DRAFT FOR PUBLIC COMMENT
PARTIAL MASSACHUSETTS CONTINGENCY PLAN
PHASE IV REMEDY IMPLEMENTATION PLAN

FORMER VARIAN FACILITY SITE
150 SOHIER ROAD
BEVERLY, MASSACHUSETTS 01915

MassDEP Site # 3-0485

Submitted by:

APTIM

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Acronyms and Abbreviations

1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
µg/L	micrograms per liter
µm	micrometers
APTIM	Aptim Environmental & Infrastructure, LLC
AOC	areas of concern
bgs	below ground surface
BWSC	Bureau of Waste Site Cleanup
CAC	colloidal activated carbon
cis-1,2-DCE	cis-1,2-dichloroethene
CIP	Communications & Power Industries, Inc.
CSA	comprehensive site assessment
COCs	chemicals of concern
CVOC	chlorinated volatile organic compound
DPT	direct push technology
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
ECD	electron capture device
EC	electrical conductivity detector
ft/day	feet per day
GAC	granular activated carbon
HASP	health and safety plan
HDD	horizontal directional drilling
HPT	hydraulic profiling tool
ISB	In situ bioremediation
ISCO	In situ chemical oxidation
ISTR	In situ thermal remediation
MassDEP	Massachusetts Department of Environmental Protection
MCP	Massachusetts Contingency Plan
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIP	membrane-interface probe
MNA	monitored natural attenuation
MPE	multi-phase extraction
OHM	oil and/or hazardous material
O&M	operation and maintenance
OMM	operation, maintenance and/or monitoring
ORP	oxygen-reduction potential
PAZ	permeable adsorptive zone

PCE	tetrachloroethene
PID	photoionization detector
PIP	public involvement plan
pounds	lbs
PRZ	permeable reactive zone
PSL	potential source locations
RAA	remedial action alternative
RAP	remedial action plan
RIP	remedy implementation plan
RCM	Reactive Core Mat®
RTN	release tracking number
SEE	steam enhanced extraction
S-mZVI	sulfidated micro zero valent iron
ft^2	square feet
SWI	steam injection wells
SVE	soil vapor extraction
TCE	trichloroethene
THC	thermal conductive heat
TMP	temperature monitoring points
trans-1,2-DCE	trans-1,2-dichloroethene
TSDF	treatment/storage/disposal facility
TTZ	thermal treatment zone
VC	vinyl chloride
VEW	vapor extraction wells
VOC	volatile organic compound
XS	halogen specific detector
ZVI	zero valent iron

1.0 INTRODUCTION

Aptim Environmental & Infrastructure, LLC (APTIM) has prepared this Phase IV Implementation of the Selected Remedial Alternative Report (Remedy Implementation Plan [RIP]) for the Massachusetts Department of Environmental Protection (MassDEP) in accordance with the Massachusetts Contingency Plan (MCP; Section 310 CMR 40.0870) for the Former Varian Facility located at 150 Sohier Road, in Beverly, MA (Site). Within this report, the “Site” is used in accordance with the MCP, being any place or area where OHM from Varian’s former facility have come to be located. The “facility” refers to Varian’s former facility property. The Site location is shown on **Figure 1-1**. Due to historical operations and releases of oil and/or hazardous material (OHM) that occurred, the Former Varian Facility is listed as a Disposal Site under the MCP and was assigned Release Tracking Number (RTN) 3-0485.

The purpose of the Phase IV is to present plans for the implementation of the selected remedial alternatives for the Building 3 Area and two downgradient locations, one along the groundwater flow pathway at Tozer Road and the second at two identified groundwater seep at Stream A. Additional investigation is necessary to finalize the implementation of the Building 5 overburden, bedrock, and PSL10 RAAs. Therefore, this Phase IV only addresses the Building 3 overburden and the two components of the downgradient plume (Tozer Road and Stream A Seep Area).

As required by the MCP, this Phase IV RIP is being submitted electronically to the MassDEP concurrently with a completed Comprehensive Response Action Transmittal Form (BWSC-108). A copy of the BWSC-108 form is provided as **Appendix A**. The Site is an active Public Involvement Plan (PIP) site under the MCP. Therefore, a copy of this report will also be sent to the Information Repositories established for the Former Varian Facility Site and to the Town of Beverly. In addition, this report will be presented at a public meeting and will undergo a 20-day public comment period.

1.1 Disposal Site Name, Location, and Locus Map

Varian’s former facility was located at 150 Sohier Road in Beverly, Essex County, Massachusetts. The property at 150 Sohier Road has the Universal Transverse Mercator coordinates of North 4,715,075 meters and East 345,475 meters, Longitude 70° 52’ 57” West: Latitude 42° 34’ 28” North. **Figure 1-2**, the Former Varian Facility Site Map identifies the location of 150 Sohier Road and the surrounding area.

The facility is located on approximately 24 acres of land and contains four large complexes of buildings covering approximately 250,000 square feet. The facility’s southern portion includes an open field and a paved parking area. The central portion of the Site includes a building complex (Buildings 5, 5A, 8, and 10) (referred to as the Building 5 complex). North of the Building 5 complex is a paved parking area and to the northwest is another building complex (Buildings 1, 2, 3, 4, and 6) (referred to as the Building 3 complex). Northeast of the Building 3 complex is a wastewater treatment plant in Building 9. West of the Building 3 complex is former Building 7, which is now operated as Kelly Classics and Restoration.

Presently, Communications & Power Industries, Inc. (CPI) maintains the use of Buildings 1 through 6, 8, 9, and 10 and other structures at the 150 Sohier Road property.

1.2 Regulatory Reporting

On October 21, 2022, a revised Phase II Comprehensive Site Assessment (CSA) was submitted by Varian. The October 2022 Phase II CSA comprehensively assesses current site conditions, including nature and extent of chlorinated volatile organic compounds (CVOCs), which were determined to be the primary compounds released at the Site, and provided an updated evaluation of risk based on these current site conditions.

On December 7, 2022, a Phase III Remedial Action Plan (RAP) addendum was submitted to MassDEP. That document completed a 20-day public comment period that ended on February 14, 2023. Based on the comments received, a Revised Phase III RAP was submitted to MassDEP on March 17, 2023. The Revised Phase III RAP included the following selected remedial action alternative (RAA):

Selected Remedial Action Alternative
Building 3 Overburden – In situ thermal remediation (ISTR), In situ bioremediation (ISB) Polish & Continued soil vapor extraction (SVE) system Operation *Building 5 Overburden – ISB & Continued SVE System Operation* *Bedrock – In situ chemical oxidation (ISCO)* *PSL10 Area – Colloidal Activated Carbon Permeable Adsorptive Zone (CAC PAZ) or ISCO* *Downgradient Plume – Sulfidated Micro Zero Valent Iron Permeable Reactive Zone (S-mZVI PRZ) for Tozer Road and Granular Activated Carbon Reactive Core Mat (GAC RCM) for the Seep Areas*

1.3 Statement of Purpose

Per the MCP (310 CMR 40.0872), the purpose of the RIP is to:

1. ensure that the information, plans, and reports related to the design, construction, and implementation of the selected remedial alternative are sufficiently developed and documented to support the implementation of the Comprehensive Remedial Alternative;

2. ensure that following initial implementation, the Comprehensive Remedial Alternative meets design and performance specifications; and,

3. meet the Response Action Performance Standard for the design, construction, and implementation of the Comprehensive Remedial Action, as described in 310 CMR 40.0191

1.4 Report Organization

The report has been developed in accordance with Section 310 CMR 40.0874(3) of the MCP to present the design, construction, and monitoring associated with the implementation of selected RAA. The report is organized as follows:

310 CMR 40.0874 (3)	Description of Section	Building 3 Thermal	Tozer Road PAZ/PRZ	Stream A Seep RCM
(a)	Relevant Project Contacts	Section 2.0		
(b)(1)	Remedial Action Goals	Section 3.2	Section 4.2	Section 5.2
(b)(2)	Significant Changes/New Information	None	None	Section 5.3
(b)(3)	Disposal Site Maps	Section 3.1	Section 4.1	Section 5.1
(b)(4)	Environmental Media/Materials to be Treated or Otherwise Managed	Section 3.1	Section 4.1	Section 5.1
(b)(5)	Conceptual Plan of Remedial Activities	Section 3.3	Section 4.3	Section 5.4
(b)(6)	Design & Operation Parameters	Section 3.4	Section 4.5	Section 5.5
(b)(7)	Spill, Accidental Discharge or System Malfunction Control	Section 3.5	Section 4.6	Section 5.6
(b)(8)	Waste Material Management-Disposal Methods	Section 3.6	Section 4.7	Section 5.7
(b)(9)	Site-Specific Characteristics	Section 3.7	Section 4.4	Section 5.8
(b)(10)	Adverse Impact Mitigation	Section 3.8	Section 4.8	Section 5.9
(b)(11)	RAA Inspections-Monitoring	Section 3.9.1	Section 4.9	Section 5.10
(c)(1)	Construction Plans-Specifications	Section 6.1 Figures 3-2 to 3-8	Section 6.2 Figures 4-1 and 4-2	Section 6.3 Appendix B
(c)(2)	Schedule	Section 3.12	Section 4.12	Section 5.13
(d)	Operation, Maintenance and/or Monitoring (OMM) Plan	Section 3.9.2	Section 4.9	Section 5.10
(e)	Health & Safety Plan	Section 8.0		
(f)	Permits, Licenses & Approvals	Section 3.10	Section 4.10	Section 5.11
(g)	Property Access Issues	Section 3.11	Section 4.11	Section 5.12
NA	Public Involvement	Section 9.0		

2.0 PROJECT CONTACTS

Per 310 CMR 40.0874 (3)(a), the RIP must include a list of contacts, including the responsible party (RP), the licensed site professional (LSP), and the party who will own, operate and/or maintain the selected RAA during and following construction.

2.1 Responsible Party

Matthew Gillis
Environmental Affairs Program Manager
Varian Medical Systems, Inc.
525 9th St NW
Washington, DC, 20004-2178
Phone: 410-459-1710

2.2 Licensed Site Professional

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2.3 Owner/Operator of the Selected RAA

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3.0 BUILDING 3 IN SITU THERMAL REMEDIATION

This section addresses the design, construction, and implementation of in situ thermal remediation (ISTR) at Building 3.

3.1 Nature & Extent of Contamination (310 CMR 40.0874 [3][b][4])

The treatment zone associated with Building 3 is shown in **Figure 3-1**. It is approximately 13,000 square feet (ft^2) and up to 45 ft deep. A mass estimate of 6,500 pounds (lbs) of total chloroethenes (5,500 lbs adsorbed[1] and 1,000 lbs dissolved[2]) was presented in the Phase III Report (APTIM, 2022). This estimate was based on a soil concentration of 100 milligrams per kilogram (mg/kg) and groundwater concentration of 100 milligrams per liter (mg/L).

3.2 Remedial Goals (310 CMR 40.0874 [3][b][1])

The general remedial objectives for the site are: (1) source elimination/control; (2) migration control; (3) dense nonaqueous phase liquid (DNAPL) removal; and (4) groundwater concentration reduction. Regarding these objectives for the Building 3 Area, it is noted:

1. **Source Elimination/Control** – The Building 3 Area ISTR will eliminate/reduce sources of contamination (see #3).
2. **Migration Control** – The Building 3 Area ISTR will control the migration of dissolved phase CVOC by focusing treatment on the reduction of the residual contaminant sources that remain in site soil. This also includes control of potential vapor migration into facility buildings.
3. **DNAPL** – The Building 3 Area ISTR will reduce levels of CVOCs in the source areas to a concentration that reduces the potential for DNAPL to act as a continuing source of CVOC migration to groundwater.
4. **Groundwater** – The Building 3 Area ISTR will reduce CVOC concentrations in groundwater. However, the goal is not to achieve background conditions, but to reduce the levels of CVOCs such that DNAPL is not a continuing source of CVOCs to groundwater (see #3).

Per 310 CMR 40.0874(3)(b)(1), the RIP must document the goals of the remedial action, including performance requirements of the remedial systems, the requirements for achieving a Permanent or Temporary Solution (whichever is applicable) under 310 CMR 40.1000 and the projected timeframe, based on available information, for achieving such Permanent or Temporary Solution.

3.2.1 Performance Standards for Building 3 ISTR

The following performance standards would apply to the ISTR:

1. Existing site operations must be maintained and interruptions minimized during remedy implementation.

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[1] 13,000 ft2 soil * 45 ft soil * 1 m3 soil/35.3147 ft3 soil * 1,500 kg soil /m3 soil = 24,848,000 kg soil * 100 mg CE/kg soil * 1 lb CE/453,592 mg CE= 5,478 lbs (say 5,500 lbs)

[2] 13,000 ft2 soil * 45 ft soil x 0.28 ft3 water/ft3 soil * 28.3168 L water/ft3 water = 4,638,000 L * 100 mg CE/L water * 1 lb CE/453,592 mg CE = 1,020 lbs (say 1,000 lbs)

2. Subsurface temperatures must be maintained for the effective removal of contaminants.
3. Vapor control must be maintained.
4. Mass recovery rate evaluations must indicate that contaminants are removed effectively from the Site. The ISTR system operation will be terminated when there are diminishing returns in mass recovery.

The ISTR system will target the remaining residual DNAPL, beneath Building 3. Given that there remains some uncertainty in the subsurface contaminant distribution beneath the building, the ISTR system operation and performance will be based on a diminishing returns strategy. Industry experience has demonstrated that extending system operation beyond the point where CVOC recovery rates reach asymptotic conditions provides little benefit to improving overall treatment system performance. This is a point when the rate of mass recovery verses time has essentially reach zero. The use of the diminishing returns strategy is common and well documented to gauge ISTR system operation. It also is aptly suited for sites with uncertainties regarding the contamination mass or which exhibit a high degree of spatial variability. Both characteristics are present within the Building 3 Source Area. The diminishing returns concept utilizes multiple lines of evidence to demonstrate that the practical (and technical) capacity of a treatment system to remove CVOCs from contaminated media has been reached. Therefore, the mass recovery rate as a function of time will serve as the primary line of evidence in determining when to terminate active treatment of the DNAPL source area.

The introduction of thermal energy to the subsurface is also a critical component in demonstrating that diminishing returns have been reached. Since DNAPL volatility (and recoverability) is strongly influenced by temperature, increasing in situ temperature will also increase the mass recovery rate for CVOCs within the treatment area. In the absence of an ongoing contaminant source, the CVOC recovery rate is governed by the mass present, the temperature achieved within the treatment zone, and the time that elevated temperature is maintained. Temporal measurement of subsurface temperature, concurrent with mass removal, will provide the basis by which diminishing returns are demonstrated for ISTR system operation. Diminishing returns for system operation would be documented through detailed operational measurements and observations, including, but not limited to, contaminant recovery rate, subsurface temperature, and other parameters such as energy input/extraction profiles, mass balance, subsurface pressure, and treatment time.

These are well-documented strategies to determine the point for diminishing returns of continued ISTR system operation that allow project stakeholders the required flexibility to determine the optimal shutdown point while simultaneously balancing the disruption of the remedial action to the facility owner's operations and attainment of remedial goals in the Building 3 source area. By assessing ISTR system performance through direct observation of CVOC recovery, subsurface temperature and time, complementary lines of evidence will be generated to define and document when [?] the input of additional thermal energy or extended system operation will no longer yield a significant reduction in CVOC mass in soil and groundwater following shutdown. Once it is determined from performance monitoring that: (1) treatment of the source area using ISTR has reached an asymptotic rate of CVOC recovery, (2) that additional input of subsurface energy will not increase CVOC mass removal rate, and

(3) that extended operation of the ISTR system can offer no further demonstrable reduction in source area contaminant mass, the decision to shut down operation of the ISTR system would be made.

3.2.2 Requirements for Achieving a Permanent/Temporary Solution

Per the Phase III RAP, the treatment goal for Building 3 Overburden is to reduce levels in the source areas to a concentration that eliminates/controls the potential for DNAPL to act as a continuing source of CVOC migration in groundwater. To that end, a reduction of concentrations in groundwater to 50% of the 1% solubility limit is proposed. The solubility limit for trichloroethene (TCE) is 1,100 mg/L; 1% is 11 mg/L. Therefore, the treatment goal for TCE would be 5 mg/L in groundwater. As discussed below, further treatment of CVOC concentrations in groundwater is planned using bioremediation after the thermal treatment. The TCE concentrations in groundwater are expected to be reduced below 5 mg/L in most areas by thermal treatment and further reduced by bioremediation.

An estimated mass reduction was calculated as part of the Phase III RAP. Using the post-treatment TCE groundwater concentration goal of 5 mg/L, the total contaminant mass must be reduced to approximately 200 lbs, which means an overall 97% reduction is required.

3.2.3 Timeframe to Achieve Permanent/Temporary Solution

The alternative is expected to achieve a Temporary Solution by February 18, 2024, as required by the MassDEP. The selected alternative is likely to achieve a Permanent Solution at Building 3.

3.3 Conceptual Plan (310 CMR 40.0874 [3][b]5])

The proposed remedial alternative for the Building 3 Area is ISTR. As previously detailed, the ISTR system installed to address the Building 3 source area would be operated until diminishing returns, as defined in section 3.2.1, are demonstrated. ISTR will be followed by ISB to address the remaining contamination within the Building 3 source area. ISB has been included as part of the proposed alternative as its efficacy has been demonstrated elsewhere on the facility and to take advantage of the elevated subsurface temperatures following ISTR, which will promote CVOC degradation processes. Per the Phase III RAP, it is assumed that primary treatment (i.e., ISTR) will result in 90% CVOC mass reduction. ISB and natural attenuation will be used to reach 97% mass reduction, which is required to achieve a Permanent Solution.

The design approach for Building 3 Source Area treatment assumes a combination of electrically powered thermal conduction heating (TCH) with supplemental steam-enhanced extraction (SEE). The target treatment zone (TTZ) is under the northeast portion of Building 3 and extends to areas outside the building to the north and east (**Figure 3-1**). The TTZ is approximately 13,000 square feet and extends below the area to impact, to an approximate depth of 55 feet deep. The top of the TZZ is defined as 15 feet below ground surface (bgs) inside the building and 5 feet bgs outside the building. The bottom of the TZZ ranges from 30 to 55 feet bgs. Approximately 92 heater wells are proposed, along with collocated vapor extraction wells (VEW), multi-phase extraction (MPE) wells, and temperature monitoring points (TMP). See **Figure 3-2**. All well locations are approximate and will be adjusted based on utilities and building features such as support columns and foundation footings. Liquid and vapor phase GAC will be used to treat contaminants extracted in subsurface vapor and groundwater. The current SVE system will be amended as needed to supplement ISTR extraction systems and to support the mitigation of potential indoor air intrusion risk.

The components of the ISTR system are:

- Vertical and angled TCH borings to heat the subsurface in the TTZ
- As determined necessary by subsurface heating trends, steam injection wells (SIWs) to provide additional subsurface heating in areas where expected groundwater flow rates exceeding 1 foot per day (ft/day)
- TMPs to monitor subsurface temperature at multiple locations and depths
- Pressure monitoring points to measure subsurface pressure and demonstrate pneumatic containment of the TTZ
- VEWs and MPE wells to remove vapors and liquids containing CVOCs from the subsurface and to maintain pneumatic and hydraulic control
- Effluent treatment equipment
- Operation of the existing SVE system to augment extraction capabilities of supplied ISTR equipment.

Preliminary details on the ISTR components are provided below. Detailed planning and design efforts for the ISTR system remain ongoing; the final system configuration and components are therefore subject to change as the detailed ISTR design process is performed. Design and monitoring activities for secondary treatment components, ISB and natural attenuation, will be reassessed based on monitoring after the completion of thermal treatment. Therefore, ISB and natural attenuation details will be provided in a future deliverable.

A schematic of the ISTR system is provided below in **Figure 3-3**.

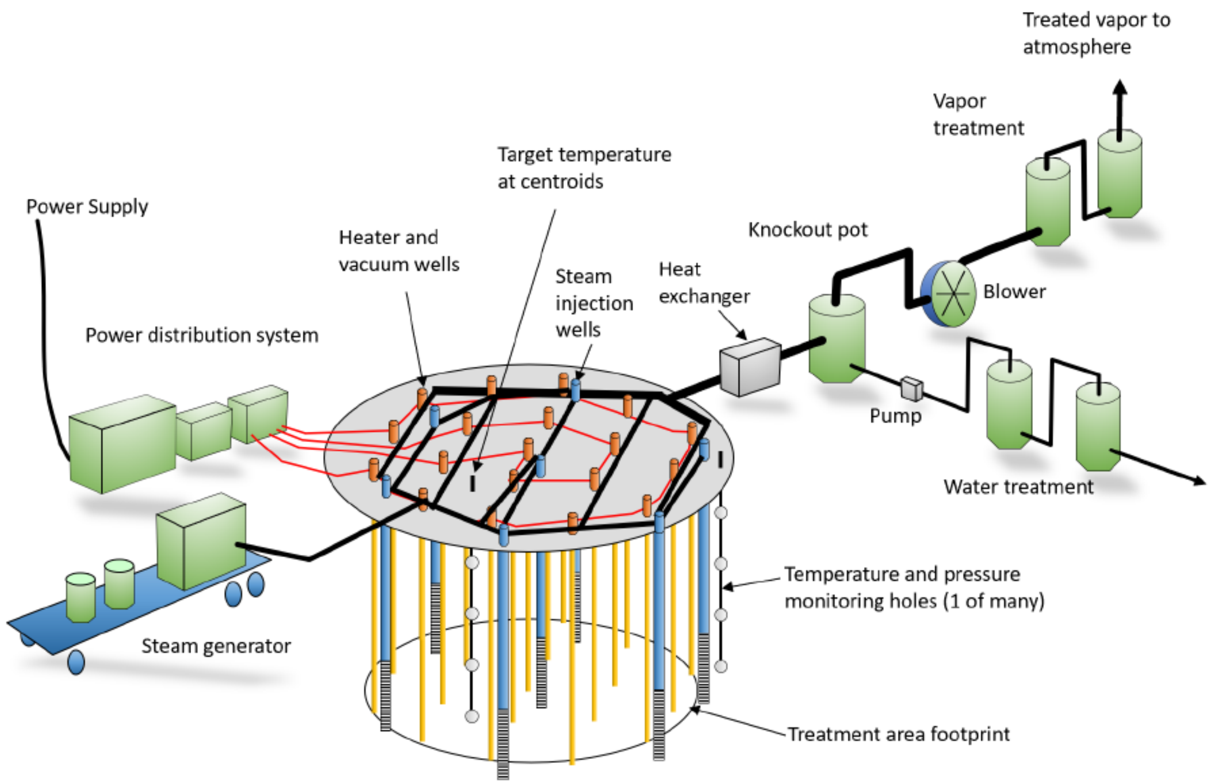


Figure 3-3: Schematic of Combined TCH and SEE Approach

3.4 Design and Operation Parameters (310 CMR 40.0874 [3][b][6])

The components of the ISTR system are outlined above. Details on the ISTR components are provided below. However, there will be additional design work in the future and details may change with the final design.

3.4.1 Vertical and Angled TCH borings:

Vertical and angled TCH heater borings will be installed to achieve a subsurface temperature of approximately 100 °C. **Figures 3-4** and **3-5** illustrate typical heater well configuration. It is estimated that 92 heater borings will be installed. Vertical heater wells will be installed to reach areas of the TTZ outside of buildings. Vertical and angled heater wells will be installed to reach areas of the TTZ below occupied buildings (approximately 75% of the TTZ is below Building 3). Rotosonic and horizontal directional drilling (HDD) will be used to install borings (see Section 3.73 for additional discussion on HDD).

Heater wells will be spaced approximately 16 to 17 feet apart in the interior and 13 to 14 feet apart in the exterior. A conceptual layout of the treatment area is provided in **Figure 3-2**. Heater borings will be installed from the top of the TTZ (five feet below grade) to the bottom of the TTZ to ensure complete treatment. Angled heaters will be installed in fans at estimated angles ranging from 16 to 75 degrees from the vertical. They will be constructed with features to prevent shallow and overlapping portions of the TTZ from overheating. Heaters will be constructed and operated to limit energy input into the volume above the TTZ.

3.4.2 Steam Injection Wells

SIWs may be used for contingency heating to supplement electrical-based heating methods (**Figures 3-4** and **3-5)**. Where groundwater velocity is expected to exceed the upper limit for effectively heating soil using TCH (>1 ft/day), SIWs may be collocated with heater wells to increase subsurface temperatures. Based on aquifer testing, it is anticipated that SIWs will be installed in saturated zones in the shallow overburden with medium to coarse sands.

3.4.3 Vapor Extraction Wells

VEWs will be collocated with some heater wells (**Figures 3-4** and **3-5**). VEWs will be installed in the vadose zone above the top of the TTZ to capture vapors. VEWs will be screened in the heated zone 5 feet above the water table under the building and within the heated vadose zone outside the building. Negative pressure will be maintained at the wellheads and within the subsurface to prevent fugitive emissions. All vapor collection and conveyance piping will be operated under a net negative pressure.

3.4.4 Multi-Phase Extraction Wells

MPE wells will be installed throughout the TTZ to provide hydraulic and pneumatic control (**Figures 3-6** and **3-7**). The number and location of MPE wells will be adjusted based on the locations of SIWs to ensure mobilized COCs are recovered. The screen will be constructed across the TTZ and into the heated zone above the TTZ. To maintain hydraulic control, the distribution of MPE wells will be greater along the downgradient edge towards the west and southwest of the treatment area. MPE wells may also be installed near the center of the TTZ, depending on the final location of the SIWs. Negative pressure will be maintained at the wellheads to prevent fugitive emissions and all vapor collection piping will be operated under a net negative pressure.

3.4.5 Temperature Monitoring Points

TMPs will be instrumented with thermocouples approximately every five feet in the vertical interval from the surface to the bottom of the TTZ to monitor subsurface temperatures (**Figures 3-6** and **3-7**).

3.4.6 Effluent Treatment System

GAC treatment systems will be used to remove CVOCs from the extracted vapor and groundwater. Vapor and groundwater extracted through VEWs and MPE wells will be directed to the treatment system. Vapor and liquid (groundwater and liquid separated from the extracted vapor) will be treated in separate treatment streams. Vapor GAC vessels will be installed in series to optimize mass loading and thereby minimize the waste generated and cost associated with vapor GAC change-outs and disposal/regeneration. In addition, to minimize vapor GAC usage, the vapors will be cooled, the steam condensed, and the non-condensable vapors will be dried prior to treatment. Pumped liquids from the wellfield will be cooled through a liquid heat exchanger, routed to a gravity separator capable of removing DNAPL, and then treated using liquid phase GAC. Effluent vapors and liquid will be discharged. Liquid and vapor samples will be routinely collected from various points in the treatment system to ensure the treatment system is working properly. A conceptual process flow diagram of the effluent treatment system in shown in **Figure 3-**.

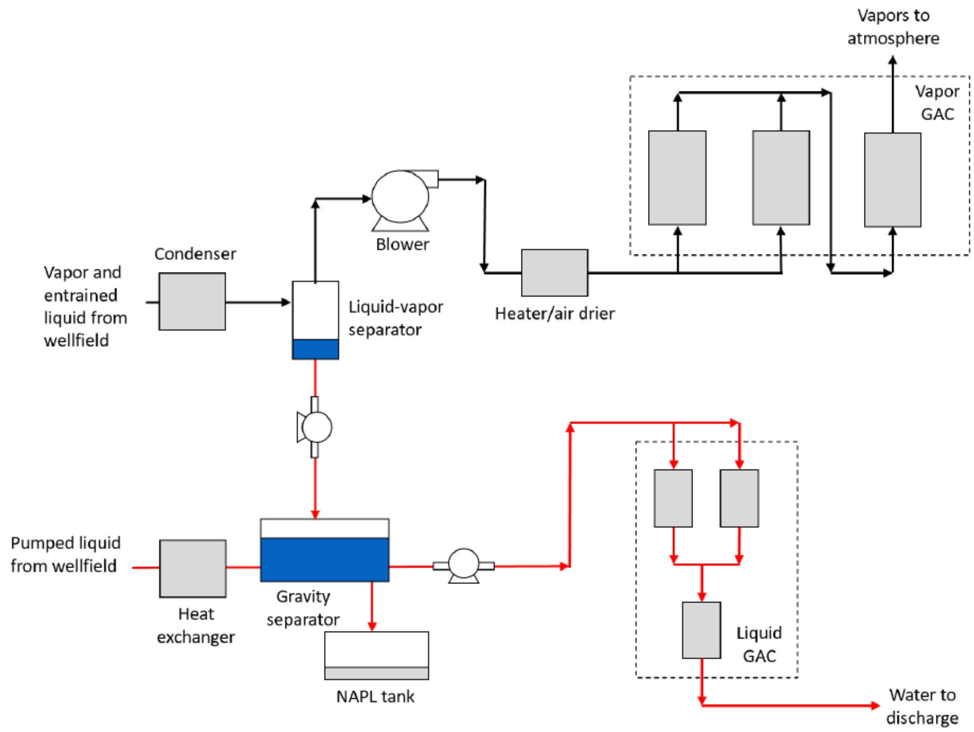


Figure 3-8: Conceptual Process Flow Diagram of the Effluent Treatment System

3.4.7 Subslab SVE System

In addition to the extraction capabilities of the ISTR system, supplemental vapor extraction may be necessary above the TTZ to augment ISTR operations and provide an additional layer of protection to control the migration of shallow soil vapor into the building. The current SVE system on site will be upgraded as needed to recover support ISTR system operation. For example, additional horizontal VEWs may be installed beneath Building 3. The subslab SVE system will remain in operation after ISTR is complete to mitigate potential vapor intrusion risk while the subsurface remains at an elevated temperature. However, it is not expected that the SVE system will remain operating permanently. The system will be deactivated after demonstrating that concentrations of CVOCs remain below MassDEP criterial for four quarterly sampling events.

3.4.8 Other Components

A vapor cover will be installed outside the north side of the building where the top of the TTZ is only 5 feet bgs. The vapor cover will promote heat retention in the shallow soil and prevent the infiltration of surface water in the upper portion of the TTZ, which can affect heating system performance. The vapor cover design has not been finalized but will likely include a layered combination of air-entrained (lightweight) concrete, geotextile liner , rigid insulating foam board and granular porous media (gravel/washed stone). In the absence of surface or property dictated constraints, vapor covers typically extend six to eight ft beyond the limits of the TTZ

3.5 Spill, Accidental Discharge & System Malfunction Controls (310 CMR 40.0874 [3][b][7])

Per 310 CMR 40.0874 (3)(b)(7), the RIP shall include design features for control of oil and hazardous material spills and accidental discharge or system malfunction, including without limitation: containment structures, leak detection devices, run-off controls, pressure valves, bypass systems, or safety cutoffs. A backup generator may be included to maintain vapor control and any essential components in the event of a power failure. Some replacement and easy to replace critical components will be kept on site.

3.6 Waste Material Management-Disposal Methods (310 CMR 40.0874 [3][b][8])

Per 310 CMR 40.0874 (3)(b)(8), the RIP shall include a description of the methods for management or disposal of any treatment residual, contaminated soils, and other waste materials containing oil and/or hazardous material generated as a result of the selected RAA. All waste will be managed in accordance with state and federal regulations. Anticipated waste streams include soil and decontamination water from drilling, GAC, and DNAPL from the effluent treatment system

3.7 Site-Specific Characteristics (310 CMR 40.0874 [3][b][9])

3.7.1 Building Use During Treatment

A portion of the Building 3 Source Area is below an occupied commercial manufacturing operation. Building operations will continue during ISTR construction and treatment. The ISTR system will be designed to minimize the impact to building operations. However, building access and temporary relocation of the components stockroom will be required (see Building Access Requirements section).

3.7.2 Building Access Requirements

The selected remedy requires access to the components stockroom in Building 3 to install vertical and angled heaters that heat the subsurface below the stockroom and other actively used areas within the Building 3 Source Area. The stockroom will be relocated for the duration of ISTR system construction and operations.

3.7.3 Angled Drilling

To access contamination located in the inaccessible areas below Building 3, angled heaters will need to be installed in the stockroom, and angled wells will need to be installed from outside the building from the north below the chemical laboratory and from the east below the machine shop basement. Many of the heater borings will be able to be installed with rotosonic drilling. However, rotosonic drill rigs only allow for well installations at angles from approximately 90 to 21 degrees from horizontal. It is estimated that 3 of the heater wells will need to be installed at angles shallower than 21 degrees, which will require an HDD rig. Additionally, any supplemental horizontal vapor extraction wells that are required to for the SVE system will need to be installed via HDD.

3.7.4 Contaminant Migration During Heating

Mobilization of CVOCs in the TTZ will be controlled with both hydraulic and pneumatic capture in the vadose zone via VEWs and groundwater capture in the saturated zone via MPE wells. The potential for transient increase in the groundwater concentration of dissolved CVOCs during heating operations is recognized. There is limited potential that CVOCs may migrate downgradient of the Building 3 Source Area during treatment. However, this will be addressed by a downgradient reactive barrier installed along Tozer Road. The barrier is intended to provide a long-term remediation solution for CVOCs dissolved in groundwater during and after completion of the ISTR remedy beneath building 3. It will be installed prior to commencement of the thermal remediation.

3.8 Deleterious Impact Mitigation (310 CMR 40.0874 [3][b][10])

Environmental impact mitigation measures are precautions incorporated into the design, construction and operation of the remedial action alternative to avoid deleterious impacts on environmental receptors and natural resource areas.

Hay bales and additional silt runoff containment measures will be used during drilling operations to contain potential soil erosion in sensitive areas, if rain events are anticipated.

Other than increased temperature, it is not anticipated that site soils outside the TTZ will be impacted. Mobilization of CVOCs downgradient of the Building 3 source area will be controlled with the remedial alternative for the downgradient plume along Tozer Road.

3.9 Inspections-Monitoring

3.9.1 Monitoring Parameters (310 CMR 40.0874 [3][b][11])

3.9.1.1 Groundwater Elevation Measurements

Groundwater gauging will be performed on selected on and off-site monitoring wells on at least a semi-annual schedule. The water level in select monitoring wells will be measured prior to the activation of the ISTR system and during the start-up and treatment periods to evaluate the influence of the ISTR system.

3.9.1.2 Subsurface Temperature Measurements

Subsurface temperature will be measured with in situ thermocouples installed in TMPs throughout the TTZ. Groundwater and soil temperatures will be measured prior to the activation of the ISTR system and during the start-up and treatment periods to assess ISTR system performance and to ensure the ISTR system is working properly and appropriate subsurface temperatures are maintained to promote CVOC removal.

3.9.1.3 System Energy Monitoring and Water Usage

The energy consumption of the ISTR system will be measured to assess system effectiveness, operating cost, and contribution to greenhouse gas emissions. Steam injection may be introduced to supplement electrical-based heating if the system is not performing effectively. If steam injection is used, the equivalent water volume injected will also be tracked and monitored alongside steam injection rates and pressure. These measurements will be used with subsurface temperature to construct subsurface material and energy balances used to assess overall ISTR system performance. These results will also guide the selection of operating conditions that yield the highest efficiency for installed heating and extraction equipment.

3.9.1.4 Groundwater and Vapor Extraction Monitoring

The well head pressure will be monitored at extraction wells to ensure negative pressure is maintained, where possible, throughout the TTZ. The flow rates of liquid and vapor extraction will be measured from MPE wells and VEWs. Measurements will be made throughout the start-up and during treatment to calculate the mass of CVOCs removed from the TTZ.

3.9.1.5 Effluent Treatment Systems Sampling and Analysis

Daily photoionization detector (PID) screening will be conducted at various points along the vapor treatment system. Results will be used to estimate mass removal and system effectiveness.

Vapor samples will be collected periodically from the vapor treatment system GAC unit's influent, midpoint, and effluent. Groundwater samples will be collected from the liquid treatment system GAC unit's influent, midpoint, and effluent. Samples will be submitted to an independent Massachusetts-certified laboratory and analyzed for the presence of CVOCs. Results will be used to ensure emissions from the ISTR system meet permit requirements, to determine when GAC units need to be replaced, and to calculate the mass of CVOCs removed from the TTZ.

The results of the sample and analysis will be used to assess the effectiveness of the ISTR system. As the effectiveness declines (i.e., rate of CVOC mass removal decreases), the benefits and cost of continued operation will be assessed and progression to secondary treatment (ISB injections and natural attenuation) will be considered.

3.9.2 Operation, Maintenance & Monitoring Plan (310 CMR 40.0874 [3][d])

In cases where the selected RAA requires operation, maintenance and/or monitoring activities to ensure the effective performance and integrity of the RAA and/or the achievement of remedial goals, an Operation, Maintenance and/or Monitoring (OMM) plan shall be developed.

3.9.2.1 Person Conducting Operation and Maintenance

Operation and maintenance of the ISTR and SVE systems will be conducted by a subcontractor. The subcontractor will provide treatment plant operators, maintenance personnel, and engineering support as necessary during the operation of the ISTR system.

3.9.2.2 Operation and Maintenance Procedures

The ISTR system installed and supplied by the subcontractor will be operated and maintained until diminishing returns are demonstrated. A comprehensive operations and maintenance plan will be developed for the specific equipment supplied to the project site by the subcontractor. The plan will define all inspection and maintenance procedures necessary for the proper operation of the ISTR system.

3.9.2.3 Equipment Maintenance

Maintenance of the remediation equipment will be performed with each inspection in conjunction with the monitoring program. Carbon consumption will be monitored by reviewing laboratory analytical data; the carbon will be replaced as required. The vapor extraction system blower will be inspected and maintained to ensure safe and proper operation. Level switches at the liquid-vapor and gravity separators and all tanks will be inspected and cleaned, as necessary. System pumps will be inspected and cleaned, as required. In-line filters upstream of liquid carbon treatment vessels will be inspected, cleaned, and replaced as necessary. Filters and desiccant on the compressed supply air to the pneumatic pumps will be inspected, cleaned, and replaced as necessary. The steam boiler will be inspected and maintained as recommended by the manufacturer.

3.9.2.4 Emergency Procedures and Shutdown

The thermal treatment system will be equipped with a microprocessor-based control system, which will constantly monitor the system for malfunctions. The system will be programmed to shut down any critical component, subsystem, or the entire system in the event of an alarm condition (depending on the severity of the alarm). All alarm conditions will trigger both local and remote alarms. As an added safety, alarms that are considered critical to preventing a release of process fluids, including untreated groundwater from the system, will incorporate redundant sensors.

3.9.2.5 Monitoring and Inspection

Following the system start-up period, operation, and maintenance of the ISTR system will occur in accordance with a comprehensive monitoring plan established for the project. Operations and monitoring plan details for the system are under development and will emerge in parallel with the final design. The fundamental components of the monitoring plan for the ISTR system are described below:

1. Continuous Monitoring
    a. Vapor and liquid flow rates, temperature, level and pressure parameters critical to system and equipment operating conditions will be measured electronically, logged and recorded in the project database.
    b. Subsurface temperature will be measured electronically, logged and recorded in the project database.
    c. Steam injection pressure and flow rate will be measured for all steam injection wells.
    d. ISTR system energy requirements and water usage.
2. Daily Monitoring
    a. Visual inspection of all installed equipment for signs of damage or operational deviation
    b. PID screening at various points in the vapor treatment system.
    c. PID screening within the operational areas
3. Weekly Monitoring
    a. Selected monitoring wells within the thermal remediation area will be gauged for depth to water.
    b. Maintenance of the treatment equipment will be performed in conjunction with the monitoring program. Carbon consumption will be monitored by review of screening results and the vapor and groundwater laboratory analytical data, and carbon will be replaced as required. Other maintenance activities, as described in this section, will be performed as required.
    c. As necessary, samples of extracted fluids (liquids, vapors, or solids) may be collected for laboratory analysis and quantification.

   d. Once the subsurface has begun heating, perimeter air monitoring will be conducted with a PID. As required by the final operations and monitoring plan, laboratory samples of ambient air within and beyond the TTZ perimeter will also be collected.
4. Monthly Monitoring
   a. Extracted vapor from the influent, midpoint, and effluent of the vapor GAC system will be collected and analyzed for CVOCs using a third-party off-site laboratory.
   b. Extracted groundwater from the influent, midpoint, and effluent of the liquid GAC system will be collected and analyzed for CVOCs using a third-party off-site laboratory.
   c. Vacuum will be measured at select wells within the thermal remediation area to document pneumatic capture within the TTZ.
   d. Individual MPE wells will be screened using a PID to assess the relative magnitude of CVOCs present in extracted vapor and the representative spatial distribution of contaminants across the TTZ.
   e. Waste disposal areas associated with ISTR system implementation or operation will be inspected for compliance with established standards.
5. ISTR Quarterly/Semiannual/Annual Monitoring
   a. Groundwater sampling of select on-site wells may be conducted quarterly and/or semiannually. Site-wide wells and surface water points will be sampled semi-annually. Groundwater samples will be analyzed for CVOCs.

3.9.2.6 Inspection and Monitoring Reports

The results of the system operation, maintenance, and monitoring program will be reported to the MassDEP semi-annually from the date of system activation, per 310 CMR 40.0874(3)(d)(3). The reporting will be performed as part of the Phase V activities as described in 310 CMR 40.0892. The Inspection and Monitoring Reports will include, at a minimum, the following information:

- Description of the type and frequency of inspections and monitoring activities conducted.
- Description of significant modifications of inspections and/or monitoring program made since the submission of the previous report.
- Description of conditions or problems noted during the reporting period that may affect the remedial system's operation and measures to correct the condition.
- Results of sampling analyses and screening.
- Name, license, signature, and seal of the LSP

The Inspection and Monitoring Report will be review and approved by the LSP of record. The report will be transmitted to the DEP with the appropriate transmittal form.

3.9.2.7 Shutdown at Completion of System Operation

As summarized in Section 3.2.1, the operational endpoint for the ISTR system will be based on diminishing returns. This assures the project stakeholders the flexibility in achieving the remedial goals for proposed treatment areas while simultaneously balancing technology implementation against the impact to the building owner’s manufacturing operations to determine the optimal shutdown point. Diminishing returns for system operation will be documented through the following observations:

- Subsurface temperature response – In situ thermal monitoring results will confirm that the target temperature was reached and maintained in the TTZ to remove the maximum practicable mass of CVOCs.
- Contaminant mass flow rate – The mass flow rate of CVOCs extracted in soil vapor and groundwater has approached a steady state non-zero value (indicative of an asymptotic recovery rate).
- Cumulative energy balance – The energy input to the treatment areas was sufficient to achieve and maintain target subsurface temperatures throughout the TTZ.
- Overall system performance – The collective monitoring results for vapor concentrations, energy delivered, and subsurface temperature indicate that the input of any additional thermal energy will no longer yield a significant reduction in CVOC mass.

Operation of the ISTR system would be terminated once it is determined from performance monitoring that:

- Treatment of the source area using ISTR has reached an asymptotic rate of CVOC recovery.
- Additional input of subsurface energy will not increase CVOC mass removal rate.
- Extended operation of the ISTR system offers no benefit for increasing the certainty of fulfilling the remedial goals.

3.10 Permits, Licenses and Approvals (310 CMR 40.0874 [3][f])

Anticipated permits include

- Conservation Commission permitting for well installation
- City electrical permitting
- Treated water discharge authorization with the local sewer commission
- Air discharge in accordance with MassDEP policy #WSC 94-150

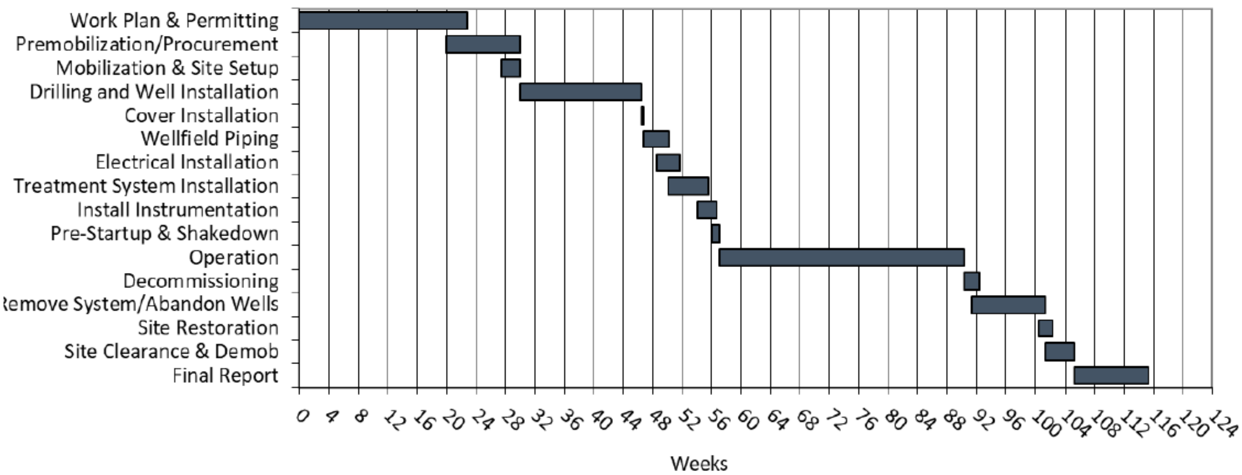
Additional permits and approvals may be required and will be obtained as needed.

3.11 Property Access Issues (310 CMR 40.0874 [3][g])

An access agreement is already in place that will cover the installation, operation, and decommissioning of the planned treatment approach. A portion of the Building 3 Source Area is below an occupied commercial building. Building operations will continue during ISTR construction and treatment. The ISTR system has been designed to minimize the impact to building operations. However, building access and temporary relocation of the stockroom will be required and are being coordinated with the current owner and operator of the facility.

3.12 Design/Construction Schedule (310 CMR 40.0874 [3][c][2])

The anticipated schedule for the Building 3 ISTR:



4.0 TOZER ROAD PERMEABLE ADSORPTIVE/REACTIVE ZONE

This section addresses the design, construction, and implementation of a permeable adsorptive/reactive zone (PAZ/PRZ) in the downgradient plume area along Tozer Road. The purpose of the PAZ/PRZ is to establish a downgradient treatment zone prior to remediation activities beginning in the various on-site source areas. This will provide containment of potential contaminant mobilization caused by the treatment proposed in the source areas at 150 Sohier Road (e.g. thermal treatment in the Building 3 Area). As discussed below, concentrations along Tozer Road are much lower than those in the source areas. Existing data and predesign data to be collected will be used to identify zones within the downgradient aquifer where the most mass flux is moving, and the PAZ/PRZ will be designed to treat groundwater that migrates along that flow path.

4.1 Nature & Extent of Contamination (310 CMR 40.0874 [3][b][4])

The downgradient plume has relatively low levels of groundwater impacts, primarily consisting of PCE, TCE, cis-1,2-DCE, and vinyl chloride. Tozer Road and the properties and wells listed below are illustrated on **Figure 1-2**. Recent (2022) groundwater concentrations in the shallow overburden aquifer (wells screened within the upper 20 feet of the overburden aquifer) ordered from north to south) in this area include:

- 0.020 mg/L tetrachloroethene (PCE), 0.11 mg/L TCE, 0.030 mg/L cis-1,2-dichloroethene (DCE), and non-detect for vinyl chloride (reporting limit of 0.002 mg/L) at GFS-3 near 28 Tozer Road
- 0.009 mg/L PCE, 0.043 mg/L TCE, 0.011 mg/L cis-1,2-DCE, and non-detect for vinyl chloride (reporting limit of 0.002 mg/L) at OB-43-S near 27 Tozer Road.
- 0.037 mg/L PCE, 0.74 mg/L TCE, 0.12 mg/L cis-1,2-DCE, and non-detect for vinyl chloride (reporting limit of 0.020 mg/L) at OB-42-S at 30 Tozer Road
- Non-detect for PCE, TCE, cis-1,2-DCE, and vinyl chloride (reporting limit of 0.002 mg/L) at OB-18-S near 31 Tozer Read
- Non-detect PCE and TCE (reporting limit of 0.002 mg/L), 0.012 mg/L cis-1,2-DCE, and 0.003 mg/L vinyl chloride at GZ-4 near 31 Tozer Road

Recent (2022) groundwater concentrations in the deep overburden aquifer indicate higher concentrations than observed in the downgradient shallow overburden aquifer, but still lower than concentrations within the upgradient source areas, including (ordered from north to south):

- 0.15 mg/L PCE, 0.18 mg/L TCE, 2.3 mg/L cis-1,2-DCE, and 0.11 mg/L vinyl chloride at OB-04-DO near Route 128
- 0.033 mg/L PCE, 0.028 mg/L TCE, 1.9 mg/L cis-1,2-DCE, and 0.055 mg/L vinyl chloride at OB-05-DO, west of 28 Tozer Road
- Non-detect PCE (reporting limit of 0.002 mg/L), 0.004 mg/L TCE, 0.031 mg/L cis-1,2-DCE, and 0.007 mg/L vinyl chloride at OB-18-DO near 31 Tozer Read

- Non-detect PCE and vinyl chloride (reporting limit of 0.002 mg/L), 0.012 mg/L TCE, and 0.008 mg/L cis-1,2-DCE at CL04-DO near 30 Tozer Road.

The PAZ/PRZ is anticipated to extend along Tozer Road from the vicinity of OB04-DO (south of Route 128) to near 30 Tozer Road (between OB-43-S and CL04-DO), a distance of about 1,000 feet. This treatment area is indicated on **Figure 4-1** and in cross-sectional view on **Figure 4-2**. However, the actual length and depth of the PAZ/PRZ will be based on mass flux data that will be collected.

4.2 Remedial Goals (310 CMR 40.0874 [3][b][1])

Per 310 CMR 40.0874(3)(b)(1), the RIP must document the goals of the remedial action, including performance requirements of the remedial systems, the requirements for achieving a Permanent or Temporary Solution (whichever is applicable) under 310 CMR 40.1000 and the projected timeframe, based on available information, for achieving such Permanent or Temporary Solution.

4.2.1 Performance Standards

For the Tozer Road remedy, treatment is not needed to address significant risk. Treatment was selected to provide additional reduction in CVOC mass migrating from the source areas. Reducing the mass flux and mass discharge (see **Section 4.4.2**) of contaminants migrating downgradient of Tozer Road will reduce remedial timeframes for the downgradient plume.

The following performance standards for the Tozer Road remedy have been selected:

- A reduction in COC mass discharge from the upgradient overburden groundwater plume to the area downgradient of Tozer Road (i.e., a decrease in the levels of VOC detected at wells upgradient of the barrier compared to those downgradient)
- Maintain COC concentrations in the downgradient plume below half of GW-3 standards.
- Demonstrate that groundwater plume downgradient of Tozer Road is stable or contracting.

4.2.2 Requirements for Achieving a Permanent/Temporary Solution

No significant risk has already been demonstrated in the downgradient plume area of Tozer Road and no threats of release exist in this area. These components satisfy the requirements for a Temporary Solution.

To achieve a Temporary Solution in the downgradient plume area:

- **Source Elimination/Control:** There is no OHM source material to be controlled or eliminated in this area.
- **Migration Control:** A groundwater treatment barrier will address COCs migrating from 150 Sohier Road and reduce the mass flux of contaminants downgradient of Tozer Road. The reduction in mass flux along Tozer Road should result in a stable or contracting plume and demonstrates migration control.
- **DNAPL:** No DNAPL is present to be eliminated or controlled in this area

4.2.3 Timeframe to Achieve a Permanent/Temporary Solution

MassDEP has set a deadline of February 18, 2024, to achieve a Temporary Solution. Placement of the PAZ/PRZ by this date will provide the treatment necessary to achieve a Temporary Solution in the area downgradient of Tozer Road. Once the various remedies at the site are implemented to achieve a Temporary Solution, an assessment of the timeframe to achieve a Permanent Solution will be evaluated.

4.3 Conceptual Plan (310 CMR 40.0874 [3][b]5])

Remedial activities along Tozer Road will include:

- An investigation to provide additional high-resolution data along Tozer Road. Data from this investigation will refine the design by identifying areas of higher and lower mass flux that will inform the final target treatment zone (TTZ), amendment selection, amendment dosing, volume and spacing for injections, and final barrier layout.
- Installation of new monitoring wells upgradient and downgradient of the treatment zone prior to completing injections. Wells will also be installed within the barrier after injections are completed.
- Baseline groundwater sampling at existing and new monitoring wells will be conducted to provide a baseline for remedy performance.
- Injection of treatment amendments to form a permeable treatment barrier in the Tozer Road right-of way downgradient of 150 Sohier Road. Remediation amendments may include colloidal activated carbon (CAC), sulfidated zero valent iron (ZVI), carbon substrate (such as emulsified vegetable oil [EVO]), or a combination of amendments.
- The barrier will provide treatment by:
    1. sorption of CVOCs to CAC,
    2. abiotic degradation of CVOCs by ZVI, and/or
    3. biotic degradation of CVOCs enhanced by the reducing environment created by the CAC/ZVI and electron donors for microbes capable of degrading the CVOCs.
- Monitoring during injection will be performed to confirm amendment distribution, injection pressures, and minimize daylighting (surfacing).
- Post-remediation monitoring will be conducted at new and existing monitoring wells to assess the performance of the treatment zone.

The goal of the proposed treatment approach is to inject amendments that provide sorption and/or treatment of site COCs to reduce mass flux downgradient of Tozer Road. The proposed barrier is called a permeable barrier because the injected remediation amendments are designed to maintain the permeability of the aquifer materials so that groundwater flow patterns are not affected. Contaminated groundwater in the overburden generally flows westwardly from the 150 Sohier Road facility to Tozer Road. With a permeable adsorptive barrier, groundwater contaminants will interact with, and sorb to the injected CAC (that is, the contaminant will “stick” to the CAC, which itself has sorbed to the aquifer materials); this treatment barrier is termed a Permeable Adsorption Zone (PAZ) and results in COCs being removed from groundwater that passes through the PAZ. A Permeable Reactive Zone (PRZ) incorporates injection of amendments such as ZVI or EVO. In this case, the COCs are degraded either through direct contact with ZVI or microbial degradation. Hereafter, the proposed barrier is termed a PAZ/PRZ. The PAZ/PRZ will focus treatment on those zones where the most mass is migrating.

4.4 Site-Specific Characteristics (310 CMR 40.0874 [3][b][9])

Figure 4-2 provides a cross-section view along Tozer Road from north of Route 128 to south of the crossing of the Unnamed Stream. The most recent CVOC groundwater concentrations for each location are presented in the cross-section. Wells with data older than 2018 have a parenthesis indicating the year and this data may not be reflective of current conditions. However, it does provide a relative indication of the distribution of CVOCs in the area. Lithology ranges from silty sand to sandy gravel and is interpreted as a relatively coarse glacial outwash. Near the bottom of the overburden, some areas have finer-grained silty sands that have been interpreted as a thin layer of glacial till deposited on top of bedrock. The underlying bedrock is primarily granite; however, gabbro may be present along portions of the transect. The overburden aquifer, which is the focus of the remedial actions along Tozer Road, ranges from about 25 to 85 feet thick based on groundwater depths of 5 to 10 feet and bedrock depths ranging from 30 feet at CL04-DO to the south to 90 feet (along the north end of Tozer Road, at CL03-DO) .

4.4.1 Hydraulic Conductivity

Aquifer testing was conducted in October 2000 at a cluster of wells at 28 Tozer Road to evaluate the hydraulic characteristics of the bedrock and overburden aquifers (IT Corporation, 2001). Because of the difficulty involved in using standard methods for evaluating aquifer test data, a groundwater flow model was created and calibrated using the aquifer testing data and non-pumping hydraulic head data. The model had multiple layers (typically 20 feet thick in the overburden) to simulate the aquifer. Within the layers, a grid of generally 50 by 50 ft was used, and hydraulic conductivity values were assigned to each cell. The calibrated hydraulic conductivity values in the overburden aquifer along Tozer Road ranged from 30 ft to 80 ft per day, with most of the overburden aquifer assigned a hydraulic conductivity of 80 ft per day. Using the hydraulic conductivity values assigned to each cell along Tozer Road, a weighted-average hydraulic conductivity value of 70 ft/day was calculated.

4.4.2 Contaminant Mass Flux and Mass Discharge

A key concept guiding the barrier design is focusing treatment on the areas where the most mass is being transported downgradient of Tozer Road, which is a function of both the groundwater concentration (how much CVOC mass is in a volume of water) and the rate at which that mass is being transported (by groundwater flow). When this value is calculated for a certain area of an aquifer (such as a square foot of the aquifer perpendicular to groundwater flow), the term is mass flux and has the units of mass per time per area. When the entire plume is considered (such as in a cross-section along Tozer Road), the term is called mass discharge and has units of mass per time.

Estimates of mass discharge and mass flux at Tozer Road have been made. Mass discharge is calculated using the following equation:

$$J = K * i * C_w$$

Where J is the mass flux in milligrams per day per square foot, K is the hydraulic conductivity in feet per day, i is the hydraulic gradient (feet per feet, unitless), and C_w is the contaminant concentration in groundwater in milligrams per cubic foot (converted from mg/L). Mass discharge (M_d) can be calculated by summing the mass flux across the cross-sectional area of the plume, as shown in **Figure 4-3**.

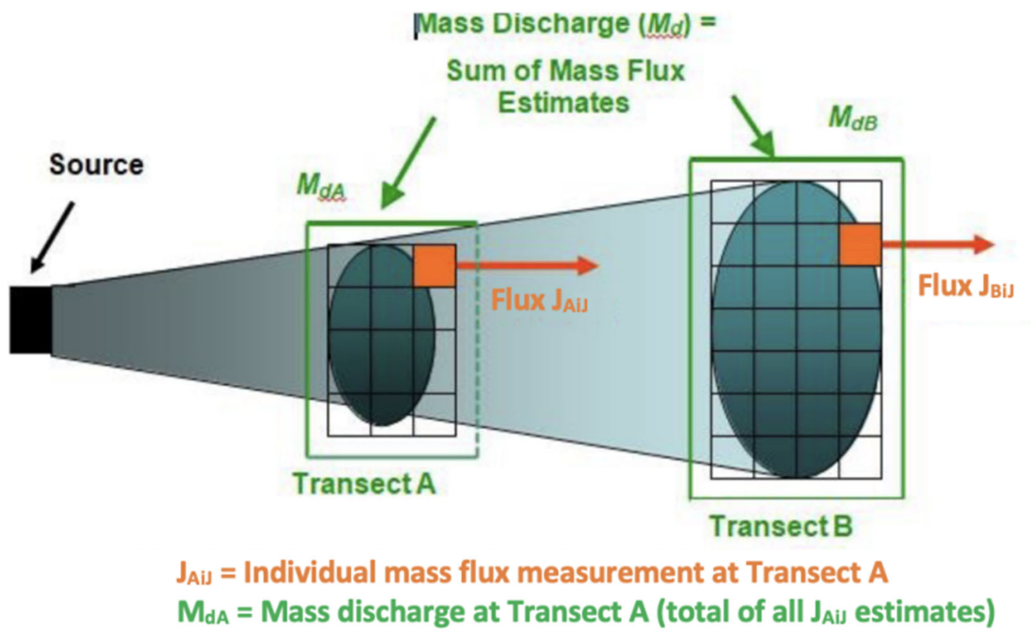


Figure 4-3: Concepts of mass flux (J) and mass discharge (M_d) (From ITRC, 2010)

There is typically a wide range of mass flux values across a plume transect due to aquifer heterogeneity. Therefore, additional investigation will be conducted to refine the understanding of the distribution of contaminants and hydraulic conductivity along the potential alignment of the PAZ/PRZ. Better understanding of the mass flux in this area will facilitate plans to appropriately place treatment amendments in the areas where COC mass is migrating.

4.5 Design and Operation Parameters (310 CMR 40.0874 [3][b][6])

4.5.1 Target Treatment Zone

The treatment barrier will be installed along Tozer Road to provide reduction of mass flux to the downgradient overburden plume. As shown on **Figure 4-1**, the length of the target treatment zone (TTZ) is estimated to be approximately 1,000 feet along the length of Tozer Road. The average depth of the TTZ is approximately 60 feet, as defined by the overburden saturated zone, from the water table (5 to 10 feet bgs) to the top of bedrock (30 to 90 feet bgs) and varies along the length of the barrier. The dimensions of the TTZ (both laterally and vertically) will be refined to focus on areas of high mass flux identified during the investigation prior to remedial amendment injection. The width of the TTZ will be defined by the radius of influence (ROI) set for the injections during the design.

4.5.2 Remediation Amendments and Degradation Mechanisms

Three potential remediation amendments are being considered for the treatment barrier: CAC, ZVI and a carbon substrate. CAC and ZVI may be used as standalone amendments within the barrier, or may be combined with each other, as well as with a carbon substrate. The selection of the final remediation amendment mixture and dosing will be completed following the investigation prior to remedy implementation.

CAC consists of very fine particles of activated carbon (1 to 2 micrometers [µm] that are mixed with water and, if needed, other additives, to form a colloidal suspension for injection. Once injected into the aquifer, the carbon binds (sorbs) to the aquifer matrix. Contaminants such as the CVOCs present at the site will sorb to the CAC, reducing their dissolved-phase concentration in groundwater. Once the contaminants are sorbed to the CAC, contaminant-degrading bacteria can colonize on the CAC and degrade the CVOCs if they have a food source (electron donor), thus freeing up the CAC to sorb additional contaminants. This process effectively regenerates the CAC (that is, the CAC is again available to sorb CVOCs dissolved in groundwater), increasing the effectiveness of the CAC by as much as 20 years. CAC usually sorbs to the aquifer materials quickly without migrating too far from the injection point and may limit the ROI that can be achieved. However, if groundwater velocities are high, an additive may be used to promote the sorption of the CAC to aquifer materials. Hydraulic conductivity and mass flux measured during the design investigation will be used to determine whether additives are required.

Sulfidated ZVI is provided as a liquid suspension with ZVI particles less than 5 µm; this suspension is diluted with water to form a colloidal suspension for injection. ZVI degrades CVOCs primarily by abiotic (chemical) degradation that degrades PCE, TCE, and cis-1,2-DCE to dichloroacetylene, chloroacetylene, and acetylene without intermediate products. Vinyl chloride that may already be present is also degraded by ZVI. The sulfidation limits corrosion of the ZVI by water, which would otherwise limit reactions between ZVI and the target CVOCs. Sulfidation also promotes the development of iron sulfides (FeS) at the particle surface that favor the degradation of CVOCs via abiotic mechanisms. These mechanisms provide increased reactivity to CVOCs and increased longevity of the sulfidated ZVI compared to ZVI without sulfidation. Sulfidated ZVI is typically expected to persist for about five years.

The CAC and ZVI can be mixed together as a colloidal suspension and injected simultaneously. The sulfidated ZVI/CAC mixture would be targeted in areas with higher groundwater concentrations and/or mass flux, whereas a CAC-only media would be targeted in areas with lower groundwater concentrations. The supplier of CAC and ZVI will conduct site-specific modeling following the investigation using contaminant concentrations, concentrations of other competing groundwater constituents (such as dissolved oxygen and nitrate), and groundwater flow information (hydraulic conductivity, hydraulic gradient, and porosity) to calculate the combined flux of groundwater constituents that will “consume” CAC sorption sites and/or ZVI. This flux will be used to calculate the dosing and volume of remediation amendments necessary to treat groundwater to achieve performance standards.

ZVI also promotes a reducing geochemical environment favorable for biologically mediated reductive dechlorination of CVOCs. Anaerobic biodegradation of PCE proceeds sequentially via reductive dechlorination to its daughter products TCE, then cis-1,2-DCE, and then vinyl chloride before degrading to ethane or ethene. In some instances, a carbon substrate may be added to the ZVI suspension to provide an organic carbon source to promote anaerobic biological growth to facilitate reductive dechlorination. The microbial populations required to support reductive dechlorination (e.g., *Dehaloccoides, Dehalobacter)* may be naturally occurring or may need to be introduced to the aquifer through a microbial consortium. Geochemical and microbial data collected during the design investigation may be used to determine if a carbon substrate and/or microbial consortium are applicable for the injections.

4.5.3 Investigation Prior to Remediation Amendment Injection

Prior to injection, an investigation will be conducted to provide the data to implement the treatment barrier effectively. The goals of the investigation will include the following:

1. Assess the spatial distribution of mass flux and concentration of CVOCs,
2. Evaluate aquifer characteristics that can affect injectability and remediation amendment behavior, and
3. Monitor the geochemical characteristics of the groundwater that may affect remediation amendment dosing and treatment behavior.

The investigation is expected to include a membrane-interface probe with hydraulic profiling tool (MiHPT) investigation, soil and groundwater grab sampling to confirm MiHPT results, groundwater sampling of selected existing monitoring wells and new wells, and the deployment and retrieval of flux meters in existing monitoring wells. These elements are described in more detail in the next paragraphs. Prior to any subsurface investigation, a utility location program, including ground penetrating radar, will be performed to identify utilities that may conflict with proposed drilling locations. Drilling locations will be adjusted to avoid conflicts with utilities. If there are any known or suspected utilities within 5 feet of a proposed location, hand-clearance by hand auger or air knifing will be performed to below the depth of the utility.

All data collected during the investigation will be provided to potential amendment suppliers to help provide insights on potential amendment composition, volumes, and injection approach. The information will also be summarized in a revised Phase IV RIP submitted before remedy implementation.

4.5.3.1 Pre-MiHPT Investigation Groundwater Sampling

Groundwater samples will be obtained from existing overburden monitoring wells along Tozer Road without recent data. This groundwater data will provide information on the groundwater geochemistry and CVOC concentration distribution, help guide locations for the MiHPT investigation, and provide a data set for estimating mass flux along Tozer Road. Groundwater samples will be collected using low-flow sampling procedures and field parameters including pH, oxygen-reduction potential (ORP), and dissolved oxygen (DO) will be collected. Groundwater samples will be analyzed by a laboratory for VOCs, total and dissolved iron and manganese, sulfate, sulfide, nitrate, total organic carbon, alkalinity, and chloride. Selected samples will also be analyzed for methane/ethane/ethene and carbon dioxide and microbial populations capable of degrading CVOCs.

4.5.3.2 MiHPT Investigation

An MiHPT investigation will be conducted to provide additional assessment of the vertical and horizontal distribution of VOCs (concentration and specific compounds), as well as aquifer characteristics. The MiHPT investigation will begin with borings advanced at approximately 50- to 100-foot spacing. Additional borings will be advanced in between these borings to improve spatial resolution in areas of higher concentrations/mass flux; locations and spacing will be adjusted based on field results. The borings will be advanced to the top of bedrock or refusal of the direct push technology (DPT) rig. The exact locations will be selected based on site characteristics such as utility locations, distribution of existing monitoring well network, and pre-investigation groundwater sample results. To provide data, the DPT rods will be equipped with a heated membrane probe which is pushed into the subsurface. A carrier gas is used to transport the vapors to a series of detectors at the surface. Anticipated detectors include:

- Photoionization detector (PID), which can detect both CVOCs and aromatic hydrocarbons (which are often found in petroleum product plumes),
- Flame ionization detector (FID), which can detect all VOCs, but has lower sensitivity than other sensors (that is, only detects contaminants at higher concentrations)
- Halogen specific detector (XSD), which only detects chlorinated compounds such as the site COCs
- Electron capture device (ECD), which detects CVOCs and has different sensitivities to different CVOCs, allowing for an indication of the relative proportions of daughter products such as cis-1,2-DCE and vinyl chloride to PCE and TCE.
- Electrical conductivity detector (EC), which measures the soil electrical conductivity and provides information on the grain size of the aquifer materials, as silts and clays exhibit higher EC readings than sands and gravels.

Given the relatively low concentrations of CVOCs along Tozer Road, low-level MIP will likely be used for all or part of the investigation. This version includes additional equipment that can detect CVOCs at lower concentrations, usually in the tens of micrograms per liters, than the standard MIP setup. The HPT tool provides information on injection pressures, which are related to the permeability of the aquifer, at 0.05 ft vertical intervals. An injection port for the HPT is included in the membrane probe for the injection of clean water, and the HPT pressure sensor detects the pressure in the line. A higher injection pressure corresponds to lower aquifer permeability, whereas lower injection pressure corresponds to areas of higher permeability. The injection pressure information can be used to estimate the hydraulic conductivity of the aquifer. This hydraulic conductivity data, in conjunction with the XSD/ECD detector information, will be used to identify areas of higher and lower mass flux. MIP sensor and HPT data will be contoured in a grid of cells along a vertical transect along Tozer Road using a contouring program such as Earth Volumetric Studio or Surfer. The mass flux in each grid cell and the mass discharge of the plume will be calculated using the program and a cross-section will be produced displaying the variations in mass flux.

4.5.3.3 Groundwater-Soil Sampling

Following the MiHPT investigation, groundwater and soil grab samples will be collected using a DPT rig at up to five locations (with up to 5 depths at each location) to confirm MiHPT results (in both areas with high and low XSD responses) thus providing data to correlate MiHPT sensor readings to soil and groundwater concentrations. This correlation will be used to calculate mass flux estimates using the MiHPT sensor readings (concentration estimate), the estimated hydraulic conductivity (from HPT data), and hydraulic gradient (based on groundwater level measurements). Groundwater samples will be analyzed for VOCs, while soil samples will be analyzed for VOCs and total organic carbon. The soil sample results will provide information on the total contaminant mass present in the subsurface and the degree of contaminant partitioning between soils and groundwater.

4.5.3.4 Flux Meters

Flux meters will also be deployed in up to ten existing monitoring wells screened at different depths and locations along Tozer Road. Flux meters measure vertical profiles of groundwater mass flux of CVOCs. A series of two-foot-long canisters filled with granular activated carbon will be deployed in the monitoring wells for a period of two weeks. As groundwater flows through the canister, groundwater contaminants sorb to the granular activated carbon in the canisters. Once retrieved, a laboratory measures the mass of contaminants accumulated in each activated carbon canister to estimate the groundwater contaminant concentration for that interval. Each canister also contains biodegradable alcohol tracers. As groundwater flows through the canister, the alcohol tracers are depleted. A laboratory measures the amount of alcohol depletion to estimate the groundwater velocity. From this information, CVOC mass flux is calculated for each canister. This data will be used to 1) confirm and calibrate the MiHPT mass flux estimates, and 2) inform the remediation amendment design.

4.5.3.5 Monitoring Well Installation and Baseline Groundwater Sampling

Prior to any injection activities, the existing monitoring well network will be evaluated to determine if it is sufficient to monitor remedy performance. The ideal monitoring network includes groundwater monitoring wells screened at multiple depths located upgradient, within (if feasible), and downgradient of the barrier to monitor changes in groundwater concentration, changes in groundwater mass flux, and changes in groundwater geochemistry. If additional monitoring wells are required, upgradient/downgradient wells will be installed and developed prior to any injection activities. Monitoring wells within the PAZ/PRZ will be installed after injections are completed so as not to create preferential pathways for injected amendments. As described in Section 4.9.2.1, baseline groundwater sampling will be conducted from the performance monitoring network before injections.

4.5.3.6 Remediation Amendment Injection

Injections are expected to be performed in the Tozer Road right-of-way using DPT. Based on the current understanding of the mass flux through the system, injection points will be located on eight-foot centers in the portions of the TTZ with higher mass flux. The injection volumes will be designed to achieve a 6-foot ROI, allowing for two-foot overlap between each injection point, creating a continuous barrier across the full length. This spacing and the length of the barrier will be adjusted as warranted based on aquifer characteristics from the investigation, observations during initial injections, or utility conflicts. If the injection spacing is increased, the injection volume for that point may also be increased to ensure adequate subsurface distribution. Given the large number of injection points, multiple points may be injected simultaneously.

The substrate contractor will confirm the barrier's width following the design investigation, to confirm that the barrier is wide enough to provide enough hydraulic residence time for sorption and degradation reactions to occur. Based on the VOC mass flux and equipment selected to perform injections, injections will be carried out at two to five- foot vertical intervals. Each vertical interval will be hydraulically separated from intervals above or below, using packers or other means. The total volume for each vertical interval will be placed prior to moving to the next injection interval.

Prior to any subsurface work, DigSafe notification and a third-party utility locate will be performed to identify utilities that may conflict with proposed injection locations.

The injections will be carried out by an injection contractor. The injection contractor will prepare a work plan prior to implementation, providing details on how the work will be carried out and the equipment to be used; the work plan will be included in the revised Phase IV RIP. The final equipment used for injection will be verified prior to mobilization. However, a standard injection setup typically includes a trailer-mounted mobile injection system. The system will include mixing tanks for batch mixing, pumps, pressure gauges, flowmeters, valves, and hoses/piping. An injection manifold may be used to inject multiple injection points simultaneously. Before injection, the mixing tank will be filled with potable water. The calculated amount of amendments will be added to the mixing tank and mechanically mixed to create a colloidal solution at the appropriate concentration. Volumes of amendments added to each batch will be documents, and the injected points for which the batch was prepared will be documented.

The DPT rods will be pushed to the target depth and the retractable sleeve (if used) will be retracted to expose the screen. The maximum injection pressure will be calculated so that the aquifer materials can safely accommodate without uncontrolled fracturing, excessive groundwater mounding, or otherwise damaging the aquifer formation. Injections will likely proceed bottom-up (start injecting at the base of the treatment zone and work up).

Borings will be grouted after injection so that they do not serve as preferential pathways for subsequent injections. The ground surface will be restored to a similar condition as before drilling (that is, an asphalt patch will be installed where drilling through asphalt).

Injection monitoring data will be collected during the injection. The data will include injection pressures, injection volumes, injection flow rates, water levels in nearby monitoring wells, the injected mass and volume of the amendments, and any other observations (such as surfacing or other abnormal conditions). During injections, the ROI will be verified at selected injection locations, where a temporary monitoring point/piezometer is installed within the ROI, via observation of changes in geochemical field parameters and visual confirmation. Additional details are provided in Section 4.9.1.

Hydraulic conductivity and aquifer material characteristics collected during the MiHPT investigation (to be conducted using DPT) will be assessed during the investigation to determine if adjustments to the injection strategy are required. If it is determined that DPT cannot be used for injecting the remediation amendment (for example, DPT can hit refusal in harder formations or on boulders/cobbles), then the injection strategy will be adjusted to using injection wells installed in the overburden in those areas.

4.6 Spill, Accidental Discharge & System Malfunction Controls (310 CMR 40.0874 [3][b][7])

The remediation amendments will be delivered to the site in concentrated liquid form and stored on pallets with secondary containment in a secure area in their original tightly closed containers until used. The CAC will be protected from freezing, while the ZVI will be stored at temperatures below 95 Fahrenheit in accordance with manufacturer guidance. The ZVI will be stored separately from potentially incompatible materials, such as oxidants or acids, which could react with the ZVI and generate hydrogen sulfide gas.

The remediation media, mixing tank, and associated hoses are the primary items that require design features to control accidental spills or discharges of the remediation media. Secondary containment will be constructed around the injection system trailer to contain spills. Spill response equipment, including sorbents and a shop vacuum, will be kept onsite near the injection system. Because the work will be conducted in the Tozer Road right-of-way, traffic control measures will be implemented. Temporary work zones will be established around the remediation areas to allow access only to authorized personnel. These exclusion zones will be clearly marked with cones and/or caution tape. Secondary containment will be set up around each injection point to contain any spills or surfacing, including protection of nearby storm sewer grates if present. Prior to injection, areas around the injection point will be visually inspected for potential preferential pathways such as utility corridors or old borings where surfacing could occur. These areas will be visually monitored during injection for any surfacing.

4.7 Waste Material Management-Disposal Methods (310 CMR 40.0874 [3][b][8])

Efforts will be made to limit the amount of waste generated during remedy implementation. Material disposal and waste generation will be conducted in accordance with the general procedures described in this section. Wastes will be characterized prior to final disposition. All of the remediation media will be mixed and applied so no waste remediation amendment is anticipated. If there are any remaining remediation media, it will be disposed of as non-hazardous waste at a licensed facility.

Soil, water, daylighted injection fluids (if generated), and PPE waste will be managed and disposed of in accordance with state and federal regulations.

4.8 Deleterious Impact Mitigation (310 CMR 40.0874 [3][b][10])

Environmental impact mitigation measures will be implemented to avoid any deleterious impact on environmental receptors. CAC is non-toxic, and the additives included in the formulation are biodegradable. While not anticipated to occur, injections will be stopped if the remediation amendment surfaces during the injection or evidence of migration to potential receptors (such as the Unnamed Stream) is observed. Any surfaced solution will be cleaned up with water, adsorbent pads, or a shop vacuum as needed. Injection locations will be staged so that initial injections are not near potential receptors to determine the likelihood of surfacing and make necessary adjustments, such as reducing injection pressures and flow rates.

4.9 Inspections-Monitoring (310 CMR 40.0874 [3][b][11] & [3][d])

This section provides a general description of inspections and monitoring to ensure adequate construction and performance of the RAA. It also provides the basis of the OMM Plan that will be further developed once the design is complete.

4.9.1 Monitoring During Injections

The number and condition of containers of remediation amendment will be inspected when delivered to the site. If production batch numbers or serial numbers are present on the remediation amendment containers, they will be recorded in a field book. The source of potable water will be documented, including an inspection and a photograph of the connection to the municipal water system. If an offsite potable water source is used, sampling may be required. During batch mixing, the amount of amendment(s) and potable water added to each batch will be documented to ensure that the prepared injection solution is consistent with the design specifications. The injection locations where the batch was placed will also be documented. Equipment such as pressure gauges, flow gauges, and pressure relief valves will be inspected prior to use to ensure proper function.

During the injection of the remediation amendment, injection pressures and flow rates at each injection point/depth will be monitored and recorded. The volume of the remediation amendment mixture will also be monitored and recorded and compared to the design. The volume injected as measured by a flow totalizer will be compared to the changes in volume observed in the injection system tank.

To assess injection volume and ROI relationships, temporary monitoring points/piezometers will be installed prior to injection at several locations. These locations will be used to assess distribution during injection. Permanent wells will not be placed within the PAZ/PRZ prior to injection so as not to bias amendment distribution and create preferential pathways/short circuiting. During the injection program, soil borings will be advanced after some injections have occurred to confirm amendment distribution and allow adjustment, as needed, to subsequent injections to achieve remedial design objectives. Before injection, groundwater parameters and groundwater elevations will be collected to provide a pre-injection baseline. Groundwater in the temporary monitoring points/piezometers will be sampled periodically when injections are being carried out nearby for evidence that the remediation media has been distributed to the monitoring point/piezometer. The groundwater samples will be visually monitored for the presence of CAC/ZVI and colorimetric field tests for the presence of iron, and field parameters will also be measured (pH, ORP, DO, and specific conductivity). Air monitoring will also be conducted prior to and during injection activities. Field monitoring equipment, including groundwater field parameter monitoring equipment and air monitoring equipment, will be calibrated daily and calibration data will be recorded in a field book. Photographs will be taken before, during, and after injection activities.

4.9.2 Groundwater Performance Monitoring

4.9.2.1 Baseline

A round of baseline groundwater sampling and water level measurements will be collected from the entire performance monitoring network before injections. Groundwater samples from all locations will be analyzed for VOCs, and at select locations for total and dissolved iron and manganese, sulfate, sulfide, nitrate, total organic carbon, alkalinity, chloride, methane/ethane/ethene and carbon dioxide. Additionally, photographs of purge water will be collected at each location, by filling a clear container, to visually compare changes over time.

4.9.2.2 Post-injection Monitoring

Periodic groundwater monitoring will be performed following the injections to monitor the changes in groundwater elevation, groundwater concentration, and groundwater mass flux/discharge. Groundwater monitoring is proposed quarterly post-injection, followed by two years of semi-annual monitoring. Each monitoring event will include synoptic groundwater elevation measurements to evaluate groundwater flow patterns and calculate hydraulic gradients. Groundwater samples will be analyzed for VOCs, but other parameters may be added as needed and the frequencies may vary at select locations. Optimization of the sampling network may be recommended after the first two years of sampling based on sample results. Similarly, additional data may be collected, as needed, for troubleshooting or assessment. After 5 years, PAZ/PRZ-related sampling will be integrated into the sitewide monitoring program. Groundwater monitoring data will be evaluated as follows:

- Upgradient monitoring well data will be monitored for potential changes in CVOC concentrations that may be related to upgradient remediation activities at the 150 Sohier Road facility. CVOC data will also be used to estimate the mass flux around each well and the total mass discharge being transported towards the PAZ/PRZ.
- As needed, groundwater data within the treatment zone will be monitored for geochemical changes attributable to the remediation amendments (for example, have geochemical conditions changed as a result of the remedial additions), as well as changes in groundwater concentrations both temporally and spatially. Geochemical data within the barrier may also be used to determine if the efficacity of the barrier is waning, indicating reinjection may be required.
- As needed, groundwater data downgradient of the treatment zone will be evaluated for changes in CVOC concentrations and geochemical conditions. Groundwater mass flux for each well area will be calculated from the groundwater concentration data, hydraulic gradients, and the previously determined hydraulic conductivity. A total groundwater mass discharge will be calculated for the entire plume cross-section.

The mass flux and mass discharge calculations downgradient of the plume will be compared to contemporaneous upgradient mass discharge to evaluate the percent reduction in mass discharge across the barrier.

The mass flux calculations will also be used to identify areas of higher mass flux that may need supplemental treatment.

Groundwater data will also be evaluated graphically and statistically evaluated, once sufficient data is collected, to verify the overall stability of the downgradient plume.

The monitoring results will be reported in semi-annual Phase V reports and include an evaluation of overall remedial performance and any recommendations for remedy optimization, such as supplemental injections, if warranted.

4.10 Permits, Licenses and Approvals (310 CMR 40.0874 [3][f])

The following permits, licenses, and approvals will be required:

- Massachusetts-certified well driller to install monitoring wells and conduct environmental sampling/investigation
- An underground injection control (UIC) permit

- Right-of-way permit from the City of Beverly to conduct investigation and remediation activities in the Tozer Road right-of-way

4.11 Property Access Issues (310 CMR 40.0874 [3][g])

Most work will be performed in the Tozer Road right-of-way. Permission to work in the right-of-way will be obtained from the city of Beverly prior to the initiation of investigation and remediation work. During remediation injections, the injection system (trailer) will likely be staged in the right-of-way or on adjacent properties. Varian has property access agreements with all properties along Tozer Road to conduct groundwater monitoring, however additional negotiations or access agreements may be required to stage remediation equipment, if necessary. Injection equipment will be staged so that ingress/egress to Tozer Road properties is not blocked. If access to a property does need to be blocked, this will be negotiated with the property owners and such strategies as night or weekend injections may be used.

4.12 Design/Construction Schedule (310 CMR 40.0874 [3][c][2])

The anticipated schedule for the Tozer Road barrier construction includes the following:

- Phase IV Comment Period and Responses – March 2023 to June 2023
- Predesign Investigation and Data Evaluation: June 2023 to July 2023
- Revision to Phase IV Design: August 2023 to September 2023
- Installation and baseline sampling of performance monitoring well network upgradient and downgradient of PAZ/PRZ: October to November 2023
- Injection of barrier: December 2023 to February 2024, depending on the length and depth of the PAZ/PRZ as determined through the predesign investigation
- Installation of performance monitoring wells within PAZ/PRZ: March to April 2024
- Post-injection performance monitoring: May 2024, August 2024, November 2024, February 2025, and then semi-annually

5.0 STREAM A SEEP REACTIVE CORE MAT

This section addresses the design, construction, and implementation of the groundwater seep treatment (reactive core mat [RCM]) for Stream A. The Phase II CSA risk assessment demonstrated that CVOC concentrations in surface water of Stream A do not pose a significant risk to human health or the environment. However, these locations are providing a direct flow of impacted groundwater to the stream. Treatment is being implemented to control VOC migration and reduce the CVOC mass discharge to the stream.

5.1 Nature & Extent of Contamination (310 CMR 40.0874 [3][b][4])

The stream sampling locations discussed below can be seen on **Figure 5-1**. Analytical results for surface water samples collected from Stream A indicate that no detectable concentrations of COCs are present in the upper portion of the stream in the Sonning Road area, including two locations where groundwater appears to be discharging to the stream (GDS-01 and GDS-02). The eight surface water sample locations at and downstream of Patton Park exhibited low concentrations of TCE, PCE, and cis-1,2-DCE ranging from 0.002 mg/L to 0.019 mg/L. The highest concentration (0.019 mg/L cis-1,2-DCE) was detected at STR-18, a location at Hill Street, downstream from the potential groundwater discharge GDS-03. The groundwater sample at GDS-03, which is located on the west bank of Stream A (opposite the Site) indicated concentrations of 0.061 mg/L for TCE, 0.003 mg/L for PCE, and 0.02 mg/L for cis-1,2-DCE. The TCE concentration in Stream A is relatively consistent, flowing downstream to the confluence with the Unnamed Stream (ranging from 0.006 mg/L at four sample points to 0.013 mg/L at STRHA-7A). PCE is detected at similar low concentrations (0.002 to 0.003 mg/L) along the stream flow and cis-1,2-DCE exhibited higher concentrations along the mid-stream (0.011 to 0.02 mg/L) and decreased downstream (0.004 and 0.005 mg/L).

5.2 Remedial Goals (310 CMR 40.0874 [3][b][1])

Per 310 CMR 40.0874(3)(b)(1), the RIP must document the goals of the remedial action, including performance requirements of the remedial systems, the requirements for achieving a Permanent or Temporary Solution (whichever is applicable) under 310 CMR 40.1000 and the projected timeframe, based on available information, for achieving such Permanent or Temporary Solution.

5.2.1 Performance Standards

For the Stream A seep remedy, treatment is not needed to address significant risk. Treatment was selected to provide a reduction in CVOC mass discharge to the stream.

5.2.2 Requirements for Achieving a Permanent/Temporary Solution

No significant risk has already been demonstrated at Stream A and in the downgradient plume area of Tozer Road, and no threats of release exist in this area. These components satisfy the requirements for a Permanent or Temporary Solution.

- **Source Elimination/Control:** There is no OHM source material to be controlled or eliminated in this area.
- **Migration Control:** The reactive core mat will treat groundwater discharging to Stream.

- **DNAPL:** No DNAPL is present to be eliminated or controlled in this area

5.2.3 Timeframe to Achieve a Permanent/Temporary Solution

This remedy is not needed to support a Temporary Solution. Once the various remedies at the site are implemented to achieve a Temporary Solution, an assessment of the timeframe to achieve a Permanent Solution will be evaluated.

5.3 Significant Changes (310 CMR 40.0874 [3][b][2])

Since the previous submittals (Phase II CSA/Phase III RAP), the following additional information was collected:

1. Additional sampling from GDS-03 on December 14, 2022. In summary, 2021-2022 sampling has indicated 0.045 – 0.12 mg/L PCE, 0.13-0.47 mg/L TCE, 0.21-0.34 mg/L cis-1,2-DCE and 0.003-0.004 mg/L VC;
2. The seep flow rate was estimated at 2.8-3.0 liters per minute on February 8, 2023; and
3. Topographical survey by A-Plus on February 14, 2023.

5.4 Conceptual Plan (310 CMR 40.0874 [3][b]5])

Remedial activities planned for the Stream A seep area involve the installation of a Granular Activated Carbon Reactive Core Mat (GAC-RCM) over each of the two identified groundwater seeps to reduce the low-level CVOC concentrations entering the stream.

A GAC-RCM is a permeable composite mat that encapsulates a ¼” thick layer of granular activated carbon between two layers of adhered, non-woven geotextile. The GAC-RCM installation will include a narrow anchor trench above the bank bench to key-in the GAC-RCM using native soil backfill. A 4-6” thick polymer marine mattress filled with stone will be placed over the GAC-RCM to hold it in position while following the natural contours of the stream bank. Using a marine mattress will allow the natural slope of the bank to be maintained, largely avoiding the re-grading that would otherwise be required to support a loose stone ballast system, thereby minimizing disturbance to the natural system.

5.5 Design and Operation Parameters (310 CMR 40.0874 [3][b][6])

The GAC-RCM engineered control system is detailed in the design package included as **Appendix B**. The design package includes a Basis of Design and design drawings, including Site Plan, Reactive Core Mat Construction Plan, and Construction Details.

5.6 Spill, Accidental Discharge & System Malfunction Controls (310 CMR 40.0874 [3][b][7])

Implementation of the GAC-RCM offers a low chance of a spill or accidental discharge. The RCM will be delivered to the site using roadways and mobilized from the road to the stream using a skid steer loader or all-terrain forklift. Spill containment material and equipment will be on site in low likelihood that a spill or release occurred from the powered equipment used. The RCM is a passive system and has no control functions.

5.7 Waste Material Management-Disposal Methods (310 CMR 40.0874 [3][b][8])

Wastes generated during the implementation of the RCM are expected to be limited to erosion controls such as haybales, silt fences, and a turbidity curtain. These materials will be handled as solid wastes and managed in a solid waste dumpster located at 150 Sohier Road. The limited soil excavated during the installation of the RCM will be backfilled to secure the mat.

5.8 Site-Specific Characteristics (310 CMR 40.0874 [3][b][9])

Site-specific characteristics for this treatment include the concentration of VOCs in the groundwater seeping from the stream bank and the flow of that water. These have been assessed and the results have been considered in the design. Additional characteristics considered in the design include the stream itself (water depth and span of the stream), the slope of the bank, and limiting impacts to area vegetation.

5.9 Deleterious Impact Mitigation (310 CMR 40.0874 [3][b][10])

Sedimentation and erosion design control features will be implemented and maintained during the project life and may include features such as silt fence, hay bale barrier, hay wattles, and/or turbidity curtain as required in the permit order of conditions.

Measures to minimize rutting and disturbance from heavy equipment will be utilized during construction and may include construction mats and equipment with rubber tracks or turf tires.

5.10 Inspections-Monitoring (310 CMR 40.0874 [3][b][11] & [3][d])

The GAC-RCM mat was specified for the Stream A seep barrier control based on the low CVOC concentrations and low groundwater flow rate observed. Based on vendor discussions and professional judgement, the expected useful life of a single RCM under these conditions is one year. To provide additional protection, the design includes a triple layer of GAC-RCM (3/4" total thickness) with a planned changeout interval of two years.

As noted above, sedimentation and erosion controls as specified in the order of conditions will be installed and maintained during the project life. Sedimentation and erosion controls will be inspected following each rainstorm for the first two months following installation. It is anticipated that the turbidity curtain, if utilized, will be removed following the GAC-RCM barrier's completion. Haybale barriers shall be only used as temporary barriers (no longer than 60 days) and then removed and used as mulch. The geotextile silt fence will remain in place for the project's duration.

Regular inspections of the RCM will be conducted after installation. Inspections will occur monthly for the first six months and then may be reduced. Additional inspections will be conducted following major rain events (i.e., greater than 3 inches in a 24-hour period, 2 inches in a 6-hour period, or 1 inch in a 1-hour period). The inspection will include observations of conditions that would affect the performance of the mat such as erosion, scouring, or vandalism.

Surface water samples will be collected quarterly for analysis of VOCs upstream, adjacent to the RCM, and downstream of the mats for the first year after installation. After the first year, sample frequency will be reduced to semi-annual.

5.11 Permits, Licenses and Approvals (310 CMR 40.0874 [3][f])

A permit application with detailed design drawings will be made to the Beverly Conservation Commission. Based on initial discussions with the Commission, a wetlands Notice of Intent will be submitted. All work conducted will be done in compliance with the Order of Conditions issued in response to the Notice of Indent.

5.12 Property Access Issues (310 CMR 40.0874 [3][g])

An access agreement is in place for the property where the RCM will be installed. Additional negotiations to amend the access agreements will be conducted as needed to cover the installation and maintenance of the RCM.

5.13 Design/Construction Schedule (310 CMR 40.0874 [3][c][2])

APTIM will prepare and submit the permit application to the Beverly Conservation Commission in the Spring of 2023. Contingent upon permit issuance by the Beverly Conservation Commission, the detailed design plans and specifications provided in **Appendix B** and will be used to procure a qualified contractor to install the GAC-RCM engineered control during the dry season in the summer of 2023. APTIM will oversee the construction of the GAC-RCM engineered control. Construction activities will be documented in the next Phase IV Status Report.

6.0 CONSTRUCTION PLANS-SPECIFICATIONS

Per 310 CMR 40.0874 (3)(c)(1), the RIP shall include construction plans shall be prepared in conformance with appropriate engineering and construction standards and practices and regulations applicable to construction plans and activities.

6.1 Building 3 Area ISTR

The implementation of Building 3 ISTR will be entirely the work of the thermal contractor. Conceptual details of the system components are presented in **Figures 3-2** through **3-8**.

6.2 Tozer Road PAZ/PRZ

As discussed in Section 4.5, investigation work is needed to complete the design of the PAZ/PRZ. Plans illustrating the location of the PAZ/PRZ are provided in **Figures 4-1** and **4-3**. Details of the PAZ/PRZ are also provided in Section 4.5. Additional construction details and drawings will be provided in a subsequent report.

6.3 Stream A Seep RCM

The construction drawings and specifications associated with the Stream A Seep RCM are presented in **Appendix B**.

7.0 HEALTH & SAFETY PLAN

Per 310 CMR 40.0874(3)(f), The RIP shall include Health and Safety Plan (HASP). A copy of the Site-Specific HASP is presented in **Appendix C.** This document will be updated as needed based on each final design and the associated work scope to implement and operate the RAAs

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8.0 PUBLIC INVOLVEMENT (310 CMR 40.0880)

In accordance with the MCP and the Site PIP, the following public involvement activities will be completed relevant to Phase IV including:

- The Chief Municipal Officer and Board of Health will be notified of the availability of the Phase IV RIP, including information about how local officials may obtain a copy of the report.
- A copy of the Phase IV RIP will be sent to the Information Repositories established in the PIP for the Former Varian Facility Site.
- A public meeting held to present this document followed by a 20-day public comment period to solicit public comments.

Copies of the Public Involvement notices are included in **Appendix D**.

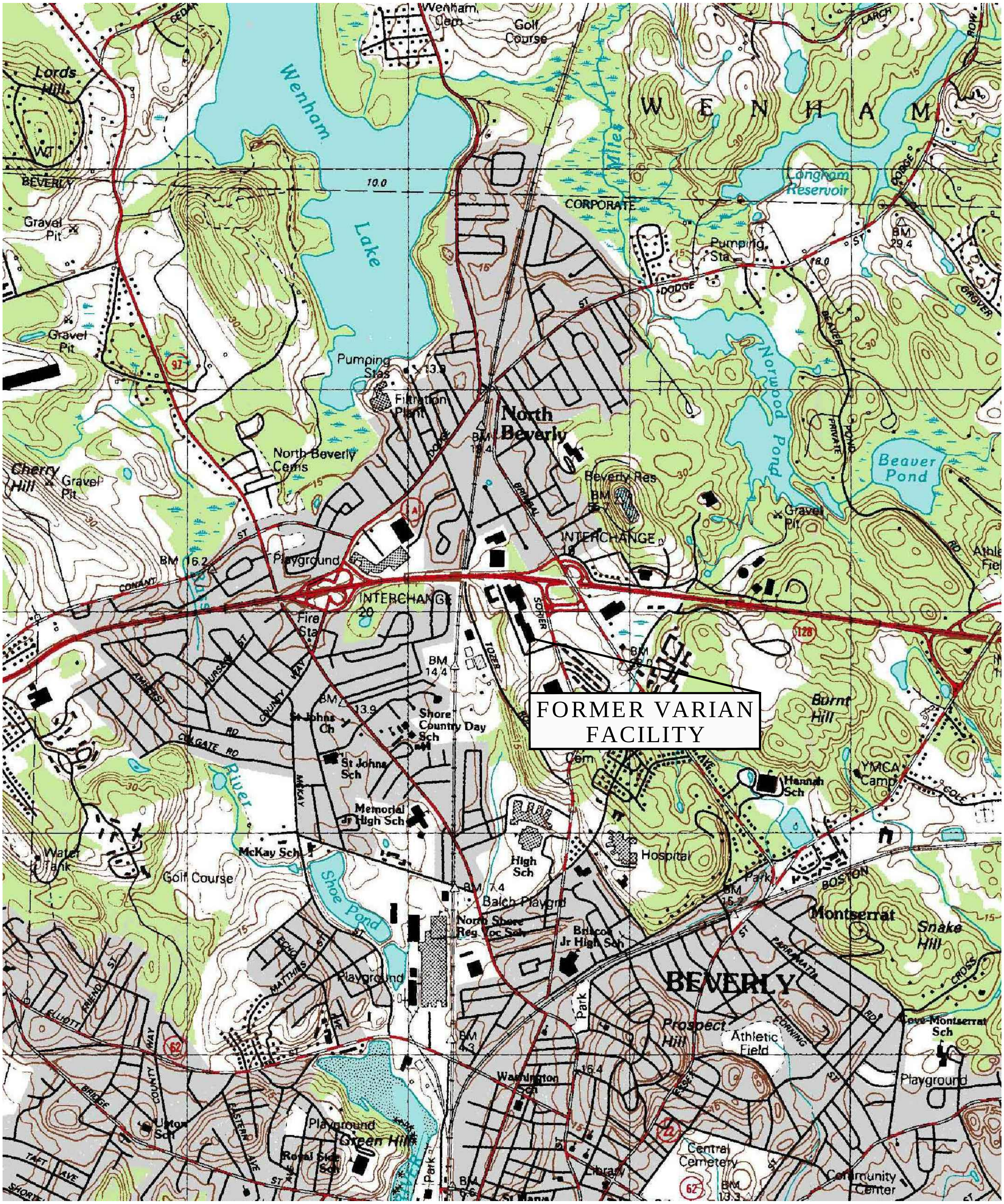
9.0 LIMITATIONS ON WORK PRODUCT

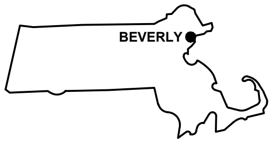
The information contained in this report, including its conclusions, is based upon the information that was made available to APTIM Environmental and Infrastructure, LLC. (APTIM) during the investigation and obtained from the services described, which were performed within time and budgetary restraints.

APTIM makes no representation concerning the legal significance of its findings or of the value of the property investigated. APTIM has no contractual liability to any third parties for the information or opinions contained in this report.

Unless and until the parties agree otherwise in writing, the use of this report or any information contained therein by any third party shall be at such third party's sole risk.

FIGURES





MASSACHUSETTS

SOURCE:
USGS 7.5 MIN. SERIES SALEM MA, TARGET QUAD, 1985
SCALE: 1:25,000
X = 250750 m
Y = 925017 m
MA STATE PLANE GRID (meters)

APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.
150 ROYALL STREET
CANTON, MASSACHUSETTS
(617) 589-5111

FIGURE 1-1
SITE LOCATION MAP

FORMER VARIAN FACILITY
150 SOHIER ROAD
BEVERLY, MASSACHUSETTS

OFFICE	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
CANTON, MA	CD 09/22/17	RC 09/22/17	-- --	139340-01SITELOC

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XREF Files: IMAGE Files:
File: O:\PROJECT\ray varian\631010764-D211.dwg Layout: Layout1 User: Greg.Jones Sep 30, 2022 - 1:52pm

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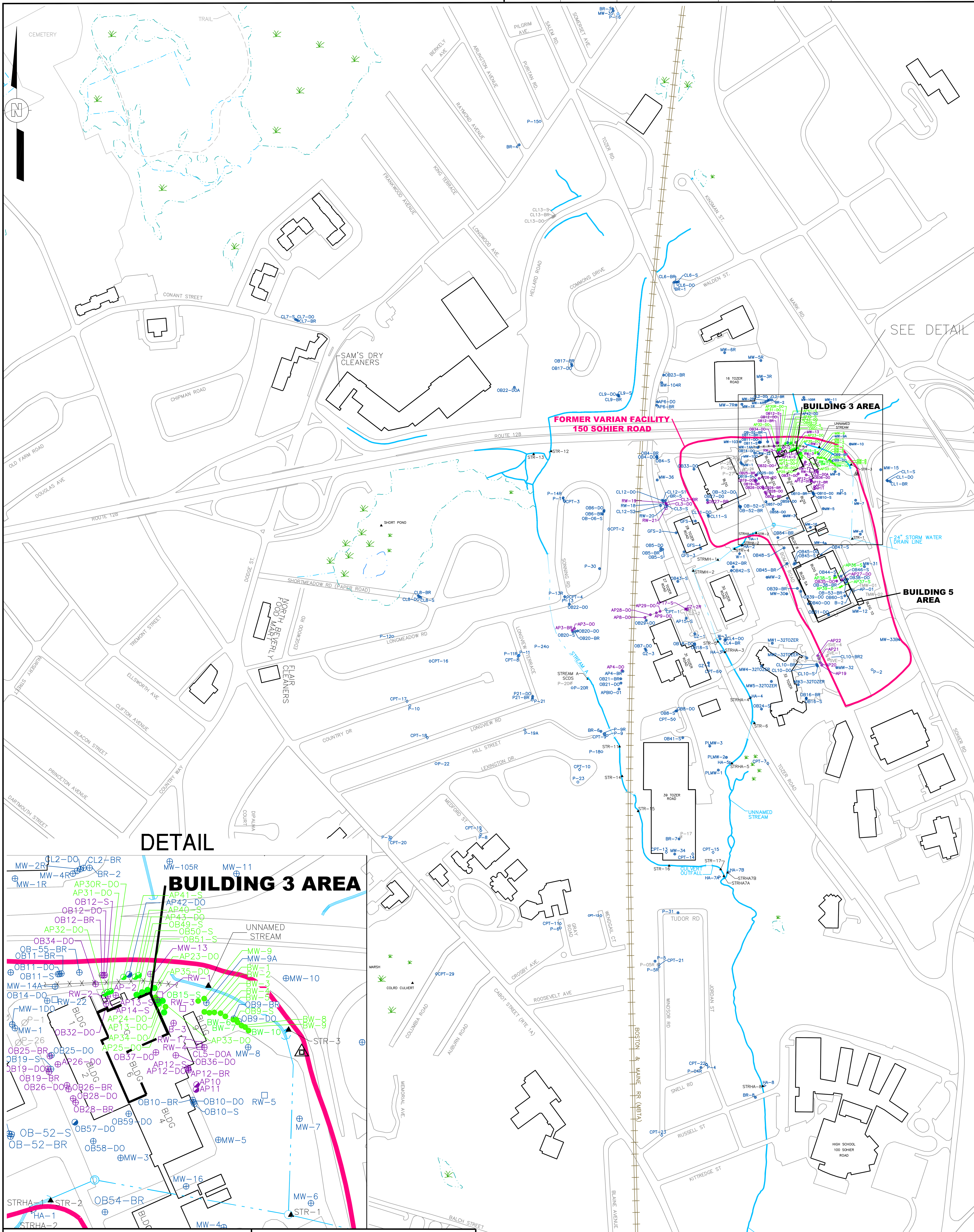


LEGEND:

- TEMPORARY PERMANGANATE INJECTION POINT
- ABANDONED OR DESTROYED WELL
- PIEZOMETER (P)
- BENCHMARK LOCATION (MSL)
- RECOVERY WELL (RW)
- MONITORING WELL (MW)
- ANGLED WELL
- BIOREMEDIATION INJECTION WELL
- SURFACE WATER STREAM (STR) SAMPLE LOCATION
- CONE PENETROMETER TESTPOINT (CPT)
- HAND AUGER SAMPLE LOCATION (HA) ADJACENT TO A STREAM (STRHA)
- STRMH — MANHOLE ACCESS TO THE STREAM LOCATED WITHIN A CULVERT
- APPROXIMATE BUILDING LOCATION
- APPROXIMATE DRAIN MANHOLE LOCATION
- APPROXIMATE LOCATION OF STREAM IN CULVERT
- APPROXIMATE STREAM LOCATION
- WATER AND MARSH AREA

CL4-BR — WELL IDENTIFICATION
MONITORING WELLS SHOWN IN BLUE
PAST AND CURRENT PERMANGANATE INJECTION WELLS SHOWN IN PURPLE
BIOREMEDIATION INJECTION WELLS SHOWN IN GREEN

CL-9 — CLUSTER WELL NUMBER
S=SHALLOW
DO=DEEP OVERBURDEN
BR=BEDROCK

STR-6	STREAM SAMPLE LOCATION NUMBER
STRHA-1	STREAM/SURFACE WATER SAMPLE
HA-1	HAND AUGER WELL LOCATION NUMBER
STRMH-1	STREAM/MANHOLE LOCATION NUMBER
MW-5	MONITORING WELL NUMBER
GZ-1	MONITORING WELL NUMBER
PLMW-1	MONITORING WELL NUMBER
BR-1	BEDROCK WELL NUMBER

BEDROCK WELLS BR-1 THROUGH BR-8 AND CL9-BR HAVE MULTILEVEL GROUNDWATER MONITORING SYSTEMS PRESENT WITHIN THE BEDROCK. ZONE 1 REFERS TO THE DEEPEST SAMPLING ZONE, ZONE 2 REFERS TO THE MIDDLE SAMPLING INTERVAL, AND ZONE 3 CLOSEST TO THE GROUND SURFACE.

THIS MAP HAS BEEN COMPILED FROM SURVEY DATA COLLECTED IN JULY 1994, MARCH 1995, OCTOBER 1995, SEPTEMBER 1996, MARCH 1997, DECEMBER 1997, SEPTEMBER 1998, JANUARY 2000, FEBRUARY 2001, JUNE 2002, SEPTEMBER 2002, JULY 2003, FEBRUARY 2004, OCTOBER 2004; 2005, JULY 2012, MAY 2014, AUGUST 2018 FROM VARIOUS EXISTING PLANS, AND OBSERVATIONS MADE IN THE FIELD BY CB&I ENVIRONMENTAL & INFRASTRUCTURE, INC., AND APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.

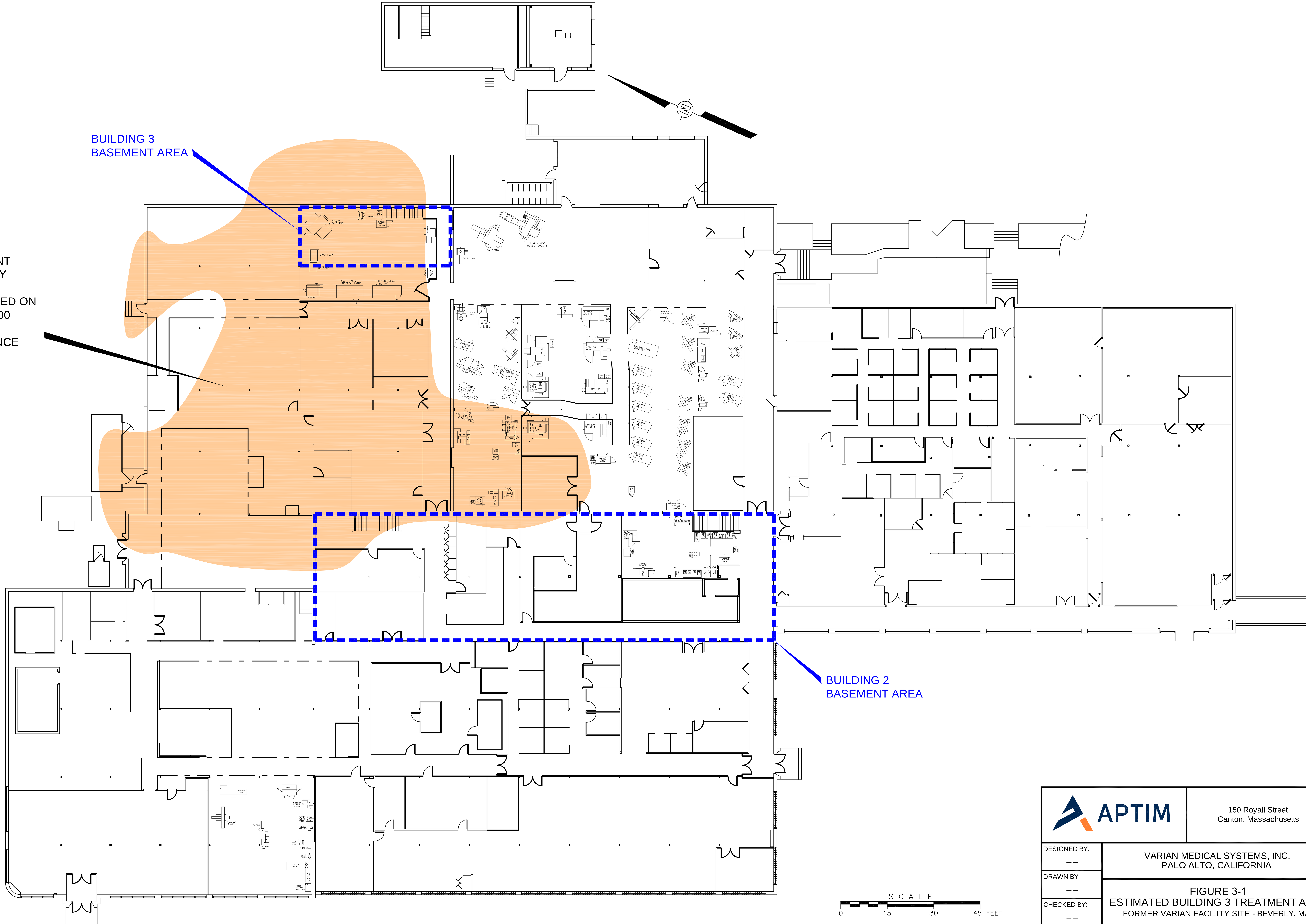
SCALE
0 250 500 750 FEET

FIGURE 1-2
EXPANDED SITE PLAN
FORMER VARIAN FACILITY SITE - BEVERLY, MA.

PREPARED FOR: VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

SCALE: 1" = 250'	DRAFTED BY: ELS
DATE: 9-13-2022	PROJECT NO.: 631010764

PREPARED BY:
APTIM
APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.



OFFICE Pittsburgh, PA

DRAWING NUMBER 631010764-D203

VERIFY SCALE 0 1"

Xref :
Image :

File: C:\ray building\631010764-D203.dwg
Plot Date/Time: Sep 12, 2022 – 6:32am
Plotted By: Greg.Jones

APTIM

150 Royall Street
Canton, Massachusetts

DESIGNED BY: --	VARIAN MEDICAL SYSTEMS, INC. PALO ALTO, CALIFORNIA
DRAWN BY: --	FIGURE 3-1 ESTIMATED BUILDING 3 TREATMENT AREA FORMER VARIAN FACILITY SITE - BEVERLY, MA
CHECKED BY: --	

APPROVED BY:	DATE:	SCALE:	DRAWING NO.	SHEET NO.
--	-/-/--	AS SHOWN	631010764-D203	--

LEGEND:

- H-20 HEATERS VERTICAL TOTAL OF (41)
- HA-15 ANGLED HEATERS (SINGLE AND CLUSTERS) TOTAL OF (51) HEATERS AT 18 LOCATIONS
- M-1 MULTIPHASE EXTRACTION WELLS (M)(1)
- M-2 ANGLED MULTIPHASE EXTRACTION WELLS (M)(4)
- T-1 TEMPERATURE MONITORING POINTS (T)(5)
- T-1 ANGLED TEMPERATURE MONITORING POINTS (T)(3)
- APPROXIMATE THERMAL TREATMENT ZONE (TTZ)
- BUILDING 3 STOCKROOM

NOTES:

1. FINAL PLACEMENT AND NUMBER OF EACH WELLS TYPE IS SUBJECT TO CHANGE AND WILL CONSIDER UTILITY LOCATIONS AND BUILDING FEATURES SUCH AS FOOTINGS.
2. HEATER WELLS WILL BE INSTALLED IN FANS AT ANGLES EXPECTED TO RANGE FROM 16 TO 75 DEGREES FROM THE VERTICAL.
3. VERTICAL HEATER DEPTHS WILL RANGE FROM 5 TO 45 FEET BELOW THE BUILDING.
4. ANGLED HEATER DEPTHS WILL RANGE FROM 15 TO 55 FEET BELOW THE BUILDING.

REFERENCE:

TERRATHERM COMPANY, JANUARY 30, 2023, BASIS OF DESIGN REPORT, FORMER VARIAN SITE, DRAWING NO. C102.

SCALE
0 10 20 30 FEET

REV	DESCRIPTION / ISSUE	DATE	APPROVED

APTIM

150 Royall Street
Canton, Massachusetts

DESIGNED BY: --
DRAWN BY: --
CHECKED BY: --
APPROVED BY: --

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

FIGURE 3-2
PRELIMINARY DESIGN WELL FIELD LAYOUT
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

DATE:	SCALE:	DRAWING NO.	SHEET NO.
-/-/--	AS SHOWN	631030170-D1	--

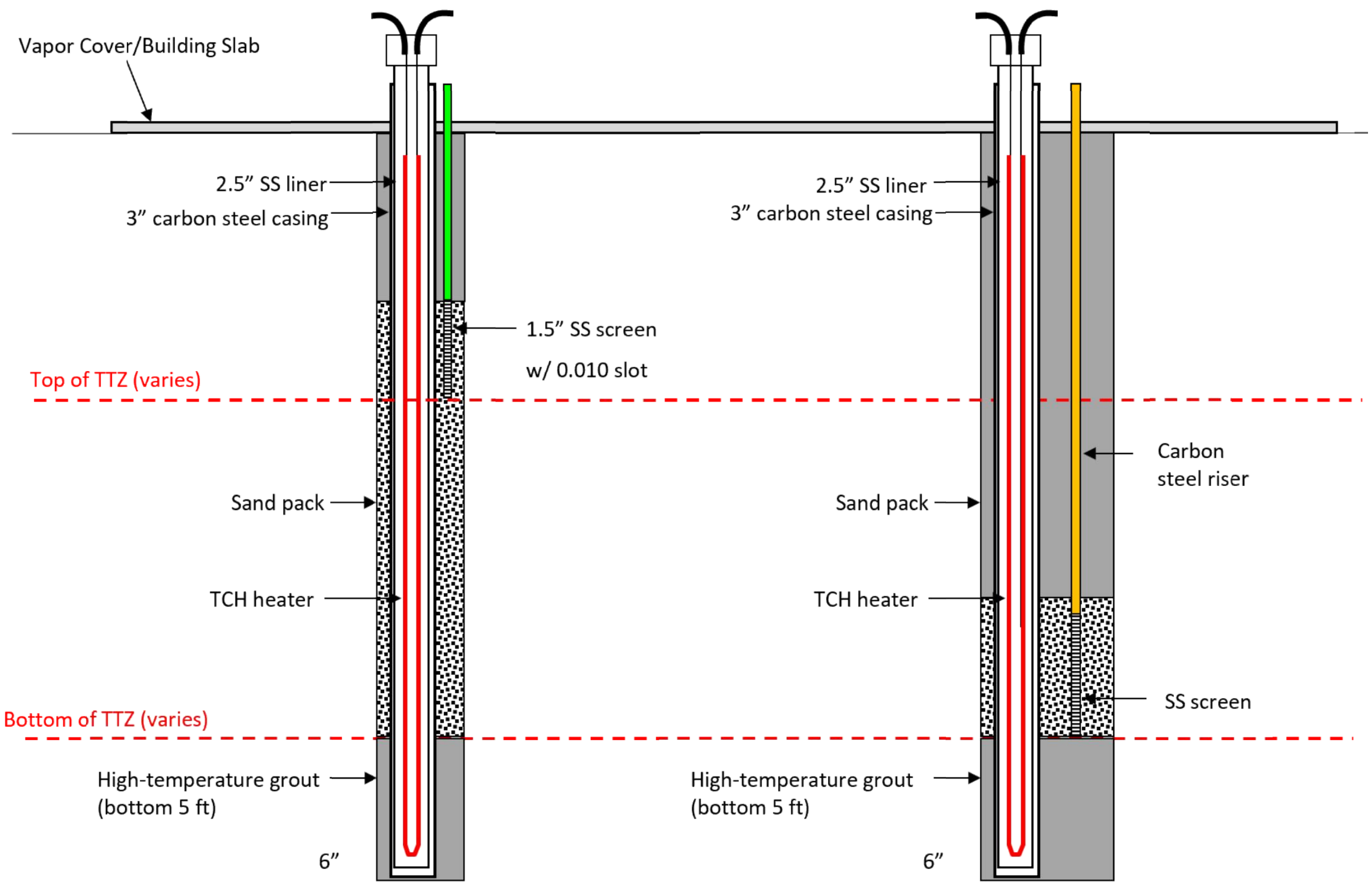
VERIFY SCALE 0 1"

Xref:
Image: CB&I.jpg

File: C:\Voy building 3\fix 631030170-D1.dwg
Plot Date/Time: Mar 06, 2023 - 12:58pm
Plotted By: Greg.Jones

File: C:\ray building 3\631030170-A1.dwg
Plot Date/Time: Mar 06, 2023 - 12:16pm
Plotted By: Greg.Jones
Xref :
Image :

OFFICE	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
Pittsburgh, PA	-/-/--	--	--	--	--	631030170-A1



REFERENCE:

TERRATHERM COMPANY, JANUARY 30, 2023, BASIS OF DESIGN REPORT, FORMER VARIAN SITE, FIGURE 3.8.

APTIM

150 Royall Street
Canton, Massachusetts

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

FIGURE 3-4

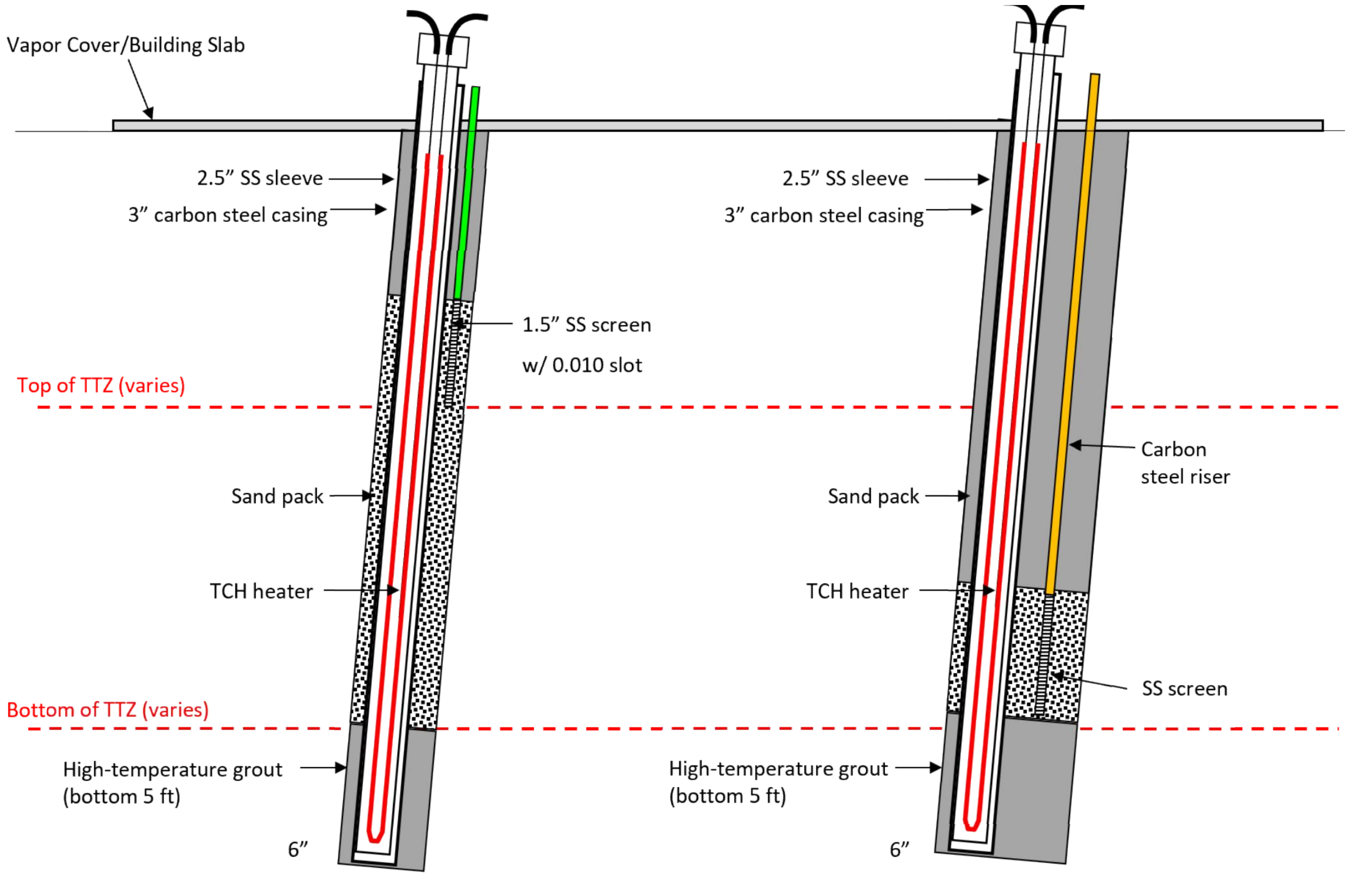
TYPICAL DESIGN FOR TCH /CO-LOCATED VEW / SIW'S

FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

File: C:\ray building 3\631030170-A1.dwg
Plot Date/Time: Mar 06, 2023 - 12:19pm
Plotted By: Greg.Jones

Xref :
Image :

OFFICE	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER	631030170-A1
Pittsburgh, PA	-/-/--	--	--	--	--		



NOTE:
HEATER WELL ANGLES EXPECTED TO RANGE FROM 16 TO 75 DEGREES FROM THE VERTICAL.

REFERENCE:
TERRATHERM COMPANY, JANUARY 30, 2023, BASIS OF DESIGN REPORT, FORMER VARIAN SITE, FIGURE 3.10.

APTIM

150 Royall Street
Canton, Massachusetts

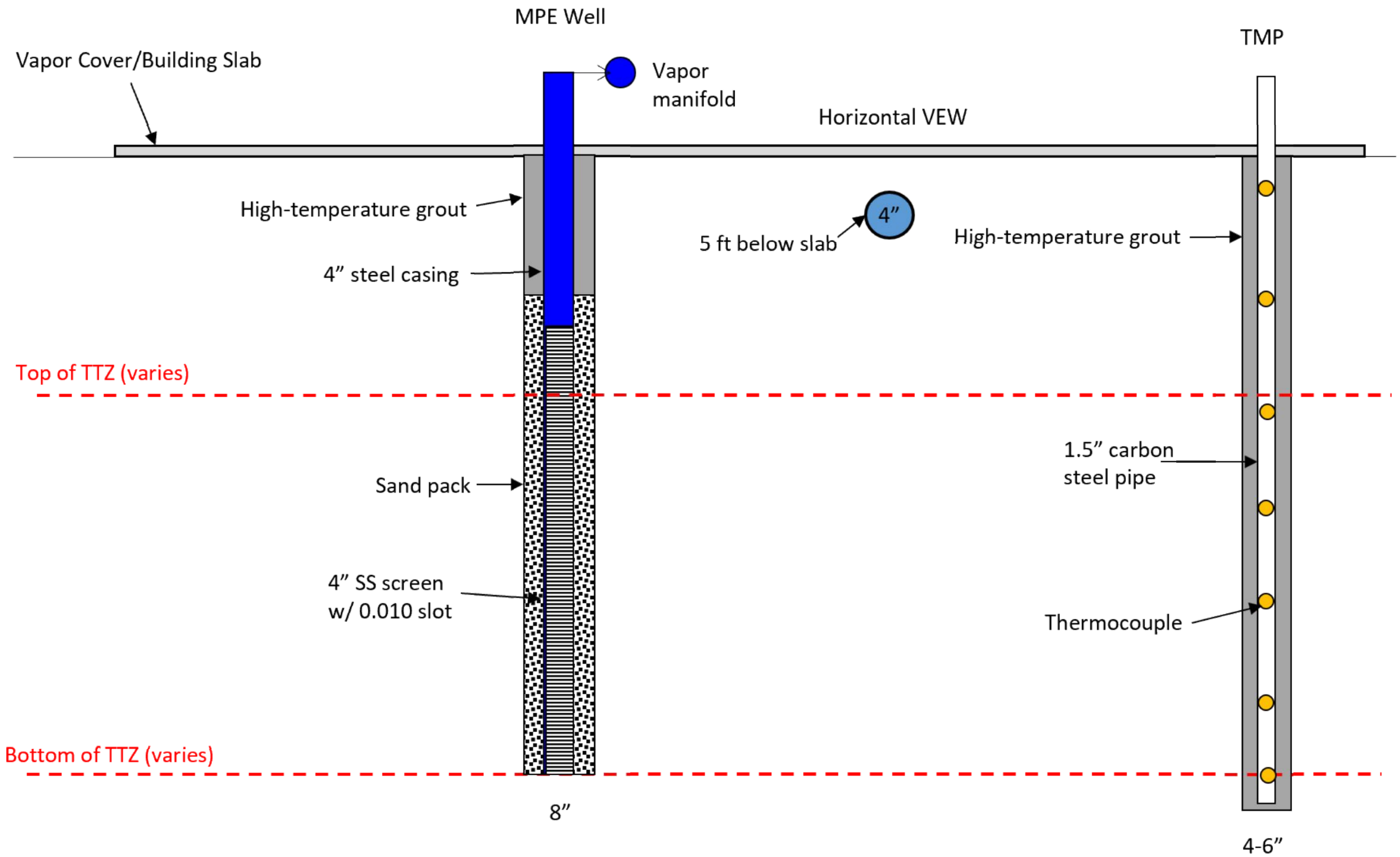
VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

FIGURE 3-5
TYPICAL DESIGN FOR ANGLED TCH / CO-LOCATED VEW / STREAM INJECTION WELLS
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

File: C:\ray building 3\631030170-A1.dwg
Plot Date/Time: Mar 06, 2023 - 12:18pm
Plotted By: Greg.Jones

Xref :
Image :

OFFICE	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER	631030170-A1
Pittsburgh, PA	-/-/--	--	--	--	--		



APTIM

150 Royall Street
Canton, Massachusetts

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

FIGURE 3-6
TYPICAL DESIGN FOR MPE, TMP, AND HVE WELLS
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

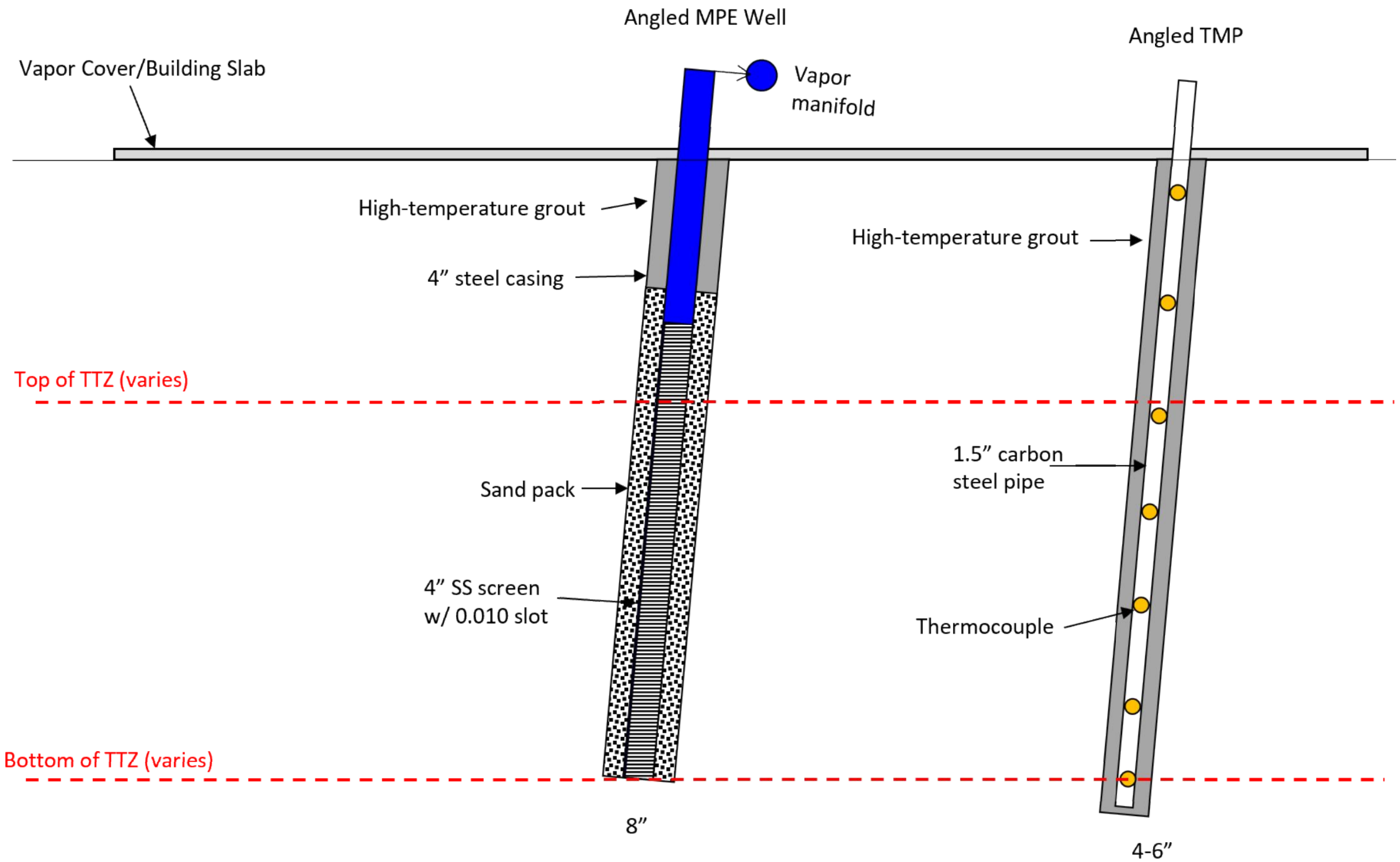
REFERENCE:

TERRATHERM COMPANY, JANUARY 30, 2023, BASIS OF DESIGN REPORT, FORMER VARIAN SITE, FIGURE 3.9.

File: C:\ray building 3\631030170-A1.dwg
Plot Date/Time: Mar 06, 2023 - 12:20pm
Plotted By: Greg.Jones

Xref :
Image :

OFFICE	DATE	DESIGNED BY	DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
Pittsburgh, PA	-/-/--	--	--	--	--	631030170-A1



REFERENCE:

TERRATHERM COMPANY, JANUARY 30, 2023, BASIS OF DESIGN REPORT, FORMER VARIAN SITE, FIGURE 3.11.

APTIM

150 Royall Street
Canton, Massachusetts

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

FIGURE 3-7

TYPICAL DESIGN FOR ANGLED MPE WELLS AND TMP

FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

XREF Files: IMAGE Files:
File: O:\PROJECT\ray varian\631010764-D211.dwg Layout: Layout1 User: Evan.Schlegel Sep 13, 2022 - 10:01am

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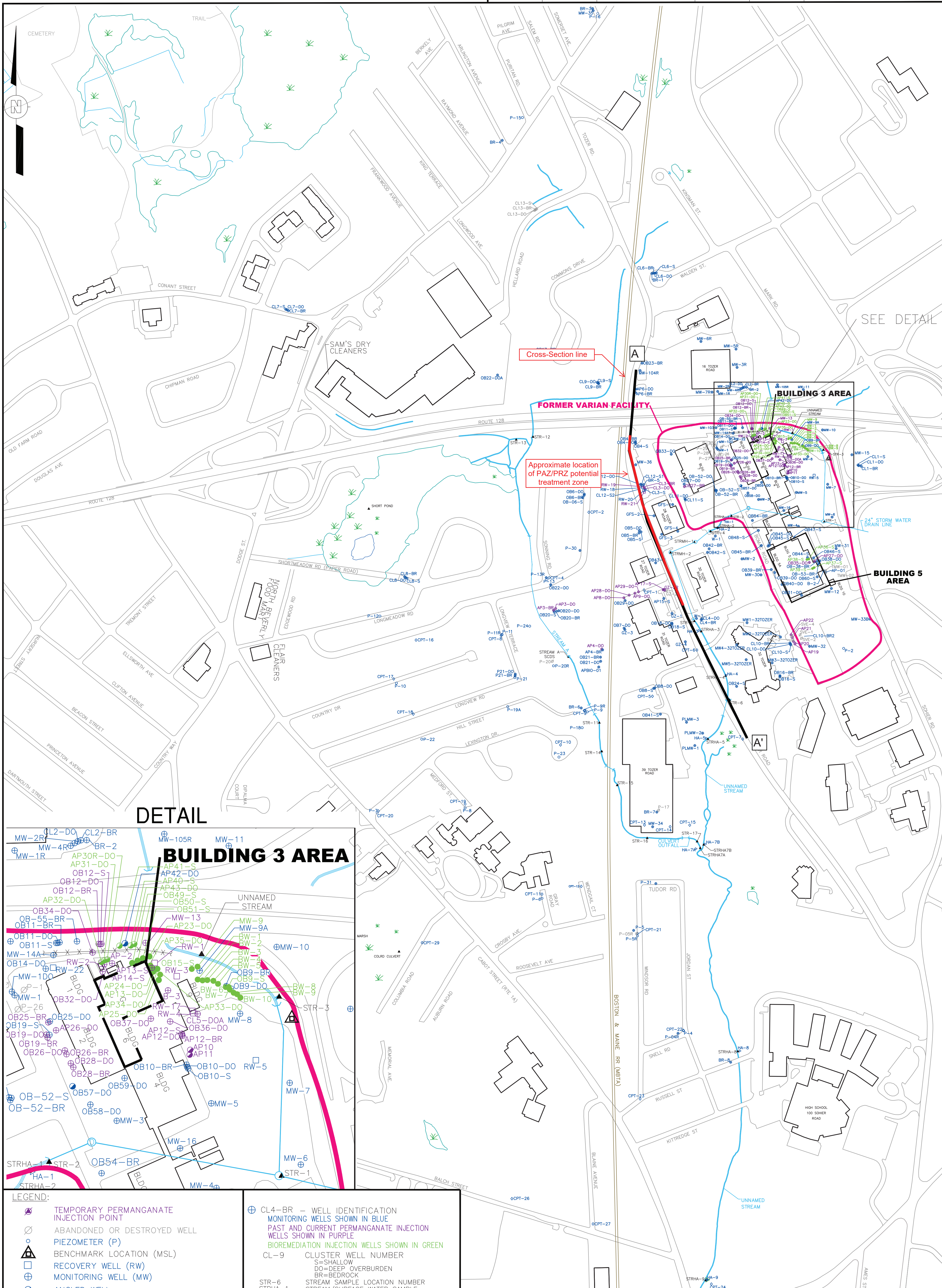
	9/13/22	APPROVED BY	RC	--		



LEGEND:

- TEMPORARY PERMANGANATE INJECTION POINT
- ABANDONED OR DESTROYED WELL
- PIEZOMETER (P)
- BENCHMARK LOCATION (MSL)
- RECOVERY WELL (RW)
- MONITORING WELL (MW)
- ANGLED WELL
- BIOREMEDIATION INJECTION WELL
- SURFACE WATER STREAM (STR) SAMPLE LOCATION
- CONE PENETROMETER TESTPOINT (CPT)
- HAND AUGER SAMPLE LOCATION (HA) ADJACENT TO A STREAM (STRHA)
- STRMH MANHOLE ACCESS TO THE STREAM LOCATED WITHIN A CULVERT
- APPROXIMATE BUILDING LOCATION
- APPROXIMATE DRAIN MANHOLE LOCATION
- APPROXIMATE LOCATION OF STREAM IN CULVERT
- APPROXIMATE STREAM LOCATION
- WATER AND MARSH AREA

CL4-BR – WELL IDENTIFICATION
MONITORING WELLS SHOWN IN BLUE
PAST AND CURRENT PERMANGANATE INJECTION WELLS SHOWN IN PURPLE
BIOREMEDIATION INJECTION WELLS SHOWN IN GREEN

CL-9	CLUSTER WELL NUMBER S=SHALLOW DO=DEEP OVERBURDEN BR=BEDROCK
STR-6	STREAM SAMPLE LOCATION NUMBER
STRHA-1	STREAM/SURFACE WATER SAMPLE
HA-1	HAND AUGER WELL LOCATION NUMBER
STRMH-1	STREAM/MANHOLE LOCATION NUMBER
MW-5	MONITORING WELL NUMBER
GZ-1	MONITORING WELL NUMBER
PLMW-1	MONITORING WELL NUMBER
BR-1	BEDROCK WELL NUMBER

BEDROCK WELLS BR-1 THROUGH BR-8 AND CL9-BR HAVE MULTILEVEL GROUNDWATER MONITORING SYSTEMS PRESENT WITHIN THE BEDROCK. ZONE 1 REFERS TO THE DEEPEST SAMPLING ZONE, ZONE 2 REFERS IS THE MIDDLE SAMPLING INTERVAL, AND ZONE 3 CLOSEST TO THE GROUND SURFACE.

THIS MAP HAS BEEN COMPILED FROM SURVEY DATA COLLECTED IN JULY 1994, MARCH 1995, OCTOBER 1995, SEPTEMBER 1996, MARCH 1997, DECEMBER 1997, SEPTEMBER 1998, JANUARY 2000, FEBRUARY 2001, JUNE 2002, SEPTEMBER 2002, JULY 2003, FEBRUARY 2004, OCTOBER 2004; 2005, JULY 2012, MAY 2014, AUGUST 2018 FROM VARIOUS EXISTING PLANS, AND OBSERVATIONS MADE IN THE FIELD BY CB&I ENVIRONMENTAL & INFRASTRUCTURE, INC., AND APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.

SCALE
0 250 500 750 FEET

FIGURE 4-1
TOZER ROAD TREATMENT AREA
FORMER VARIAN FACILITY SITE - BEVERLY, MA.

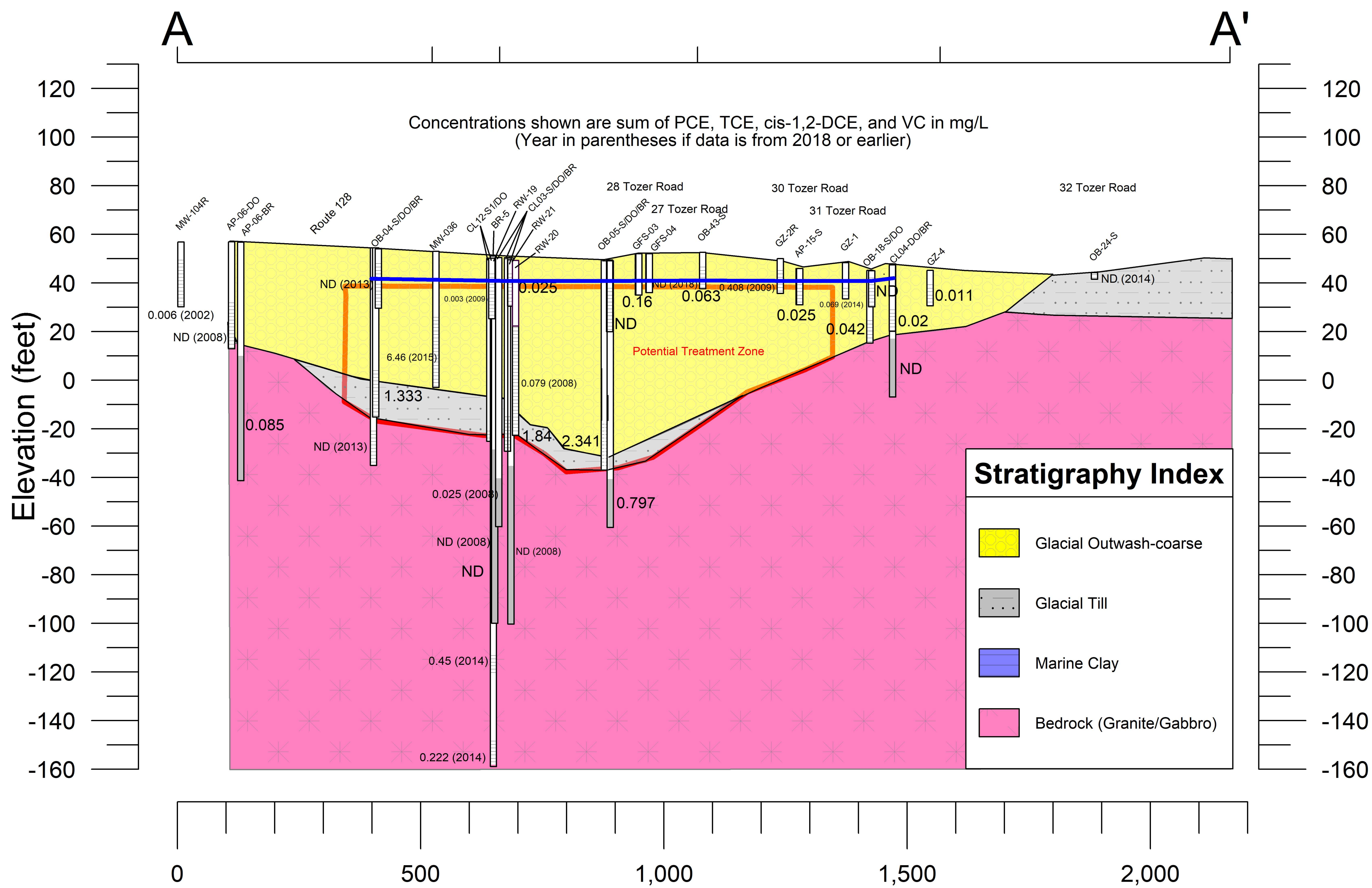
PREPARED FOR: VARIAN MEDICAL SYSTEMS, INC. PALO ALTO, CALIFORNIA

SCALE: 1" = 250'	DRAFTED BY: ELS
DATE: 9-13-2022	PROJECT NO.: 631010764

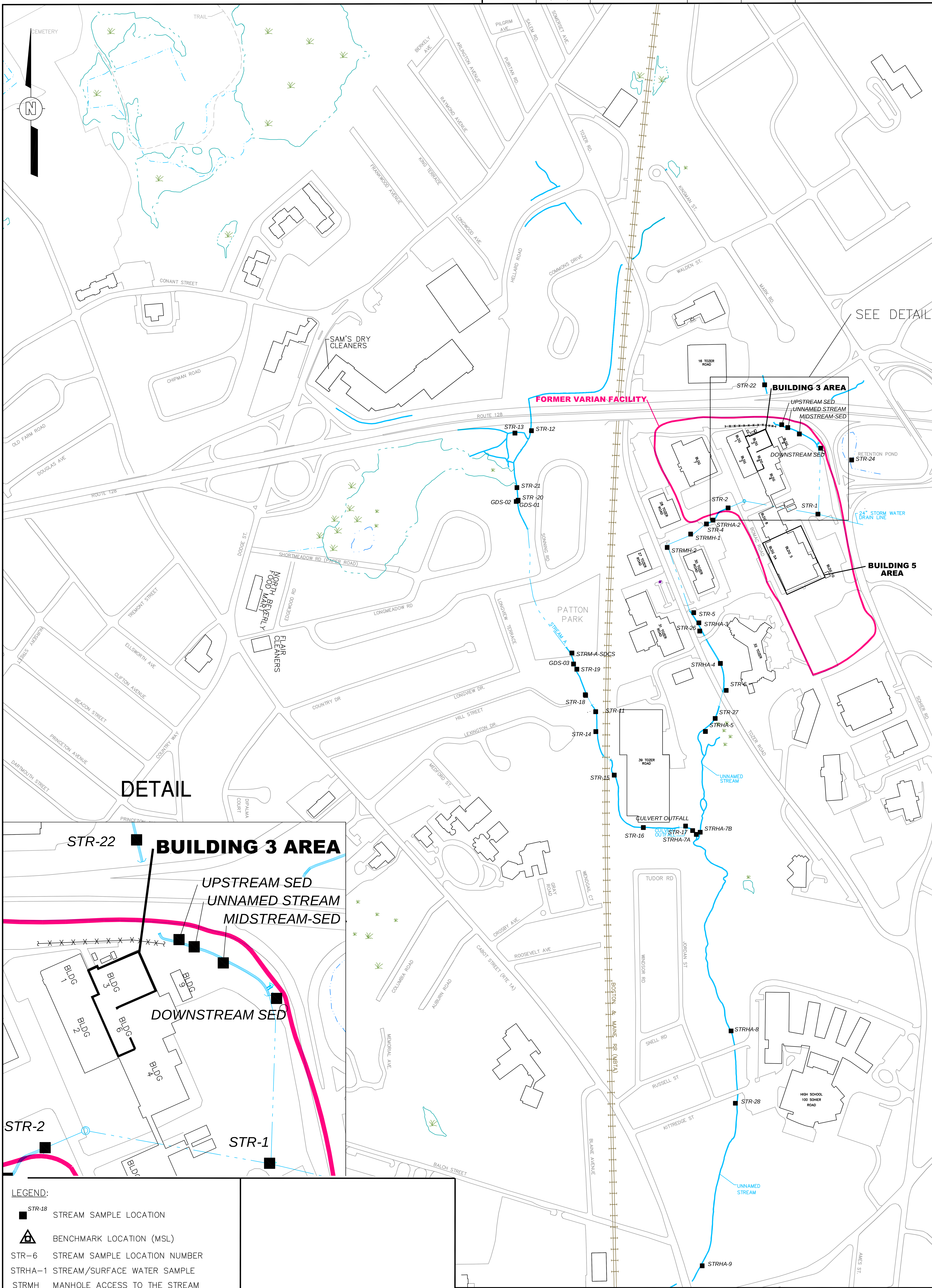
PREPARED BY:

APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.

Figure 4-2: Cross-Section A-A' along Tozer Road



DRAWN BY	ELS	CHECKED BY	RC	--	DRAWING NAME	631237906-D9
	6/18/19	APPROVED BY	RC	--		



LEGEND:

STR-18	STREAM SAMPLE LOCATION
	BENCHMARK LOCATION (MSL)
STR-6	STREAM SAMPLE LOCATION NUMBER
STRHA-1	STREAM/SURFACE WATER SAMPLE
STRMH	MANHOLE ACCESS TO THE STREAM LOCATED WITHIN A CULVERT
	APPROXIMATE BUILDING LOCATION
D	APPROXIMATE DRAIN MANHOLE LOCATION
	APPROXIMATE LOCATION OF STREAM IN CULVERT
	APPROXIMATE STREAM LOCATION
	WATER AND MARSH AREA

THIS MAP HAS BEEN COMPILED FROM SURVEY DATA COLLECTED IN JULY 1994, MARCH 1995, OCTOBER 1995, SEPTEMBER 1996, MARCH 1997, DECEMBER 1997, SEPTEMBER 1998, JANUARY 2000, FEBRUARY 2001, JUNE 2002, SEPTEMBER 2002, JULY 2003, FEBRUARY 2004, OCTOBER 2004; 2005, JULY 2012, MAY 2014, AUGUST 2018 FROM VARIOUS EXISTING PLANS, AND OBSERVATIONS MADE IN THE FIELD BY CB&I ENVIRONMENTAL & INFRASTRUCTURE, INC., AND APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.

SCALE

0 250 500 750 FEET

FIGURE 5-1
STREAM SAMPLE LOCATION MAP
FORMER VARIAN FACILITY SITE - BEVERLY, MA.

PREPARED FOR: VARIAN MEDICAL SYSTEMS, INC. PALO ALTO, CALIFORNIA	
SCALE: 1" = 250'	DRAFTED BY:
DATE:	PROJECT NO.:
PREPARED BY: APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC.	

APPENDIX A

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM BWSC-108

Massachusetts Department of Environmental Protection
Bureau of Waste Site Cleanup

COMPREHENSIVE RESPONSE ACTION TRANSMITTAL FORM & PHASE I COMPLETION STATEMENT
Pursuant to 310 CMR 40.0484 (Subpart D) and 40.0800 (Subpart H)

BWSC 108

Release Tracking Number
3 - 485

A. SITE LOCATION:

1. Site Name: VARIAN-MICROWAVE DIV

2. Street Address: 150 SOHIER RD

3. City/Town: BEVERLY 4. ZIP Code: 019150000

☐ 5. Check here if the disposal site that is the source of the release is Tier Classified. Check the current Tier Classification Category:

☐ a. Tier I ☐ b. Tier ID ☐ c. Tier II

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

☐ 1. Submit a **Phase I Completion Statement,** pursuant to 310 CMR 40.0484.

☐ 2. Submit a **Revised Phase I Completion Statement,** pursuant to 310 CMR 40.0484.

☐ 3. Submit a **Phase II Scope of Work,** pursuant to 310 CMR 40.0834.

☐ 4. Submit an **interim Phase II Report.** This report does not satisfy the response action deadline requirements in 310 CMR 40.0500.

☐ 5. Submit a **final Phase II Report and Completion Statement,** pursuant to 310 CMR 40.0836.

☐ 6. Submit a **Revised Phase II Report and Completion Statement,** pursuant to 310 CMR 40.0836.

☐ 7. Submit a **Phase III Remedial Action Plan and Completion Statement,** pursuant to 310 CMR 40.0862.

☐ 8. Submit a **Revised Phase III Remedial Action Plan and Completion Statement,** pursuant to 310 CMR 40.0862.

☑ 9. Submit a **Phase IV Remedy Implementation Plan,** pursuant to 310 CMR 40.0874.

☐ 10. Submit a **Modified Phase IV Remedy Implementation Plan,** pursuant to 310 CMR 40.0874.

☐ 11. Submit an **As-Built Construction Report,** pursuant to 310 CMR 40.0875.

☐ 12. Submit a **Phase IV Status Report,** pursuant to 310 CMR 40.0877.

☐ 13. Submit a **Phase IV Completion Statement,** pursuant to 310 CMR 40.0878 and 40.0879.

Specify the outcome of Phase IV activities: (check one)

☐ a. Phase V Operation, Maintenance or Monitoring of the Comprehensive Remedial Action is necessary to achieve a Permanent or Temporary Solution.

☐ b. The requirements of a Permanent Solution have been met. A completed Permanent Solution Statement and Report (BWSC104) will be submitted to DEP.

☐ c. The requirements of a Temporary Solution have been met. A completed Temporary Solution Statement and Report (BWSC104) will be submitted to DEP.

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

☐ 14. Submit a **Revised Phase IV Completion Statement,** pursuant to 310 CMR 40.0878 and 40.0879.

☐ 15. Submit a **Phase V Status Report,** pursuant to 310 CMR 40.0892.

☐ 16. Submit a **Remedial Monitoring Report.** (This report can only be submitted through eDEP.)

a. Type of Report: (check one) ☐ i. Initial Report ☐ ii. Interim Report ☐ iii. Final Report

b. Frequency of Submittal: (check all that apply)

☐ i. A Remedial Monitoring Report(s) submitted monthly to address an Imminent Hazard.

☐ ii. A Remedial Monitoring Report(s) submitted monthly to address a Condition of Substantial Release Migration.

☐ iii. A Remedial Monitoring Report(s) submitted every six months, concurrent with a Status Report.

☐ iv. A Remedial Monitoring Report(s) submitted annually, concurrent with a Status Report.

c. Status of Site: (check one) ☐ i. Phase IV ☐ ii. Phase V ☐ iii. Remedy Operation Status ☐ iv. Temporary Solution

d. Number of Remedial Systems and/or Monitoring Programs: ______________________

A separate BWSC108A, CRA Remedial Monitoring Report, must be filled out for each Remedial System and/or Monitoring Program addressed by this transmittal form.

☐ 17. Submit a **Remedy Operation Status,** pursuant to 310 CMR 40.0893.

☐ 18. Submit a **Status Report to maintain a Remedy Operation Status,** pursuant to 310 CMR 40.0893(2).

☐ 19. Submit a **Transfer and/or a Modification of Persons Maintaining a Remedy Operation Status (ROS),** pursuant to 310 CMR 40.0893(5) (check one, or both, if applicable).

☐ a. Submit a Transfer of Persons Maintaining an ROS (the transferee should be the person listed in Section D, "Person Undertaking Response Actions").

☐ b. Submit a Modification of Persons Maintaining an ROS (the primary representative should be the person listed in Section D, "Person Undertaking Response Actions").

c. Number of Persons Maintaining an ROS not including the primary representative: ______________________

☐ 20. Submit a **Termination of a Remedy Operation Status,** pursuant to 310 CMR 40.0893(6).(check one)

☐ a. Submit a notice indicating ROS performance standards have not been met. A plan and timetable pursuant to 310 CMR 40.0893(6)(b) for resuming the ROS are attached.

☐ b. Submit a notice of Termination of ROS.

☐ 21. Submit a **Phase V Completion Statement,** pursuant to 310 CMR 40.0894.

Specify the outcome of Phase V activities: (check one)

☐ a. The requirements of a Permanent Solution have been met. A completed Permanent Solution Statement and Report (BWSC104) will be submitted to DEP.

☐ b. The requirements for a Temporary Solution have been met. A completed Temporary Solution Statement and Report (BWSC104) will be submitted to DEP.

☐ 22. Submit a **Revised Phase V Completion Statement,** pursuant to 310 CMR 40.0894.

☐ 23. Submit a **Temporary Solution Status Report,** pursuant to 310 CMR 40.0898.

☐ 24. Submit a **Plan for the Application of Remedial Additives** near a sensitive receptor, pursuant to 310 CMR 40.0046(3).

a. Status of Site: (check one)

☐ i. Phase IV ☐ ii. Phase V ☐ iii. Remedy Operation Status ☐ iv. Temporary Solution

C. LSP SIGNATURE AND STAMP:

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

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

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

> *if Section B indicates that an* ***As-Built Construction Report,*** *a* ***Remedy Operation Status,*** *a* ***Phase IV, Phase V or Temporary Solution Status Report,*** *a* ***Status Report to Maintain a Remedy Operation Status,*** *a* ***Transfer or Modification of Persons Maintaining a Remedy Operation Status*** *and/or a* ***Remedial Monitoring Report*** *is being submitted,* the response action(s) that is (are) the subject of this submittal (i) is (are) being implemented in accordance with the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, (ii) is (are) appropriate and reasonable to accomplish the purposes of such response action(s) as set forth in the applicable provisions of M.G.L. c. 21E and 310 CMR 40.0000, and (iii) comply(ies) with the identified provisions of all orders, permits, and approvals identified in this submittal.

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

1. LSP#: 4689

2. First Name: BRIAN J 3. Last Name: COTE

4. Telephone: 6175896175 5. Ext.: ______ 6. Email: ______

7. Signature: ______

8. Date: ______ (mm/dd/yyyy) 9. LSP Stamp:

D. PERSON UNDERTAKING RESPONSE ACTIONS:

1. Check all that apply: ☐ a. change in contact name ☐ b. change of address ☐ c. change in the person undertaking response actions

2. Name of Organization: VARIAN MEDICAL SYSTEMS INC

3. Contact First Name: MATTHEW 4. Last Name: GILLIS

5. Street: 525 9TH STREET 6. Title:

7. City/Town: WASHINGTON 8. State: DC 9. ZIP Code: 200040000

10. Telephone: 11. Ext: 12. Email:

E. RELATIONSHIP TO SITE OF PERSON UNDERTAKING RESPONSE ACTIONS: ☐ Check here to change relationship

☑ 1. RP or PRP ☐ a. Owner ☐ b. Operator ☐ c. Generator ☐ d. Transporter

☑ e. Other RP or PRP Specify: NON-SPECIFIED PRP

☐ 2. Fiduciary, Secured Lender or Municipality with Exempt Status (as defined by M.G.L. c. 21E, s. 2)

☐ 3. Agency or Public Utility on a Right of Way (as defined by M.G.L. c. 21E, s. 5(j))

☐ 4. Any Other Person Undertaking Response Actions Specify Relationship:

F. REQUIRED ATTACHMENT AND SUBMITTALS:

☑ 1. Check here if the Response Action(s) on which this opinion is based, if any, are (were) subject to any order(s), permit(s) and/or approval(s) issued by DEP or EPA. If the box is checked, you MUST attach a statement identifying the applicable provisions thereof.

☐ 2. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the submittal of any Phase Reports to DEP.

☐ 3. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase III Remedial Action Plan.

☑ 4. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of the availability of a Phase IV Remedy Implementation Plan.

☐ 5. Check here to certify that the Chief Municipal Officer and the Local Board of Health have been notified of any field work involving the implementation of a Phase IV Remedial Action.

☐ 6. If submitting a Transfer of a Remedy Operation Status (as per 310 CMR 40.0893(5)), check here to certify that a statement detailing the compliance history for the person making this submittal (transferee) is attached.

☐ 7. If submitting a Modification of a Remedy Operation Status (as per 310 CMR 40.0893(5)), check here to certify that a statement detailing the compliance history for each new person making this submittal is attached.

☐ 8. Check here if any non-updatable information provided on this form is incorrect, e.g. Release Address/Location Aid. Send corrections to: BWSC.eDEP@state.ma.us.

☑ 9. Check here to certify that the LSP Opinion containing the material facts, data, and other information is attached.

G. CERTIFICATION OF PERSON UNDERTAKING RESPONSE ACTIONS:

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

>*if Section B indicates that this is a* **Modification of a Remedy Operation Status (ROS),** I attest under the pains and penalties of perjury that I am fully authorized to act on behalf of all persons performing response actions under the ROS as stated in 310 CMR 40.0893(5)(d) to receive oral and written correspondence from MassDEP with respect to performance of response actions under the ROS, and to receive a statement of fee amount as per 4.03(3).

I understand that any material received by the Primary Representative from MassDEP shall be deemed received by all the persons performing response actions under the ROS, and I am aware that there are significant penalties, including, but not limited to, possible fines and imprisonment, for willfully submitting false, inaccurate or incomplete information.

2. By: ____________________ (Signature)   3. Title: ____________________

4. For: VARIAN MEDICAL SYSTEMS INC (Name of person or entity recorded in Section D)   5. Date: __________ (mm/dd/yyyy)

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

7. Street: ____________________

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

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

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

Date Stamp (DEP USE ONLY:)

Attachment to BWSC 108
150 Sohier Road, Beverly, MA
RTN 3-0485

Approvals from the Massachusetts Department of Environmental Protection that this submittal is subject to include:

- Massachusetts Department of Environmental Protection Termination of Remedy Operation Status Notice of Noncompliance, dated February 18, 2022.

- Massachusetts Department of Environmental Protection approval of extension request, letter to Varian Medical Systems, Inc., dated July 6, 2022.

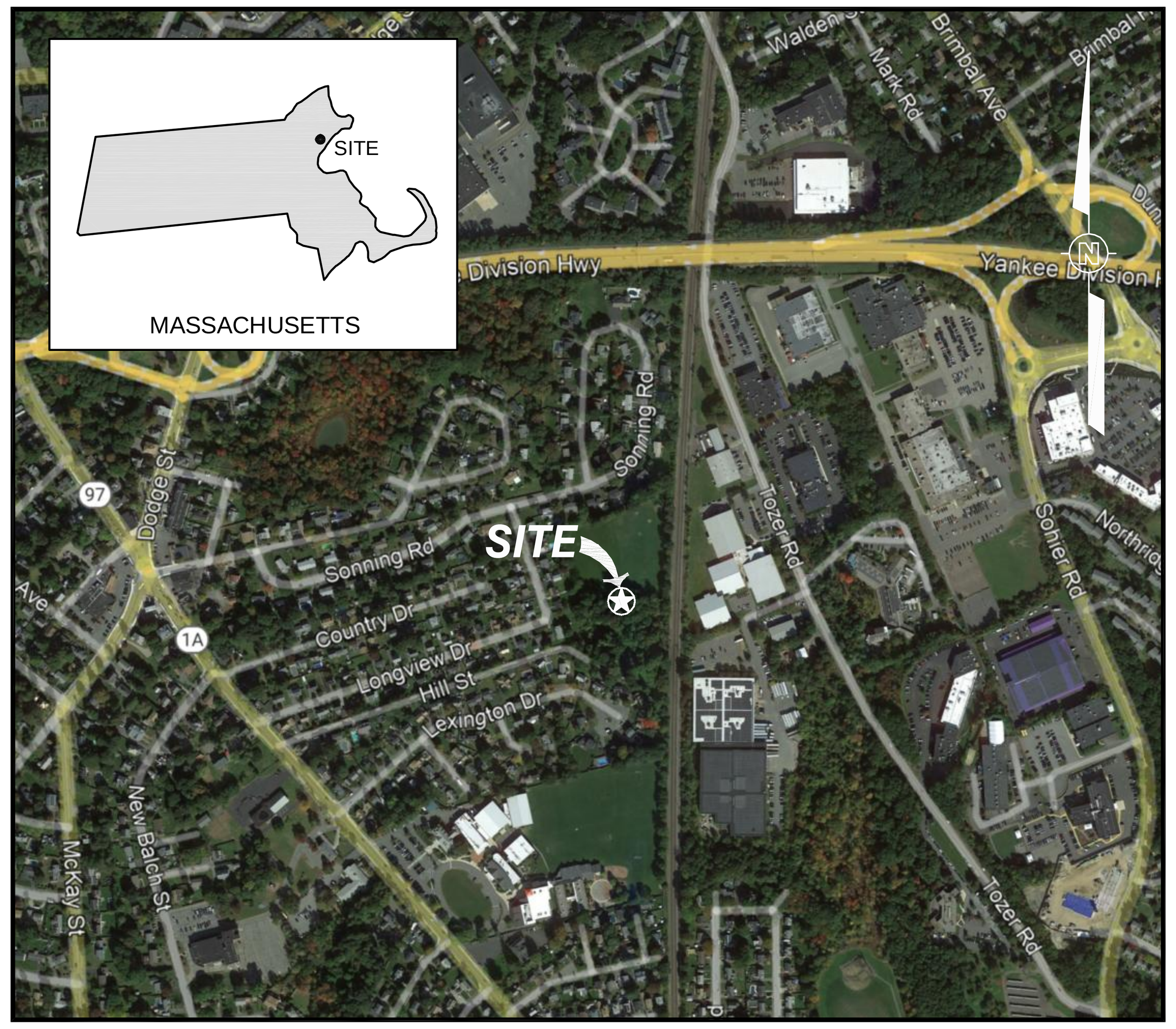
- Public Comment Draft Phase II Addendum Reporting Schedule, Aptim Environmental and Infrastructure, LLC letter to Massachusetts Department of Environmental Protection, dated September 12, 2022

APPENDIX B

STREAM A SEEP RCM CONSTRUCTION DRAWINGS

INDEX OF DRAWINGS

APTIM DRAWING NUMBER	SHEET REFERENCE NUMBER	DESCRIPTION
631030174-T1	T-1	TITLE SHEET
631030174-C1	C-1	SITE PLAN
631030174-D1	D-1	REACTIVE CORE MAT CONSTRUCTION PLAN
631030174-D2	D-2	CONSTRUCTION DETAILS



SITE LOCATION MAP

SCALE 0 600 1200 FEET

SITE VICINITY MAP

SCALE 0 30 60 FEET

ENGINEERED CONTROLS STREAM A SEEP
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

PREPARED FOR:

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

REV	DESCRIPTION / ISSUE	DATE	APPROVED

APTIM
150 Royall Street
Canton, Massachusetts

DESIGNED BY: EV	VARIAN MEDICAL SYSTEMS, INC. PALO ALTO, CALIFORNIA
DRAWN BY: GJ	TITLE SHEET
CHECKED BY: --	ENGINEERED CONTROLS STREAM A SEEP FORMER VARIAN FACILITY SITE BEVERLY, MASSACHUSETTS

APPROVED BY:	DATE:	SCALE:	DRAWING NO.	SHEET NO.
--	2/20/23	AS SHOWN	631030174-T1	T-1

DRAWING NUMBER 631030174-T1
OFFICE Canton, MA

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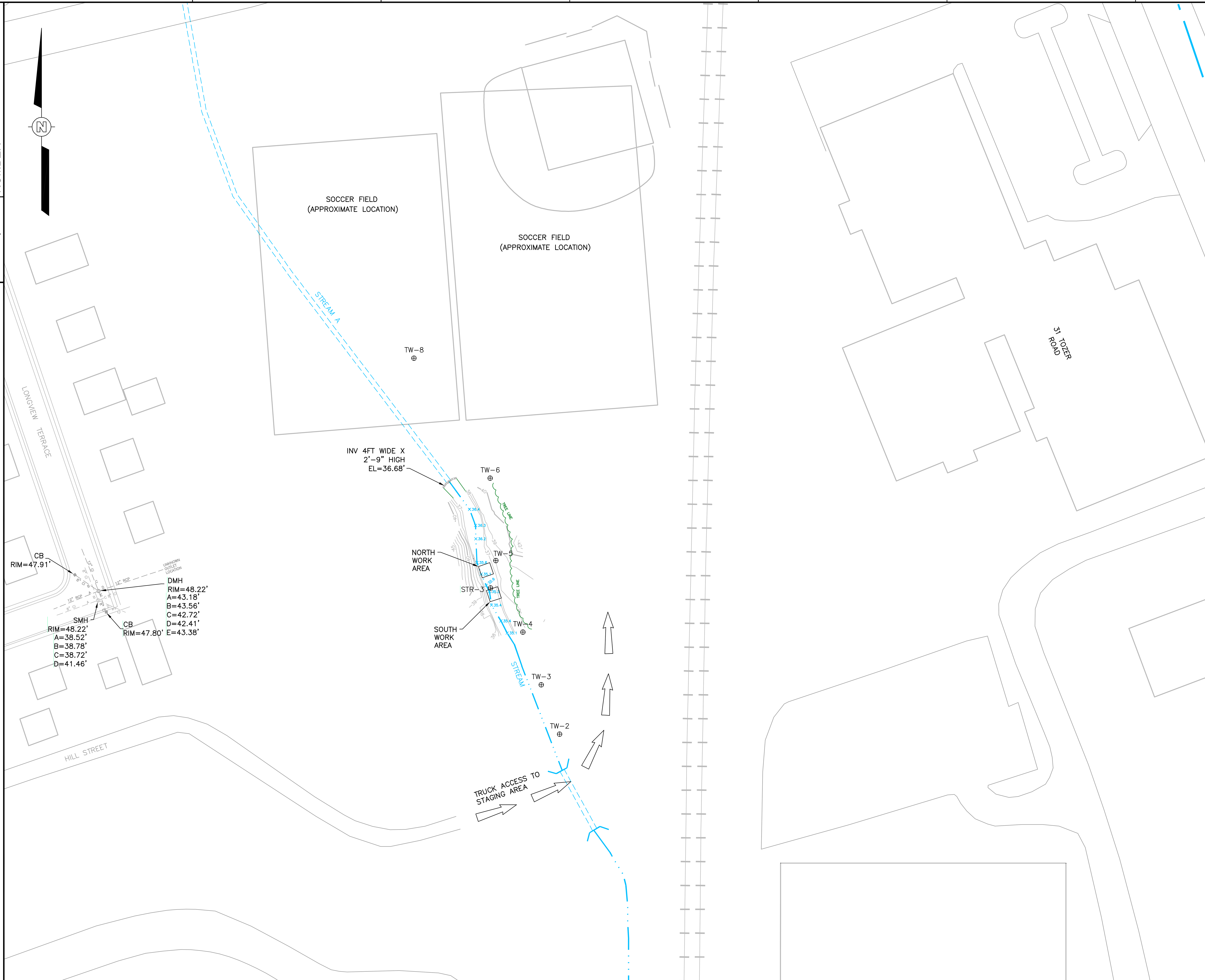
Plot Date/Time: Feb 24, 2023 - 9:48am
Plotted By: Greg.Jones



SURVEY NOTES:

1. HORIZONTAL DATUM IS MASSACHUSETTS NORTH AMERICAN DATUM OF 1927 (NAD27)
2. VERTICAL DATUM SHOWN IS BASED ON SITE WELL DATUM.

REFERENCE:

1. EXISTING CONDITIONS PLAN, LONGVIEW TERRACE STREAM, BEVERLY, MASS. A-PLUS CONSTRUCTION SERVICES CORP. 17 ACCORD PARK DRIVE, NORWELL, MA, FILE: 4280 BEVERLY STREAM EXISTING SURVEY 2-17-23, REV 0, FEBRUARY 17, 2023.
2. BASE MAP FROM APTIM ENVIRONMENTAL & INFRASTRUCTURE, INC., TITLED: LONGVIEW/HILL STREET TREATMENT AREA, DATED: 11 NOVEMBER 2023, DRAWING NUMBER: 631010764-B203.

SCALE
0 40 80 120 FEET

REV	DESCRIPTION / ISSUE	DATE	APPROVED

APTIM

150 Royall Street
Canton, Massachusetts

DESIGNED BY: EV
DRAWN BY: GJ
CHECKED BY: --
APPROVED BY: --

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

SITE PLAN

ENGINEERED CONTROLS STREAM A SEEP
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

DATE: 2/20/23
SCALE: AS SHOWN
DRAWING NO. 631030174-C1
SHEET NO. C-1

OFFICE Canton, MA
DRAWING NUMBER 631030174-C1

VERIFY SCALE 0 1"

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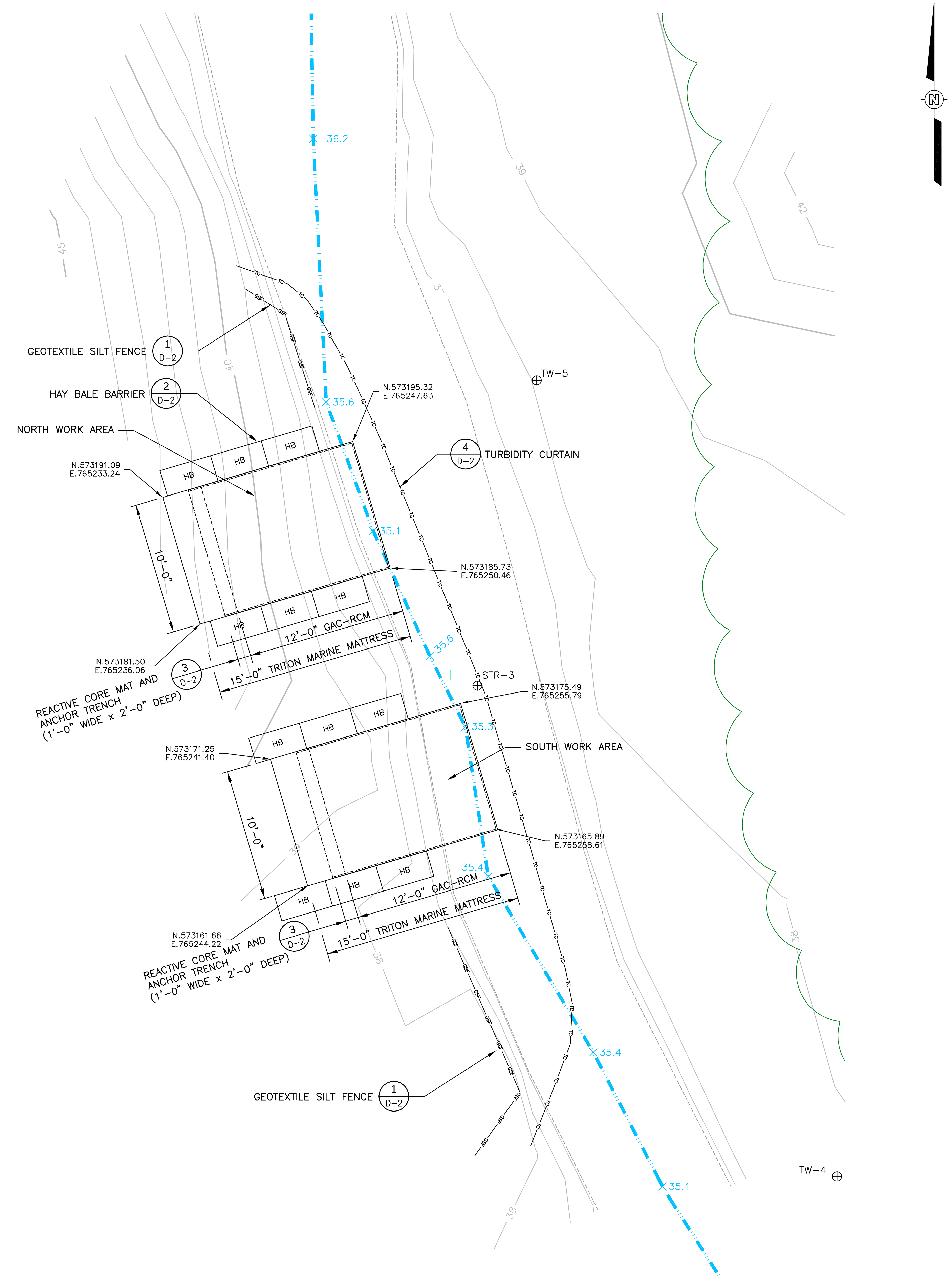
Plot Date/Time: Mar 02, 2023 - 9:12am
Plotted By: Greg.Jones

DRAWING NUMBER 631030174-D1

OFFICE Canton, MA



LEGEND:

- 22 EXISTING CONTOUR
- GSF SILT FENCE
- ANCHOR TRENCH
- GAC-RCM LIMIT
- HB HB HB HAY BALE BARRIER
- STREAM A
- POLYMER MARINE MATTRESS LIMIT

NOTES:

1. CONTRACTOR SHALL COMPLY WITH ALL PROJECT PERMIT CONDITIONS AND SHALL OBTAIN ALL PERMITS FOR TEMPORARY FACILITIES.
2. CONTRACTOR TO FURNISH AND INSTALL COMPLETE EROSION CONTROL SYSTEM(S) AS SPECIFIED IN ORDER OF CONDITIONS. EROSION CONTROL STRUCTURES SHALL BE INSTALLED PRIOR TO WORK.
3. MEASURES TO PREVENT RUTTING AND DISTURBANCE FROM EQUIPMENT SHALL BE USED WHEN ACCESSING WORK AREA AND DURING INSTALLATION I.E. HEAVY EQUIPMENT CONSTRUCTION MATS AND EQUIPMENT WITH RUBBER TRACKS OR TURF TIRES.
4. CONTRACTOR TO FURNISH AND INSTALL COMPLETE GAC-RCM AND POLYMER MARINE MATTRESS ENGINEERED CONTROL SYSTEM, WITH 1-YEAR WARRANTY ON ALL MATERIAL AND LABOR.
5. CONTRACTOR TO COORDINATE ALL DETAILS OF EROSION AND ENGINEERED CONTROLS INSTALLATION.
6. CONTRACTOR TO SUBMIT SHOP DRAWINGS AND MATERIAL PROPOSALS FOR ACCEPTANCE FOR ANY SUBSTITUTIONS PRIOR TO START OF WORK.
7. CONTRACTOR SHALL INSTALL NEW, AND REPLACE ANY DAMAGED, EROSION AND SEDIMENTATION CONTROLS THROUGH THE LIFE OF THE PROJECT.
8. SEDIMENT LADEN WATER SHALL NOT BE PERMITTED TO DRAIN OFF WORK AREA WITHOUT PASSING THROUGH EROSION AND SEDIMENTATION CONTROLS I.E., SILT FENCE, HAY WATTLES, HAY BALE BARRIER.
9. RETURN ALL WORK AREAS TO PRE-CONSTRUCTION CONDITION.
10. PROVIDE PRE AND POST CONSTRUCTION DIGITAL PHOTO RECORD.

SURVEY NOTES:

1. HORIZONTAL DATUM IS MASSACHUSETTS NORTH AMERICAN DATUM OF 1927 (NAD27)
2. VERTICAL DATUM SHOWN IS BASED ON SITE WELL DATUM.

REFERENCE:

EXISTING CONDITIONS PLAN, LONGVIEW TERRACE STREAM, BEVERLY, MASS. A-PLUS CONSTRUCTION SERVICES CORP. 17 ACCORD PARK DRIVE, NORWELL, MA, FILE: 4280 BEVERLY STREAM EXISTING SURVEY 2-17-23, REV 0, FEBRUARY 17, 2023.

SCALE 0 5 10 15 FEET

REV	DESCRIPTION / ISSUE	DATE	APPROVED

APTIM

150 Royall Street
Canton, Massachusetts

DESIGNED BY: EV

DRAWN BY: GJ

CHECKED BY: --

APPROVED BY: --

VARIAN MEDICAL SYSTEMS, INC.
PALO ALTO, CALIFORNIA

REACTIVE CORE MAT CONSTRUCTION PLAN

ENGINEERED CONTROLS STREAM A SEEP
FORMER VARIAN FACILITY SITE
BEVERLY, MASSACHUSETTS

DATE:	SCALE:	DRAWING NO.	SHEET NO.
2/20/23	AS SHOWN	631030174-D1	D-1

VERIFY SCALE 0 1"

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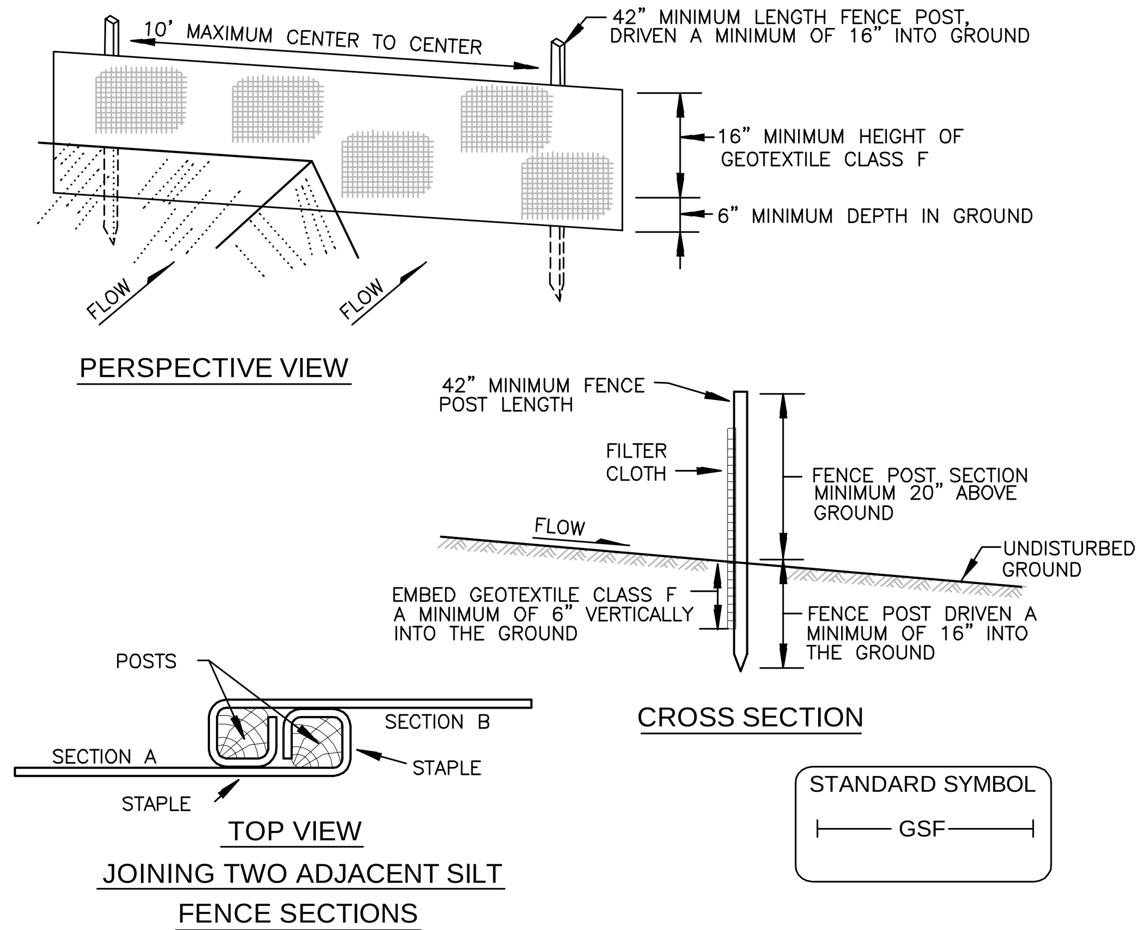
Plotted By: Greg.Jones

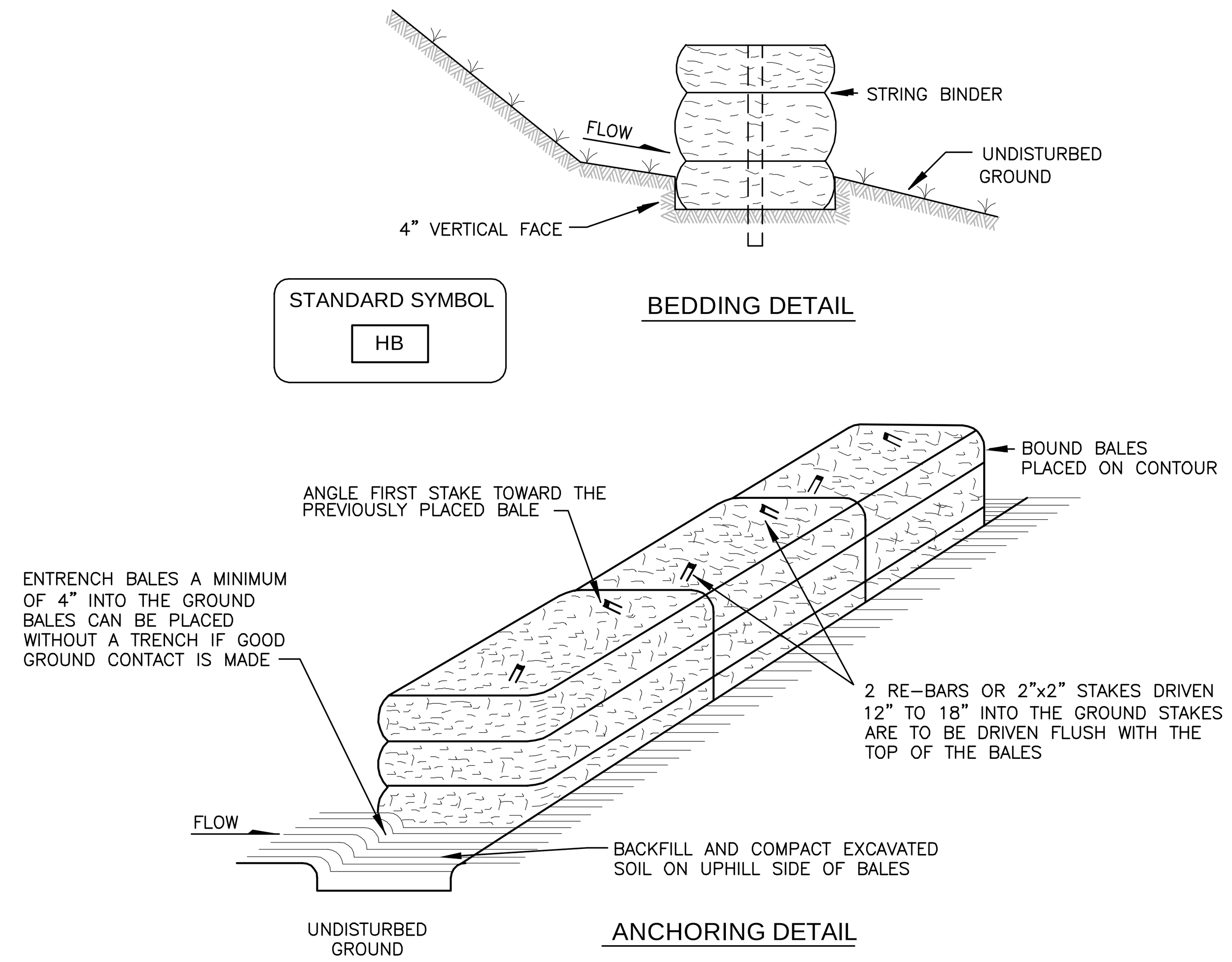


NOTES:

1. FENCE POSTS SHALL BE A MINIMUM OF 42 " LONG DRIVEN 16" MINIMUM INTO THE GROUND. WOOD POSTS SHALL BE 11/2" X 11/2" SQUARE (MINIMUM) CUT, OR 13/4" DIAMETER (MINIMUM) ROUND AND SHALL BE OF SOUND QUALITY HARDWOOD. STEEL POSTS WILL BE STANDARD T OR U SECTION WEIGHTING NOT LESS THAN 1.00 POND PER LINEAR FOOT.
2. GEOTEXTILE SHALL BE FASTENED SECURELY TO EACH FENCE POST WITH WIRE TIES OR STAPLES AT TOP AND MID–SECTION AND SHALL MEET THE REQUIREMENTS SHOWN IN SECTION 01572.
3. WHERE ENDS OF GEOTEXTILE FABRIC COME TOGETHER, THEY SHALL BE OVERLAPPED, FOLDED AND STAPLED TO PREVENT SEDIMENT BYPASS.
4. SILT FENCE SHALL BE INSPECTED AFTER EACH RAINFALL EVENT AND MAINTAINED WHEN BULGES OCCUR OR WHEN SEDIMENT ACCUMULATION REACHED 50% OF THE FABRIC HEIGHT.

DETAIL 1 / D-1
GEOTEXTILE SILT FENCE

SCALE: N.T.S.

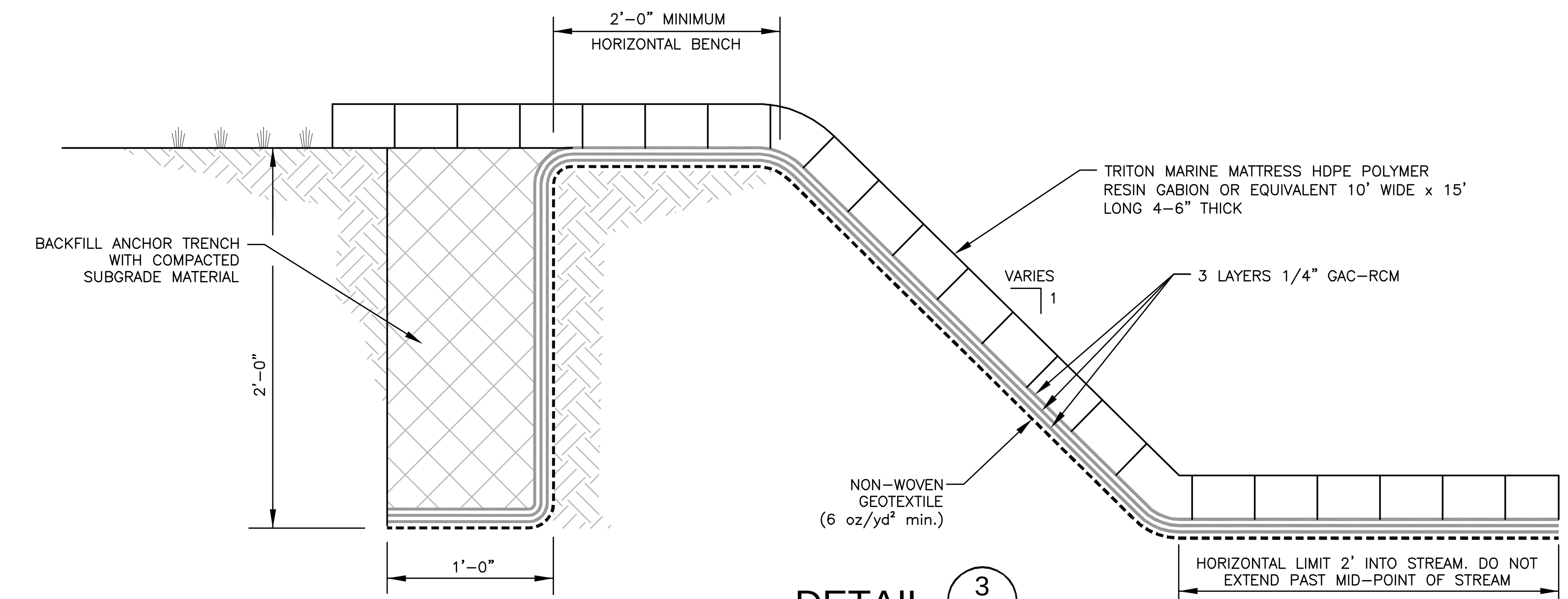


DETAIL 2 / D-1
HAY BALE BARRIER

SCALE: N.T.S.

NOTES:

1. IDEALLY, BALES SHOULD BE ENTRENCHED 2 TO 4 INCHES AND TIGHTLY BUTTED TOGETHER. BALES CAN BE SUCCESSFULLY PLACED WITHOUT A TRENCH IF GOOD GROUND CONTACT IS MADE. REMOVE HEAVY BRUSH AND FILL ALL VOIDS WITH LOOSE STRAW.
2. BALES SHALL BE ONLY USED AS A TEMPORARY BARRIER AND FOR NO LONGER THAN 60 DAYS. THEY SHALL NOT BE USED IN A WATER COURSE.
3. UPON ESTABLISHMENT OF GROUND COVER ON DISTURBED AREAS AND WHEN DIRECTED BY ENGINEER, HAY BALES WILL BE REMOVED AND USED AS MULCH. ANY SEDIMENTATION WILL BE THINLY SPREAD UPON ESTABLISHED GROUND COVER.



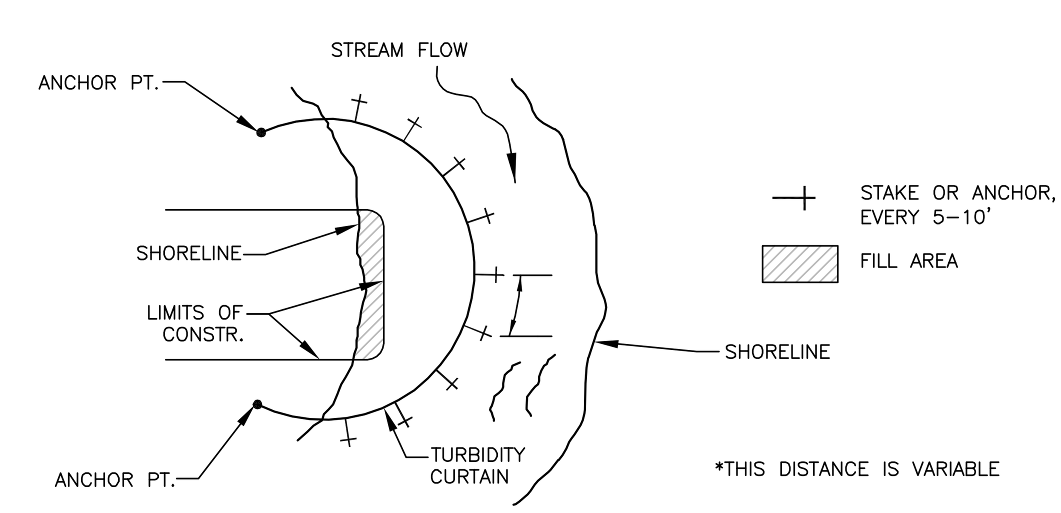
DETAIL 3 / D-1
REACTIVE CORE MAT AND ANCHOR TRENCH

"NOT TO SCALE"

NOTES:

1. INSTALL CETCO GRANULAR ACTIVATED CARBON REACTIVE CORE MAT (GAC–RCM) PER MANUFACTURER'S INSTRUCTIONS.
2. GAC–RCM PANELS SHALL BE CUT TO LENGTH AND PREPARED OFFSITE. COMPLETED PANELS SHALL BE TRANSPORTED TO WORK AREA AND PLACED WITH MINIMAL DISTURBANCE TO NATIVE VEGETATION AND SOIL COVER. GAC–RCM PANELS 10'WIDE X 15'LONG X ¼" THICK (3 LAYERS EA, STACKED).
3. INSTALL TRITON POLYMER MARINE MATTRESS OR APPROVED ALTERNATIVE PER MANUFACTURER'S INSTRUCTIONS & DRAWING DETAILS.
4. TRITON POLYMER MARINE MATTRESS SHALL BE PREPARED OFFSITE WITH STONE FILL PER MANUFACTURER'S INSTRUCTIONS. COMPLETED ASSEMBLY SHALL BE TRANSPORTED TO WORK AREA AND PLACED WITH MINIMAL DISTURBANCE TO NATIVE VEGETATION AND SOIL COVER. EACH MATTRESS 5'WIDE X 15'LONG X 4–6" THICK (TWO/AREA PLACED OVER GAC–RCM, BUTTED ADJACENT).
5. INSTALL EROSION CONTROLS PER ORDER OF CONDITIONS.

TYPICAL LAYOUTS:
STREAMS,PONDS & LAKES (PROTECTED & NON–TIDAL)



DETAIL 4 / D-1
TURBIDITY CURTAIN

SCALE: N.T.S.

REV	DESCRIPTION / ISSUE	DATE	APPROVED

APTIM

150 Royall Street
Canton, Massachusetts

DESIGNED BY: EV	VARIAN MEDICAL SYSTEMS, INC. PALO ALTO, CALIFORNIA
DRAWN BY: GJ	CONSTRUCTION DETAILS
CHECKED BY: --	ENGINEERED CONTROLS STREAM A SEEP FORMER VARIAN FACILITY SITE BEVERLY, MASSACHUSETTS

APPROVED BY:	DATE:	SCALE:	DRAWING NO.	SHEET NO.
--	2/20/23	AS SHOWN	631030174-D2	D-2

DRAWING NUMBER 631030174-D2

OFFICE Canton, MA

VERIFY SCALE 0 1"

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Plot Date/Time: Mar 02, 2023 – 9:08am
Plotted By: Greg.Jones

APPENDIX C

HEALTH & SAFETY PLAN

Available Upon Request

Site Specific Health and Safety Plan for Environmental Investigations and remedial Activities 150 Sohier Road, Beverly, MA

March 2014
Updated September 15, 2021
Updated January 2023

Varian Medical Systems Inc.
3120 Hansen Way M/S G-100
Palo Alto, CA

Prepared by:
Aptim Environmental & Infrastructure, Inc.
150 Royall Street
Canton, MA 02021

Raymond J. Cadorette
Project Manager

Greg McElroy
HSE Manager

The information in this HASP has been designed for the methods presently contemplated by Aptim Environmental & Infrastructure, Inc. (APTIM) for execution of the proposed work. Therefore, this HASP may not be appropriate if the work is not performed by or using the methods presently contemplated by APTIM. In addition, as the work is performed, conditions different from those anticipated may be encountered and the HASP may have to be modified. Therefore, APTIM only makes representations or warranties as to the adequacy of the HASP for currently anticipated activities and conditions

APPENDIX D

PUBLIC NOTICE

NOTICE OF AVAILABILITY

PUBLIC COMMENT DRAFT PARTIAL PHASE IV MASSACHUSETTS CONTINGENCY PLAN PHASE IV REMEDY IMPLEMENTATION PLAN

FORMER VARIAN FACILITY SITE
150 SOHIER ROAD, BEVERLY, MASSACHUSETTS
MADEP SITE #3-0485

On March 17, 2022, a Partial Phase IV Remedy Implementation Plan (Partial Phase IV Plan) was provided to the Massachusetts Department of Environmental Protection for the former Varian Facility Site in Beverly, Massachusetts. The purpose of the Partial Phase IV Plan is to present plans for the implementation of the selected remedial alternatives for the Building 3 Area and two downgradient locations, one along the groundwater flow pathway at Tozer Road and the second at two identified groundwater seeps at Stream A. The Partial Phase IV Plan will be presented at a public meeting on May 2, 2023. Additional information about this meeting will be provided in a separate notice, and a public comment period will begin the next day.

A copy of the Public Comment Draft Partial Phase IV Remedy Implementation Plan is on file and available for review at the Beverly Board of Health (90 Colon Street), the Beverly Conservation Commission (Beverly Town Hall), and the local information repository established for this Site at the Beverly Public Library:

Beverly Public Library – Reference Desk
32 Essex Street
Beverly, MA 01915
978.921.6062
HOURS: Monday-Thursday 9:00 am- 9:00 pm
Friday and Saturday: 9:00 am- 5:00 pm
Sunday: 1:00 pm-5:00 pm

A copy of this report is also available at the Massachusetts Department of Environmental Protection website at the following link:

Insert link

Copy: PIP Mailing List

PARTIAL PHASE IV REMEDY IMPLEMENTATION PLAN
Former Varian Facility Site in Beverly, Massachusetts,
Executive Summary

This Partial Phase IV Remedy Implementation Plan (Partial Phase IV Plan) was prepared for the Former Varian Facility Site in Beverly, MA. The Partial Phase IV Plan presents plans for the implementation of the selected remedial alternatives to address the presence of chlorinated volatile organic compounds (CVOCs) in three site areas. This cleanup plan, as well as the remedial actions that will be implemented at the remaining site areas once finalized, are expected to result in a Permanent Solution at the site. The following three site areas are included in the Partial Phase IV Plan:

- **Building 3 Source Area:** In situ thermal remediation, followed by in situ bioremediation polish, and continued soil vapor extraction (SVE) system operation.
    - In situ thermal remediation uses heat in place underground to remove CVOCs.
    - In situ bioremediation involves using microbes in place that consume CVOCs as a source of food or energy.
    - The SVE system, which is already in place, uses a vacuum to remove CVOC vapors from the soil above the water table to prevent CVOC migration into the overlying building.

- **Downgradient Tozer Road Area:** Installation of a treatment barrier that includes a sulfidated micro zero-valent iron permeable reactive zone
    - A permeable reactive zone is an underground “wall” of reactive material such as iron. Groundwater containing CVOCs flows through the wall. The CVOCs react chemically with the iron, and treated groundwater flows out the other side.

- **Stream A Seep Area:** For the two downgradient Stream A seep locations, installation of a treatment barrier that includes a granular activated carbon reactive core mat
    - A permeable adsorptive zone involves creating an underground area of granular activated carbon to which contaminants stick, similar to a water filter.

The Partial Phase IV Plan presents the following general remedial objectives for each of the three treatment areas:

- source elimination/control
- migration control
- dense nonaqueous phase liquid (DNAPL) removal, where present (i.e., in the case of the Building 3 source area)
- groundwater concentration reduction

In compliance with the Massachusetts Department of Environmental Protection (MassDEP) requirements, the purpose of the Partial Phase IV Plan is to:

- ensure that the information, plans, and reports related to the design, construction, and implementation of the selected remedial alternative(s) are sufficiently developed and documented to support the implementation of the selected cleanup alternative(s)
- ensure that following initial implementation, the selected cleanup plan meets design and performance specifications

To achieve this requirement, the Partial Phase IV Plan provides detailed information on the cleanup approaches for each treatment area. These details include:

- design and operation parameters for the cleanup alternatives

- spill control in each area
- waste management at the site
- control measures for possible adverse impact of treatment
- inspection and monitoring that will be completed
- construction plans and specifications
- operation and maintenance for the cleanup alternatives
- permits and approvals
- general schedule