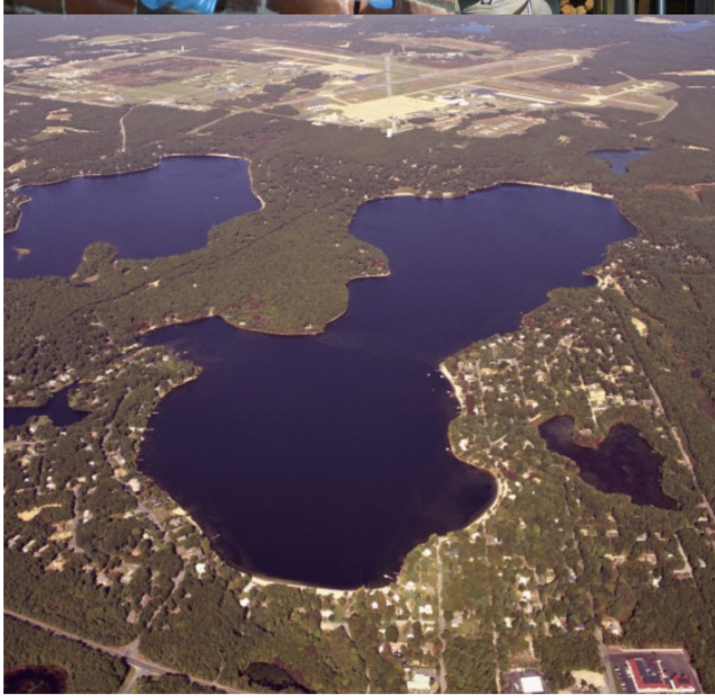
Installation Restoration Program at Joint Base Cape Cod

Groundwater Plume Maps and Information Included




2021

Table of Contents

Terms Used

AFCEC = Air Force Civil Engineer Center
AFFF = Aqueous Film Forming Foam
ANG = Air National Guard
ARAR = Applicable or Relevant and Appropriate Requirement
ARNG = Army National Guard
AS/SVE = Air Sparging/Soil Vapor Extraction
AST = Aboveground storage tank
AV = Ashumet Valley
AVGAS = Aviation gasoline
BSVR = Biosparge/soil vapor recovery
BTEX = Benzene, toluene, ethylbenzene and xylenes
CERCLA = Comprehensive Environmental Response, Compensation and Liability Act
CIA = Central Impact Area
COC = Contaminant of Concern
CS = Chemical Spill
CSE = Comprehensive Site Evaluation
CSM = Conceptual site model
DD = Decision Document
E&RC = Environmental & Readiness Center
EDB = Ethylene Dibromide
EPA = Environmental Protection Agency
EPH = Extractable petroleum hydrocarbon
ESD = Explanation of Significant Differences
ETD = Extraction, Treatment and Discharge
ETI = Extraction, Treatment and Reinjection
EW = Extraction Well
FTA = Firefighter Training Area
FS = Fuel Spill or Feasibility Study
GAC = Granular Activated Carbon
GPM = Gallons Per Minute
HATF = Hunter Ave Treatment Facility
IAGWSP = Impact Area Groundwater Study Program
IRP = Installation Restoration Program
JBCC = Joint Base Cape Cod
JP-4 = Jet Fuel (50% kerosene and 50% gasoline)
LF = Landfill
LHA = Lifetime Health Advisory
LTM = Long Term Monitoring
LUCs = Land Use Controls
MassDEP = Massachusetts Department of Environmental Protection
MC = Munitions Constituents
MCL = Maximum Contaminant Level. A maximum contaminant level is the highest level of a contaminant that is allowed in drinking water. MCLs are enforceable standards by the U.S. EPA.
MEC = Munitions and explosives of concern
MG = Million Gallons
MMCL = Massachusetts Maximum Contaminant Level. In cases where the MMCL is lower than EPA's MCL, the more stringent lower standard may be applied.
MMRP = Military Munitions Response Program
Mn = Manganese
MNA = Monitored Natural Attenuation
MRSPP = Munitions Response Site Prioritization Protocol
NFA = No Further Action
OWS = Oil, water separator
PA = Preliminary Assessment
PCE = Perchloroethene
PCM = Post Closure Monitoring
PFAS = Per– and polyfluoroalkyl substances
PFAS6 = PFDA, PFHpA, PFHxS, PFNA, PFOA, PFOS
PFBS = Perfluorobutane Sulfonic Acid
PFDA = Perfluorodecanoic Acid
PFHpA = Perfluoroheptanoic Acid
PFHxS = Perfluorohexane Sulfonic Acid
PFNA = Perfluorononanoic Acid
PFOA = Perfluorooctanoic Acid
PFOS = Perfluorooctane Sulfonate
PFSA = Petroleum Fuel Storage Area
PLUME = An area of groundwater containing contaminants that exceed federal and/or state safe drinking water standards.
Projected Finish or Date Finished = Aquifer restoration (achieved cleanup standards)
RACR = Remedial Action Closure Report
RBC = Risk-Based Concentration
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine
RI = Remedial Investigation
ROD = Record of Decision
SI = Site Inspection
STP = Sewage Treatment Plant
TCE = Trichloroethene
TMB = Trimethylbenzene
µg/L = Micrograms Per Liter, 1 µg/L is approximately one drop in 22,000 gallons
USCG = United States Coast Guard
UXO = Unexploded ordnance
VFDs = Variable frequency drives
VPH = Volatile petroleum hydrocarbons

A Message from Remediation Program Manager Rose H. Forbes
Air Force Civil Engineer Center, Joint Base Cape Cod

Thank you for taking the time to review our publication. We hope you find it informative and helpful in explaining our Installation Restoration Program (IRP) at Joint Base Cape Cod (JBCC). The IRP is the program that cleans up soil and groundwater contamination resulting from historic military use of the southern portion of JBCC. Fuels, solvents, 1,4-dioxane, per– and polyfluoroalkyl substances (PFAS), and military munitions are investigated by the IRP. The Air Force is the lead agency responsible for the IRP. The U.S. Environmental Protection Agency (EPA) and Massachusetts Department of Environmental Protection (MassDEP) oversee the Air Force's cleanup efforts. The Air Force also works with local and state public health officials and will continue to take response actions to eliminate exposure pathways that could put people at risk from base-related contamination.

The primary potential health risk associated with contamination from JBCC is through drinking water wells. In areas potentially affected by groundwater contamination the IRP has replaced over 1,300 drinking water wells located off-base with municipal water. The IRP conducts extensive reviews to identify and test private wells in the vicinity of the plumes. Residences have had their wells tested free of charge by the IRP and many have received free bottled water, filtration and/or municipal connections. These actions eliminate potential exposure to base-related contaminants. Surface water near groundwater plumes is tested, with results showing no public health concerns. Chemicals related to fire-fighting foams used at JBCC have been detected in the surface waters of Ashumet and Johns Ponds, above the EPA Lifetime Health Advisory (LHA) for two PFAS in drinking water and the MassDEP cleanup standard for six PFAS, but those ponds are not used as a source for drinking water and recreational use is not affected per Massachusetts Department of Public Health guidance.

Much progress has been made since the program's beginning in 1982. Most source areas have been cleaned up and seven groundwater plumes are undergoing pump-and-treat cleanup action both on and off-base; four remedial systems have been shut down because they successfully cleaned up the plumes and other systems are expected to be shut down in the coming years; and one groundwater site has received regulatory closure. Although many environmental cleanup decisions and remedies are in place, decisions remain to be made for several sites and plumes. In the future the program will continue to monitor, adjust, and shut down treatment systems as cleanup progresses. The Air Force conducts the most efficient cleanup operations while ensuring the protection of public health and the environment. The groundwater plume cleanup summaries and progression over time graphics later in this plume book illustrate the reduction of size and toxicity of the plumes over time due to the effect of cleanup actions and natural processes. Groundwater cleanup actions are assisted by natural attenuation (NA) processes such as dilution, dispersion and degradation. Current and former plumes receive long-term monitoring (LTM) to ensure protectiveness of public health and environment.

Other JBCC Environmental Programs

⇒ The U.S. Army National Guard's Impact Area Groundwater Study Program (IAGWSP) is responsible for addressing soil and groundwater contamination from historic activities at Camp Edwards on the northern portion of JBCC. See page 47 for contact information.

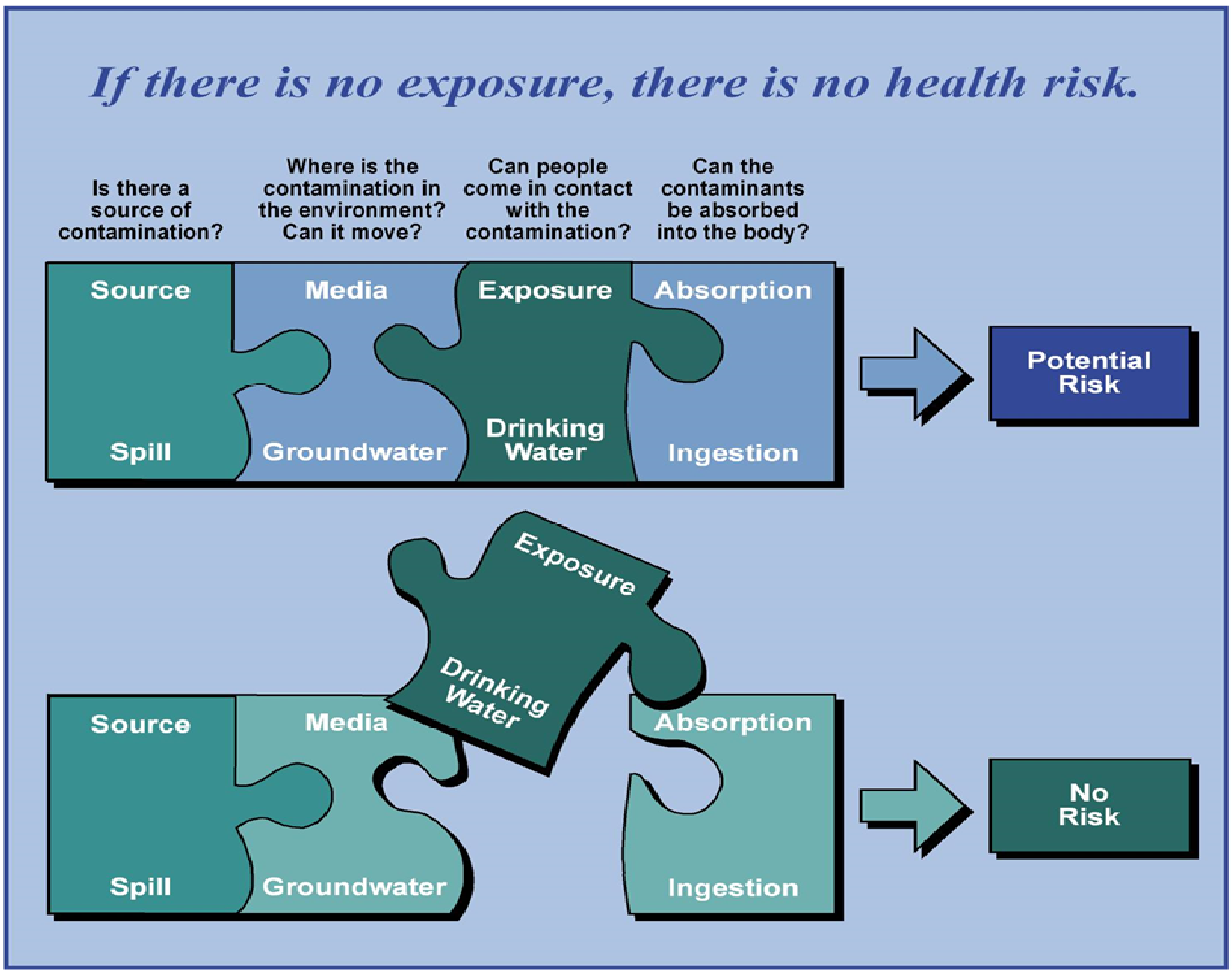
⇒ The Massachusetts National Guard Environmental & Readiness Center (E&RC) manages programs to maintain and improve training lands, protects natural and cultural resources, plans and designs installation improvements, and manages and minimizes hazardous materials and hazardous waste generated at Camp Edwards to guarantee the best training for soldiers and the highest level of protection for the environment at Camp Edwards. The center is responsible for balancing the needs of current training with environmental protection of the Massachusetts Army National Guard training lands at the base. The center also conducts community outreach activities, coordinates with all organizations on the base, and is a central point of contact for JBCC environmental program information. See page 47 for contact information.

Base and IRP History

The JBCC comprises approximately 22,000 acres in portions of the Towns of Bourne, Falmouth, Mashpee, and Sandwich on Upper Cape Cod, Massachusetts. It's origins go back to the 1920s. The highest level of activity at JBCC was during World War II (1940s) and the cold war (1950s-1970s).

JBCC provides facilities for the Air National Guard (ANG), the Massachusetts Army National Guard (ARNG), the U.S. Space Force, the U.S. Coast Guard (USCG), the Veterans Affairs Cemetery and others. Past military training, maneuvers, and aircraft operations, maintenance and support activities at the JBCC have resulted in releases of hazardous materials that contaminated soil in source areas and generated plumes of contaminated groundwater in an unconfined sand and gravel aquifer that underlies the JBCC and the surrounding towns. Otis ANG Base on JBCC was listed on the Superfund National Priorities List (NPL) in 1989. The Air National Guard managed the IRP from 1982-1995. Since 1996 the Air Force has managed the program and is the lead agency.

Understanding Exposure



Examples of actions to eliminate exposure pathways are providing bottled water, filters, municipal water connections, addressing source areas and constructing treatment systems to clean up groundwater plumes. Systems are monitored to ensure no unsafe levels of contaminants are reintroduced back into the environment when treating water and cleaning soil.

Understanding Exposure

Exposure can occur only if there is a completed pathway for the contaminants to travel from the source to an individual, animal or plant. At JBCC the sources of the contaminants were chemical spills, fuel spills, landfills and other military activities that occurred at numerous locations.

Exposure pathways include:

1. Ingestion (drinking or eating contaminated water, food or soil)
2. Dermal contact (touching contaminated soil or water: e.g., showering, swimming)
3. Inhalation (breathing in contaminated vapors of chemicals that volatize into air)

Exposure can occur through:

- *WATER:* People, plants and animals may be exposed to contaminants through direct contact with, or drinking, contaminated groundwater. Contaminated groundwater may also flow into ponds, rivers, or harbors. People and animals may be exposed by direct contact with or ingesting the contaminated surface water, or consumption of contaminated fish. Using contaminated groundwater and surface water for irrigation can result in plants taking up the contaminants. People and animals may be exposed by eating the contaminated plants.
- *SOIL:* People and animals may be exposed to contaminants by eating or touching the contaminated soil. Plants growing in the contaminated soil may take up the contaminants through their roots; people and animals may be exposed by eating the contaminated plants.
- *AIR:* People and animals may be exposed through the air by breathing contaminants. Contaminants may travel from water to the air as a vapor if contaminated water is used for showering. Contaminated dust and airborne contaminants may be deposited on plants and in ponds and rivers.

Factors affecting level of risk:

- Concentration (how much)
- Carcinogenic or non-carcinogenic contaminant
- Frequency (number of days per year)
- Age (child or adult)
- Exposure
- Duration (number of years)
- Specific sensitive groups (e.g., pregnant women)
- Toxicity (characteristics of the chemical)

TO LIMIT EXPOSURE:

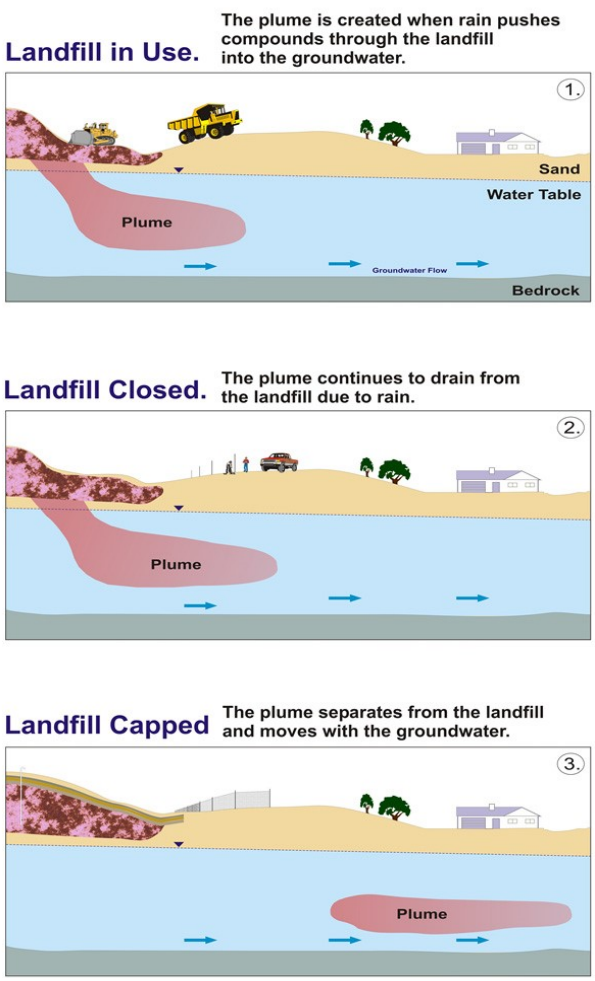
Avoid use of contaminated groundwater. If you have a private drinking water well and you are not sure if your well is contaminated, have your well tested. Contact your town's health agent for more information on the recommended tests and procedures. If you are located in an area that may be affected by groundwater contamination from JBCC, you may be eligible for our residential well sampling program at no charge to you. Please refer to the maps on pages 45 and 46 for the locations of source areas and groundwater plumes. See page 47 for a list of contacts who can help address your questions or concerns.

If your well is tested as part of this program and is found to be affected, you may be provided with an alternate source of safe drinking water (bottled water, granular activated carbon [GAC] filter, and/or a municipal water hook-up).

Note that mercury in area waterbodies is not associated with groundwater contamination at JBCC. The Air Force recommends reviewing and following fishing advisories and recommendations for surface waters. **See: https://www.massnationalguard.org/JBCC/afcee-documents/MADPH-2021.pdf**

Where did the contamination come from?

Since the early 1900s JBCC has been used for military purposes, including troop training and maneuvers, military aircraft operations, vehicle maintenance, and support. Some activities required the use of petroleum products, solvents, and other hazardous materials. It was common practice for many years at JBCC, as it was at other military bases and industrial facilities throughout the country, to dispose of wastes in unlined landfills and drywells, to dump and burn them at firefighter-training areas, or to rinse them down drains. Pipeline breaks and accidental spills occurred. More recently, compounds associated with fire-fighting foam and a stabilizer in solvents have been added to the list of contaminants that the IRP addresses. Today, the use and disposal of hazardous materials is strictly managed and regulated at JBCC to protect the environment.



What is a groundwater plume?

A plume is a body of groundwater containing contaminants that exceed federal and/or state safe drinking water standards. When chemicals from source areas travel downward through the sandy soils, they eventually reach the aquifer where they begin to dissolve in groundwater. Once dissolved, they begin to move with the groundwater, creating a groundwater plume. *The graphic on the left shows how a groundwater plume forms from an unlined landfill.*

Photos top to bottom: Barracks construction at JBCC during World War II; underground storage tank removal; groundwater plume graphic; and a monitoring well boring off-base.

Source Areas

A source area is an area considered to be a possible "source" of contamination to the environment. These areas contain contaminated soil as a result of past spills or other activities and, depending on the type and concentration of contamination, could threaten the underlying groundwater or the plants, animals, or humans who come into direct contact with the contaminated soil.

There are over 100 locations on JBCC that have been evaluated as part of the Air Force cleanup efforts. Many of those locations were confirmed as source areas that contributed to soil and/or groundwater contamination at some point in the past, and over 70 source areas have been cleaned up. Sixty-one source areas were removed from the JBCC IRP via a partial deletion from the National Priorities List in 2007. Perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and 1,4-dioxane have been added to the IRP. PFOS and PFOA are related to the use of fire-fighting foam containing those chemicals. AFCEC will address the MassDEP PFAS6 MMCL in the Feasibility Study (FS) phase for applicable sites. 1,4-Dioxane is related to chlorinated solvents. Several potential source areas are being investigated by the Military Munitions Response Program (MMRP) under the IRP.

Left to Right: Old rusted drums located in woods on JBCC with evidence of pesticides which resulted in soil removal; soil samples collected at the Otis Rotary, a source area for PFOS/PFOA from the use of fire-fighting foam after two tanker truck rollovers; soil around an underground storage tank is investigated, the tank later removed; aerial photo of the former base's wastewater treatment plant infiltration and sludge drying beds that are a source of groundwater contamination.

Contaminated soil has been treated in place or excavated and transported to an approved facility for on-base or off-base treatment and/or disposal. For contamination that is too deep to safely excavate, in-place soil cleanup can be conducted. One such treatment is soil vapor extraction (SVE). In the SVE process, pipelines are used to apply a vacuum to the soil and remove the contaminants as vapor, which is then treated with GAC in a vapor treatment system.

In several cases, source areas have contributed to groundwater contamination at concentrations exceeding cleanup standards, thereby creating a groundwater plume. In 2021 seven groundwater plumes were being treated by six treatment plants.

Contaminants of Concern (COCs) (µg/L = micrograms per liter)

CHEMICAL NAME	REGULATORY STANDARD	CHEMICAL TYPE
1,1,2,2-tetrachloroethane	2 µg/L	Solvent
1,2,4-trimethylbenzene (TMB)	56 µg/L	Fuel
1,3,5-trimethylebenzene	60 µg/L	Fuel
1,4-dichlorobenzene (1,4-DCB)	5 µg/L	Fuel
1,4-dioxane	0.46 µg/L	Solvent
2-methylnaphthalene	10 µg/L	Fuel
benzene	5 µg/L	Fuel
carbon tetrachloride (CCl_4)	5 µg/L	Solvent
C_5-C_8 aliphatics (VPH)	300 µg/L	Fuel
C_9-C_{12} aliphatics (VPH)	700 µg/L	Fuel
C_9-C_{10} aromatics (VPH)	200 µg/L	Fuel
C_{11}-C_{22} aromatics (EPH)	200 µg/L	Fuel
ethylene dibromide (EDB)	0.02 µg/L	Fuel
hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.7 µg/L	Explosive
lead	15 µg/L	Metal
manganese (Mn)	300 µg/L	Metal
perchloroethene (PCE)	5 µg/L	Solvent
perfluorooctane sulfonate (PFOS) *	0.07 µg/L	Fire-fighting foam related
perfluorooctanoic acid (PFOA) *	0.07 µg/L	Fire-fighting foam related
thallium	2 µg/L	Metal
toluene	1,000 µg/L	Fuel
trichloroethene (TCE)	5 µg/L	Solvent
vinyl chloride	2 µg/L	Solvent

These don't have a cleanup level in a Record of Decision (ROD). The values are "Final Health Advisory" numbers sourced from EPA's Safe Drinking Water Act Program. A Massachusetts Maximum Contaminant Level (MMCL) has been established by the MassDEP for the sum of six PFAS (PFDA, PFHpA, PFHxS, PFNA, PFOS, PFOA) which is 0.02 µg/L.

The most toxic COCs are those with the lowest allowable contaminant levels. For example a half of a drop of EDB would conceptually bring an Olympic size swimming pool's concentration equal to the EDB Massachusetts Maximum Contaminant Level (MMCL) of 0.02 µg/L. Similarly it would take 1 ¾ teaspoons of TCE to bring an Olympic size swimming pool's concentration equal to the EPA TCE Maximum Contaminant Level (MCL) of 5 µg/L.

For years, a plume of phosphorus from the old wastewater treatment plant on the base discharged to Ashumet Pond in Falmouth/Mashpee, elevating phosphorus levels. Too much phosphorus can negatively overload the pond's ecosystem. Phosphorus is a nutrient for plants, including algae, which deplete the water of oxygen. The Air Force performed two aluminum-based chemical treatments which immobilized much of the available phosphorus. A permeable reactive barrier consisting of iron filings mixed with native sand in the area of upwelling phosphorus was installed. It significantly reduces the amount of phosphorus entering the pond thus improving pond water quality and clarity. Photo depicts aluminum-based chemical treatment application.

How are the groundwater plumes cleaned up?

To clean up groundwater contamination, extraction wells are placed within a plume and/or at its leading edge to pump the contaminated groundwater from the aquifer to a treatment plant where the water is filtered through GAC held in large vessels. Treated water is returned to the aquifer using reinjection wells or infiltration galleries, while treatment facilities at river systems utilize bubblers. Chemical monitoring data at the treatment plants determine when GAC needs to be replaced. Spent GAC is transported off-site for recycling.

In 2021 the Air Force is addressing 18 groundwater plumes, four of which have been cleaned up as the contamination is now below applicable cleanup standards and are no longer delineated. They are Fuel Spill 1 (FS-1) and FS-29, Chemical Spill 20 (CS-20) and CS-23. There are six treatment plants currently treating approximately eight million gallons of groundwater per day from seven plumes and those systems and the groundwater in the area of each plume are regularly monitored to verify that cleanup goals are being achieved. The Air Force owns and operates three 1.5 megawatt wind turbines that offset 100% of the power used by the treatment systems. The program continually looks at ways to optimize system operations and cleanup actions, and will work with state and federal regulators to determine when cleanup efforts are completed.

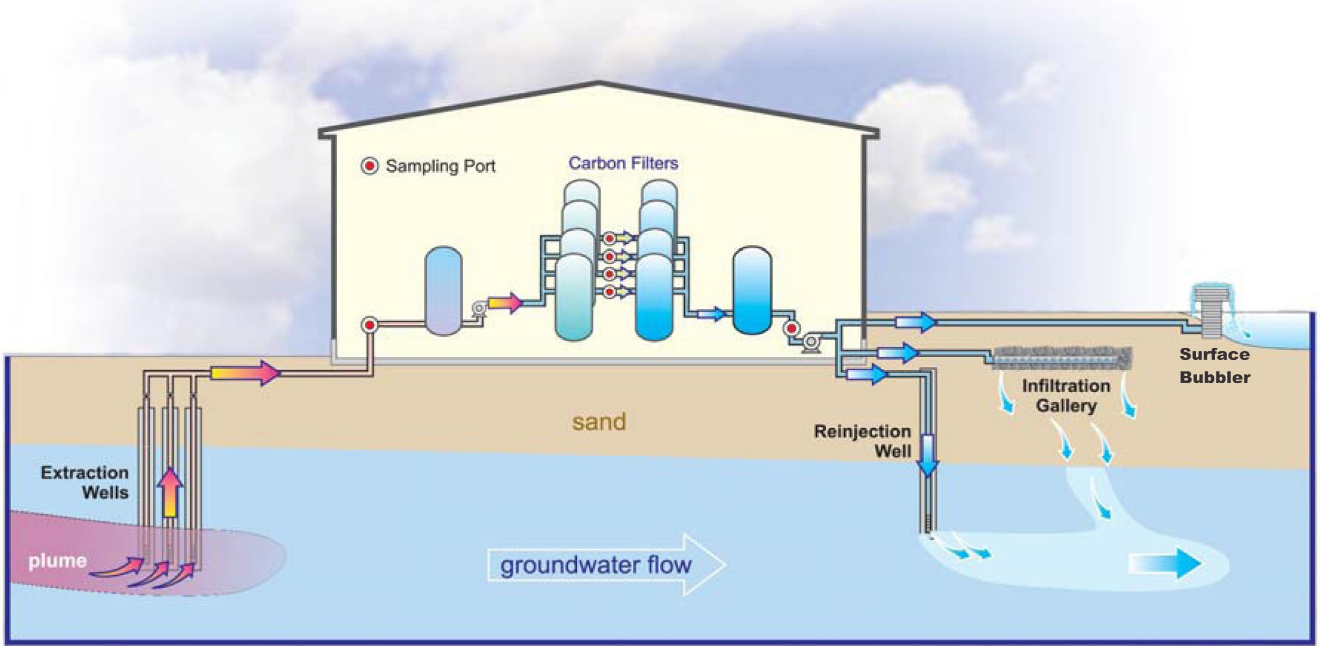
Several plumes have shown dramatic decreases in size and contaminant concentrations due to years of groundwater treatment actions. Plumes and treatment systems are being monitored and optimized to reduce the overall cleanup time. Some systems are still projected to operate for more than 30 years to achieve cleanup goals. Summaries of investigations and groundwater plumes can be found on the following pages.

A three-step process for site closure was developed for assessing contaminants in groundwater, consisting of:

⇒ **Step 1: Operate the remedial systems and/or monitor the plumes following regulator-approved plans to track progress toward meeting the overarching objective of aquifer restoration. Step 1 is concluded when it can be demonstrated that cleanup goals have been reached.**

⇒ **Step 2: Complete a residual risk assessment, if deemed necessary, which considers human health and ecological exposure under unlimited use/unrestricted exposure conditions.**

⇒ **Step 3: Assess the feasibility of approaching or achieving background.**



Contaminated water is extracted, treated with GAC to remove the contaminants and returned to the environment.

1,4-Dioxane

The initial recommendation for investigation of 1,4-dioxane and PFAS was presented in the 4th Five-Year Review, 2007-2012. The following sections provide background information and a brief summary of the investigation work completed at JBCC to date.

1,4-Dioxane

- The primary industrial use of 1,4-dioxane was to stabilize solvents, particularly 1,1,1-trichloroethane (TCA), which is less chemically stable than other common solvents such as PCE and TCE. Therefore, 1,4-dioxane is commonly associated with 1,1,1-TCA, or its breakdown product 1,1-dichloroethene (1,1-DCE). 1,4-Dioxane has also been used in printing and textiles (e.g., polyester); household cleaners and detergents; cosmetics; paints, varnishes, and paint remover; industrial processing of fats and oils; pharmaceuticals; and the chemical industry. 1,4-Dioxane is soluble and mobile in groundwater and biologically persistent in the environment and is not readily adsorbed or treated by GAC.

- There is no MCL or MMCL for 1,4-dioxane in drinking water, but there is an EPA risk-based concentration of 0.46 µg/L for drinking water exposure and a MassDEP standard of 0.3 µg/L.

- A field investigation for 1,4-dioxane was completed between October 2013 and June 2014 at seven IRP chlorinated solvent plumes: Ashumet Valley, CS-4, CS-10, CS-20, CS-21, CS-23, and Landfill 1 (LF-1). Sampling for 1,4-dioxane was completed at the treatment plant influent and effluent ports, operating extraction wells, selected monitoring wells, selected private wells, and selected public water supply wells. The results of this investigation confirmed that 1,4-dioxane was present at four plumes (Ashumet Valley, CS-10, CS-20 and LF-1) and additional investigation was recommended.

- A Supplemental Remedial Investigation (RI) has been completed for LF-1, CS-10 and CS-20. A Supplemental FS to discuss and determine remedial alternatives is scheduled for LF-1. The Supplemental FS for CS-10 has been completed and a Final Explanation of Significant Differences (ESD) was issued to document changes to the remedy for the CS-10 ground-water plume which include the addition of 1,4-dioxane as a Contaminant of Concern (COC). The EPA requested that the remediation goal for 1,4-dioxane be set at 0.46 µg/L, which is a risk-based concentration developed using federal risk assessment guidance, as part of the remedy modification described in the ESD. The Air Force held a 30-day public comment period on the CS-10 ESD from 17 August 2020 to 15 September 2020 and a Responsiveness Summary was produced and issued addressing comments.

- Based on the conclusions of the Supplemental RI and the risk assessment for CS-20, 1,4-dioxane should not be considered a COC at CS-20 and no further action is needed for 1,4-dioxane at CS-20. The Fact Sheet for No Further Action (NFA) for 1,4-Dioxane at CS-20 was prepared to present the Air Force's approach for 1,4-dioxane at the CS-20 groundwater plume and to solicit public input to be considered by the Air Force and regulatory agencies prior to finalizing this decision. The comment period was held from 01 August 2020 to 30 August 2020. The Fact Sheet for No Further Action was finalized and a Responsiveness Summary was produced and issued addressing submitted comments.

PFAS

Per– and Polyfluoroalkyl Substances

- PFAS are found in aqueous film-forming foam (AFFF), a firefighting foam used in fire training exercises, suppressing aircraft and other vehicle fires, and in aircraft hangar fire suppression systems since 1970. PFAS were also used extensively in household and industrial products, clothing, and food wrappers. PFAS are soluble and mobile in groundwater and are chemically and biologically persistent in the environment and some PFAS can be treated by GAC with varying effectiveness.
- There are no federal MCLs for PFAS. In May 2016, the EPA Provisional Health Advisory values for PFOS (0.2 µg/L) and PFOA (0.4 µg/L) were reduced to the final LHA of 0.07 µg/L for each compound. In situations where both PFOS/PFOA are present in drinking water, the EPA recommends that the concentrations be added together and the sum compared to the LHA of 0.07 µg/L.
- The MassDEP issued an MMCL in September 2020 of 0.02 µg/L effective 02 Oct 2020 for six PFAS (PFAS6) compounds which are: Perfluorodecanoic Acid (PFDA), Perfluoroheptanoic Acid (PFHpA), Perfluorohexane Sulfonic Acid (PFHxS), Perfluorononanoic Acid (PFNA), Perfluorooctanoic Acid (PFOA), and Perfluorooctane Sulfonate (PFOS). MassDEP sent a letter to the Air Force requesting that they accept the PFAS6 MMCL as an applicable or relevant and appropriate requirement (ARAR) at JBCC. The Air Force responded that they would evaluate the PFAS6 MMCL in the site-specific FS at JBCC. The Air Force will continue to provide response actions (bottled water, filter systems, etc.) for drinking water impacted by PFOS/PFOA above the EPA LHA level of 0.07 µg/L. The MassDEP MMCL will be evaluated during the FS phase to determine if the MMCL will be adopted and used in future response actions.
- A presence/absence Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) field investigation was completed between October 2013 and September 2014 at Ashumet Valley. The results of this PFAS investigation confirmed a release of PFOS/PFOA above the available EPA LHA to the environment at Ashumet Valley and additional investigation was recommended. Based on an initial assessment of the characterization data collected under the Supplemental RI and the EPA May 2016 release of final LHA values for PFOS and PFOA, it became evident that the extent of PFOS/PFOA was more widespread than originally anticipated and additional data collection was necessary. A work plan for Ashumet Valley identified the actions needed to address data gaps to complete a Supplemental RI for PFOS/PFOA and 1,4-dioxane in soil, groundwater, and surface water.
- AFCEC will evaluate the MassDEP PFAS6 MMCL during the FS phase on a site-specific basis. An Expanded Site Inspection (SI) at multiple flight line sites is ongoing to determine the presence or absence of PFAS contaminants. JBCC PFOS/PFOA sites and status are below:
    - Ashumet Valley – Supplemental RI in progress
    - Tanker Truck Rollovers – RI in progress
    - Landfill-1 – Supplemental RI complete; – FS in progress
    - ANG Motor Pool Area – Expanded SI in progress
    - Former Fire Department Building 122 – Expanded SI in progress
    - USCG Hangars 3170 and 3172 – Expanded SI in progress
    - Lower 40 Ramp Area – Expanded SI in progress
    - Hangar 2816 – Expanded SI in progress
    - Fuel Spill-1 – Expanded SI in progress
    - Former Building 118 and Runway 32 – Expanded SI in progress
    - Waste Water Treatment Plant Infiltration Beds – Expanded SI in progress

Military Munitions Response Program

The MMRP follows the CERCLA process. The goal of the MMRP is to make Munitions Response Areas (MRAs) safe for reuse and to protect human health and the environment in the process. The MMRP addresses issues related to Munitions and Explosives of Concern (MEC) and Munitions Constituents (MC) associated with the then MRAs at JBCC, as related to hazardous substances, pollutants, and potential contaminants of concern on other than operational ranges.

In support of the MMRP a Comprehensive Site Evaluation (CSE) was conducted at JBCC. The CSE is an approach to munitions response and environmental restoration that assesses the unique challenges faced at MRAs, including explosives safety issues posed by MEC and associated releases of MC (e.g., hazardous substances, pollutants, contaminants, and petroleum, oil, and lubricants) to the environment. An MRA is defined as any area on a defense site that is known or suspected to contain MEC (includes unexploded ordnance [UXO], discarded military munitions, or MC in high enough concentrations to pose an explosive hazard) or MC (e.g., former ranges or munitions burial areas).

The CSE process provides the historical, anecdotal, visual, analytical, and geophysical data that serve as the basis for decision-making regarding follow-on munitions response actions. The CSE is conducted in two distinct phases. The CSE Phase I generally consists of historical records reviews, visual surveys, and interviews. The CSE Phase II generally will consist of visual surveys, environmental sampling, and geophysical surveys. CSE Phase I and Phase II investigations differ from the traditional CERCLA Preliminary Assessment (PA) and SI, however, with respect to data requirements. PA and SI activities primarily are focused on obtaining data to input into the Department of Defense Munitions Response Site Prioritization Protocol (MRSPP) and site-sequencing for cleanup. The CSE process utilizes an expanded array of analytical, tracking, and reporting tools to support decision-making, and therefore, has greater data requirements. Tools utilized as part of the CSE for each MRA include:

- Conceptual Site Model (CSM) for project communication, hazard assessment, and data gap analysis
- MRSPP to prioritize MRAs for further munitions response actions, based on relative risk
- Hazard Ranking System data elements to ensure full characterization of the MRA

The objective of the CSE Phase I and II investigations was to determine whether any of the 10 individual MRAs within JBCC warrant additional munitions response activities, require definition as munitions response sites, or meet requirements for a NFA decision. The JBCC MRAs and status are presented below:

- MB701: Former Otis Bomb Storage Magazines, site closed
- MB702: Ordnance Area 1 (World War II era), conducting Supplemental CSE Phase II
- ML701: Otis Target Butt, site closed
- MMR-001-R-01: Mock Village, completed RI/FS, preparing a ROD
- MMR-003-R-01: Old Grenade Courts, conducting Supplemental CSE Phase II
- MMR-004-R-01: Old K Range, conducting FS
- MMR-009-R-01: Otis Gun Club, conducting FS
- MMR-010-R-01: Former Ammunition Supply Point - West, future work under discussion with EPA/MassDEP
- MMR-011-R-01: Former Ammunition Supply Point - East, future work under discussion with EPA/MassDEP
- TS701: Skeet Range, conducting RI/FS

Ashumet Valley Groundwater Plume

The AV groundwater plume is located in the Town of Falmouth south of the JBCC. The AV plume has two sources: the former Firefighter Training Area 1 (FTA-1) and the former JBCC Sewage Treatment Plant (STP). Firefighter-training exercises were held from 1958 to 1985 at FTA-1, during which time flammable waste liquids were burned and extinguished, some of which entered the sandy soil and eventually reached the groundwater aquifer. The former JBCC STP operated from 1936 to 1995 and released treated wastewater to a series of sand infiltration beds now named CS-16. De-watered sewage sludge was disposed of in a nearby wooded area called CS-17. These two practices and locations (FTA-1 and STP) are considered to be the sources of contaminants that have resulted in the AV groundwater plume. Treatment of contaminated soils at FTA-1 was completed in September 1997. A total of 42,531 tons of soil were treated at FTA-1 using a thermal treatment process. In 2001 and 2002 contaminated soil was removed from the CS-16 and CS-17 sites and taken off-base for proper disposal. The COCs in the AV plume are the solvents PCE and TCE detected above state and federal MCLs of 5 µg/L. The AV plume is undergoing remediation.

The Air Force installed the AV extraction, treatment, and infiltration (ETI) system under an Interim ROD. The final remedy for AV, as specified in the Final ROD for the AV Groundwater Plume, consists of continued operation of the optimized ETI system, the addition and operation of the leading edge extraction, treatment, and discharge (ETD) system, LTM for the thallium and manganese area, and land use controls (LUCs). A 2011 ESD clarified the inclusion of monitored natural attenuation as a component of the selected remedy. The AV remedial system consists of: (1) an ETI remedial system; and (2) a leading-edge ETD remedial system (which is now shutdown). Both systems were designed to remediate the PCE and TCE groundwater plume. The treatment plants use GAC to remove the solvents from the groundwater and the treated water is returned to the aquifer through the infiltration galleries.

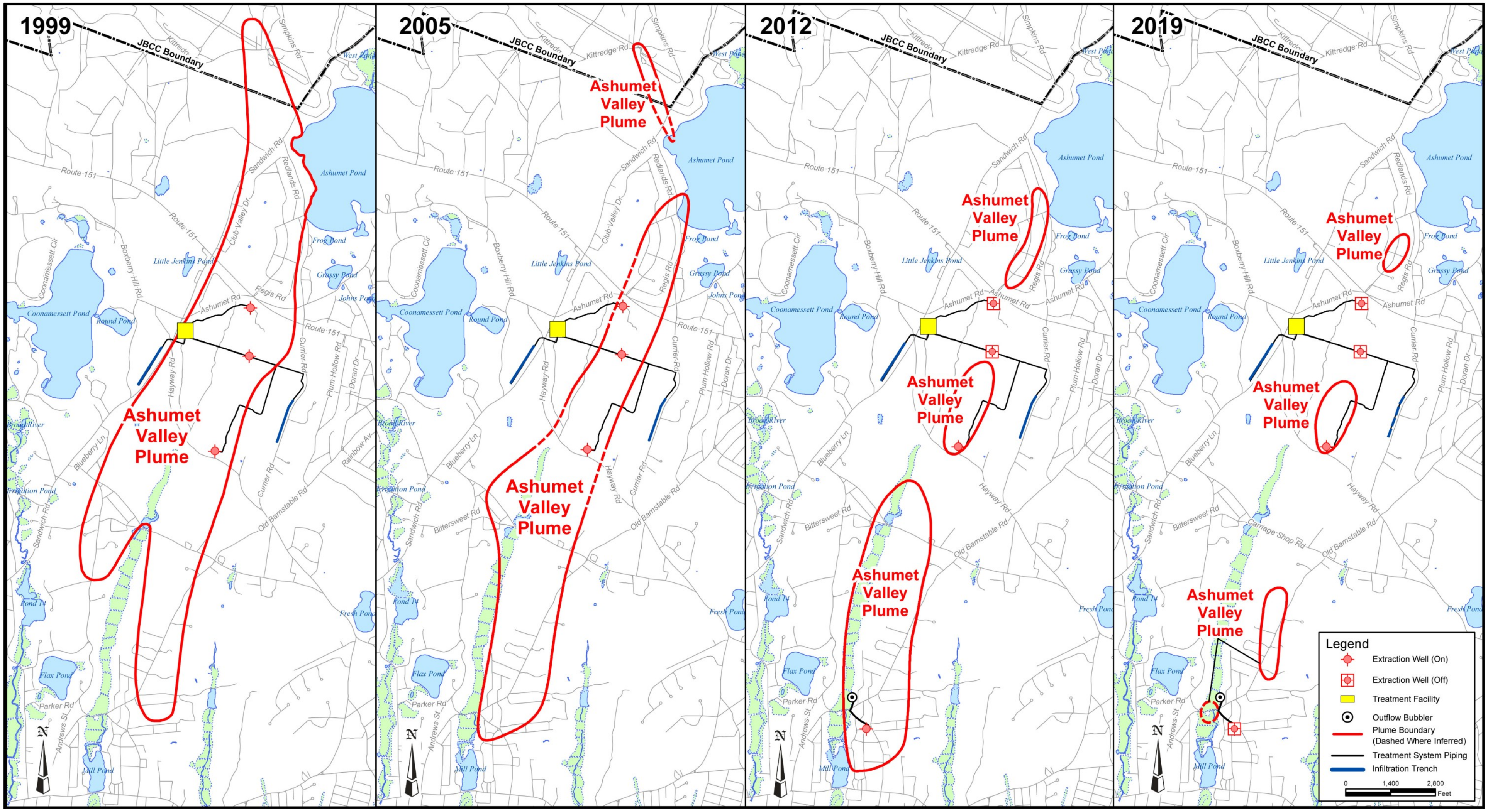
1,4-Dioxane, PFOS and PFOA have been detected in AV groundwater at concentrations greater than EPA Risk-Based Concentration (RBC) for 1,4-dioxane and the EPA LHA, for the sum of PFOS and PFOA. The extent of and potential risks to human health and the environment associated with 1,4-dioxane and PFOS/PFOA at Ashumet Valley are being evaluated through the completion of a Supplemental RI, which is currently underway. The MassDEP PFAS6 MMCL will be evaluated during the FS phase which evaluates remedial alternatives. In 2001 the Air Force performed an alum treatment of Ashumet Pond water to reduce the amount of phosphorus in the pond, much of which comes from the base's wastewater treatment plant phosphorus plume. In 2004a zero-valent iron permeable barrier was installed along the shoreline of Ashumet Pond to reduce the amount of phosphorus in groundwater entering the pond. A second alum treatment was performed in 2010. Based on post-alum treatment monitoring data collected in 2010 and 2011, it was concluded that prior negative impacts had been reversed, and a steady improvement in pond trophic health is being observed. It was also noted that because total phosphate concentrations in the groundwater plume discharging to the pond are gradually decreasing with time and the barrier is continuing to effectively reduce phosphate loading to the pond, the 2010 alum treatment may last significantly longer than the 2001 alum treatment.

Ashumet Valley					
Date ROD/Decision Document (DD) and/or ESD in Place	**Cleanup Start**	**Projected Finish**	**Primary Contaminants**	**2020 Highest Levels (µg/L)**	**Highest Historic Levels (µg/L)**
ROD/DD March 2009 ESD September 2011	November 1999	2021	PCE	11	109 (October 1998)
			TCE	13	83 (August 1997)

Treatment Components (Total/Current)	**# Treatment Plants (Total/current)**	**Treatment Rate (GPM) (Original/Current)**	**Volume Treated (MG) Through 2020**
Extraction Wells 4/1 Infiltration Trenches 2/1 Surface Discharge Bubbler 1/0	2/1	1,200/200	6,595

NOTE: Projected Finish or Date Finished refers to aquifer restoration (achieved cleanup standards).

Ashumet Valley Groundwater Cleanup Progression



The Ashumet Valley groundwater plume is delineated by PCE and TCE exceedances of cleanup standards. PFOS/PFOA/1,4-dioxane are also present and are undergoing investigation.

CS-4 Groundwater Plume

The CS-4 groundwater plume is located south of the JBCC in the Town of Falmouth. The CS-4 groundwater plume is one of the four Southwest Plumes which also include the CS-20, CS-21, and FS-29 groundwater plumes. The source area for the CS-4 plume is located on JBCC near the intersection of West Truck Road and Gaffney Road and consists of a former motor pool used from 1941 to 1973, and a Defense Property Disposal Office that operated from 1956 to 1983. The CS-4 plume is now detached from the source area and is located entirely off-base. The Air Force conducted several source removals at CS-4 West Truck Road Motor Pool. In 1994, more than 13,000 tons of contaminated soils at the CS-4 site were treated using an on-site thermal treatment unit. The Air Force removed 24 drainage structures and 3,000 tons of contaminated soil from the CS-4 source area in 1996. In 2001 an additional 5,200 tons of contaminated soils, along with an old underground storage tank, were removed from the site. These removal actions resulted in a no further action decision for CS-4. The COCs for the CS-4 groundwater plume are PCE, TCE, 1,1,2,2-tetrachloroethane (1,1,2,2-TeCA), and EDB. The MCL for PCE and TCE is 5 µg/L, and the MMCL for EDB is 0.02 µg/L.

A groundwater treatment system was installed at CS-4 in 1993 under an Interim ROD. Thirteen extraction wells were installed with the goal of capturing the CS-4 plume. However, it was discovered during the SWOU RI in 1998 that the interim remedial system was not capturing the entire CS-4 plume. In May 2003 and subsequent to the issuance of the ROD, the Air Force turned off the original CS-4 treatment system because of its ineffectiveness. The original CS-4 treatment system was decommissioned in 2004. The ROD for CS-4, CS-20, and CS-21 was issued in February 2000. Three new CS-4 extraction wells were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes at the Hunter Avenue Treatment Facility (HATF). The contaminated groundwater is captured by extraction wells in each plume, treated at the HATF, and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery.

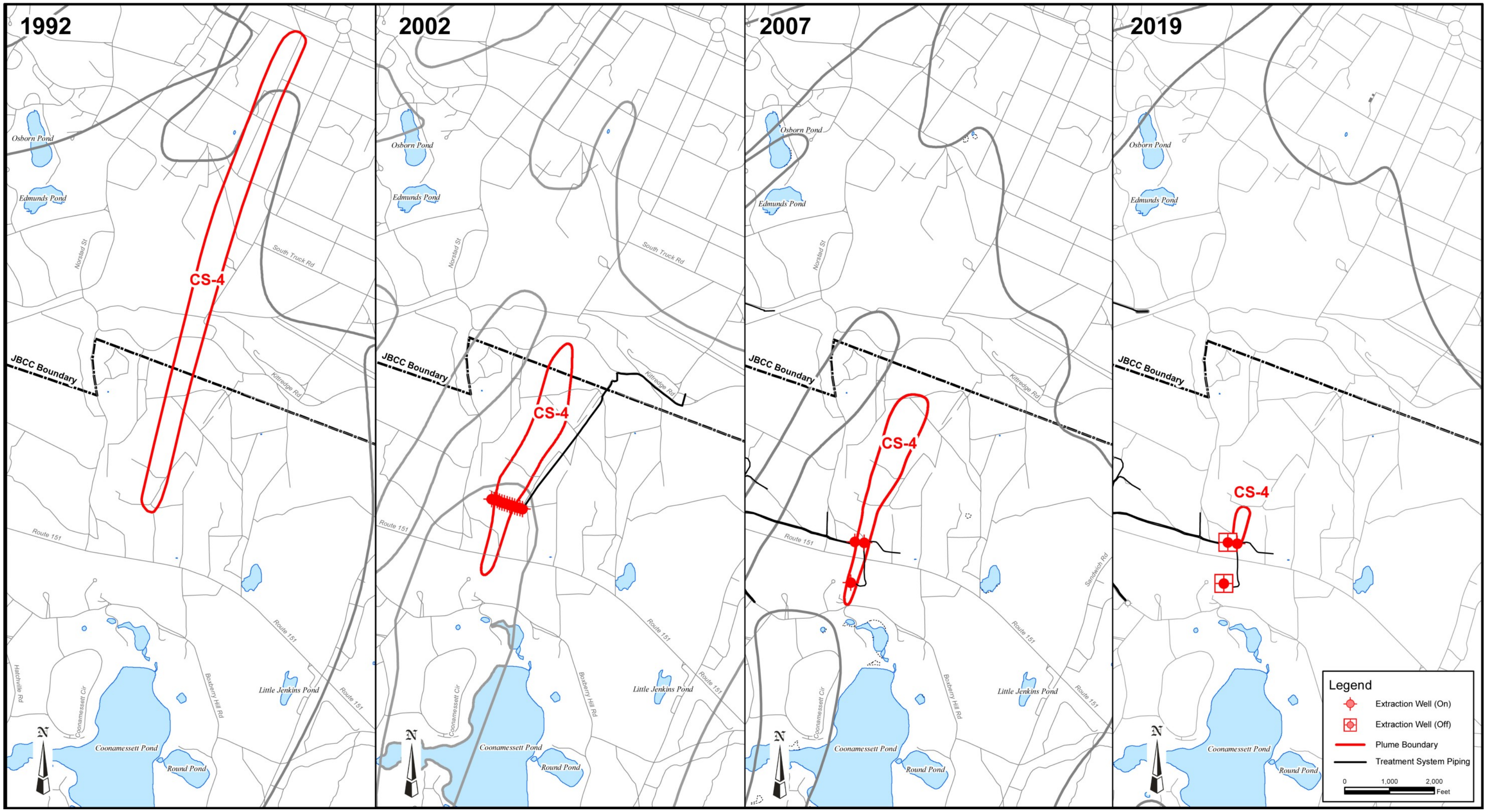
An ESD was submitted in 2008 to document changes to the selected remedy for CS-4. The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-4 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-4 to reach cleanup levels through natural attenuation instead of through active treatment. An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of Monitored Natural Attenuation (MNA) as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

CS-4					
Date of ROD/DD and/or ESD in Place	**Cleanup Start**	**Projected Finish**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD February 2000 ESD September 2008/2011	November 2005	2022	PCE	13	61 (February 1997)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2020
Extraction Wells* 3/1 Infiltration Trenches 2/0	1/1	620/100	1,772

The original 13 extraction wells for CS-4 were shut off in 2003 due to their ineffectiveness, 3 new wells replaced them.

Chemical Spill 4 Groundwater Cleanup Progression



The Chemical Spill 4 groundwater plume is delineated by PCE and TCE exceedances of cleanup standards.

CS-10 Groundwater Plume

The CS-10 groundwater plume is located in the southeast area of the JBCC, extending off-base into the Towns of Falmouth and Mashpee. The CS-10 groundwater plume was formed from numerous sources. The main source of the CS-10 groundwater plume is referred to as CS-10/FS-24, which occupies approximately 38 acres at the eastern boundary of the JBCC to the west of Snake and Weeks Ponds. Originally the CS-10/FS-24 source area consisted of a number of buildings constructed as part of the former Boeing Michigan Aerospace Research Center site (which operated from 1960 to 1973) and the Unit Training Equipment Site (which has been in operation since 1978). Numerous other sources of contamination are presumed to have contributed to the CS-10 plume.

The CS-10 groundwater plume is a large dilute groundwater plume and is currently defined as the extent of groundwater contaminated with TCE and PCE, the CS-10 plume COCs, at concentrations exceeding the federal MCL of 5 µg/L for both compounds. 1,4-Dioxane is present above groundwater standards and has been added as a COC. The CS-10 plume is currently in long-term remediation. There are four separate areas in the CS-10 plume: (1) the In-Plume (IP) area, (2) the Sandwich Road Lobe, (3) the Southern Trench area, and (4) the leading edge area comprised of three lobes between Ashumet and Johns ponds: the Northern Lobe, North-Central Lobe, and Southern Lobe. A mobile treatment unit was installed to assist in mass removal in the In-Plume Lobe and operated between June 2014 and February 2020. The CS-10 Plume Final ROD, which was signed in 2009, specified continued operation and monitoring of the existing treatment system along with LUCS.

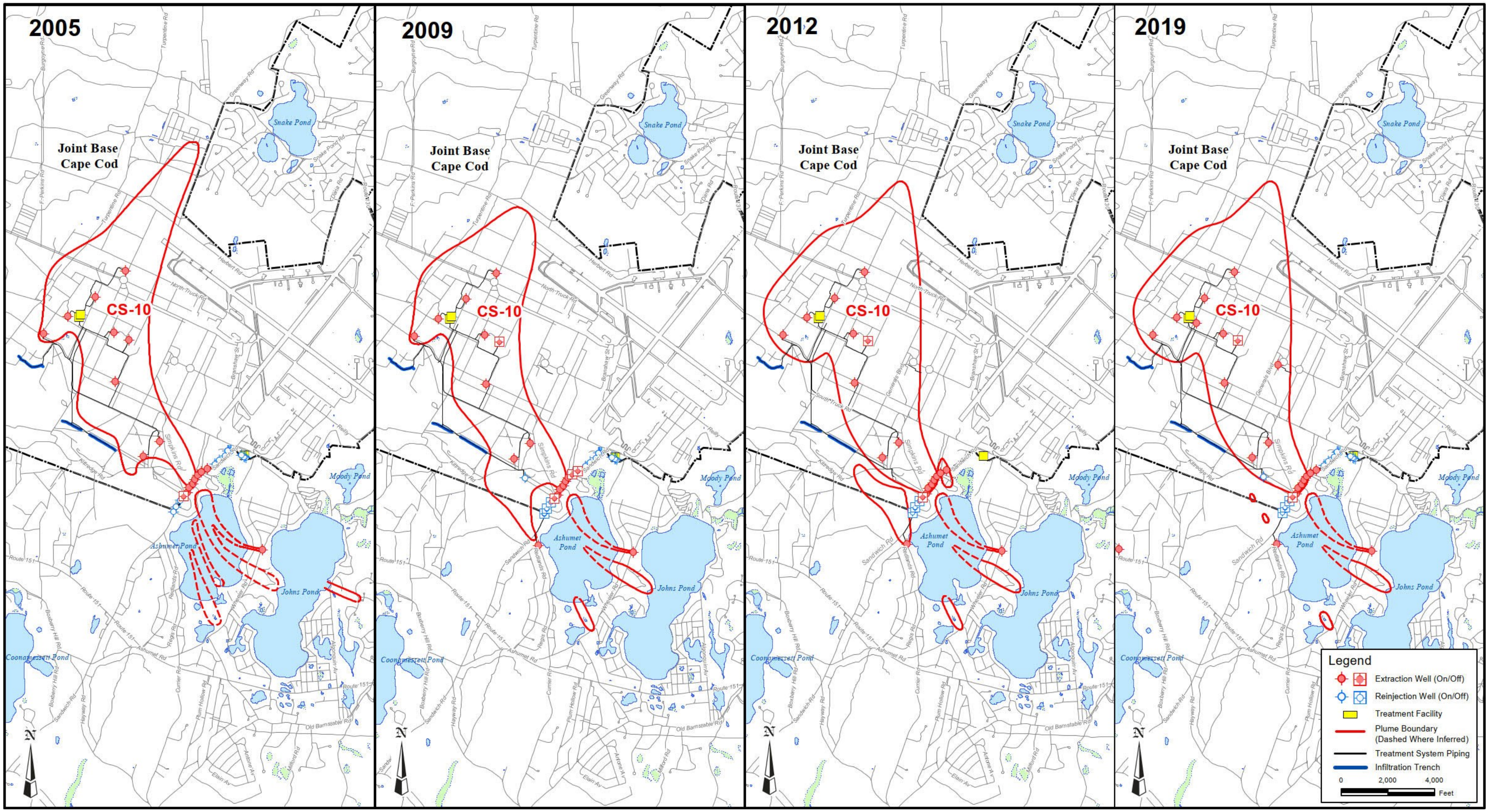
An ESD for the IRP groundwater plumes was prepared in 2011. This ESD clarified the inclusion of MNA as a component of the selected remedy for CS-10, and updated the text regarding the three-step process to achieve site closure. A data gap investigation was initiated in 2008 and continued through June 2012 to provide information needed to optimize the CS-10 remedial systems. An optimization evaluation was completed in 2013 in response to the findings of the post-ROD data gap investigation to improve plume capture and reduce the aquifer restoration timeframe. An ESD was prepared in 2014 to document the changes to the CS-10 CSM, amend the estimate of aquifer restoration timeframe at CS-10 presented in the ROD, and modify the remedy to more aggressively remove contaminants from the aquifer so cleanup levels can be achieved sooner.

CS-10

Date of ROD/DD and/or ESD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2020 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
ROD/DD August 2009 ESD September 2011/2014	June 2009	2060	PCE	45	400 (July 2000)
			TCE	930	5,110 (June 1997)

Treatment Components (Total/Current)		# Treatment Plants		Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2020
Extraction Wells	21/17	In Plume	1	2,780/2,575	26,568
Reinjection Wells	9/5	Sandwich Road	1	820/670	7,857
Infiltration Trenches	2/2	Northern Lobe uses Sandwich Road		75/210	1,850

Chemical Spill 10 Groundwater Cleanup Progression



The Chemical Spill 10 groundwater Plume is delineated by PCE and TCE exceedances of cleanup standards. 1,4-dioxane is also present and was added as a COC.

CS-19 Groundwater Plume

The CS-19 groundwater plume is located within the Central Impact Area (CIA) of the JBCC. The Impact Area is located in the northern portion of the JBCC and has been used primarily for military training. The CS-19 site involves past ordnance and military waste disposal. An area of approximately two acres was used to bury and detonate ordnance and munitions debris at depths to 12 feet. These ordnance and waste disposal practices at the CS-19 site resulted in contaminants being released to the surrounding soil and groundwater. The Air Force conducted multiple testing and cleanup actions at CS-19 between 2004 and 2009, including the removal of more than 2,800 cubic yards of soil, 8,500 ordnance items, and 27,000 pounds of munitions debris from the original two-acre site. Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), an explosives compound, is the COC associated with CS-19. The plume is defined by RDX concentrations above the EPA risk-based level of 0.97 µg/L. The historic high concentration was 21 µg/L, and the highest RDX concentration in 2020 was 1.3 µg/L.

The CS-19 plume is located adjacent to the CIA groundwater plume, which is managed by the IAGWSP. For more information about the IAGWSP, please call (339) 202-9360 or visit the website at http://jbcc-iagwsp.org.

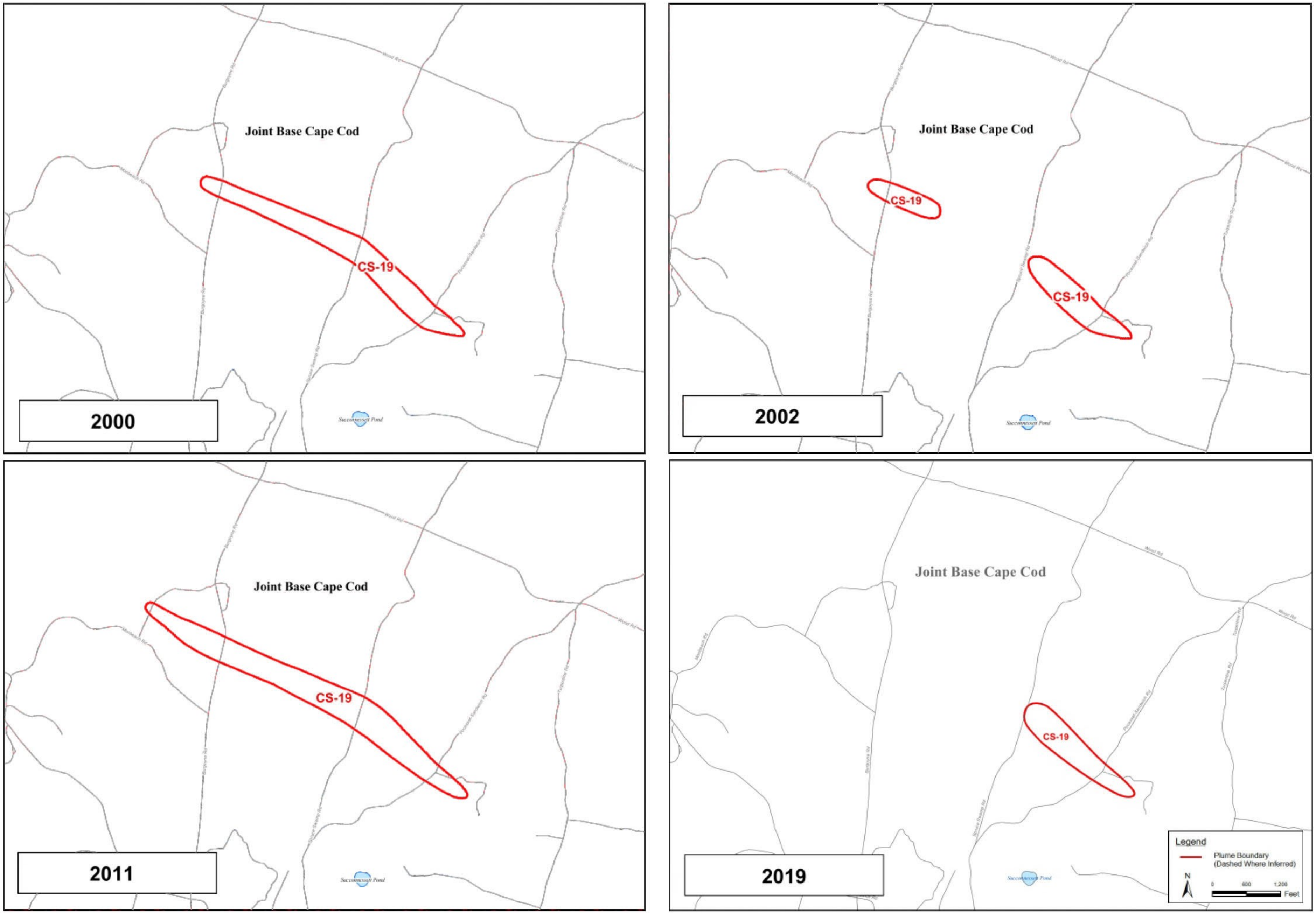
The 2009 ROD selected remedy was MNA and implementation of LUCs to prevent residential exposure. The plume is not anticipated to migrate beyond the base boundary. The estimated aquifer restoration timeframe presented in the ROD is approximately 2037.

An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

Soil was excavated at the CS-19 site for proper disposal. Soil removal was preceded by the removal of ordnance items and munitions debris from past training activities. The plume is confined within base boundaries and is being monitored as it continues to naturally attenuate which is a process by which chemicals disperse, dilute and degrade naturally.

Another soil removal project occurred at the former FTA-1 where solvents and fuels were set on fire for firefighting practice. The chemicals leached to groundwater and created a groundwater plume. In recent years the site has been identified as a source of PFOS and PFOA that was contained in fire-fighting foam used at the site during training. The site is undergoing further investigation.

Chemical Spill 19 Groundwater Cleanup Progression



The Chemical Spill 19 groundwater plume is delineated by RDX exceedances of cleanup standards.

CS-20 Groundwater Plume

The former CS-20 groundwater plume was located in the southwest corner of JBCC and extended south into the Town of Falmouth. The CS-20 plume was detached from an unknown source area that was located on the JBCC. The CS-20 groundwater plume was one of the four Southwest Plumes which also includes the CS-4, CS-21, and FS-29 groundwater plumes. The COC for the CS-20 groundwater plume is PCE, which has an MCL of 5 µg/L. However, a plume boundary has not been defined at CS-20 since 2015 as all concentrations have decreased below cleanup standards.

The ROD for CS-4, CS-20, and CS-21 was issued in February 2000. Two CS-20 extraction wells were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes. The contaminated groundwater is captured by extraction wells in each plume, treated, and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery.

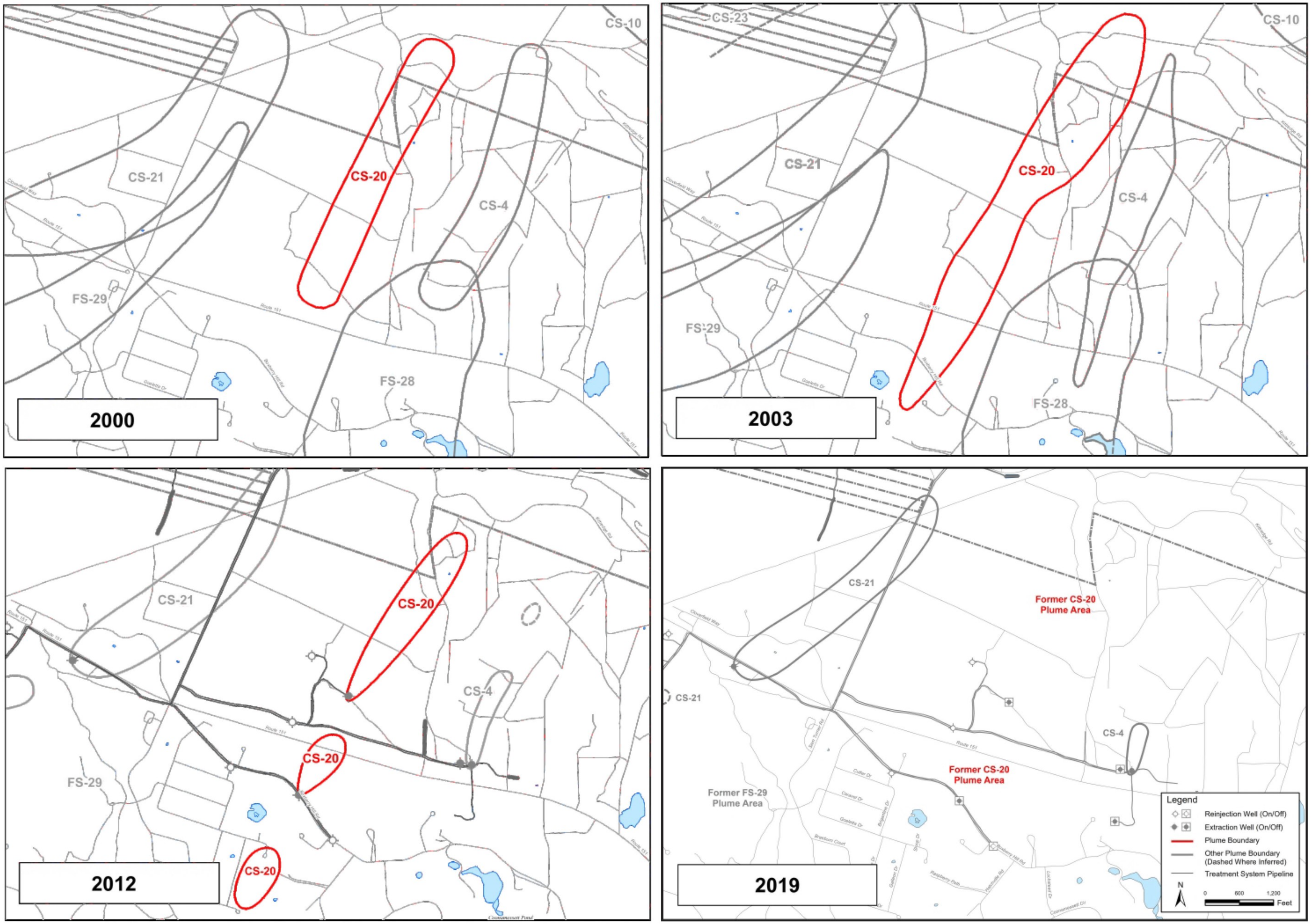
An ESD was submitted in 2008 to document changes to the selected remedy for CS-20. The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire CS-20 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of CS-20 to reach cleanup levels through natural attenuation instead of through active treatment. An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

The CS-20 remedial system was shut down in September 2015 having substantially remediated the aquifer within its hydraulic capture zone. The CS-20 groundwater plume has completed the three-step process and a Draft Remedial Action Closure Report (RACR) has been prepared which will lead to site closure. 1,4-Dioxane was assessed at CS-20 to determine whether it should be added as a COC. This assessment, which included an interim monitoring program at select CS-20 wells between 2017 and 2019, concluded that 1,4-dioxane should not be added as a CS-20 COC.

CS-20					
Date of ROD/DD and/or ESD in Place	**Cleanup Start**	**Date Finished**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD February 2000 ESD September 2008/2011	January 2006	September 2015	PCE	3.3	98.1 (September 2005)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2015
Extraction Wells 2/0 Reinjection Wells 4/0	1/0	775/0	2,845

Chemical Spill 20 Groundwater Cleanup Progression



The Chemical Spill 20 groundwater plume is delineated by PCE exceedances of cleanup standards.

CS-21 Groundwater Plume

The CS-21 groundwater plume is located in the southwest corner of JBCC and extends southwest into the Town of Falmouth. The CS-21 plume is detached from an unknown source area that was located on the JBCC. The CS-21 groundwater plume was one of the four Southwest Plumes which also include the CS-4, CS-20, and FS-29 groundwater plumes. The COC for the CS-21 groundwater plume is TCE, which has an MCL of 5 µg/L. The CS-21 plume is currently in long-term remediation.

The ROD for CS-4, CS-20, and CS-21 was issued in February 2000. Four CS-21 extraction wells were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes. The contaminated groundwater is captured by extraction wells in each plume, and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery.

An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

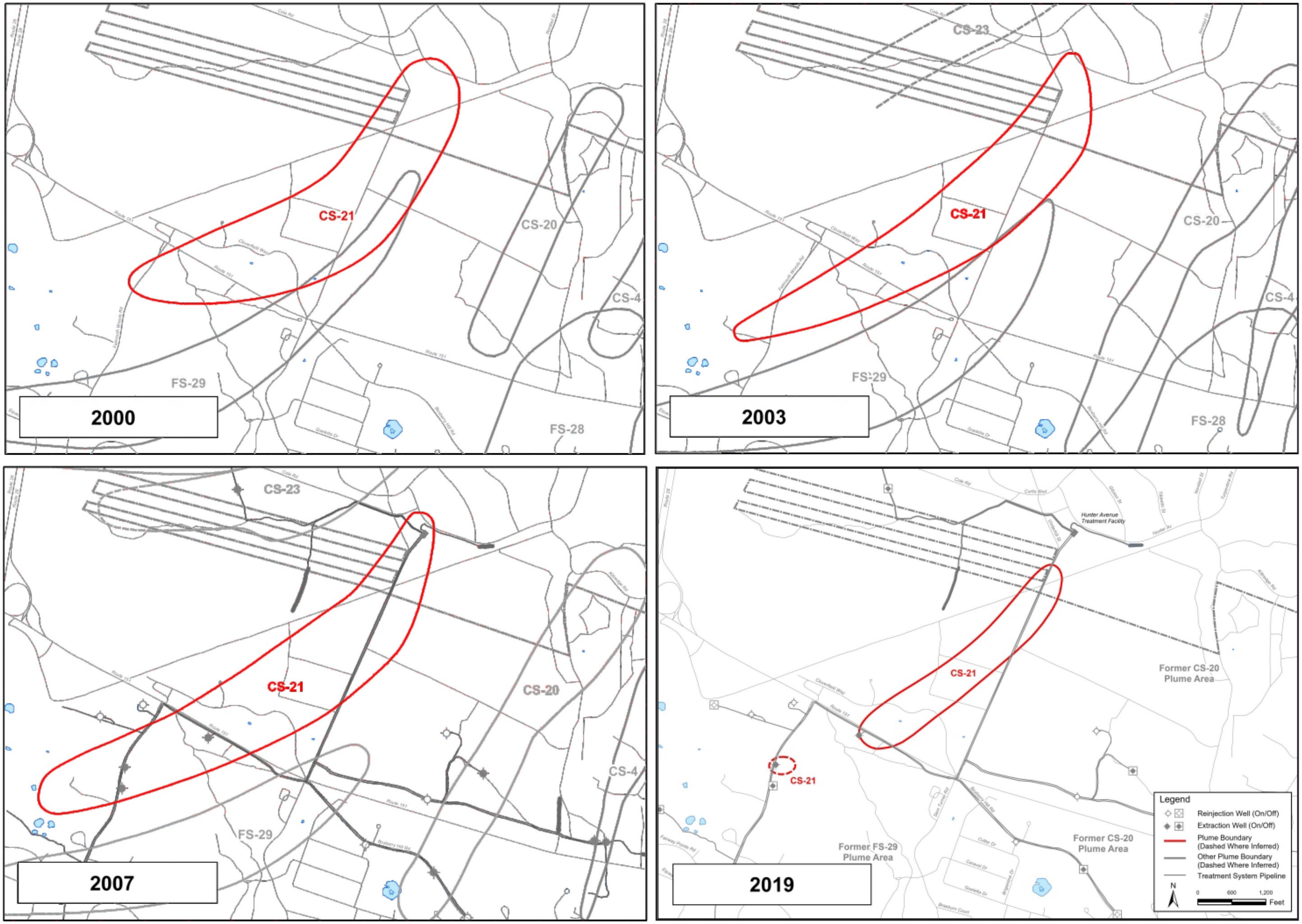
Construction of the Air Force's largest groundwater treatment facility on JBCC with 16 vessels each containing 20,000 pounds of GAC. The cleanup system treats contaminated groundwater that comes from several plumes on and off-base including CS-21 via extraction wells and pipelines. Cleaned water is then returned to the groundwater aquifer.

CS-21

Date of ROD/DD and/or ESD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2020 Highest Level (µg/L)	Highest Historic Level (µg/L)
ROD/DD February 2000 ESD September 2008/2011	September 2006	2025	TCE	22	98.8 (June 2001)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2020
Extraction Wells 4/2 Reinjection Wells 3/3	1/1	1400/400	5,954

Chemical Spill 21 Groundwater Cleanup Progression



The Chemical Spill 21 groundwater plume is delineated by TCE exceedances of cleanup standards.

CS-23 Groundwater Plume

The former CS-23 groundwater plume was located south of, and adjacent to the LF-1 plume in the southwest corner of JBCC and extended west into the Town of Falmouth. The CS-23 plume was from an unknown source area that was located on the JBCC. The contamination that initially indicated the presence of a groundwater plume in the CS-23 area was detected in 2000 during the CS-4, CS-20, CS-21, and FS-29 pre-design investigation. The data from that area indicated a different chemical signature than Landfill-1 (LF-1), CS-10, or CS-21, and as a result, CS-23 was defined as a groundwater plume in 2002. The CS-23 COCs are TCE and CCl_4, which both have an MCL of 5 µg/L. However, a plume boundary has not been defined at CS-23 since 2017 as all concentrations have decreased below cleanup standards.

The final design for the CS-23 remedial system consisted of two extraction wells (27EW0007 and 27EW0008), which were installed concurrently with a new LF-1 extraction well (27EW0006). The extracted groundwater from the extraction wells in the southern portion of LF-1 (27EW0002 and 27EW0006) was combined with the extracted groundwater from the CS-23 extraction wells 27EW0007 and 27EW0008 and treated at the HATF, which was constructed as part of the remedial action for the CS-4, CS-20, CS-21, and FS-29 plumes. The expanded LF-1/CS-23 remedial system became operational on 05 December 2006. The 2007 ROD selected remedy consisted of continued operation and optimization of the existing ETI system.

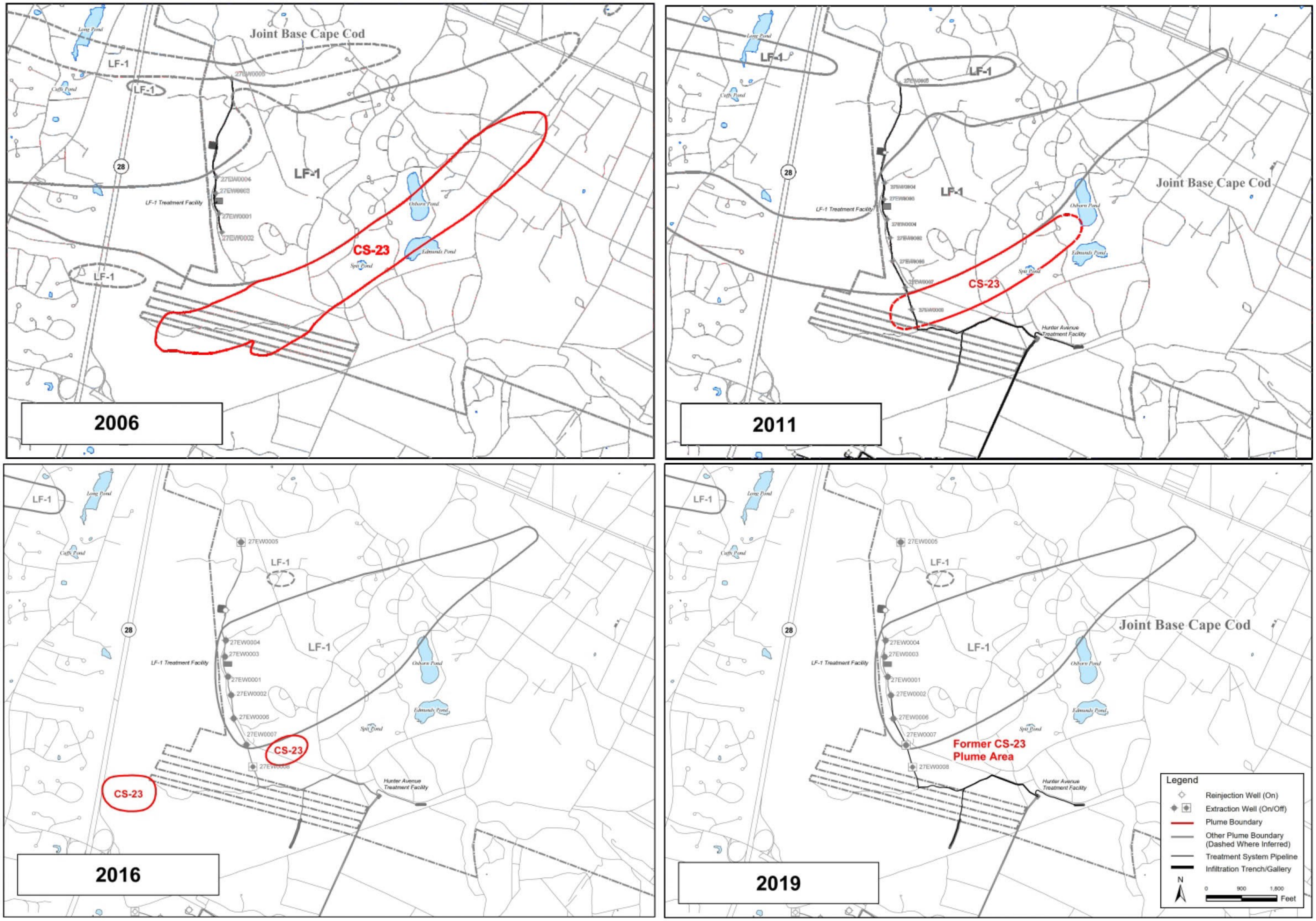
An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

The CS-23 remedial system was shut down in June 2019 having substantially remediated the aquifer within its hydraulic capture zone, and the CS-23 groundwater plume is proceeding through the three-step process to site closure.

CS-23					
Date of ROD/DD and/or ESD in Place	**Cleanup Start**	**Date Finished**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD October 2007 ESD September 2011	December 2006	March 2019	TCE	2.8	57.2 (June 2002)
			CCl_4	1.3	42 (August 1999)

Treatment Components (Total/Current)	**# Treatment Plants (Total/Current)**	**Treatment Rate (GPM) (Original/Current)**	**Volume Treated (MG) Through 2019**
Extraction Wells 2/0 Infiltration Trenches 2/0	1/0	700/0	2,821

Chemical Spill 23 Groundwater Cleanup Progression



The Chemical Spill 23 groundwater plume is delineated by TCE and CCl_4 exceedances of cleanup standards.

FS-1 Groundwater Plume

The former FS-1 groundwater plume was located southeast of the JBCC in the Town of Mashpee. The source of the FS-1 groundwater plume is the Aviation Gas Fuel Valve Test Dump Site in the eastern part of the base. The site was used from 1955 to 1970 to test fuel dump valves on EC-121 Super Constellation aircraft, which involved the release of fuel directly onto the ground. The COCs for the source area groundwater are lead, thallium, and toluene. However, no significant levels of COCs are present in the surface or subsurface soils at the FS-1 source area, and source area groundwater monitoring is no longer conducted. Soils at the FS-1 source have never had concentrations of COCs above cleanup standards. A plume has not been defined at FS-1 since 2019 as the concentration of all COCs have decreased below cleanup standards. PFAS has been detected within the area of the former FS-1 groundwater plume; however, the source of the PFAS is related to the flight line sites. PFAS at the flight line sites is currently being addressed in an expanded SI and will continue to be investigated during a subsequent RI. AFCEC will address the MassDEP PFAS6 MMCL in the FS phase for applicable sites.

The Air Force installed the original FS-1 remedial system as a pilot test, which operated between April 1999 and October 2002, when a fire destroyed the treatment plant. The original remedial system consisted of one extraction well and 175 shallow well points and was located in the Quashnet River cranberry bog area, just northeast of Johns Pond. The system was designed to prevent upwelling of EDB contamination into the Quashnet River and associated cranberry bogs. The FS-1 ROD was issued in April 2000. Three additional extraction wells were installed to treat the FS-1 plume and began operation in September 2003. The treatment plant used GAC to remove EDB from the groundwater, which was discharged to the Quashnet River through a series of oxygenating bubblers.

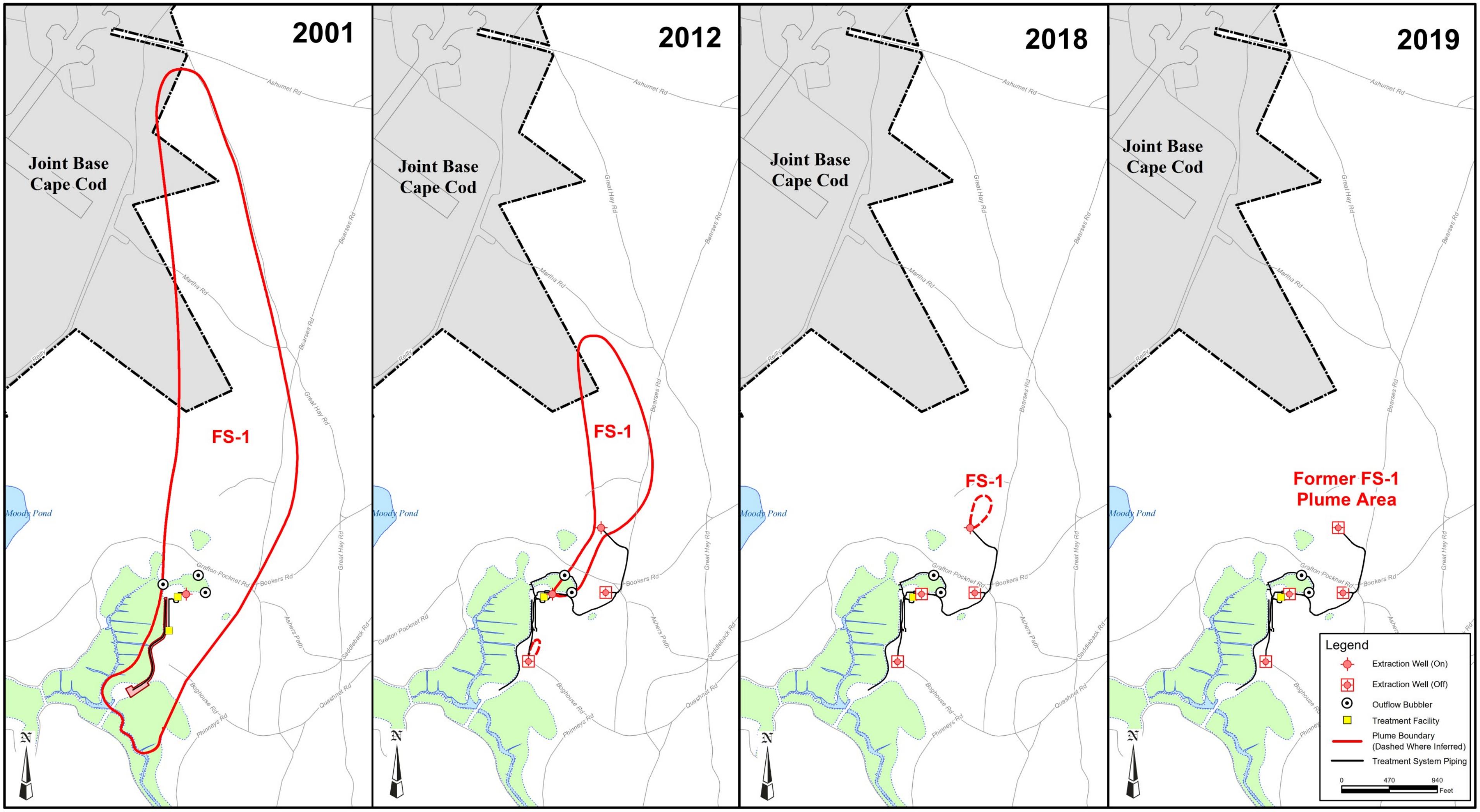
An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process). The FS-1 remedial system was shut down in August 2019 having substantially remediated the aquifer within its hydraulic capture zone. The Air Force is proceeding through the three-step process toward site closure for the plume’s COCs.

PFOS and PFOA have been detected in groundwater at concentrations above the EPA Lifetime Health Advisory and a site inspection is ongoing to define their extent. AFCEC will address the MassDEP PFAS6 MMCL in the FS phase. Investigation of groundwater in the FS-1 plume area for PFOS and PFOA continued in 2019 as part of an expanded site inspection that is in process for the Flight Line sites. The PFOS/PFOA investigation activities at the Flight Line area are will be reported in an expanded SI report.

FS-1					
Date of ROD/DD and/or ESD in Place	**Cleanup Start**	**Date Finished**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD April 2000 ESD September 2011	April 1999	August 2019	EDB	0.013	44.5 (October 2000)

Treatment Components (Total Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2019
Extraction Wells 4/0 SWP System 1/0 Infiltration Trenches 1/0 Surface Discharge Bubblers 3/0	1/0	750/0	4,630

Fuel Spill 1 Groundwater Cleanup Progression



The Fuel Spill 1 groundwater plume is delineated by EDB exceedances of cleanup standards. PFOS and PFOA are also present and are undergoing investigation.

FS-12 Groundwater Plume

The FS-12 groundwater plume is located along the eastern boundary of the JBCC, mostly under private property located northeast of Snake Pond in the Town of Sandwich. The source of the FS-12 groundwater plume was an estimated 70,000-gallon release from a section of a now-abandoned fuel pipeline that ran from the Cape Cod Canal to JBCC. The pipeline was cleaned and closed with state and federal regulatory approval. An air sparging/soil vapor extraction (AS/SVE) system was installed in 1995 as a time critical removal action to address the jet fuel identified at the FS-12 source area. The AS/SVE system was shut down in 1998 because remaining levels of contaminants in the source area could not be effectively addressed by the system any longer. Subsequent data indicate that the FS-12 groundwater plume has fully detached from its source area and there is no evidence that there is a continuing source of contamination to the groundwater plume.

The COCs for FS-12 are EDB, which has an MMCL of 0.02 µg/L, and benzene, which has an MCL of 5 µg/L. EDB is the only remaining contaminant above cleanup standards in the FS-12 groundwater plume.

The FS-12 plume is currently undergoing remediation with a groundwater extraction and treatment system. The treatment system consists of extraction wells, a treatment plant, and reinjection wells. The selected remedy in the 2006 ROD called for the continued operation of the existing FS-12 remedial system, monitoring of the plume and LUCs.

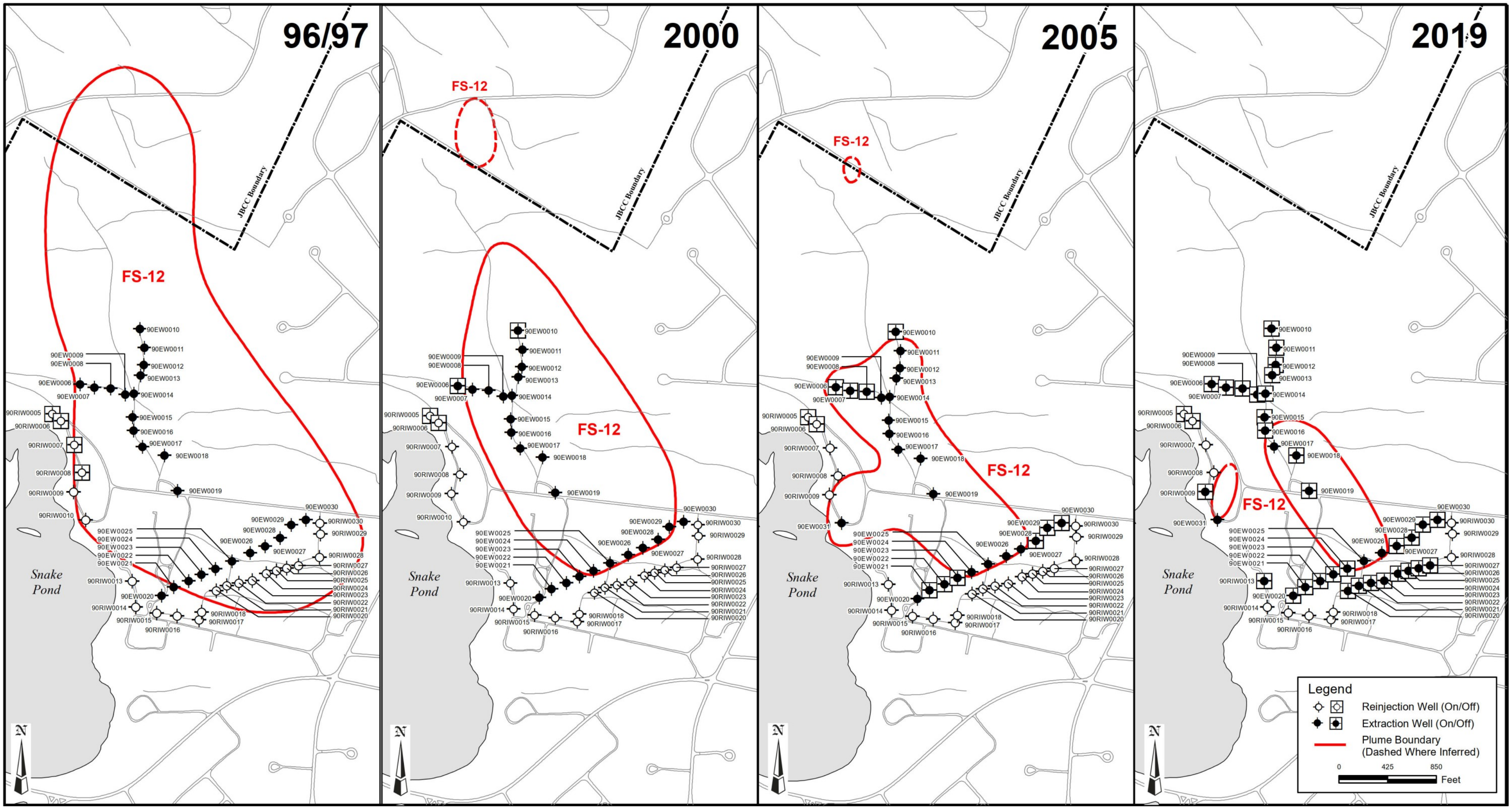
An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

Members of the JBCC Cleanup Team gather for a 2019 meeting. Citizen volunteers, military, state and federal officials serve on the team to review the status of the Air Force and Army environmental cleanup programs at JBCC. Meetings are advertised and open to the public. In 2020 the Air Force began a series of online meetings due to the COVID–19 Pandemic.

FS-12					
Date of ROD/DD or ESD in Place	**Cleanup Start**	**Projected Finish**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD September 2006 ESD September 2011	September 1997	2037	EDB	4.1	890 (November 2000)

Treatment Components (Total/Current)	**# Treatment Plants (Total/Current)**	**Treatment Rate (GPM) (Original/Current)**	**Volume Treated (MG) Through 2020**
Extraction Wells 25/4 Reinjection Wells 22/10	1/1	772/280	5,821

Fuel Spill 12 Groundwater Cleanup Progression



The Fuel Spill 12 groundwater plume is delineated by EDB exceedances of cleanup standards.

FS-28 Groundwater Plume

The FS-28 plume is located in the Town of Falmouth, south of the JBCC. The FS-28 plume is a dissolved-phase groundwater plume that is defined as the extent of groundwater containing the FS-28 plume COC, EDB, at concentrations exceeding the MMCL of 0.02 µg/L. The FS-28 plume is detached from its source area which was never identified.

The FS-28 ETD system was installed in 1997 under a time-critical removal action process to capture the majority of the plume mass at Hatchville Road and to minimize upwelling of the plume into the Coonamessett River system.

In April 1999 additional extraction capacity was added to the system in the form of shallow well points in an attempt to capture EDB-contaminated groundwater prior to its discharge to the Coonamessett River and neighboring cranberry bogs. Installation and operation of this system was successful in improving water quality in the river and bogs. The shallow well points were removed in 2010. Berms and sheet piles were installed as part of this non-time critical removal action. The berms and sheet piles were designed to separate the Coonamessett River from the surrounding cranberry bogs. During 2007 the FS-28 ETD system was further expanded through the installation of a second extraction well to remediate a deeper leading edge lobe of the plume, which operated between December 2007 and June 2015.

The FS-28 plume is currently in long-term remediation with a groundwater extraction and treatment system. The 2000 ROD selected remedy called for the continued operation of the existing FS-28 remedial system, monitoring of the plume, and LUCs.

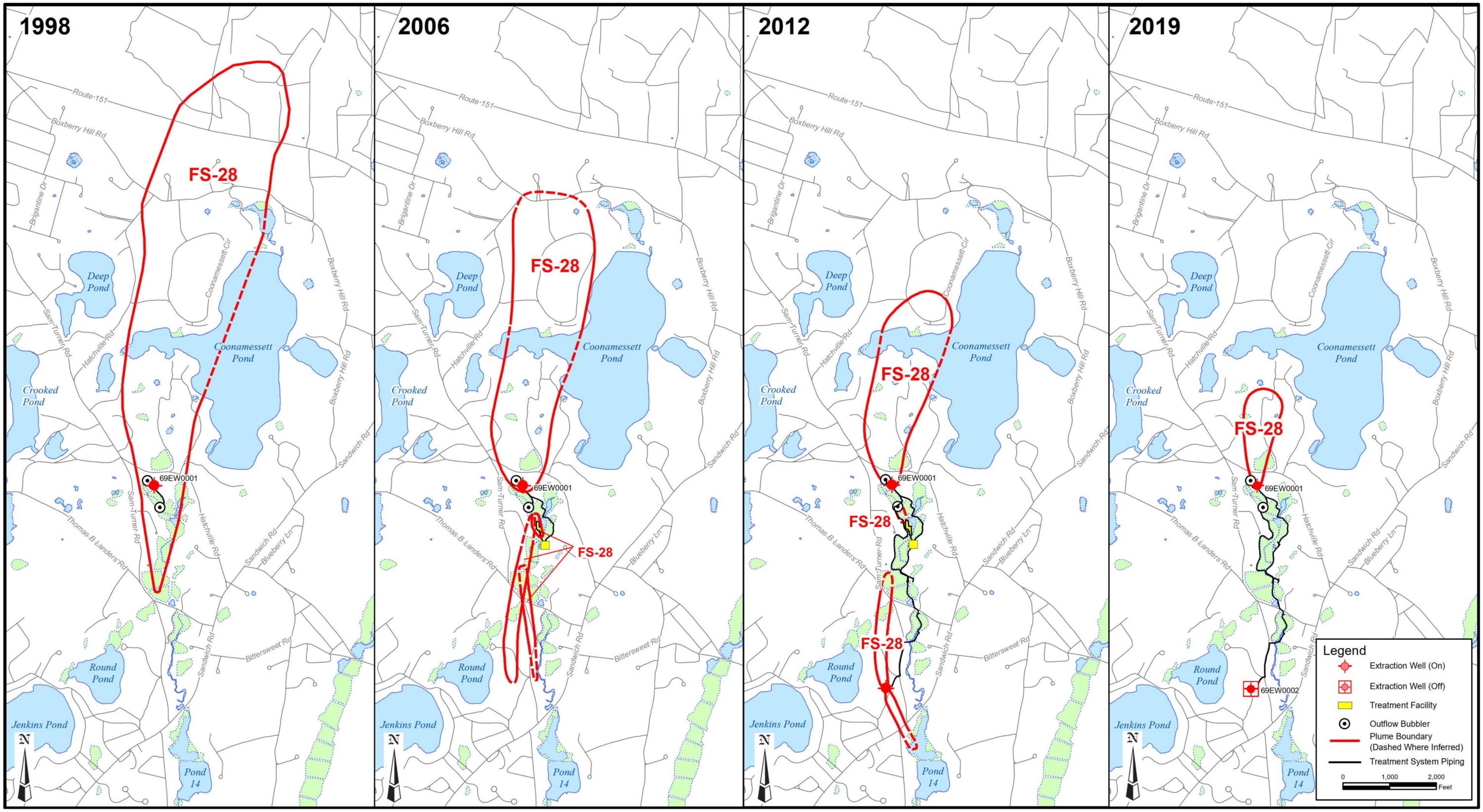
An ESD for the groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy, and updated the steps to achieve site closure (i.e., the three-step process).

FS-28					
Date of ROD/DD or ESD in Place	**Cleanup Start**	**Projected Finish**	**Primary Contaminants**	**2020 Highest Level (µg/L)**	**Highest Historic Level (µg/L)**
ROD/DD October 2000 ESD September 2008/2011	October 1997	2023	EDB	0.11	57.2 (June 2002)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2020
Extraction Wells 2/1 SWP System 1/0 Surface Discharge Bubbler 8/2	1/1	700/200	6,957

The SWP system became operational in April 1999, shut down in February 2010.

Fuel Spill 28 Groundwater Cleanup Progression



The Fuel Spill 28 groundwater plume is delineated by EDB exceedances of cleanup standards.

FS-29 Groundwater Plume

The former FS-29 groundwater plume was located in the southwest corner of JBCC and extended southwest into the Town of Falmouth. The FS-29 plume was detached from an unknown source area that was located on the JBCC. The FS-29 groundwater plume was one of the four Southwest Plumes which also included the CS-4, CS-20, and CS-21 groundwater plumes. The COCs for the FS-29 groundwater plume are EDB and CCl_4. The MMCL for EDB is 0.02 µg/L and the MCL for CCl_4 is 5 µg/L. However, a plume boundary has not been defined at FS-29 since 2012.

The ROD for FS-29 and FS-28 was issued in October 2000. Two FS-29 extraction wells were installed as part of the Southwest Plumes remedial system, which was designed to collectively remediate the CS-4, CS-20, CS-21, and FS-29 groundwater plumes at the HATF. The contaminated groundwater is captured by extraction wells in each plume, treated at the HATF, and the treated water is returned to the aquifer through reinjection wells, an infiltration trench, and an infiltration gallery.

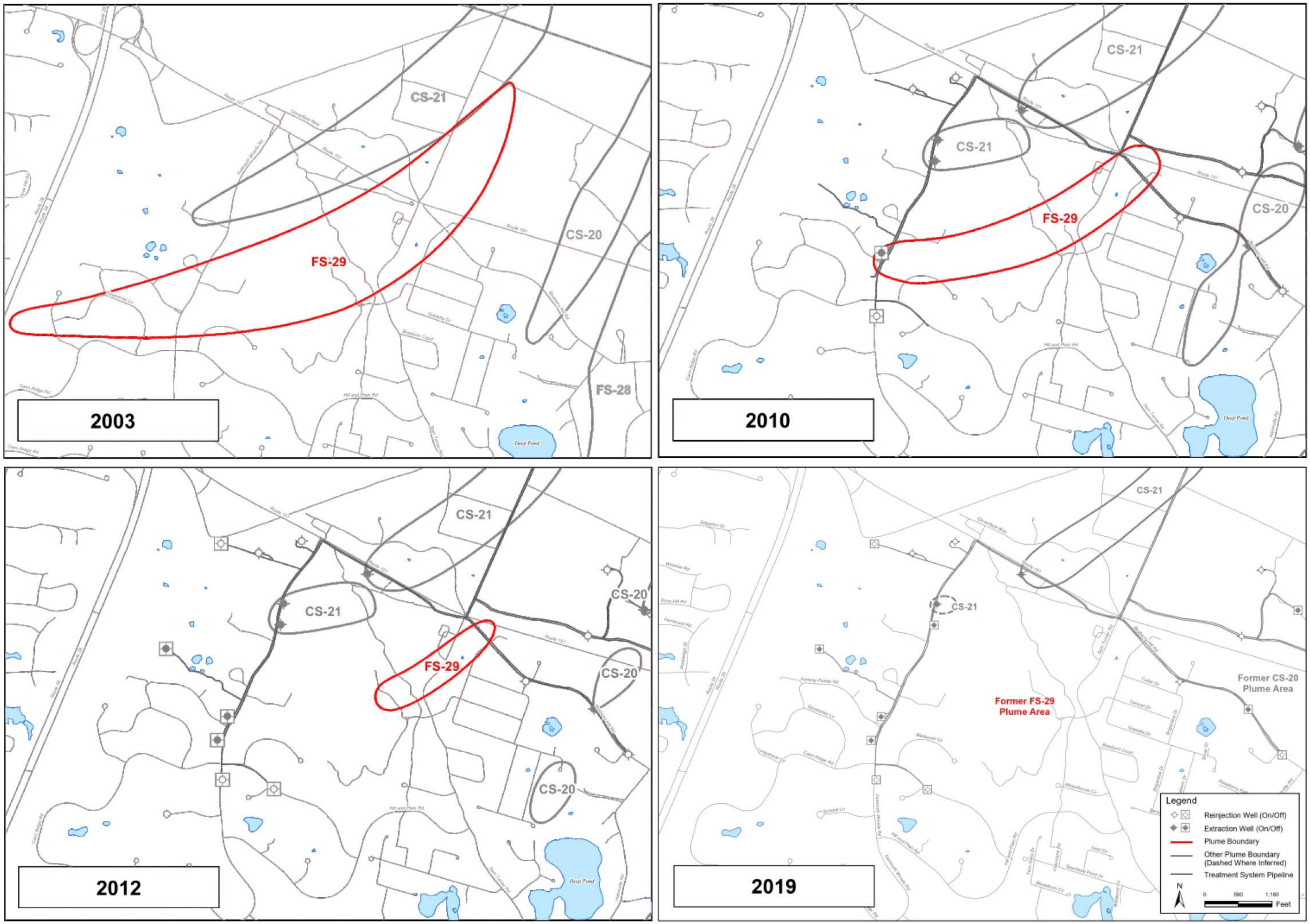
An ESD was submitted in 2008 to document changes to the selected remedy for FS-29. The primary difference between the cleanup strategy identified in the ROD and the final design is that the selected alternative presented in the ROD anticipated that the entire FS-29 plume would be hydraulically captured by the remedial system; however, the final design allowed the groundwater contamination in the downgradient leading edge of FS-29 to reach cleanup levels through natural attenuation instead of through active treatment. An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy to achieve site closure.

The FS-29 remedial system was shut down in September 2010 having substantially remediated the aquifer within its hydraulic capture zone, and the FS-29 groundwater plume is proceeding through the three-step process to site closure. Letters were sent to residents with private wells in the FS-29 area in September 2020 to inform them that there were no longer restrictions on the use of their well. The three-step process was completed for the plume COCs and the FS-29 RACR was finalized in November 2020 and the site is closed.

FS-29					
Date of ROD/DD or ESD in Place	Cleanup Start	Date Finished	Primary Contaminants	Highest Level (µg/L)	Highest Historic Level (µg/L)
ROD/DD February 2000 ESD September 2008/2011	September 2006	September 2010	EDB	0.0098 (2017)	0.318 (May 2001)
			CCl_4	3.8 (April 2017)	10.3 (February 2002)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2010
Extraction Wells 2/0 Reinjection Wells 2/0	1/0	525/0	722

Fuel Spill 29 Groundwater Cleanup Progression



The Fuel Spill 29 groundwater plume is delineated by EDB and CCl_4 *exceedances of cleanup standards.*

LF-1 Groundwater Plume

The LF-1 groundwater plume is located at the southwest corner of the JBCC and extends off-base into the Towns of Bourne and Falmouth. It is a large dilute dissolved-phase groundwater plume that originated from the main base landfill which operated from 1941 to 1990. The LF-1 groundwater plume contains eight COCs but the plume boundary is defined by the two COCs, PCE and TCE, at concentrations exceeding their MCL of 5 µg/L. The current distribution of the additional six LF-1 COCs is contained within the area of the PCE/TCE plume boundary. The cleanup levels for the remaining six LF-1 COCs are as follows: vinyl chloride with an MCL = 2 µg/L; CCl_4 with an MCL = 5 µg/L; 1,4-dichlorobenzene (1,4-DCB) with an MMCL = 5 µg/L; 1,1,2,2-TeCA with Massachusetts Contingency Plan Groundwater 1 = 2 µg/L; EDB with an MMCL = 0.02 µg/L; and Mn with an EPA LHA = 300 µg/L.

Monitoring data for LF-1 groundwater COCs indicate that the landfill is not a significant ongoing source for the plume. The landfill cap which was installed in 1995 effectively eliminated leachate from the landfill. The LF-1 source area (1970 Cell, Post-1970 Cell, and the Kettle Hole) is currently being maintained as a capped landfill and access to the capped and uncapped cells (1947, 1951, and 1957) is restricted. Source area controls, in the form of environmental LUCs, are in place that protect human health by limiting exposure to the landfill source areas and preventing intrusive activities on the landfill. Landfill post-closure monitoring (PCM) activities are conducted in accordance with the PCM Plan. PCE and TCE are the aquifer restoration timeframe drivers for LF-1. The remaining six COC concentrations are expected to be below their respective cleanup goals by the time the LF-1 remedial system is turned off, which is projected to be in 2045.

The LF-1 plume is in long-term remedial action with a groundwater extraction and treatment system. The Air Force installed the five extraction well LF-1 ETI system under an Interim ROD. The final remedy for LF-1 specified in the Final 2007 ROD consists of continued operation of the ETI system with system expansion to the south (one extraction well, 27EW0006), and LUCs. A reinjection well was installed in 2008 to provide additional recharge capacity to offset diminished infiltration gallery capacity. The extracted groundwater was treated through GAC systems located in the LF-1 treatment plant and the HATF; however through a 2018 optimization, all groundwater extracted from LF-1 is now treated at the HATF and the LF-1 plant has been shut down. Two extraction wells (27EW0005 and 27EW0006) were shut down as they were no longer needed for plume capture and treatment.

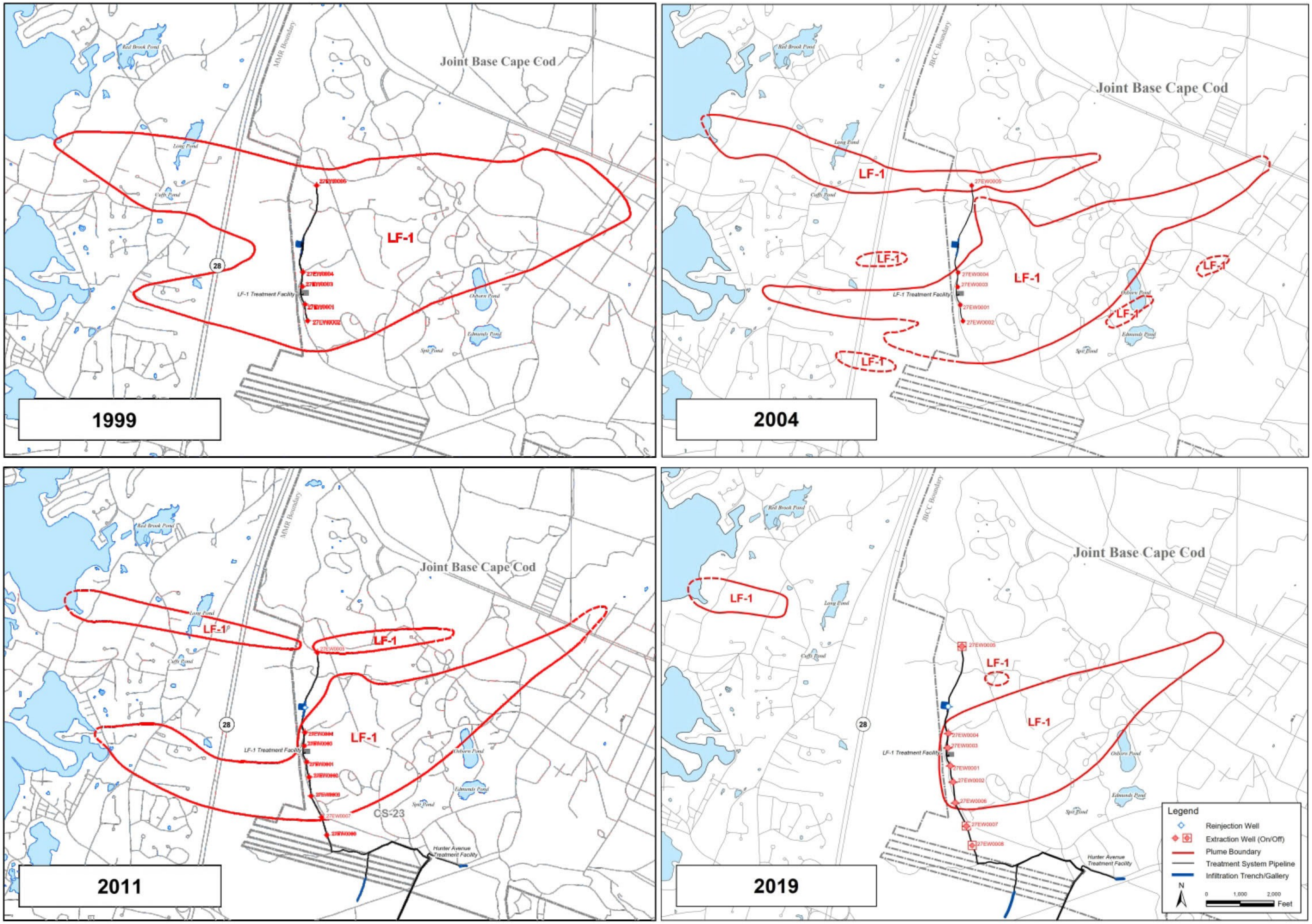
An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy to achieve site closure.

1,4-Dioxane, PFOS and PFOA were detected in the LF-1 plume footprint at concentrations greater than EPA RBC (for 1,4-dioxane) and the EPA LHA (for the sum of PFOS and PFOA). A Final Supplemental RI was completed in 2018 which recommended 1,4-dioxane, PFOS and PFOA be added as COCs. A Supplemental FS is underway to evaluate remedial alternatives for groundwater within the LF-1 plume. AFCEC will address the MassDEP PFAS6 MMCL in the FS phase.

LF-1					
Date of ROD/DD or ESD in Place	Cleanup Start	Projected Finish	Primary Contaminants	2020 Highest Levels (µg/L)	Highest Historic Levels (µg/L)
ROD/DD October 2007 ESD September 2011 and October 2013	August 1999	2045	TCE	130	150 (TCE, August 1999)
			PCE	13	67 (PCE, December 1998)

Treatment Components (Total/Current)	# Treatment Plants (Total/Current)	Treatment Rate (GPM) (Original/Current)	Volume Treated (MG) Through 2020
Extraction Wells 6/5 Reinjection Wells 1/0 Infiltration Trenches 3/1	1/1	700/985	9,443

Landfill 1 Groundwater Cleanup Progression



The Landfill 1 groundwater plume is delineated by PCE and TCE exceedances of cleanup standards. PFOS/PFOA/1,4-dioxane are also present and are undergoing investigation.

FTA-2/LF-2 Groundwater Plume

The FTA-2/LF-2 area is located near the southeastern border of the JBCC and includes a former fire training area that was located within a larger area used for landfill operations.

Landfill operations at LF-2 began in approximately 1940 and were discontinued in 1944. LF-2 contains primarily solid waste (e.g., bottles, glass, ash, metal scrap, wood, concrete, and asphalt construction debris). However, analytical results indicate the presence of localized areas of petroleum contaminated soil at LF-2. The landfill was covered with fill material before fire training activities were conducted at FTA-2 from 1948 to 1956. FTA-2 may have received up to 7,000 gallons per year of waste oil, aviation gasoline (AVGAS), JP-4 fuel, and solvents, which were ignited during fire training exercises. Sand, asphalt, and concrete rubble fill were apparently placed in a drainage swale before, during, and after fire-training activities at FTA-2. The FTA-2 area was covered with additional soil following its abandonment in 1956.

The Western Aquafarm source area consisted of former underground storage tanks containing petroleum products located to the north of the LF-2 area. A dissolved-phase groundwater plume of benzene, toluene, ethylbenzene and xylene (BTEX) was formerly delineated in the Western Aquafarm area, LF-2 and FTA-2.

The 1998 ROD for the FTA-2/LF-2 source area documented ethylbenzene and total xylenes as the COCs for soil at the FTA-2 source area because these compounds were present at concentrations greater than the soil target cleanup levels and posed a potential leaching threat to groundwater. A biosparge/soil vapor recovery (BSVR) system was installed at the FTA-2 source area and operated from 2001 to 2003, when it was shut down because the remedial goals for soil were met (i.e., the cleanup levels for ethylbenzene and total xylenes in soil were achieved) such that soils at FTA-2 were no longer considered a potential leaching source of xylene and ethylbenzene to groundwater.

The FTA-2/LF-2 groundwater plume is a dissolved-phase groundwater plume that contains the following COCs: C5-C8 aliphatic, C9-C12 aliphatic, and C9-C10 aromatic volatile petroleum hydrocarbon (VPH) ranges; the C11-C22 aromatic extractable petroleum hydrocarbon (EPH) range; 1,2,4-TMB; 1,3,5-TMB; and 2-methylnaphthalene. The groundwater monitoring for EPH/VPH carbon range (including TMBs and 2-methylnaphthalene) at FTA-2/LF-2 has been ongoing since 2005 and data indicate that the current EPH/VPH, TMB, and 2-methylnaphthalene plume is the remnant of the dissolved-phase plume that was previously defined by the BTEX compounds that were monitored under the Western Aquafarm LTM program from 1996-2005. The Western Aquafarm plume was closed under a No Further Action (NFA) decision in the ROD for Western Aquafarm because BTEX were no longer detected above MCLs. The Air Force and the regulatory agencies agreed that the TMB and EPH/VPH groundwater contamination could be managed under the FTA-2/LF-2 groundwater program. The LF-2/FTA-2 ROD Amendment in 2016 added the groundwater media to the original ROD. MNA and LUCs are the groundwater remedy.

Petroleum Fuel Storage Area (PFSA) Groundwater Plume

The PFSA site, which has historically been referred to as FS-10/FS-11, is located in the southeast corner of JBCC within the base boundary. The PFSA site served as the storage and distribution center for JP-4 jet fuel, AVGAS, motor gasoline, and No. 2 fuel oil for JBCC from the 1950s until 2009. A potion was demolished in 1998 and the remainder in 2011. Historically, fuel received or stored at the PFSA was transferred through underground pipelines to the fuel distribution pump houses. From 1955 to 1965 AVGAS and JP-4 were delivered to the PFSA from the railroad fuel pumping station at JBCC (located approximately 9,500 feet west of the PFSA near the intersection of Kittredge and Turpentine Roads). From 1965 to 1973, AVGAS and JP-4 were delivered to the JBCC through a 3-inch-diameter underground pipeline extending from the Cape Cod Canal to the PFSA.

Fuels were subsequently delivered by truck to the PFSA and then distributed by truck to aircraft or other points of use including aboveground storage tanks (ASTs). Two of the ASTs (15 and 16) were constructed with floating lids, allowing rainwater and condensation to enter and migrate to the bottom of each of the tanks. This water was reportedly removed from the tank bottoms by opening drain valves and discharging the accumulated water to the containment berms that surrounded the ASTs until fuel product discharge was observed. The floating lids on the ASTs 15 and 16 were replaced with solid lids in 1977 and 1988, respectively.

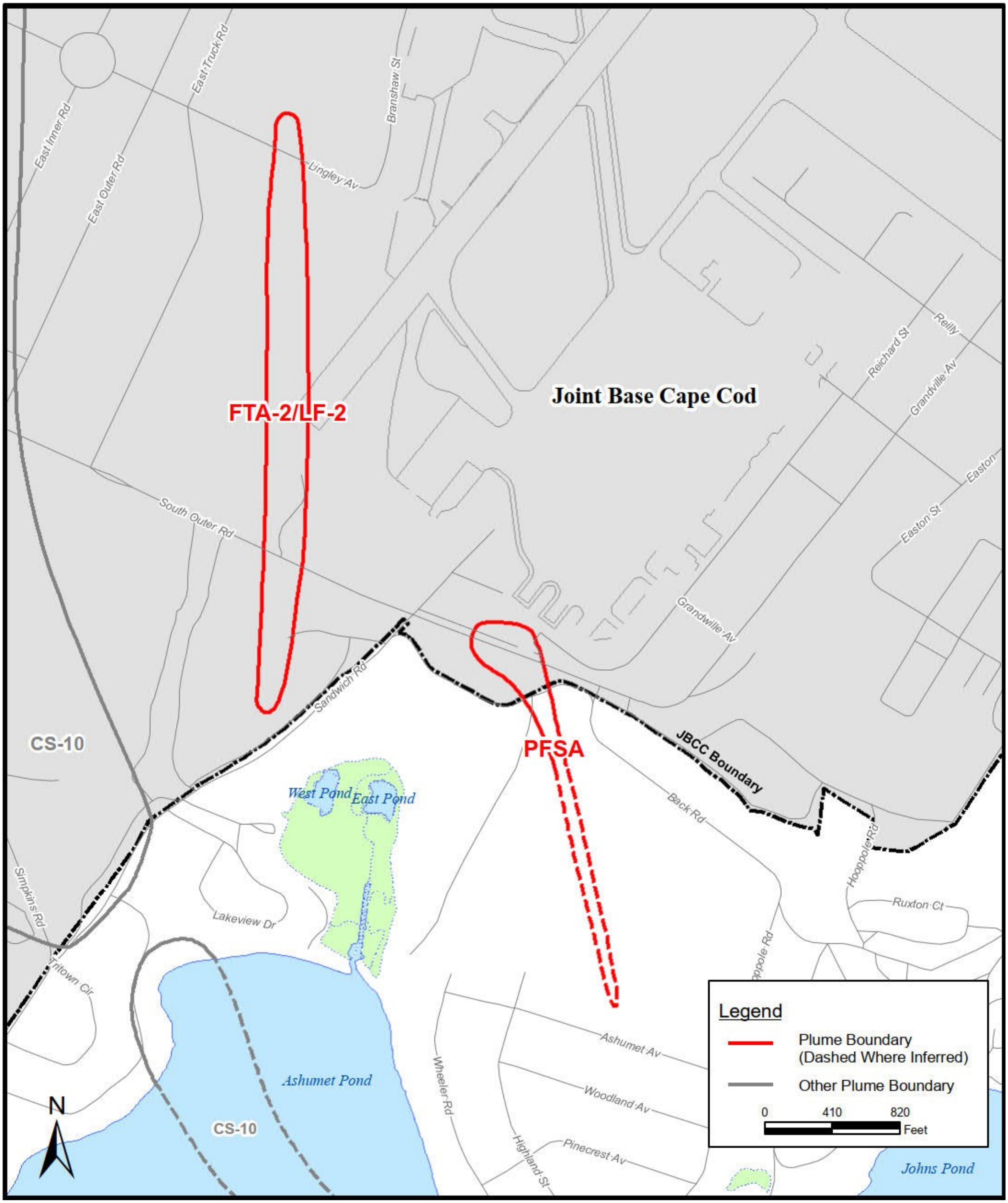
Discharges from the AST containment berms and paved surfaces at fuel unloading areas entered storm drain catch basins via asphalt-lined ditches and exited to the JBCC storm water sewer system; and then ultimately to the Oil Water Separator (OWS) located on the southeast side of South Outer Road.

The OWS discharged to a drainage ditch, referred to as SD-2, which lies south of the far eastern portion of the PFSA boundary. Two 42-inch-diameter storm drains and the OWS discharged to the upstream end of Storm Drain 2 (SD-2) until removed in 2002.

The 1998 ROD for the PFSA source area documented ethylbenzene and total xylenes as COCs in capillary fringe soils and established the selected remedial alternative as biosparging with off-gas collection and treatment. A BSVR system began operation at PFSA in 2001 and ran until 2008 when the soil vapor recovery portion of the system was shut down due to low or negligible petroleum concentrations in influent air samples.

The PFSA groundwater plume is a dissolved-phase groundwater plume that contains the following COCs: C11-C22 EPH carbon ranges, the C5-C8, C9-C12, and C9-C10 VPH carbon ranges, and volatile organic compounds (2-methylnaphthalene, 1,2,4-TMB, and 1,3,5-TMB). The PFSA ROD Amendment in 2016 added the groundwater media to the original ROD, MNA and LUCs are the groundwater remedy.

FTA-2/LF-2/PFSA Groundwater Plumes



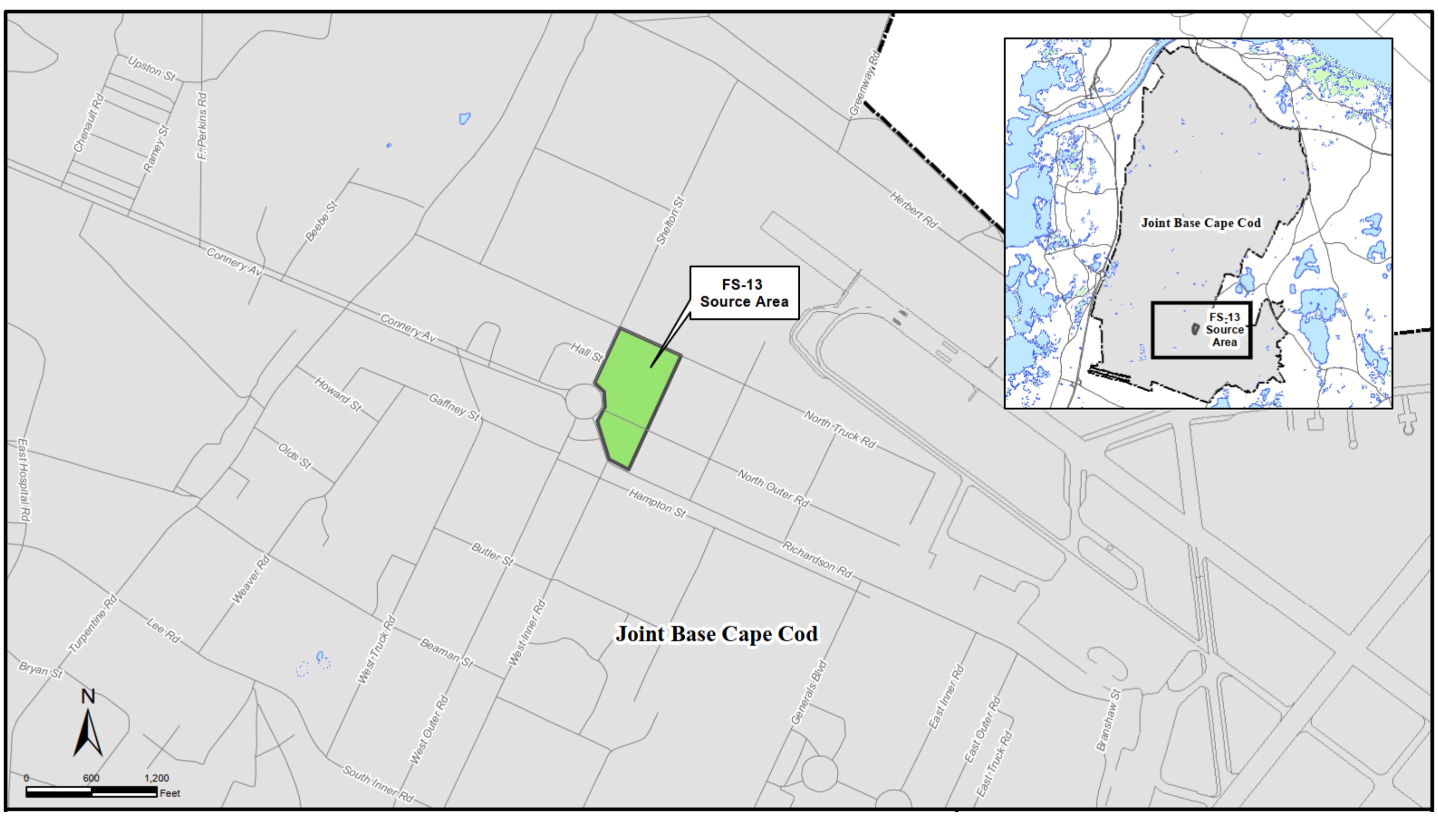
The FTA-2/LF-2/PFSA groundwater plumes are delineated

FS-13 Groundwater Plume

The former FS-13 plume is located on-base within the footprint of the CS-10 plume. The source of the FS-13 plume was the release of an estimated 2,000 gallons of JP-4 fuel that is believed to have occurred near the rotary at the east end of Connery Avenue. The fuel spill was discovered in 1972 during a routine walkover inspection of an underground fuel supply pipeline. The area was investigated and excavated and a section of pipe was replaced. The remaining residual contamination is located near the water table. The COCs for the FS-13 plume are 1,2,4-TMB and 1,3,5-TMB. There are no applicable drinking water standards for 1,2,4-TMB and 1,3,5-TMB. However, the calculated hazard equivalent concentration, based on a hazard index equal to 1 for each COC, is 56 µg/L for 1,2,4-TMB and 60 µg/L for 1,3,5-TMB. The groundwater contamination at FS-13 has not been delineated as a contiguous plume since 2004 due to its limited extent.

No further action was recommended for the FS-13 source area based on the evaluation of sampling data collected from the site characterization efforts of the 1996 Site Inspection Technical Memorandum and 2006 Supplemental Site Inspection. A Decision Document (DD) was prepared to document the no further action decision for the FS-13 source area. In October 2007, the FS-13 source area was delisted as part of the partial deletion of sites from the Otis Air National Guard Base/Camp Edwards Superfund Site.

The 2000 ROD identified the remedy for the FS-13 groundwater plume as Limited Action, consisting of LTM and institutional controls. A 2008 ESD further described the institutional controls associated with the remedy. An ESD for the IRP groundwater plumes was submitted in September 2011 that clarified the inclusion of MNA as a component of the selected remedy to achieve site closure.



Sustainable Remediation

Zero-valent iron barrier along Ashumet Pond Shore
(The rust colored area to right)

In-situ chemical oxidation operation

The Air Force's aggressive optimization activities have resulted in a more sustainable remediation program at JBCC. Our "better, cheaper, faster" approach is intended to expedite aquifer restoration and cleanup timeframes while reducing costs to the taxpayers and minimizing our carbon footprint. Optimization activities conducted by the Air Force at JBCC include:

- Demonstrating alternative in-situ technologies such as a passive zero-valent iron barrier. This barrier requires no operations and maintenance and was installed along the Ashumet Pond shoreline to help reduce phosphorus discharging into the surface water.

- Continuously adjusting groundwater remediation systems as the groundwater plumes change over time. For example, extraction wells are taken out of operation once the portion of the aquifer is cleaned up. In some cases, extraction wells are added if deemed necessary to expedite aquifer restoration and eliminate risks to human health and the environment. Flow rates at extraction wells are modified and/or systems are pulse-pumped, and packers are installed in extraction wells to focus extraction stress on changing contaminant distribution. In one case, a reinjection well was converted to an extraction well when contamination was detected unexpectedly in monitoring wells outside of the delineated plume area.

- Installing variable frequency drives (VFDs) on extraction well pump motors to save energy and reduce wear and tear on pump/motor assemblies. In the absence of VFDs, extraction well pumps and motors are changed out by well maintenance staff to appropriately size the pumps and motors to optimize flow rates at extraction wells. This reduces unnecessary energy use. Also, energy saving premium efficiency motors have been installed on booster and transfer pumps in treatment plants.

- Adjusting the number of monitoring locations, frequency of sampling, and analytes in the monitoring program as the remediation requirements are refined. Passive sampling techniques such as passive diffusion bags and Hydra-sleeves® are used to the maximum extent possible to save time, reduce costs, and reduce impacts to the environment, as compared to conventional pumped sampling.

Passive sampling technique

Sustainable Remediation

- Using virgin GAC produced from coconut shells in the treatment systems to remove the contaminants from the groundwater. When the GAC needs to be replaced, it is removed from the vessels and sent to be recycled.

- Providing treated water for beneficial uses such as irrigating the Veterans Affairs Cemetery and as a geothermal source for heating, ventilating, and air conditioning.

- Pilot testing new technologies such as ozone and hydrogen treatment of plant influent water to determine if they can be used effectively to pretreat the water and extend the life of the GAC beds and/or reduce operating costs.

- Evaluating various types of GAC to determine if a more efficient product is available.

- Employing energy conservation measures such as efficient lighting, occupancy sensors, and programmable thermostats in treatment plants and administrative buildings, and recycling products such as paper, tubing, batteries, and light bulbs to the maximum extent possible.

- Using biodiesel fuel and vegetable-based hydraulic oil to the maximum extent possible in our diesel powered equipment.

Air Force contractor staff routinely climb the ladder inside of the wind turbines to the top for conducting inspections and required maintenance.

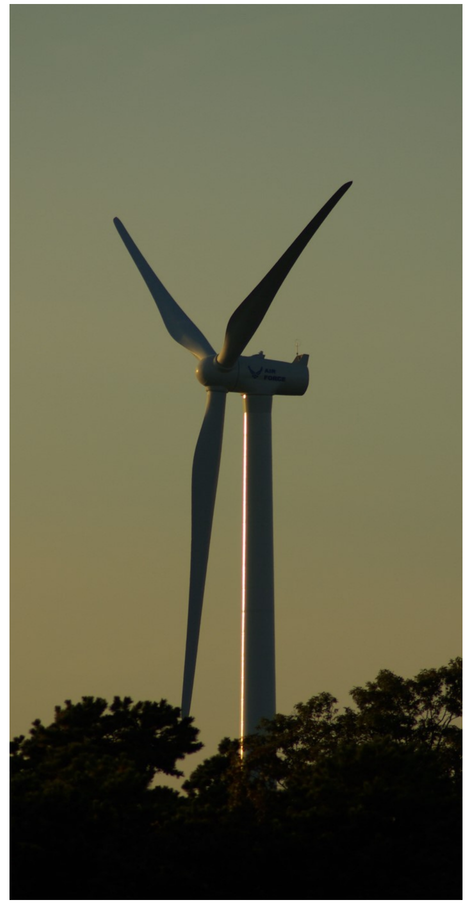
- Employing low impact direct-push technology to collect groundwater samples instead of using auger/sonic well drilling when viable. The Air Force owns and operates a direct push rig that is track mounted, has a smaller footprint, is quieter and uses environmentally sensitive biofuels. Not only is this method of drilling more sustainable than other methods, it is less expensive since the work is done by site staff. The IRP at JBCC holds the world's depth record for a direct-push boring which is 319 feet below ground surface.

- Optimizing power purchase agreements for additional cost savings, purchasing green energy, and participating in the New England Energy Demand Response Program.

- Accounting for costs, efficiency, and environmental impact of our program decisions. These activities are tracked and reported in quarterly optimization reports.

Shallow groundwater sampling near Hen Cove in Pocasset for PFOS and PFOA. The source is the past use of fire-fighting foam at the Otis Rotary on Route 28 in Bourne at the entrance to JBCC on Connery Avenue.

Sustainable Remediation



Photos L to R: One of three wind turbine tower sections being raised. Turbine blade assembly being installed (contains the nacelle that houses the gearbox and generator. Workers inspect the condition of turbine blades by rappelling from the top of the turbines. Drones are also used for inspections. Twilight at one of the IRP's two turbines near the Sagamore Bridge.

A major optimization effort was the installation of renewable energy. The Air Force owns and operates three 1.5 megawatt wind turbines that offset 100% of the power used by the treatment systems (over $1 million dollars in savings annually). The Fuhrlaender wind turbine started operating on December 2, 2009 and the two General Electric wind turbines started operating on November 8, 2011.

The wind turbines also offset air emissions, generated indirectly through the use of electricity from fossil fuel based power plants, by 100%. Based on a range of utility cost projections and an estimate of the turbine's energy production, the General Electric wind turbines are anticipated to have a payback period of 8-10 years. Due to various component and technical issues the Fuhrlaender wind Turbine is estimated to have a payback period of 20 years.

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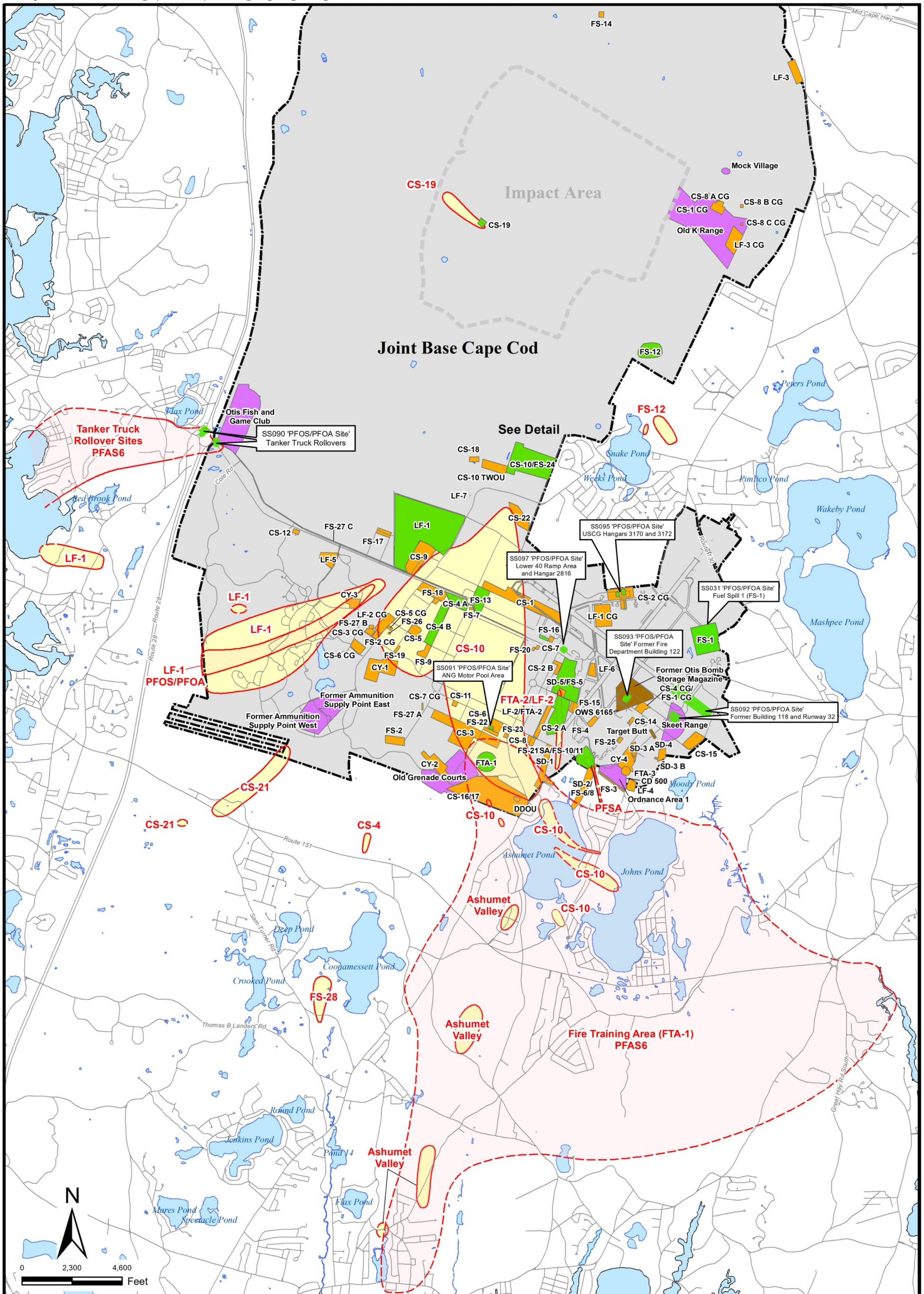


Legend

- Draft IRP PFAS6 Groundwater Plume
- IRP Groundwater Plume
- IRP Source Area - Active
- IRP Source Area - Closed
- MMRP Site - Active
- MMRP Site - Closed
- Joint Base Cape Cod Boundary
- Plume Boundary (Dashed Where Inferred)
- Impact Area

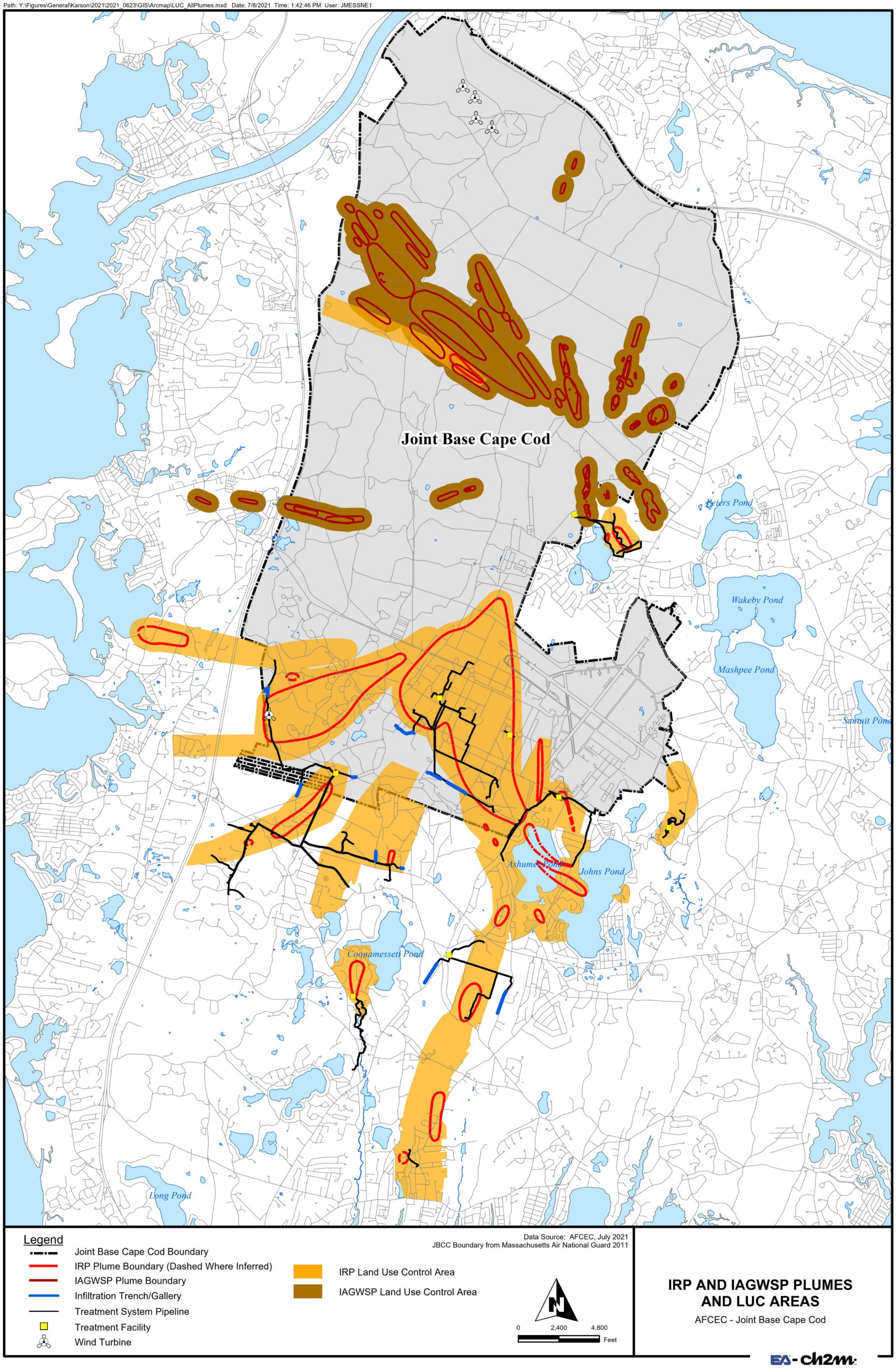
Note: PFAS6 = Sum of PFOS, PFOA, PFHxS, PFNA, PFHpA, and PFDA

Data Source: AFCEC, June 2021
JBCC Boundary from Massachusetts Air National Guard 2011

IRP AND MMRP SOURCE AREA SITES AND IRP GROUNDWATER PLUMES

AFCEC - Joint Base Cape Cod

EA-ch2m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Joint Base Cape Cod
Peters Pond
Wakeby Pond
Mashpee Pond
Santuit Pond
Ashumet Pond
Johns Pond
Coonamessett Pond
Long Pond
Legend
Joint Base Cape Cod Boundary
IRP Plume Boundary (Dashed Where Inferred)
IAGWSP Plume Boundary
Infiltration Trench/Gallery
Treatment System Pipeline
Treatment Facility
Wind Turbine
IRP Land Use Control Area
IAGWSP Land Use Control Area
Data Source: AFCEC, July 2021
JBCC Boundary from Massachusetts Air National Guard 2011
0
2,400
4,800
Feet
IRP AND IAGWSP PLUMES
AND LUC AREAS
AFCEC - Joint Base Cape Cod
EA-ch2m

For More Information

Visit our webpage to view plume maps, program summaries, community involvement plan, and various fact sheets on contaminants, recreational use of area waterbodies, and more.

https://www.massnationalguard.org/JBCC/afcec.html

To access all of the documents used in the decision making process for the Air Force cleanup program at JBCC visit our online administrative record. It is available at the webpage link above and directly at:

https://ar.afcec-cloud.af.mil/

A fact sheet explaining how to access the administrative record/webpage can be found at the webpage link above and directly at:

https://www.massnationalguard.org/JBCC/afcec-documents/how-to-updated.pdf

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https://www.massnationalguard.org/ERC/index.htm

Cover photos L to R:

- **A private well is sampled in a neighborhood.**
- **A direct push rig being used to install metal rods to sample groundwater.**
- **Soil is prepared for shipping to the lab after collection from a source area.**
- **Aerial of Ashumet and Johns Ponds in Falmouth and Mashpee.**
- **Turbine hub assembly - Look closely for aircraft contrails in the sky . There are also two ropes hanging from the top of the turbine that were used for workers to rappel in order to inspect the blades. See related photo on Page 44.**

Restoring our sole-source aquifer for future generations

AIR FORCE CIVIL ENGINEER CENTER