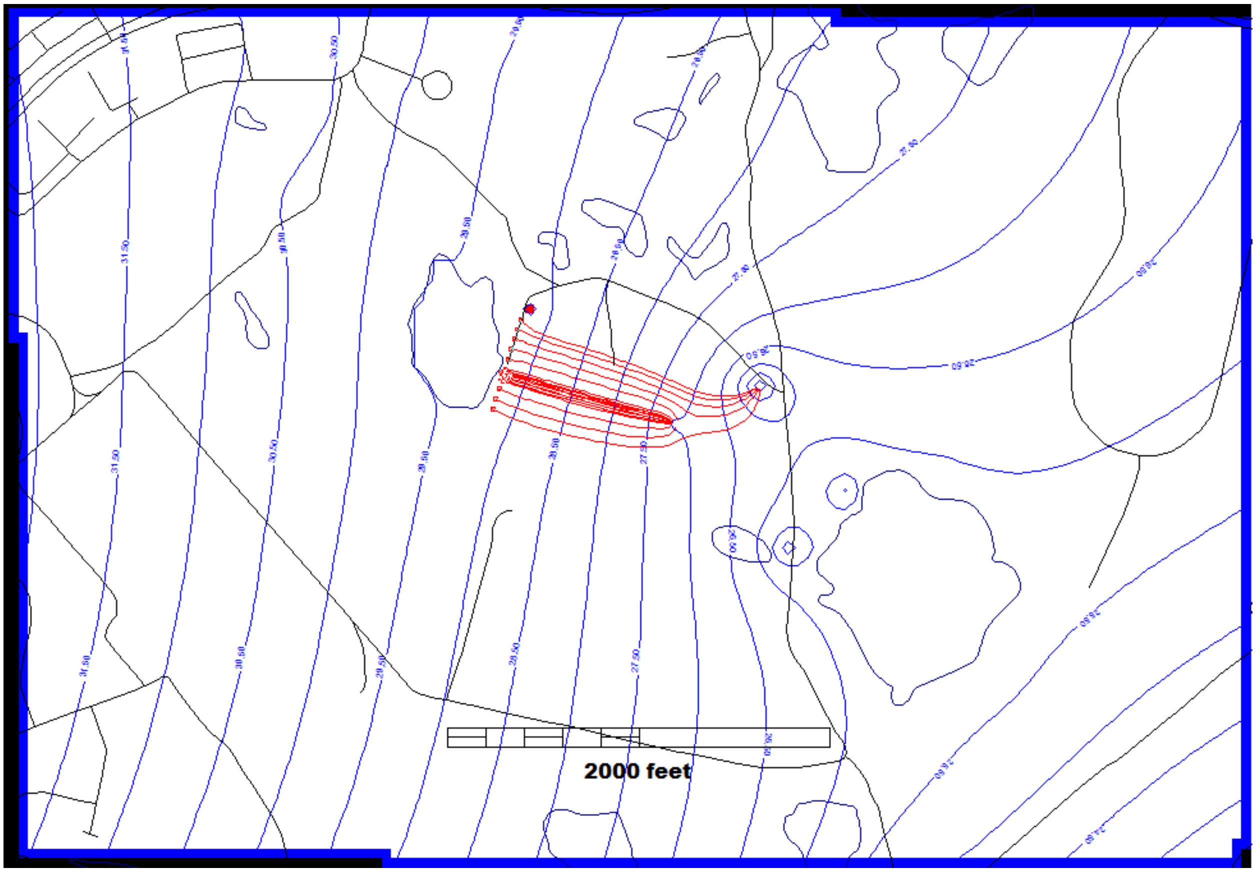

Figure 29 Recovery Well Pumping at 40 GPM under 2016 Summer Pumping

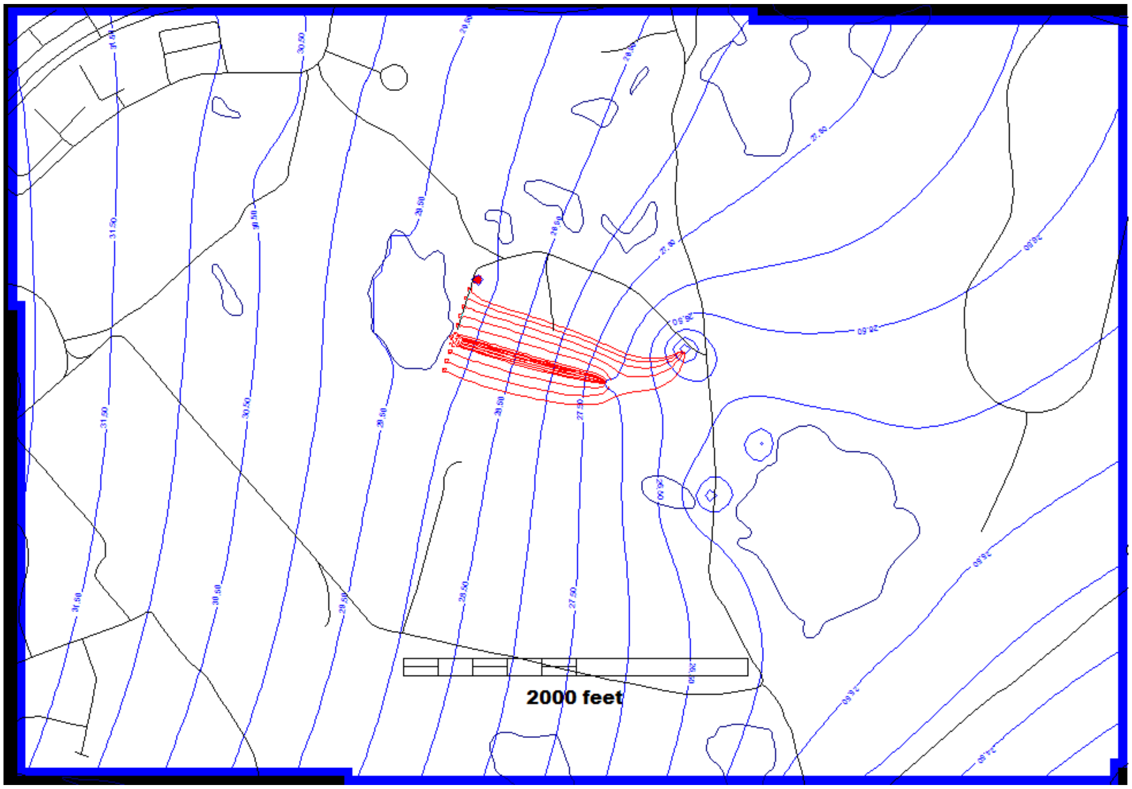

Figure 30 Recovery Well Pumping at 60 GPM under 2016 Summer Pumping

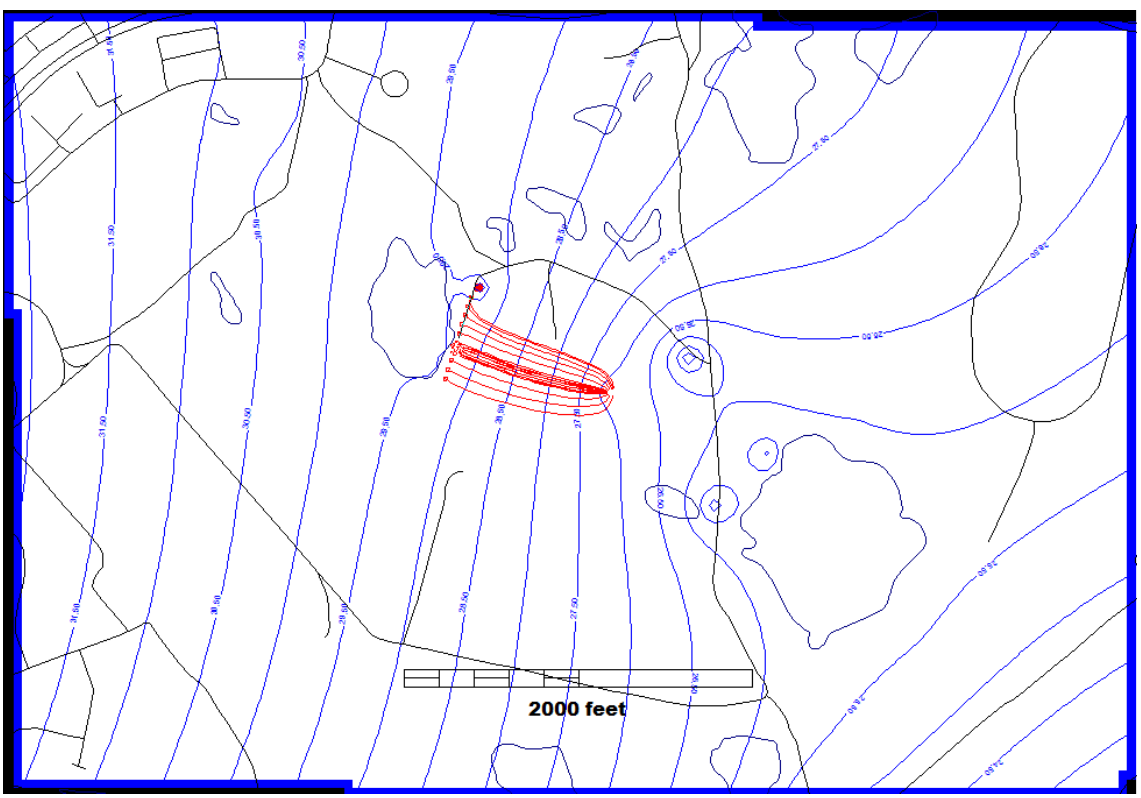

Figure 31 Recovery Well Pumping at 80 GPM under 2016 Summer Pumping

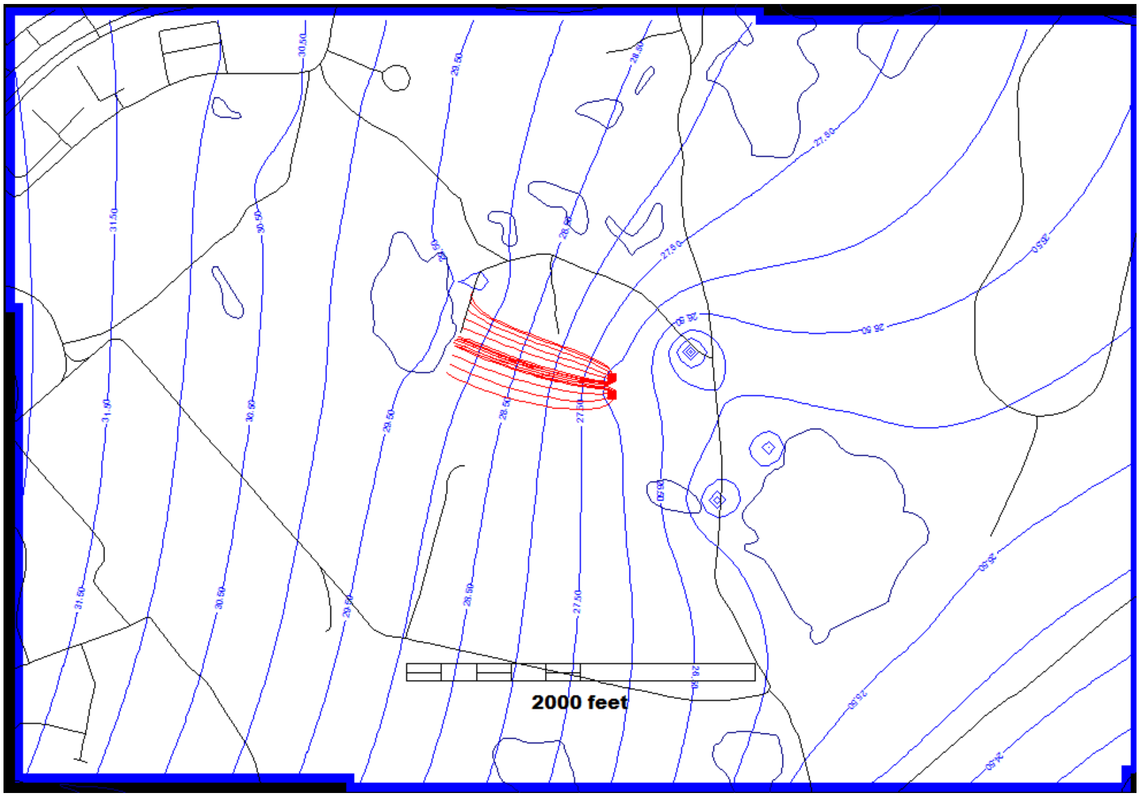

Figure 32 Two Recovery Wells Pumping at 40 GPM each under 2016 Summer Pumping

The model results also illustrate the need for better PFOS definition both south and north of the down gradient areas of Flintrock Pond. This assessment is recommended prior to deciding on the appropriate plume capture scenario.

IRA Plan for Expanded Treatment System

These model runs demonstrate that it is feasible to increase the recovery pumping rate to attain better capture. In July 2016 the County and its contractors were able to get the Recovery Well to pump up to 60 gpm. The pumping rate however has steadily declined, as discussed above, to 30 gpm presently. Options to maintain the higher rate include the installation of a larger diameter well and/or larger pump and cleaning or replacing the lines. The existing pump has a 1 1/2 HP motor. Electrical conversion equipment would be necessary to power a higher 5 HP engine. This could be accomplished relatively quickly under the present system to attain 80 to 100 gpm or more. Depending on the yield, the pump will need to be sized to maintain treatment levels.

On the treatment side it is possible to treat up to 80 gpm at the existing facility with the two 1,500 lb carbon vessels. The contact time would be just over the 10 minute required Empty Bed Contact Time (EBCT) needed for PFAFs adsorption. The two 60 cubic feet carbon vessels lasted one year before needing a change out at a cost of $10,000. It is likely that there may be at least 3 carbon change outs at the 80 gpm rate if the County keeps the existing system in place. The County will evaluate the use of ion exchange media that is being promoted as a better longer lasting media than carbon, at the time of the next change out.

A containment system pumping more than 80 gpm will require a large investment by the County to install a new system with more treatment capacity. There are market dual carbon vessel systems of 5,000 lbs capacity available for $85,000, which would not fit in the existing treatment building. A complicating aspect of this is the iron fouling that has affected the performance of the existing well and the need for iron removal at the treatment plant. A containment system that pumps 80 gpm might require that the present bag filter system be replaced by a green sand filter and the addition of siting a southern discharge basin.

If the County proceeds to install a new treatment system then another option is to install two new recovery wells so there would be two 40+ gpm wells. Two new wells could be designed for better yield and potentially to reduce iron fouling. Higher initial pumping rates from new wells that could be adjusted down is a preferred approach to attaining the higher withdrawal rate 24/7.

For the interim, the County is equipped to move forward with an expansion of the existing pump and treat system with a larger pump and/or well as it further evaluates the advantages of providing a significant investment in a new system.

Immediate Response Actions and Comprehensive Options

The removal of the Hot Spot can be scheduled within a month of approval. A larger pump and/or well to expand the area of capture can be installed in the PRW-4 recovery well also within two months of approval. The results of the Hot Spot removal will be monitored regularly as indicated. If this action is successful the containment system is expected to experience reduced concentrations of PFOS in groundwater associated with the Hot Spot in 2 years.

These actions do not however address the total area or all suspected sources of PFOS contamination. Below are several other long term Comprehensive options that the County is considering.

Continued Operation of MD Wells for Capture and Treatment

The condition of an imminent hazard to public health has been addressed by the Town of Barnstable through its actions to provide treatment of the affected downgradient water supplies (MD1, MD2 and MD3). The Town's action abates the public health threat from the PFOS contamination. The action also effectively contains the further downgradient migration of the PFOS. Given the level of contamination at the site, it is likely that treatment of the Mary Dunn supply wells will be necessary for an interim period, until remedial actions reduce the mass of contamination at the Site.

As an alternative to a significant investment of downgradient remedial capture, the County, Town and DEP could consider continued operation of the MD well treatment system operation with a dual purpose as a containment response for an interim period. During this interim period the County would focus its resources on Comprehensive Response Actions to further reduce PFAS mass at the site and Flintrock Pond as discussed below.

The Telescoped Model was used to evaluate the capture of the PFOS groundwater. Particles were “seeded” into the model in a configuration as observed in the monitoring well data (Figures 33). The MD wells were run using the average pumping rate (from the 2008-2010 period) of 171, 165 and 143 gpm from MD1, 2, & 3 respectively. The model results indicate complete capture of the particles (Figure 34). The time of travel from the west side of the BCFRTA site to the MD-wells is approximately 3 years to MD3 and 4 years for MD2.

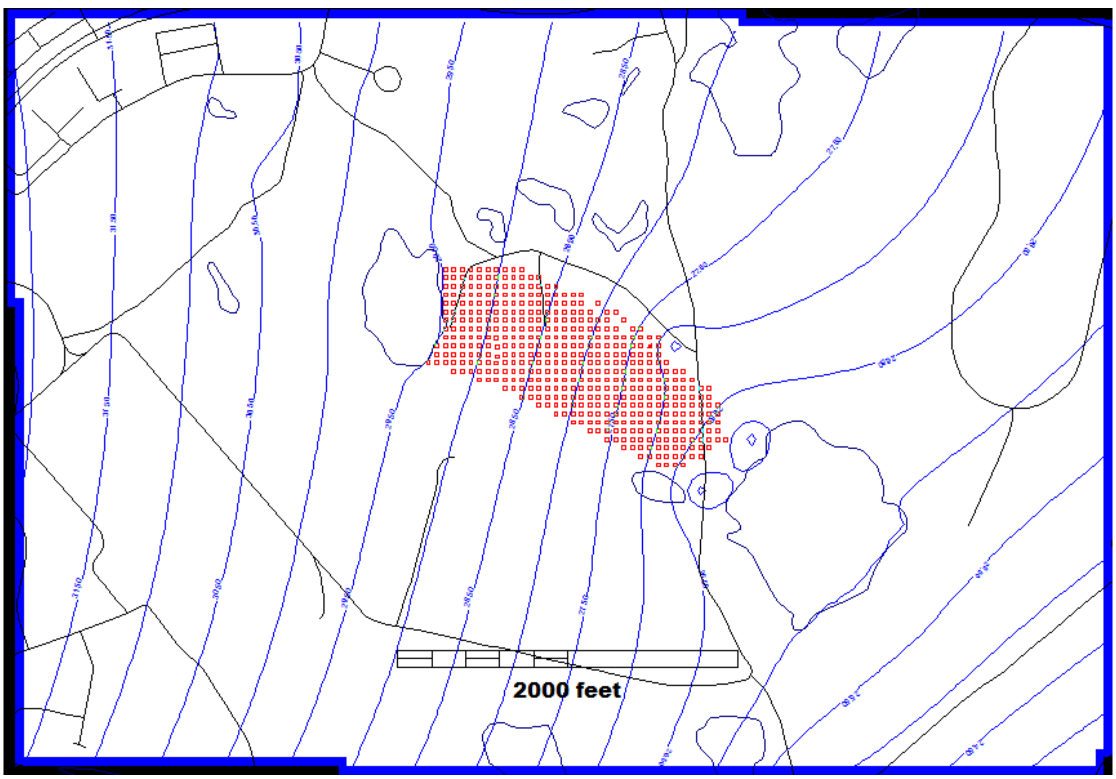

Figure 33 Seeded PFOS Particles and Capture under average pumping conditions.

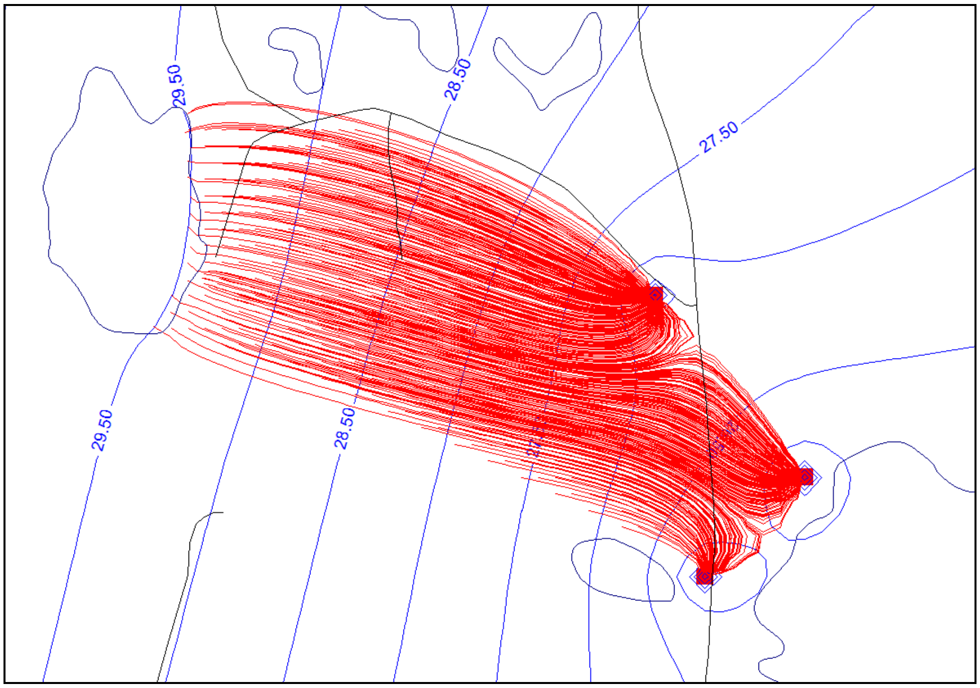

Figure 34 Particle Traces of Seeded PFOS Particles and Capture under average pumping conditions.

Source Reduction at Site

At this time there are few tested options for source treatment of PFAS. Most response actions to PFAS contamination have been pump and treat systems and/or providing alternative water sources. Another option is in-situ treatment of groundwater through chemical oxidation/destruction. In-situ chemical oxidation consists of injecting (a) reactive oxidant(s) into the subsurface groundwater to treat a target compound (Ball, 2016). In this instance, the target compounds are PFAS including PFOS and PFOA. The County contracted with EnChem Engineering, Inc. to perform a bench scale test of their treatment technology (EnChem Engineering Inc, 2016). The Bench Tet report is available in Appendix IX.

The first step was to perform a bench scale test of the reactive compound's (oxidant mixture called OxyZone®) effect on the PFAS in groundwater at the site. The bench test commenced in March 2016 and consisted of collecting 5 gallon samples of groundwater from PFW-2 and HSW-6 from the Hot Spot. The sample was delivered to the lab for a series of tests in which the OxyZone® was injected and samples were taken to evaluate the destruction of PFAS compounds. The bench scale test indicated that the OxyZone® was capable of destroying the PFOS and PFOA and through measuring the increase in fluoride concentration it was determined that even more PFAS compounds than those detected by the standard analytical method were destroyed. This is a very important aspect. AFFF foam is comprised of a large number of PFAS compounds. The standard analytical method can measure 23 compounds and presently only two compounds have an EPA health advisory. Given that science will be able to detect even more PFAS compounds in the future and the likelihood that even more, perhaps smaller shorter carbon chain PFASs will become regulated, a prudent approach is to destroy the PFAS with a single approach. This approach was tested by EnChem at a fire training site in Virginia and the results indicated that it destroyed the PFAS compounds in-situ. Presently, EnChem Engineering, Inc. has proposed a pilot scale test at the BCFRTA to evaluate the effectiveness of OxyZone® in practice. The pilot test is under consideration as a tool to reduce the overall mass of PFAS in the site's groundwater.

The same approach can also be used to treat soil. However, soil would need to be excavated and treated ex-situ in on site containers and either returned to the site or disposed elsewhere. EnChem Engineering, Inc. has proposed doing a bench test on the PFASs contaminated soil to evaluate it effectiveness. While the bench test for soil can be conducted at a relative small cost, the cost for pilot or site wide implementation will be significant. The industry is working to develop remedial approaches that the County, State and Federal officials that will need to further consider.

Flintrock Pond Sediment

Surface water samples of Flintrock Pond and its sediments indicate that the Pond is a receptor of PFAS and a source to downgradient groundwater. Additional assessment work is necessary both north and south of the Pond to evaluate the extent of the Pond's discharge of PFAS to the groundwater. The initial sediment samples of March 2015 were significantly higher than the later sediment samples in June 2015. Also the southern downgradient monitoring wells found similar but higher concentrations in groundwater than the contemporary Pond surface water samples. It is not known if the Pond concentrations of PFOS are stable, potentially declining or subject to temperature changes. Regular sampling to monitor the concentrations over time and an ecological impact assessment will be required prior to formulating appropriate remedial response actions that might include: dredging, treatment of sediments, or permeable reactive barrier.

Site Containment

The IRA proposes the Hot spot soil removal action and expanding the existing containment recovery system with options for significant investment. The IRA also indicates that the Town of Barnstable's treatment of the PFOS in the supply wells effectively captures the entire area of PFAS contamination from the BCFRTA site. As the County evaluates source reduction options at the Site, another option is to invest in a proximal containment system instead of the present downgradient location. The Telescoped Model was used to evaluate the conceptual layout of the proximal containment system. A containment system consisting of 5 recovery wells located at the site boundary pumping a total of 110 gpm could contain groundwater flowing to the east (Figure 35). In this case a new treatment facility would be located near the wells with a single or dual recharge basin system located downgradient. If the proximal containment system is totally effective, then, according to the time of travel, the proximal containment system could relieve the Town of treating its source in 3 to 4 years if there is no attenuated contaminant mass in downgradient groundwater that continues to slowly release further contaminants (Figure 36). A site containment system could be part of an innovative in-situ soil treatment design as well.

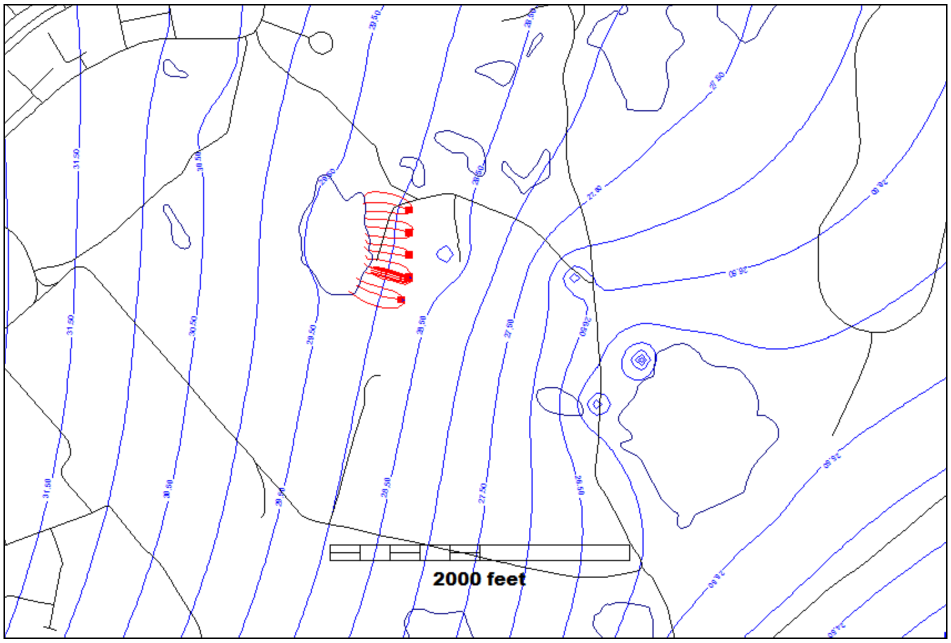

Figure 35 Site Containment Option

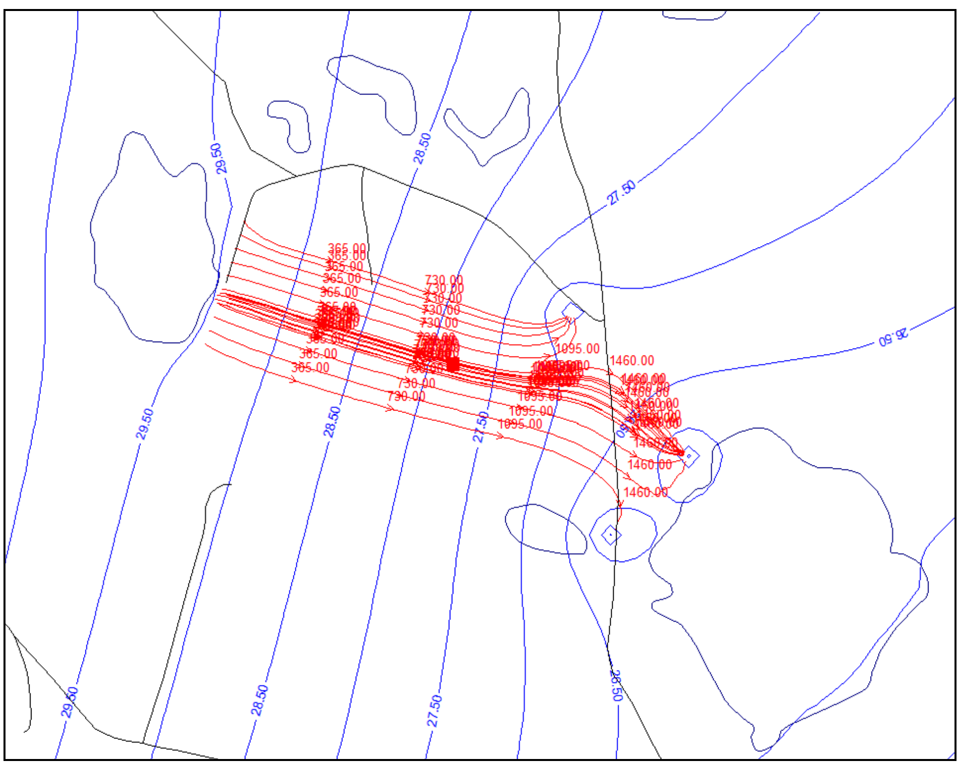

Figure 36 Annual Particle Migration Time of Travel from the BCFRTA Site under Average Pumping

Hyannis Water Quality Partnership

In 1995, the Department of Environmental Protection coordinated the Barnstable Aquifer Protection Project (BAPP). This was a partnership including the DEP, the Town, private entities (or responsible Parties) and the Cape Cod Commission water resources program. The water quality issues of the Town and Hyannis transcend the source and cleanup issues of the BCFRTA. Other issues to be addressed are: the airport as a potential source, high density urban housing within the Town's Wellhead Protection Areas, and a need to explore and acquire new water supply sources. In addition, the issue of the availability and use of these compounds in the environment and determining who is ultimately responsible needs to involve the entire community. A partnership is needed to develop and share important data and tools and securing additional state and federal resources. The County is prepared to partner with others on a number of these issues.

Requirement for IRA Plan:

IRA Plans shall be proposed, upon meeting the notification requirements established by the DEP, and shall be to initiate assessment and/or remedial actions in an effort to expeditiously assess, eliminate, abate or mitigate, and remediate sudden releases, imminent hazards, and other time critical releases or site conditions. IRA Plans are required as set forth in Sections 40.0411 through 40.0429 and as appended. This IRA Plan is being submitted to meet requirements substantial release migration under Section 40.0420 (7) (b) and maintain the abatement of an imminent hazard.

Objective of IRA Plan:

The objective of this IRA Plan submittal is to outline the actions necessary to abate and imminent hazard condition caused by the presence of PFAS in the Mary Dunn drinking water supply wells through immediate responses to reduce the mass of contaminants at the Site and migrating downgradient as long term comprehensive solutions, indicated above, are also being considered.

Schedule of IRA Plan:

The PRP has been actively working to assess and identify the source of PFAS at the site since 2014. Environmental oversight of this IRA plan will be conducted by Thomas C. Cambareri, LSP #3788 during assessment and remediation procedures. The IRA work will commence upon the receipt of Department's approval. Funding for the IRA soil excavation component has been secured from the Barnstable County Commissioners and the Barnstable ConCom issued a negative determination under the wetlands protection Act to proceed. Pending final contracting for the excavation, soil amendment, transportation and disposal, the IRA is projected to be completed in a month.

The IRA Plan for installing a larger pump and/or well to expand the existing system to a maximum of 80 gpm can move forward with the finalization of these two options within a month upon DEP approval. Because this flow expansion will be at the upper capacity of the system, additional options and upgrades may be subsequently required (iron treatment, switch to ion exchange media, and an additional southern discharge basin).

The Comprehensive options described above should be considered and discussed with DEP and the Town prior to further significant investment for enhancing the interim downgradient containment and submitted as future IRA modification.

The IRA has identified several areas where additional refinement of the potential extent of contamination from Flintrock Pond is required to evaluate the advantages of significant investment in further site containment. These assessments will be scheduled in the next month.

The County intends to continue working with the Town of Barnstable to continue measures that abate an imminent hazard and to further develop long term options in in conjunction with the DEP.

IRA Monitoring Plan:

An IRA monitoring plan consisting of post soil removal assessment, assessment monitoring wells and performance of the existing treatment system will be developed and implemented as each component moves forward and submitted in monthly IRA status reports

Waste Remediation:

The carbon filters have been exchanged and we are awaiting their pick-up by Calgon in the next two weeks. There is no other waste remediation anticipated.

Federal, State, and Local Permits:

The soil removal will require approval through a negative determination for the soil removal. This approval has been acquired. Potential enhancement of the containment system could exceed the 100,000 gpd water withdrawal permit.

LSP Certification:

"I attest under the pains and penalties of perjury that I have personally examined and am familiar with this Immediate Response Action (IRA) Plan, including any and all documents accompanying this plan. In my professional opinion and judgement based upon the 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 (*iii*) the provisions of 309 CMR 4.03(5), to the best of my knowledge, information and belief, the response actions that are the subject of this submittal (*I*) have been developed in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (*ii*) are appropriate and reasonable to accomplish the purposes of such response actions as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000 and (*iii*) comply 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."

LSP Signature: LSP #: 3788
LSP Name: Thomas C. Cambareri LSP Stamp:
Organization: Barnstable County Fire Training Academy
Barnstable Court House
Barnstable, MA 02630
Tel: (508) 744-1234
Fax: (508) 362-3136

cc: Jack Yunits, County Administrator
Mark Ells, Barnstable Town Manager
Dan Santos, Barnstable DPW Director
Tom Mckeon, Barnstable Health Department

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