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TECHNICAL GUIDANCE MANUAL 2022

BUREAU OF UNDERGROUND STORAGE TANK REGULATIONS (BUSTR)

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Commonly Used Acronyms

AL(s)	action level(s)
ASTM	American Society for Testing and Materials
BDL	below detection limit
BUSTR	Bureau of Underground Storage Tank Regulations
CA	corrective action
CIDARS	Chemical Information Database and Applicable Regulatory Standards
COC(s)	chemical(s) of concern
CUSTI	Certified Underground Storage Tank Inspector
DWSPA	Drinking Water Source Protection Area
DERR	OHIO EPA – Division of Environmental Response and Revitalization
EDB	1,2 - Dibromoethane
EDC	1,2 - Dichloroethane
EPA	Environmental Protection Agency
FPR	free product recovery
GUPUS	Generic Unrestricted Potable-Use Standards
IRA	Interim Response Action
MCL	maximum contaminant level
MTBE	methyl tertiary butyl ether
MW	monitoring well
ND	not detectable
NFA	no further action
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
O/O	owner/operator
ORC	Ohio Revised Code
OWS	Oil/Water Separator
PCS	petroleum contaminated soil
POD	point of demonstration
POE	point of exposure
RAP	Remedial Action Plan
SB	soil boring
SCEM	site conceptual exposure model
SDS	safety data sheet
SSTL	site-specific target level
TGM	technical guidance manual
TPH	total petroleum hydrocarbon
TT	tightness test
UCL	upper confidence limit
USCA	United States Code Annotated
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	underground storage tank
USEPA	United States Environmental Protection Agency
VAP	Voluntary Action Program
VOC	volatile organic compound
WWTTS	Wastewater treatment tank system

Regulatory Overview

Leaking USTs have become an increasing source of groundwater contamination. Corrosion and improper installation of systems are the major causes of leaking USTs and their piping. Because of the increasing numbers of water supplies being contaminated by toxic substances stored in underground tanks, regulations concerning USTs, their construction, installation, use, cleanup, and closure have been promulgated and finalized.

On October 21, 1976, Congress enacted the Resource Conservation and Recovery Act (RCRA) to protect human health and the environment. Under Subtitle C of the Act, The United States Environmental Protection Agency (USEPA) was directed to promulgate regulations to identify hazardous waste and regulate its control. On January 12, 1981, the agency promulgated standards for hazardous waste storage and treatment tanks that could be entered for inspection. These regulations were codified as 40 CFR Part 264, Subpart J. On November 8, 1984, the Hazardous and Solid Waste Amendments (HSWA) were enacted (Public Law 98-616). Section 3004(w) of the amendments required USEPA to promulgate final standards for hazardous waste storage tanks that cannot be entered for inspection. As a result, on July 14, 1986, USEPA amended hazardous waste regulations 40 CFR Parts 260, 261, 262, 264, 265, 270, and 271 for regulating the storage and treatment of hazardous waste in tank systems. These amendments became effective on January 12, 1987.

In the HSWA amendments of 1984, the United States Congress also enacted Subtitle I out of concern for the risks that leaking underground tanks posed to the nation's groundwater resources.

Subtitle I provided for the development and implementation of a comprehensive regulatory program for underground tanks. Proposed regulations for USTs storing either petroleum products or hazardous chemicals were issued on April 17, 1987. The final regulation appeared in September 23, 1988, Federal Register and became effective on December 22, 1988. Financial Responsibility requirements appeared on January 24, 1989.

The Ohio Department of Commerce, Division of State Fire Marshal, is the implementing agency for the state and federal UST programs. In 1986 the Governor's Office designated the State Fire Marshal to implement the UST program. The Ohio General Assembly amended section 3737.87 of the Revised Code authorizing the State Fire Marshal to implement provisions of Subtitle I of the Resource Conservation and Recovery Act (RCRA Subtitle I). This authority was expanded in July 1987 and again in July 1989 with the enactment of Substitute House Bill 421. The current regulatory program provisions are found in sections 3737.87 through 3737.89 of the Revised Code.

In 1987, the State Fire Marshal created BUSTR to develop a USEPA approved state UST program to administer the federal Leaking UST Trust Fund. The mission of the bureau is to protect human health and the environment from regulated UST leaks. The primary goals of the bureau are to prevent and detect releases of petroleum and hazardous substances from USTs into the environment and undertake corrective actions where a petroleum release occurs.

Chapter 1 - Introduction

The Technical Guidance Manual (TGM) is designed to help owners and operators (O/Os) and volunteers understand the underground storage tank (UST) closure, corrective action (CA), and petroleum contaminated soil (PCS) processes and provide a discussion of the required activities for complying with the Bureau of Underground Storage Tank Regulations (BUSTR) rules, as stated in Ohio Administrative Code (OAC) 1301:7-9-12, OAC 1301:7-9-13, OAC 1301:7-9-16, and OAC 1301:7-9-17, effective date September 1, 2022. Definitions that are applicable to these rules can be found in OAC 1301:7-9-02. The information in this TGM is intended to clarify the regulations, to provide examples of how BUSTR interprets certain parts of the regulations, and to assist the O/Os in complying with those regulations.

OAC 1301:7-9-12 (closure rule) includes rules that address out-of-service (OOS), closure-in-place, permanent removal (including modifications), and change-in-service for USTs. Chapter 2 of this document identifies the UST systems that BUSTR regulates, describes the process for obtaining permits, and the requirements for conducting a closure assessment and preparing a Closure Assessment report.

OAC 1301:7-9-13 (corrective action rule) includes rules that address the investigation of releases and suspected releases of petroleum from UST systems and the required corrective actions for clean-up of a release to the appropriate levels. Chapter 3 of this document describes the process of investigating a petroleum release, evaluating source area concentrations in comparison to action level (AL) concentrations, determining site-specific target level (SSTL) concentrations, and implementing the appropriate monitoring or remediation activities at a UST site. To protect human health and the environment, BUSTR uses a risk-based corrective action process to ensure the appropriate investigation and clean-up of releases from UST systems.

OAC 1301:7-9-16 and 17 include rules that address sampling and management of PCS. Chapter 4 of this document describes the procedures for sampling PCS stockpiles, treating PCS and other aspects of petroleum contaminated soil regulations.

Finally, Appendices A through G provide additional details into aspects of the closure and corrective action rules.

1.1 Owner and/or Operator Applicability

O/Os of UST systems are required to comply with regulations OAC 1301:7-9-01 through 1301:7-9-19 (excluding 1301:7-9-11 UST Installer Certification and Training, and 1301:7-9-15 Delegated Authority) by statute.

1.1.1 Owner

UST Systems in Service on or After November 8, 1984

For any UST system in use on or after November 8, 1984, the person who owns the UST system is considered the owner.

If the UST system was in use on or after November 8, 1984, but is no longer located on the property, the owner of the UST system is the person who owned the UST system when it was removed from the ground.

UST Systems Taken Out-of-Service Prior to November 8, 1984

In the instance of a UST system in use before November 8, 1984, but no longer in use on that date, the person who owned the UST system immediately before the discontinuation of its use is considered the owner.

If the UST was last used prior to November 8, 1984, the owner is any person who held a legal, equitable, or possessory interest of any kind in the UST system or in the property on which the UST system is located on the date the UST system was last in operation. The definition of owner may include a trust, vendor, vendee, lessor, or lessee.

The term, owner, does not include any person who, without participating in the management of a UST system and without otherwise being engaged in petroleum production, refining, or marketing, holds indicia of ownership (i.e., mortgage, deed of trust, legal or equitable title, etc.) in the UST system primarily to protect the person's security interest in it.

1.1.2 Operator

The person in daily control of, or having responsibility for, the daily operation of the UST system is considered the operator.

1.1.3 Non-Owner/Operator or Volunteer Requirements

It is not uncommon for underground storage tank systems to be removed by non-owner/operators (non-O/Os). A non-O/O would be a person or entity who holds legal, possessory, or equitable interest in a parcel of property on which a UST is located, but who does not meet the definition of an O/O. Non-O/Os are not required to be in compliance with all BUSTR regulations. While non-O/Os are required to comply with permitting, out-of-service, and removal requirements for UST systems, they are not required to perform a closure assessment or submit the associated report. Likewise, non-O/Os are not required to conduct corrective action activities for UST systems that have had releases.

While not all corrective action and closure assessment requirements apply to non-O/Os, these requirements must be followed to receive no further action (NFA) status.

In addition, when activities are being conducted at sites that may be regulated by BUSTR (i.e., a former filling station), closure and corrective action requirements must be followed to receive no further action status.

1.2 Definition of a UST

A UST is defined as one or a combination of tanks, including the underground piping that is used to contain an accumulation of regulated substances, the volume of which, including the volume of the underground piping, is 10% or more below ground.

1.3 Tanks that do not meet the definition of a UST

As specified in OAC 1301:7-9-02, the following **do not** meet the definition of a UST and are exempt from closure and corrective action requirements:

- Farm or residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
- Tanks used for storing heating fuel for consumptive use on the premises where stored;
- Pipeline facilities, including gathering lines, regulated under the Natural Gas Pipeline Safety Act of 1968, 82 Stat. 720, 49 USCA 2001 (United States Code Annotated), as amended;
- Surface impoundments, pits, ponds, or lagoons;
- Storm or wastewater **collection** systems;
- Flow-through process tanks;
- Storage tanks located in underground areas, including without limitation, basements, cellars, mine workings, drifts, shafts, or tunnels, when the tanks are located on or above the surface of the floor and are **visible for inspection on all sides**;
- Septic tanks; and
- Liquid traps or associated gathering lines directly related to oil or gas production and gathering operations.

Two of the most common inquiries regarding the definition of a UST are discussed below.

1.3.1 Residential and Farm Tanks

Farm and residential tanks of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes are exempt from the definition of USTs under BUSTR regulations (Section 1.3).

A farm or residential UST must meet the following qualifications to be exempt from the definition of UST under BUSTR regulations defined in OAC:

- Have a maximum capacity of no more than 1,100 gallons.
- Must contain motor fuel, i.e., for use in an internal combustion engine (mobile or stationery).
- The motor fuel stored cannot be sold commercially.
- A farm UST must be located on the property where products are produced.
- Residential USTs must be located on a property used primarily for dwelling purposes, i.e., apartment complexes, nursing homes, corporate living facilities, monasteries, etc.

Examples of farm or residential USTs that meet the residential or farm tank exemption and are **not regulated by BUSTR**:

- A diesel UST with a capacity of less than 1,100 gallons used to fill up farm machinery at XYZ Farms.
- A diesel UST with a capacity of less than 1,100 gallons used for the emergency generator at a nursing home, monastery or apartment complex.

Examples of USTs that do not meet the residential and/or farm tank exemption and **are regulated by BUSTR**:

- A diesel UST with a capacity of less than 1,100 gallons used for the emergency generator at a hospital, prison, campgrounds university/dormitory or hotel.

1.3.2 Heating Fuel USTs

Tanks used for storing "*heating fuel for consumptive use on the premises where stored*" (heating fuel tank exclusion) are exempt from the definition of USTs under state and federal regulations (Section 1.3). The term "heating fuel" is defined in OAC 1301:7-9-02 as petroleum that is No. 1, No. 2, No. 4-light, No. 4-heavy, No. 5-light, No. 5-heavy, and No. 6 technical grades of fuel oil; other residual fuel oils (including, without limitation, Navy Special Fuel Oil and Bunker C); and other fuels when used as substitutes for one of these fuel oils. Heating fuel is typically used in the operation of heating equipment, boilers, or furnaces, and the petroleum product must be used for heating purposes to qualify for the heating fuel tank exemption under BUSTR policy.

Single Use USTs

The regulation of single-use USTs will be based on the intended use of fuel stored. Single use USTs that contain heating fuel which is consumed for heating purposes on the premises where stored are exempt from BUSTR regulation. The type of petroleum stored in the single use UST may be any of the fuel oils listed in the definition of "heating fuel" or any other petroleum product used as a substitute (e.g., #2 diesel fuel, kerosene, used oil, etc.). BUSTR may require documentation to support the heating fuel exemption.

Emergency generators are not considered to be a heating activity. Therefore, a single use UST used to store diesel fuel, heating fuel, or any other type of petroleum product used by an emergency generator is regulated by BUSTR, and the heating fuel exemption does not apply.

Dual-Use USTs

The regulation of dual-use USTs will be based on the fuel stored. Some USTs store petroleum products for dual use activities, such as for a boiler or furnace for heating and for an emergency generator. If the fuel stored in the UST is heating fuel, then the UST is not regulated. If the fuel stored in the UST is diesel, the UST is regulated. BUSTR may require documentation to justify the heating fuel exemption.

1.4 Regulated UST Systems and Exemptions

A regulated UST is defined as a tank and the underground piping connected to the tank, which has at least 10% of its volume below ground and contains a hazardous substance (as listed in OAC 1301:7-9-03) or petroleum (as defined in OAC 1301:7-9-02).

The following sections address the applicability of OAC 1301:7-9-12 and OAC 1301:7-9-13 to UST systems. These UST systems should be carefully evaluated to determine if other parts of BUSTR's rules are applicable. In addition, while a UST system may not be regulated by BUSTR's closure and/or corrective action rules, they may be regulated by other governmental agencies.

1.4.1 Exempt UST Systems

The following UST systems are exempt from all BUSTR rules:

- Any UST system holding hazardous wastes listed or identified under OAC Chapter 3745-51 or a mixture of such hazardous wastes and other regulated substances;

- Any wastewater **treatment** tank system that is part of a wastewater treatment facility regulated under Section 402 or 307(B) of the Federal Water Pollution Control Act (33 USCA 1251 and following);
- Equipment or machinery that contains regulated substances for certain operational purposes such as hydraulic lift tanks and electrical equipment tanks;
- Any UST system whose capacity is 110 gallons or less;
- Any UST system that contains a *de minimis* concentration of regulated substances; and
- Any emergency-spill or overflow-containment UST system that is emptied expeditiously after use.

1.4.2 Partially Exempt UST Systems

The following regulated UST systems are exempt from the closure rule, OAC 1301:7-9-12, but releases from these systems are regulated under the corrective action rule, OAC 1301:7-9-13:

- Wastewater **treatment** systems **not** regulated under Section 402 or 307(B) of the Federal Water Pollution Control Act (33 USCA 1251 and following) (e.g., some oil/water separators);
- Any UST system containing radioactive material that is regulated under the Atomic Energy Act of 1954 (42 USCA 2014 and following);
- Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the United States Nuclear Regulatory Commission;
- Above ground storage tanks associated with airport hydrant fuel distribution systems; and
- Above ground storage tanks associated with UST systems with field-constructed tanks.

Below are additional details regarding the most common partially exempt USTs.

1.4.3 Wastewater Treatment Tank Systems (Oil/Water Separators)

BUSTR defines a “wastewater treatment tank” as a tank that is designed to receive and treat an influent wastewater through physical, chemical, or biological methods. For example, an oil/water separator (OWS) treats wastewater by separating the oil from the water, and therefore is a wastewater treatment tank system.

For a wastewater treatment tank system (WWTTS) to be regulated by BUSTR, it must meet all the following criteria:

- First, it must meet the definition of an underground storage tank in OAC 1301:7-9-02.
  - At least 10% of the total capacity of the UST system must be beneath the surface of the ground.
  - The WWTTS must contain an accumulation of regulated substances.
  - The WWTTS cannot be listed as excluded from the definition of UST in OAC 1301:7-9-02.
- Second, the WWTTS cannot be listed as exempt in OAC 1301:7-9-01(D). Under this exemption, a WWTTS tank or OWS tank that is regulated under sections 402 or 307(b) of the Clean Water Act (CWA) is exempt from BUSTR regulations. An example of this exemption is an OWS located at a gas station or truck stop which discharges pollutants into a water body protected by the CWA. In this example, the facility must have a CWA

discharge permit (NPDES permit or pre-treatment permit), and therefore, the OWS would be exempt from BUSTR regulations pursuant to OAC 1301:7-9-01(D).

However, if a WWTTS or OWS tank meets the definition of a UST, and is **not** regulated under the CWA, then it is regulated by BUSTR as specified in OAC 1301:7-9-01(E). Specifically, these WWTT/OWS systems must comply with the regulations in OAC 1301:7-9-13 (corrective action rule) but not OAC 1301:7-9-12 (closure rule).

For example:

- A WWTTS or OWS tank which does not discharge wastewater. These tanks receive, treat, and store wastewater until it is pumped out and hauled off-site. This system would be regulated by BUSTR.
- A WWTTS or OWS tank that discharges to the environment (such as an onsite retention pond) but not to waters of the State, would be subject to the BUSTR Corrective Action requirements. This type of system would be regulated by BUSTR.
- A WWTTS or OWS that discharged to a sanitary sewer that is regulated by the CWA is not regulated by BUSTR.

1.4.4 Airport Hydrant Fuel Distribution Systems and Field Constructed USTs

Airport Hydrant Systems

Airport hydrant systems (a.k.a. airport hydrant fuel distribution systems) are UST systems that fuel aircraft and operate under high pressure with large diameter piping that typically terminate into one or more hydrants or fill stands. An airport hydrant system begins where fuel enters one or more above or below ground storage tanks from an external source such as a pipeline, barge, rail car, or other motor fuel carrier.

For an airport hydrant system to be regulated by BUSTR, it must first meet the definition of a UST. An airport hydrant system is not regulated unless 10% or more of the total capacity of the system is beneath the surface of the ground. When performing the 10% calculation, all tanks and product piping must be included. This would include above ground tanks, underground tanks, field constructed tanks, or factory constructed tanks. Field constructed tanks that are part of the airport hydrant system are treated as part of the airport hydrant system and not independent UST systems that are field constructed.

Since 1988, airport hydrant systems have been required to comply only with BUSTR's corrective action rule. However, as of September 1, 2017, airport hydrant systems must also comply with several other of BUSTR's rules, including but not limited to the closure rule.

UST Systems with Field Constructed Tanks

A tank constructed of concrete that is poured in the field, or a steel or fiberglass tank primarily fabricated in the field is considered field constructed. This would exclude any tank with components primarily manufactured in a factory with minimal assembly in the field. These tanks include those that are mounded or partially buried if 10% or more of the volume of the system is beneath the ground's surface or otherwise covered with earthen material.

Since 1988, USTs associated with field constructed tanks have been required to comply only with BUSTR's corrective action rule. However, as of September 1, 2017, they must also comply with several other BUSTR's rules, including, but not limited to, the closure rule.

1.5 Hazardous Substance USTs

USTs containing hazardous substances as listed in OAC 1301:7-9-03 are regulated by BUSTR for closure but not corrective actions. **Prior to removal of the system, the O/O must identify and obtain written approval from BUSTR for the selection of the appropriate chemicals of concern (COCs), laboratory analytical methods and Action Levels (ALs).** The Closure Assessment report must be forwarded to BUSTR. If the analytical results for COCs do not exceed the laboratory method detection limits and ALs, then BUSTR will issue an NFA letter. If the analytical results for COCs exceed the laboratory method detection limits, a copy of the Closure Assessment report will be forwarded to USEPA Region 5 by BUSTR. USEPA Region 5 will provide corrective action oversight.

If analytical results exceed the method detection limit, a release must be reported to both BUSTR and USEPA Region 5. USEPA Region 5 can be contacted at (312) 353-2000.

Please note that used oil USTs typically contain both petroleum and hazardous substances. These UST systems are regulated by BUSTR for both Closure Assessment and Corrective Action activities. These Closure Assessment reports only need to be submitted to BUSTR.

Chapter 2 - UST Closure Requirements - OAC 1301:7-9-12

2.1 Introduction

OAC 1301:7-9-12 is often referred to as the closure rule and establishes the requirements for UST systems that contain regulated substances and:

- Are out of service (OOS);
- Have been closed-in-place;
- Have undergone a change-in-service;
- Have been permanently removed; or
- Have undergone specific modifications of the system and related components.

The closure rule also addresses closure assessments and permitting.

2.1.1 Removal Requirements

OAC 1301:7-9-12 requires that any BUSTR regulated UST that has been OOS for more than 12 months, or more than the time period approved in the OOS permit or the renewal of the OOS permit, must be closed-in-place, removed or put back into service. In addition, the Ohio Fire Code (OFC) 1301:7-7-34 requires that any underground tank which is not regulated by BUSTR and contains a flammable or combustible liquid and has not been used for a period of one year or longer must be closed-in-place or removed from the property.

In some instances, if the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority for the jurisdiction where the UST system is located determines that the UST cannot be physically or safely removed, that official may allow the tank to be closed-in-place. Note that a Certified UST Inspector (CUSTI) and a Certified UST Installer do not have authority to allow a UST system to be closed-in-place (Section 2.4.4).

The O/O must comply with the entire closure rule. However, a property owner, who does not meet the definition of the O/O, who holds a legal, possessory, or equitable interest in a parcel of real property on which a UST system is located, must comply with paragraphs A through H of the closure rule. Any person or contractor performing work on the UST system must obtain a permit for the work and have a CUSTI and a Certified UST Installer present when work is being performed.

2.2 Hazardous Substance USTs

USTs containing hazardous substances as listed in OAC 1301:7-9-03 are regulated by BUSTR for closure but not corrective actions. **Prior to removal of the system, the O/O must identify and obtain written approval from BUSTR for the selection of the appropriate chemicals of concern (COCs), laboratory analytical methods and Action Levels (ALs).** The Closure Assessment report must be forwarded to BUSTR. If the analytical results for COCs do not exceed the laboratory method detection limits and ALs, then BUSTR will issue an NFA letter. If the analytical results for COCs exceed the laboratory method detection limits, a copy of the Closure Assessment report must also be submitted to USEPA Region 5 who will provide corrective action oversight. For example, if UST containing only tetrachloroethane is removed, and the analytical results exceed the method detection limit, a release must be reported to both BUSTR and USEPA Region 5. Subsequently, USEPA Region 5 will direct corrective action activities. The contact information for USEPA Region 5 is as follows:

Corrective Action Manager
Underground Storage Tank Section
Land and Chemicals Division
USEPA Region 5
77 West Jackson Boulevard (LR-17J)
Chicago, IL 60604
r5hotline@epa.gov
800-621-8431

Please note that used oil USTs typically contain both petroleum and hazardous substances. These UST systems are regulated by BUSTR for both Closure Assessment and Corrective Action activities. These Closure Assessment reports only need to be submitted to BUSTR.

2.3 Permitting

2.3.1 Permit Requirements

Pursuant to OAC 1301:7-9-10 and/or OAC 1301:7-9-12, a permit must be obtained for the following activities:

- Out-of-Service (OOS) for more than 90 days;
- Closure-in-place;
- Change-in-service;
- Permanent removal and/or replacement;
- A *major repair* on a portion of the UST system that has caused a release; or
- A *modification* of a UST system or component that has not caused a release.

A *major repair* includes the restoration of a tank or a UST system component that has caused a release of product. This does not include modifications, upgrades, or routine maintenance for normal operational upkeep to prevent a UST system from releasing a product. **Major repairs are always associated with a reportable release**.

A *modification* includes work performed on UST system components that have not leaked, such as adding, altering, replacing, or retrofitting. This includes, but is not limited to, under-dispenser containment sumps, containment sumps over USTs, vent lines, flexible connectors, shear valves, leak detection systems, or UST lining components. The full definition of these terms can be found in OAC 1301:7-9-02(B)(34).

Before any of the closure activities listed above are conducted, a BUSTR permit application with the State Fire Marshal's Bureau of Testing and Registration must be filed. **If a permit application is filed with a delegated authority, a copy of the permit shall be sent to BUSTR and the Bureau of Testing and Registration (per rule 1301:7-9-15(B)(2)(a)) within 30 days of the final inspection.** In emergencies, UST removal permits can be issued at the discretion of the State Fire Marshal's Bureau of Testing and Registration or the delegated authority.

All permit requirements are included in OAC 1301:7-9-10 and the closure rule. BUSTR permits are issued by:

- State Fire Marshal's Bureau of Testing and Registration (614-752-7126); or
- The local fire department that has delegated authority status.

Permits are not required for routine maintenance or normal operational upkeep as defined by OAC 1301:7-9-02(B)(56). In addition, a CUSTI, Certified UST Installer, and Closure Assessment report are not required.

2.3.2 Permit Application Process

BUSTR Closure Permits

After receiving a completed permit application, BUSTR will determine and verify that the UST system complies with all applicable BUSTR registration requirements. If the system does not have current registration, the State Fire Marshal's Bureau of Testing and Registration may require the O/O to pay any unpaid registration fees before a permit is issued.

Delegated Authority Closure Permits

If the local fire department has delegated authority in the jurisdiction where the closure will take place, that fire department will issue permits, determine fees, and schedule inspections. However, local fire departments are not required to determine if the UST system complies with BUSTR requirements (e.g., compliance, registration, financial responsibility). UST systems should be checked to ensure they comply with BUSTR's and the Petroleum Underground Storage Tank Release Compensation Board's (PUSTRCB) requirements before conducting any closure activities. Compliance with both BUSTR and PUSTRCB requirements is crucial in establishing eligibility for reimbursement (if corrective actions are required).

Other Permits

In addition to BUSTR requirements, other local, regional, or state regulations may affect the closure process. For example, the Ohio Environmental Protection Agency (Ohio EPA) may require permits for air emissions and water discharges. Local governments may require special permits.

2.3.3 Required On-Site Personnel

A Certified UST Installer and a CUSTI must be on-site for each of the following activities:

- Inspection of the UST system OOS for more than 90 days;
- Closure-in-place;
- Change-in-service;
- Permanent removal and/or replacement;
- Major repairs; and
- Modifications.

The Certified UST Installer directs all removal activities and directly controls the personnel performing the work on the UST system. The Certified UST Installer **does not have** the authority to authorize a closure-in-place. **Additionally, a Certified UST Installer does not determine if petroleum contamination exists on the site**.

The UST Inspector may be a BUSTR Inspector, an inspector from a delegated authority, or a private CUSTI. The UST Inspector is on-site to document that all potential fire and explosion hazards are properly handled by the Certified UST Installer. **UST Inspectors do not determine if petroleum contamination exists on the site nor are they in control of on-site personnel**. Removal of any part of the UST system can only take place if the UST Inspector is on-site.

2.4 Closure Options

2.4.1 Out-of-Service for 90 Days or Less

When an operating UST system is taken OOS for 90 days or less, it is considered "temporarily OOS". The fill line, gauge opening, and dispensing unit must be secured against tampering. Vent lines must remain open and functioning. BUSTR regulations continue to apply, including the release detection requirements during the temporary OOS period. BUSTR prefers that the system be emptied when temporarily OOS. If the system is empty, then the release detection requirements do not apply. The system is considered empty when regulated substances have been removed so that no more than one inch of residue or 0.3% by volume of the system's capacity remains in the tank. **Neither a permit nor a closure assessment is required for taking a UST system temporarily OOS for 90 days or less.**

During this OOS period, the UST system must also comply with the following:

- Registration requirements;
- Financial responsibility requirements; and
- Construction and operational requirements for cathodic protection.

2.4.2 Out-of-Service for More Than 90 Days

In addition to the items outlined above in Section 2.4.1, if the UST system is OOS for more than 90 days, the UST system must be maintained by performing ***all*** the following:

- Empty all contents;
- Leave all vent lines open and functioning;
- Cap and secure all lines, pumps, manways, and ancillary equipment;
- Obtain an OOS permit from the State Fire Marshal or a delegated authority; and
- Have an inspection of the OOS UST system as required by OAC 1301:7-9-10(D) by the State Fire Marshal, a CUSTI with a delegated authority or a CUSTI.

Prior to the expiration of an OOS permit, a renewal or extension of the OOS permit may be requested by submitting a new permit application pursuant to OAC 1301:7-9-10. Neither a Certified UST Installer nor a Certified UST Inspector is required for the renewal of an OOS permit.

A variance from the timely submittal of the initial OOS permit application may be granted if the person making the request demonstrates good cause as determined by the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority. Each variance request will be reviewed on a case-by-case basis. **A closure assessment is not required for UST systems that are OOS**

for more than 90 days if the UST system is placed back into service within 12 months or if an OOS permit, or renewal is obtained, and the UST system is placed back into service during the allotted time.

UST systems with a scheduled "seasonal discontinuation" are not required to obtain the OOS permit if *all* the following conditions are met:

- The UST system is located at a marina, golf course, amusement park, or other seasonal facility as recognized by the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority;
- Written approval is obtained from the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority;
- The UST system has not been OOS for a period exceeding 12 months; and
- The UST system has been maintained by performing *all* the following:
  - Empty all contents;
  - Leave all vent lines open and functioning;
  - Cap and secure all lines, pumps, manways, and ancillary equipment.

2.4.3 Out-of-Service for More Than 12 Months

In addition to the items outlined above in Sections 2.4.1 and 2.4.2, if the UST system has been OOS for more than 12 months or more than the time period approved in the OOS permit or a renewal of the OOS permit, *one* of the following activities must be conducted:

- The system must be placed back into service within 90 days of the permit's expiration date provided ***all*** the following requirements are met:
  - The UST system complies with the performance standards pursuant to paragraphs (D)(1) to (D)(4) of rule 1301:7-9-06 of the Administrative Code;
    - If the UST system does not meet the performance standards, the only options available are to remove the system or perform a closure assessment **prior to** requesting a renewal of the OOS permit.
  - The UST system passes a tightness test, as described in OAC 1301:7-9-07;
  - The UST system is compliant with all registration and financial responsibility requirements, as listed in OAC 1301:7-9-04 and 1301:7-9-05; and
  - The State Fire Marshal has not issued an order prohibiting the UST system from being placed back into service.
- The UST system must be permanently removed, undergo a change-in-service, or be closed-in-place within 90 days of date of the permit's expiration; or
- An OOS permit or renewal of OOS permit application may be submitted for approval by BUSTR or the local delegated authority. The OOS permit or a renewal of OOS permit application will not be automatically approved. BUSTR will review and approve the application based on, but not limited to, the reason(s) for requesting an extension, release prevention compliance history, input from local authorities and location of the site (within a Sole Source Aquifer or drinking water source protection area [DWSPA]).

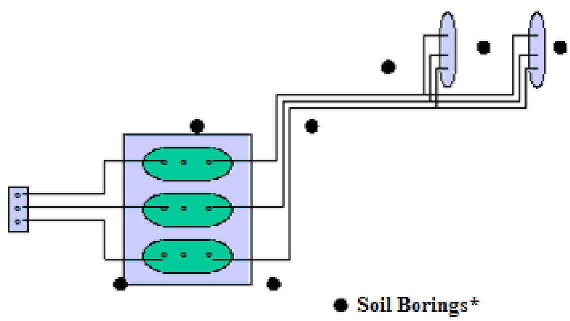
Systems that have been OOS for more than 12 months without a permit or with an expired permit without approved renewal are subject to the closure assessment requirements. A minimum of three soil borings/monitoring wells (SB/MWs) must be installed and sampled **within 90 days** of the expiration of the permit, or end of the 12-month OOS period if a renewal to the OOS permit was not obtained. The SB/MWs must be located in the areas most likely to contain concentrations of

COCs. See Figure 2.1 for example SB/MW locations. Sampling requirements are outlined in Appendix A. In situations where site conditions interfere with this sampling approach, a written Alternate Sampling Plan must be submitted to BUSTR for approval prior to implementation.

The results of the OOS closure assessment must be submitted on a Closure-In-Place Form 2022. The Closure-in-Place Form 2022 must be received by BUSTR **within 90 days** of sample collection.

A closure assessment is not required if a variance from the timely submittal of an extension request for an OOS permit is granted by BUSTR or the Certified Fire Safety Inspector with delegated authority. A variance will be reviewed on a case-by-case basis and may be granted if good cause exists (e.g., change in ownership).

Figure 2.1 - Closure-in-Place, Change-in-Service, Systems Out-of-Service for More than 12 Months Without a Permit



*NOTE: a minimum of three SBs must be converted into MWs.

2.4.4 Closure-in-Place

Only the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority may grant permission for all or part of a UST system to be closed-in-place. The CUSTI **does not** have the authority to approve closure-in-place. A request for closure-in-place containing sufficient documentation must be submitted as part of the permit application. If approved, the UST system must be closed-in-place in accordance with American Petroleum Institute (API) Standard 1604-01: *Closure of Underground Petroleum Storage Tanks*. The UST system must also be cleaned and filled with a solid inert material with a density that is greater than the density of water (e.g., concrete slurry mix).

Closure-in-place of all or a portion of a UST system is only allowed when good cause is demonstrated. A good cause demonstration may include, but is not limited to, the removal of the UST threatening the structural integrity of an existing building, inaccessibility of the UST system, or removal activities present hazards to the safety of site personnel or the public, etc.

When a UST system is closed-in-place, a minimum of three SB/MWs must be installed in the areas most likely to contain concentrations of COCs and sampled **within 90 days** of the Closure-in-Place activities. Sampling requirements are outlined in Appendix A. See Figure 2.1 for example SB/MW locations. In situations where site conditions interfere with this sampling approach, a written Alternate Sampling Plan must be proposed to BUSTR for approval prior to implementation. Geotechnical analysis is required to change the soil classification to Class 2 or 3.

Any stockpile generated during the closure-in-place process must be handled and sampled in accordance with OAC 1301:7-9-16 and 1301:7-9-17.

The results must be submitted on a Closure-In-Place Form 2022. The Closure-in-Place Form 2022 must be received by BUSTR **within 90 days** of sample collection.

2.4.5 Change-in-Service

A change-in-service means that the substance stored in the UST system has been changed from a regulated to a non-regulated substance (e.g., gasoline to water). To perform a change-in-service, the following must be conducted:

- The UST must be completely emptied and cleaned; and
- All piping and ancillary equipment that is not part of the change-in-service must be closed-in-place or removed in accordance with the closure rule.

When a change-in-service occurs, a minimum of three SB/MWs must be installed in the areas most likely to contain concentrations of COCs and sampled **within 90 days** of the change-in-service date. Sampling requirements are outlined in Appendix A. See Figure 2.1 for example SB/MW locations.

In situations where site conditions interfere with this sampling approach, a written Alternate Sampling Plan must be proposed to BUSTR for approval prior to implementation. Geotechnical analysis is required to change the soil classification to Class 2 or 3.

Any stockpile generated during the change-in-service process must be handled and sampled in accordance with OAC 1301:7-9-16 and 1301:7-9-17.

The results must be submitted on a Closure-In-Place Form 2022. The Closure-in-Place Form 2022 must be received by BUSTR **within 90 days** of sample collection.

2.4.6 Permanent Removal

When a UST system or any part of a UST system is removed from the ground, *all* the following must be completed:

- Obtain a permit prior to removal;
- Remove the portions of the UST system from the ground that are specified on the removal permit unless prior approval for closure-in-place (Section 2.4.4) has been granted by the State Fire Marshal or a Certified Fire Safety Inspector with delegated authority;
- Clean and remove the UST system according to *all* the following applicable standards:
    - API Recommended Practice 1604: *Closure of Underground Petroleum Storage Tanks;* and
    - National Institute for Occupational Safety and Health (NIOSH) Publication 80-106: *Criteria for a Recommended Standard for Working in Confined Space.*
- Once empty and clean, monitor the UST system to ensure that explosive vapors do not accumulate above a level that creates a hazardous or unsafe condition;
- Ensure that the UST is free of residue and liquid, is rendered unusable, and is free of explosive vapors before the UST leaves the site; **no UST may be reused for any purpose unless prior written approval is obtained from the State Fire Marshal;**

- Remove all backfill from the tank cavity excavation, piping trenches, and dispensing unit areas; handle according to PCS rules OAC 1301:7-9-16 and 17; and
- Remove **no more than one foot of native soil** from the sidewalls, bottom of the tank cavity excavation, piping trenches, and dispensing unit areas**. Further removal of soil from the tank cavity, piping trenches, dispensing unit areas, and remote fill pipe trenches for purposes of corrective action (over-excavation) shall not be conducted without prior approval of the State Fire Marshal. Conducting over-excavation of soils will require a Tier 1 Source Investigation. The over-excavated area must be sampled according to the "Open Excavation" sampling protocol in Appendix A, unless a written Alternate Sampling Plan is proposed to BUSTR for approval.**

A closure assessment must be completed, and a Closure Assessment Form 2022 submitted to BUSTR **within 90 days** of removal of part or all the UST system.

2.4.7 Sampling Protocol for Previously Closed Systems

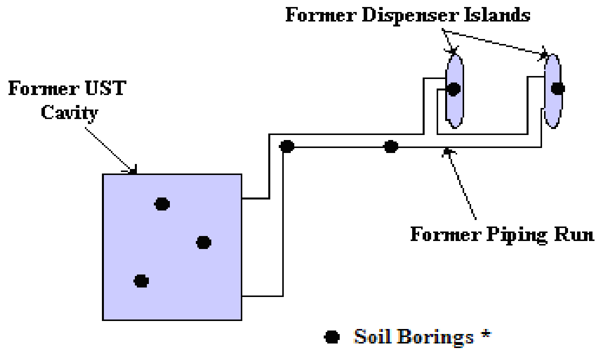
To properly evaluate a UST system previously closed **on or after September 1, 1992**, and a closure assessment was not conducted in accordance with the closure assessment rules in effect at the time or a closure assessment was not submitted, the State Fire Marshal may direct the O/O to collect soil and groundwater samples by advancing a minimum of three soil borings in the are most likely to contain COCs above action levels. If groundwater is encountered, monitoring wells must be installed in the soil borings which a closure assessment was not conducted, soil and groundwater samples may be collected. Previously closed systems include ones that have been:

- Permanently removed (including removals resulting from modifications of components that routinely contain product);
- Closed-in-place;
- Undergone a change-in-service; or
- OOS for more than 12 months with no permit or with an expired permit.

Sufficient sampling points must be selected to ensure the evaluation of the area(s) most likely to contain COCs above ALs. A minimum of three SBs must be converted into MWs of which at least one must be installed in the former tank cavity and one into the area of the dispensers. See Appendix A for SB/MW installation and sampling procedures. Examples of SB/MW locations are illustrated in Figures 2.1 and 2.2. The COCs and the ALs used for previously closed systems will be based on the rules in effect at the time of closure sampling. Geotechnical analysis is required to change the soil classification to Class 2 or 3.

Please note that UST systems removed on or after December 22, 1988, but prior to September 1, 1992, are subject to Federal requirements as set forth in 40 CFR 280.70 through 74.

Figure 2.2 - Closure of a Previously Removed System



* NOTE: a minimum of three SBs must be converted into MWs.

2.5 Closure Assessment – Sampling Not Required

As discussed in OAC 1301:7-9-12, activities that are defined as modifications require a closure assessment report to be submitted. These activities include modifications to piping, piping components, flexible connectors, and ancillary equipment (e.g., piping couplings, boots, flanges, fittings, adapters, joints, valves). This section covers modifications that take place both inside and outside of a secondary containment system. Please note that shear valve replacement is discussed in Section 2.6. Product line removals/replacements are not included in this section and require the collection of soil samples.

All modification activities described in OAC 1301:7-9-12(I)(1)(c) and (d) require a permit, CUSTI, Certified UST Installer and the applicable report submitted to BUSTR.

Note that all permit driven work requires the 0.1 gallons per hour (GPH) tightness test at 1.5 times the operating pressure as part of the final inspection prior to the line going back into service. On-site electronic line testing **cannot** be used in place of a final inspection after work performed under a permit.

The replacement of a product line within a chase or conduit (e.g., corrugated drainage pipe) requires closure assessment sampling. Please see Section 2.7 for details on sampling and reporting requirements.

The applicable portion of the site UST system must meet corrosion protection requirements pursuant to paragraph (D)(3) through (D)(4) of OAC 1301:7-9-06.

2.5.1 Piping Modifications Conducted Inside of a Secondary Containment System

When piping modifications are conducted within a secondary containment system pursuant to OAC 1301:7-9-12(I)(1)(d), the following criteria are used to eliminate the closure assessment soil sampling requirements:

- The system has corrosion protection pursuant to OAC 1301:7-9-06(D)(3) and (4); and
- The piping or containment sump has passed a tightness test, pursuant to OAC 1301:7-9-07(F)(2) and (3), within 60 days prior to the piping modification activities.

If the above criteria are met, then soil sampling is not required. Submit a completed Piping Modification/Closure Assessment – Sampling Not Required Form 2022 report to BUSTR (Flow Chart 2.1).

If the above criteria **are not** met, soil sampling must be conducted. Submit a completed Closure Assessment Form 2022 to BUSTR.

If evidence indicates that a component is leaking or has leaked and the leakage appears to be contained within the secondary containment system, a tightness test (i.e., hydrostatic test) on the containment sump may be performed. If the tightness test passes, a Site Check is not required. Submit a completed Suspected Release – Tightness Test Form 2022.

If evidence indicates that a component is leaking or has leaked in the containment sump and the sump cannot be tested, or if the sump fails the hydrostatic test, a suspected release must be reported to BUSTR pursuant to OAC 1301:7-9-13(D). Submit a completed Suspected Release – Tightness Test Form 2022. Conduct a Site Check pursuant to OAC 1301:7-9-13(F)(3).

If free product is encountered or evidence exists that a component is leaking or has leaked into the soil or backfill around the containment sump, a suspected release must be reported to BUSTR, and a Site Check conducted.

For example, if a flex line in a secondary containment sump is replaced and the replacement will require disconnection of the product line, this activity is defined as a "modification". The information above will apply.

2.5.2 Piping Modifications Conducted Outside of Secondary Containment

The following types of modification activities can take place outside of a secondary containment system and are subject to OAC 1301:7-9-12(I)(1)(c):

- Product piping that is taken permanently OOS and is a common trench with other piping that will remain in service.
- Modifications to piping and piping components, including flex connectors, located beneath dispensers or over USTs that are not contained in a secondary containment sump. For modifications to shear valves refer to Section 2.6.
- Modifications to piping and piping components to install/replace a secondary containment system.

When piping modifications are conducted outside of a secondary containment system, the following criteria are used to eliminate the closure assessment soil sampling requirements:

- The piping and piping components have passed a tightness test, pursuant to OAC 1301:7-9-07(F)(2) and (3), within 60 days prior to the piping modification activities.
- The applicable portion of the site UST system meets corrosion protection requirements pursuant to OAC 1301:7-9-06(D)(3) and (4).

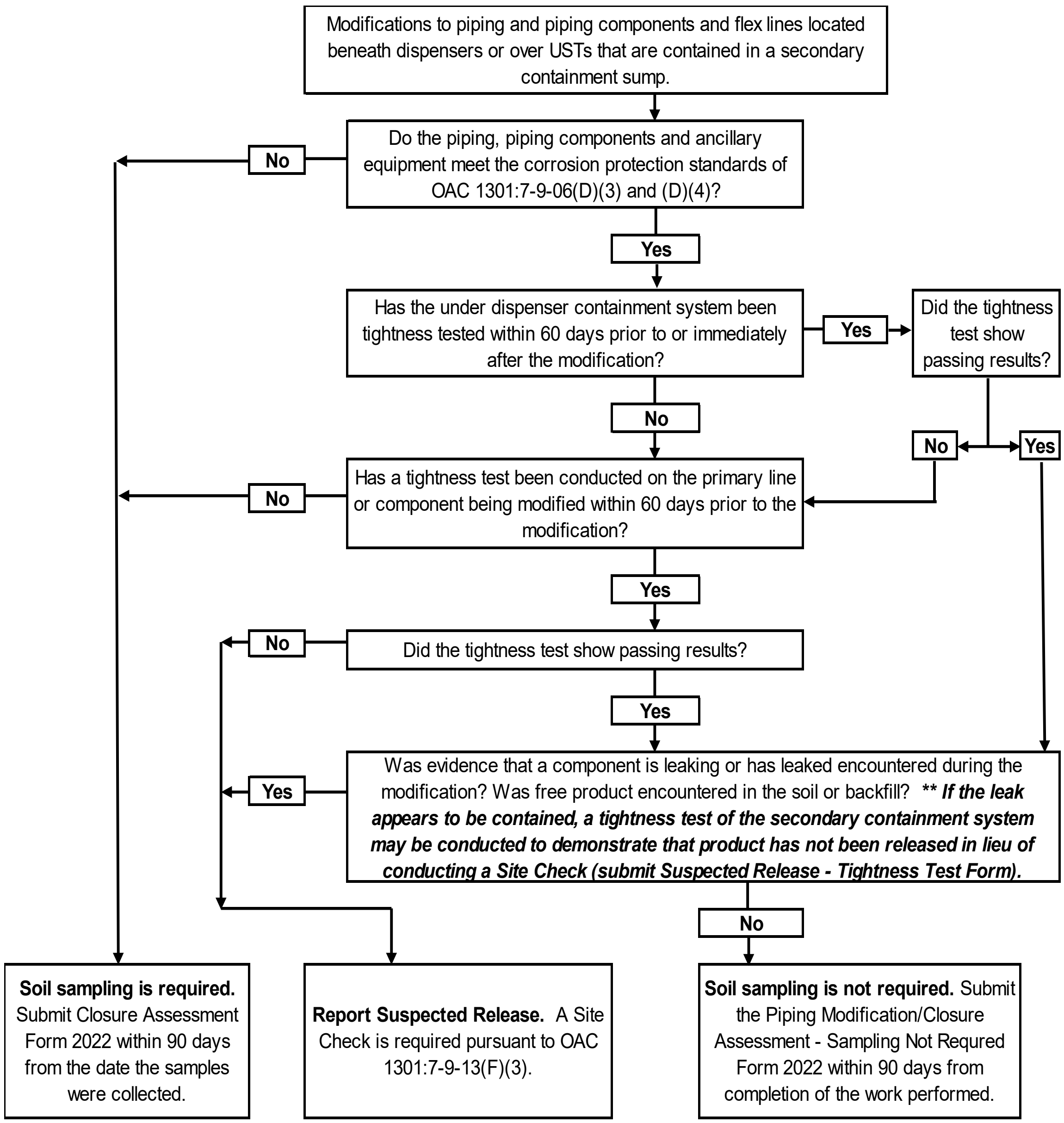
- The site is not located in a DWSPA.
- The site is not located in a Sole Source Aquifer.

If the above criteria are met, then soil sampling is not required. Submit a completed Piping Modification/Closure Assessment Sampling Not Required Form 2022 report to BUSTR (Flow Chart 2.2).

If the above criteria **are not** met, soil sampling must be conducted. Submit a completed Closure Assessment Form 2022 to BUSTR.

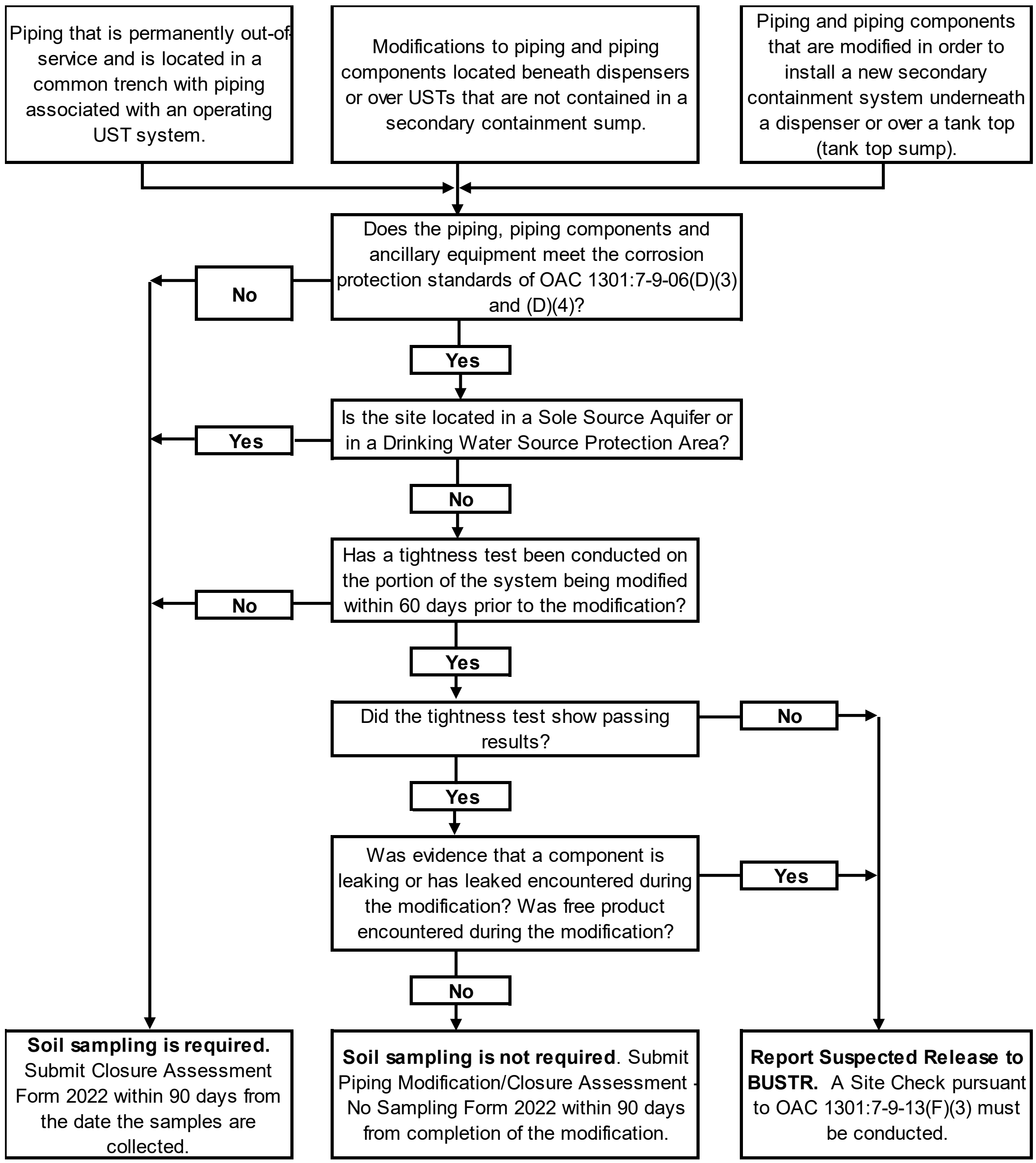
If free product is encountered or evidence exists that a component is leaking or has leaked during modification activities, a suspected release must be reported to BUSTR and a Site Check conducted.

Flow Chart 2.1: Piping Modifications Conducted Inside of a Secondary Containment System



*** NOTE: THE 0.1 GPH TIGHTNESS TEST AT 1.5 TIMES THE OPERATING PRESSURE IS STILL REQUIRED AS PART OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK PRIOR TO THE PRODUCT LINE GOING BACK INTO SERVICE. THE ON-SITE ELECTRONIC LINE TESTING UNIT CANNOT BE USED IN PLACE OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK.**

Flow Chart 2.2: Piping Modifications Performed Outside of a Secondary Containment System



*** NOTE: THE 0.1 GPH TIGHTNESS TEST AT 1.5 TIMES THE OPERATING PRESSURE IS STILL REQUIRED AS PART OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK PRIOR TO THE PRODUCT LINE GOING BACK INTO SERVICE. THE ON-SITE ELECTRONIC LINE TESTING UNIT CANNOT BE USED IN PLACE OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK.**

2.6 Shear Valve Modification

As discussed in OAC 1301:7-9-12, activities that are defined as modifications require a closure assessment report to be submitted. Effective September 1, 2017, shear valves were added to the definition of a "modification." For pressurized UST systems, shear valves are required to stop the flow of product when a dispenser is damaged. If the shear valve functions properly when engaged, the supply flow will be shut off and no product will be released from below the shear valve. If it does not function properly, product can escape into the containment sump, specifically the under-dispenser containment (UDC) system, or into the environment if no UDC is present. **The term UDC indicates that the containment in place under the dispenser was designed to be tight.**

All modification activities described in OAC 1301:7-9-12(I)(1)(c) and (d) require a permit, CUSTI, Certified UST Installer, and the applicable report submitted to BUSTR.

The applicable portion of the site UST system must meet corrosion protection requirements pursuant OAC 1301:7-9-06(D)(3) and (4).

Please note that the flow charts and forms associated with modifications to shear valve are designed to ensure that the appropriate reports are submitted to BUSTR. If there is a failed 0.1 GPM tightness test after the modifications to the shear valve(s) are completed, it is necessary to report a suspected release to BUSTR. The appropriate suspected release investigation activities must be completed. These activities may include the completion of a Site Check.

Note that all permit driven work requires the 0.1 GPH tightness test at 1.5 times the operating pressure as part of the final inspection prior to the line going back into service. On-site electronic line testing **cannot be** used in place of a final inspection after work performed under a permit.

2.6.1 Shear Valve Replacement Performed Inside of a Secondary Containment System

When the shear valve functions properly, the following testing procedures are used to eliminate the soil sampling requirements (Flow Chart 2.3). At least one of the following must be true:

- The UDC tightness test is conducted no more than 60 days prior to or immediately after modification of the shear valve(s). The UDC cannot be altered in any way prior to tightness testing activities;
- The product line, including the modified shear valve(s), has passed a third party 0.1 gph test at 1.5 times the operating pressure no more than 60 days prior to modification activities;
- The product line, including the modified shear valve(s), has passed a 0.2 gph test, conducted by an electronic line leak detector system, no more than 30 days prior to the modification; or
- The product line, including the modified shear valve(s), has passed a third party 0.1 gph test at 1.5 times the operating pressure immediately after the modification.

If any of the above testing methods show a passing result, soil sampling is not required, and the Shear Valve Replacement Form 2022 must be submitted.

Should the testing requirements not be completed, closure sampling is required. Submit a completed Shear Valve Replacement Report Form 2022 and Closure Assessment Report Form 2022.

If the shear valve did not function properly and product was released (Flow Chart 2.4), report a suspected release to BUSTR. In addition, the secondary containment system must be tightness tested (i.e., hydrostatic test) immediately after the shear valve replacement. The UDC cannot be altered in any way prior to tightness testing activities.

If the containment passes the tightness test, submit a completed Shear Valve Replacement Form 2022 requesting disproved status.

If the containment tightness test fails the after-repair tightness test, a suspected release must be reported to BUSTR. Submit a completed Shear Valve Replacement Form 2022 and conduct a Site Check.

2.6.2 Shear Valve Replacement Performed Outside of a Secondary Containment System

When the shear valve functions properly, the following testing procedures are necessary to eliminate the soil sampling requirements (Flowchart 2.5). At least one of the following must be true:

- The product line, including the modified shear valve(s), has passed a third party 0.1 gph test at 1.5 times the operating pressure no more than 60 days prior to modification activities; or
- The product line, including the modified shear valve(s), has passed a 0.2 gph test, conducted by an electronic line leak detector system, no more than 30 days prior to the modification; and
    - The product line, including the modified shear valve(s), must also pass a third party 0.1 gph test at 1.5 times the operating pressure immediately after the modification.

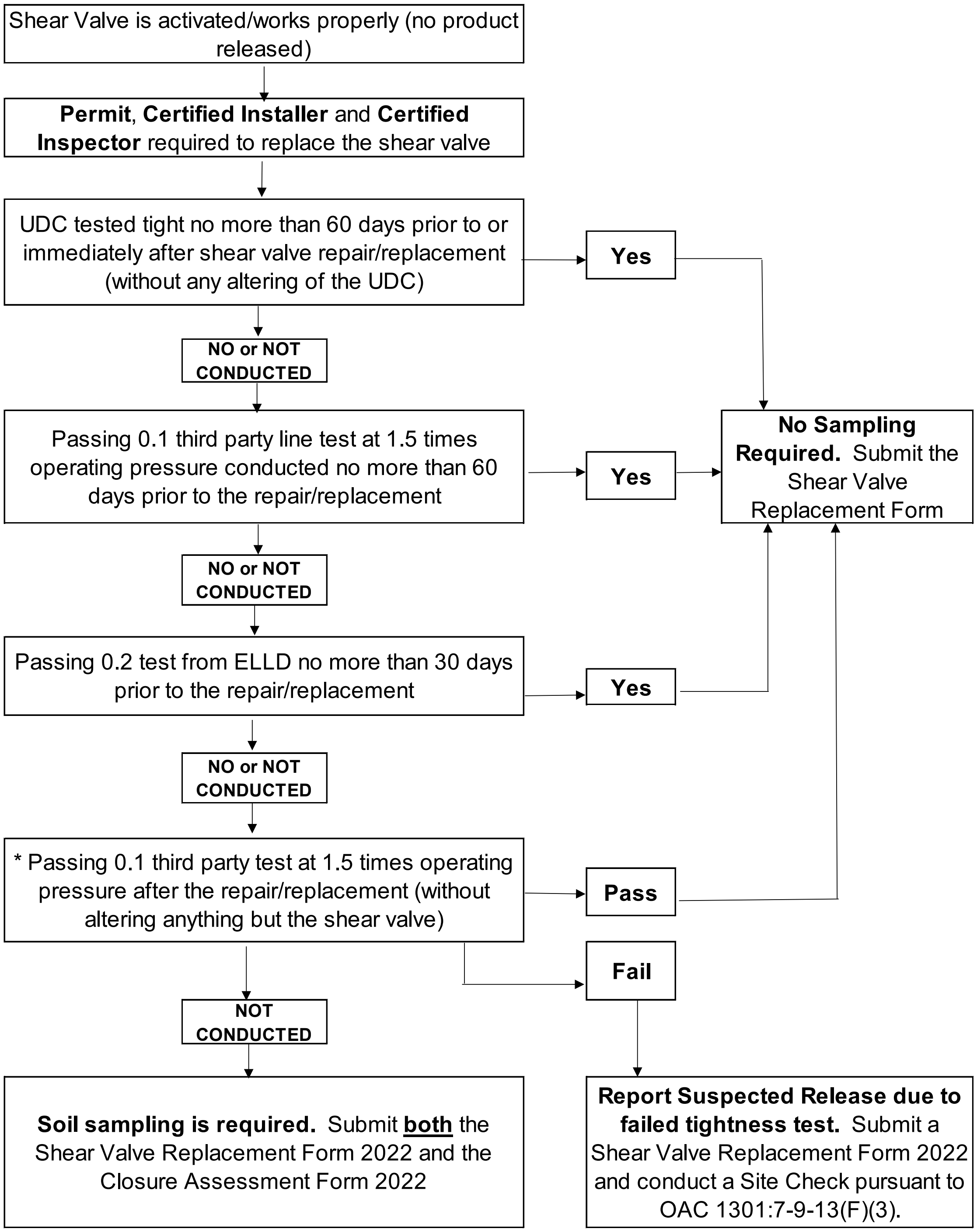
If any of the above testing methods show a passing result, soil sampling is not required, and the Shear Valve Replacement Form 2022 must be submitted.

Should the testing requirements not be completed prior to modification activities, soil sampling is required. Submit a completed Shear Valve Replacement Report Form 2022 and Closure Assessment Report Form 2022.

Should the testing requirements not be completed prior to modification activities and a failed 0.1 GPH test is recorded after modification activities are completed, a suspected release must be reported to BUSTR, and soil sampling is required. Submit a completed Shear Valve Replacement Report Form 2022 and Closure Assessment Report Form 2022. In addition, it will be necessary to conduct a Site Check.

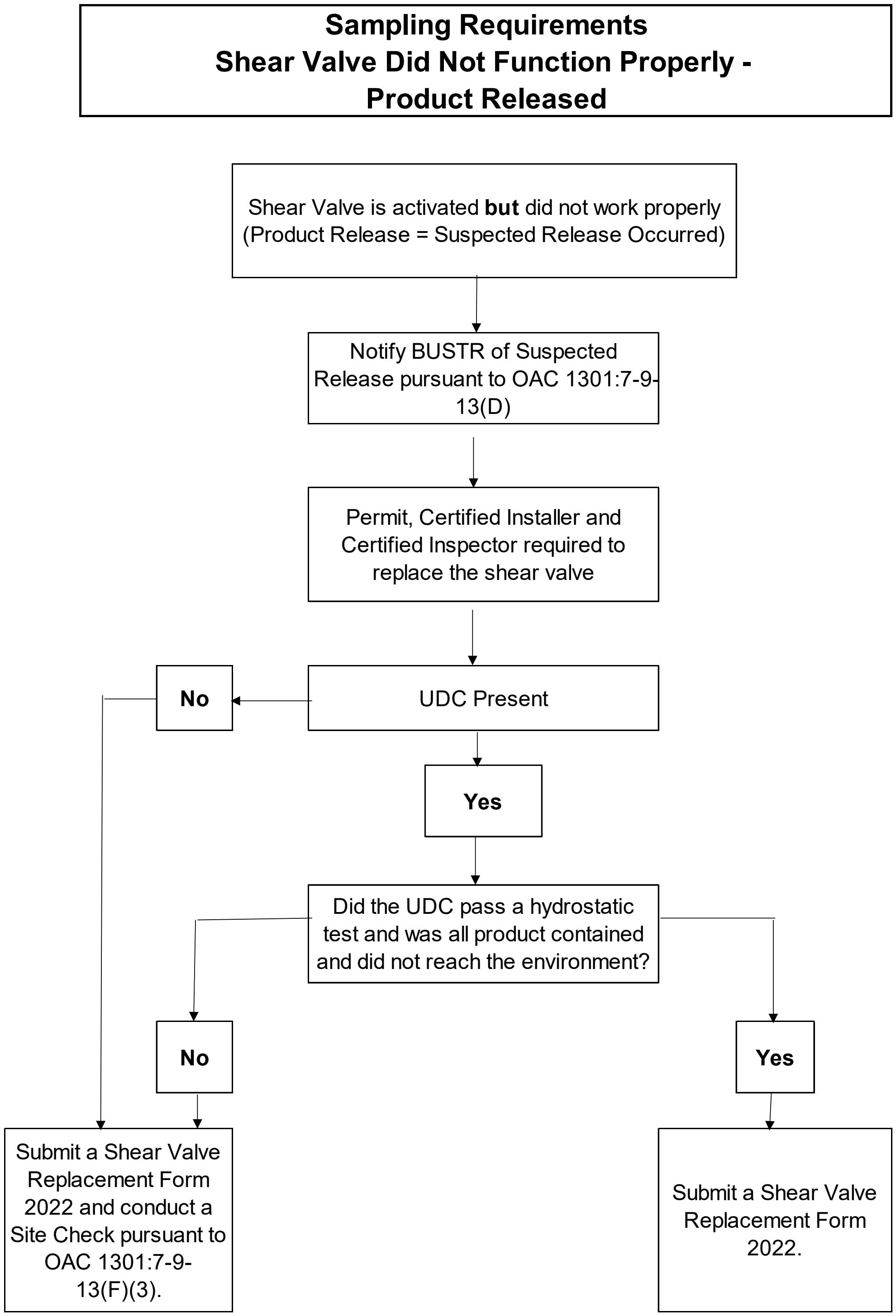
If the shear valve did not function properly and product was released (Flow Chart 2.4), a suspected release must be reported to BUSTR. Submit a completed Shear Valve Replacement Report Form 2022 and conduct a Site Check.

Flow Chart 2.3: Shear Valve Replacement Performed Inside of a Secondary Containment System

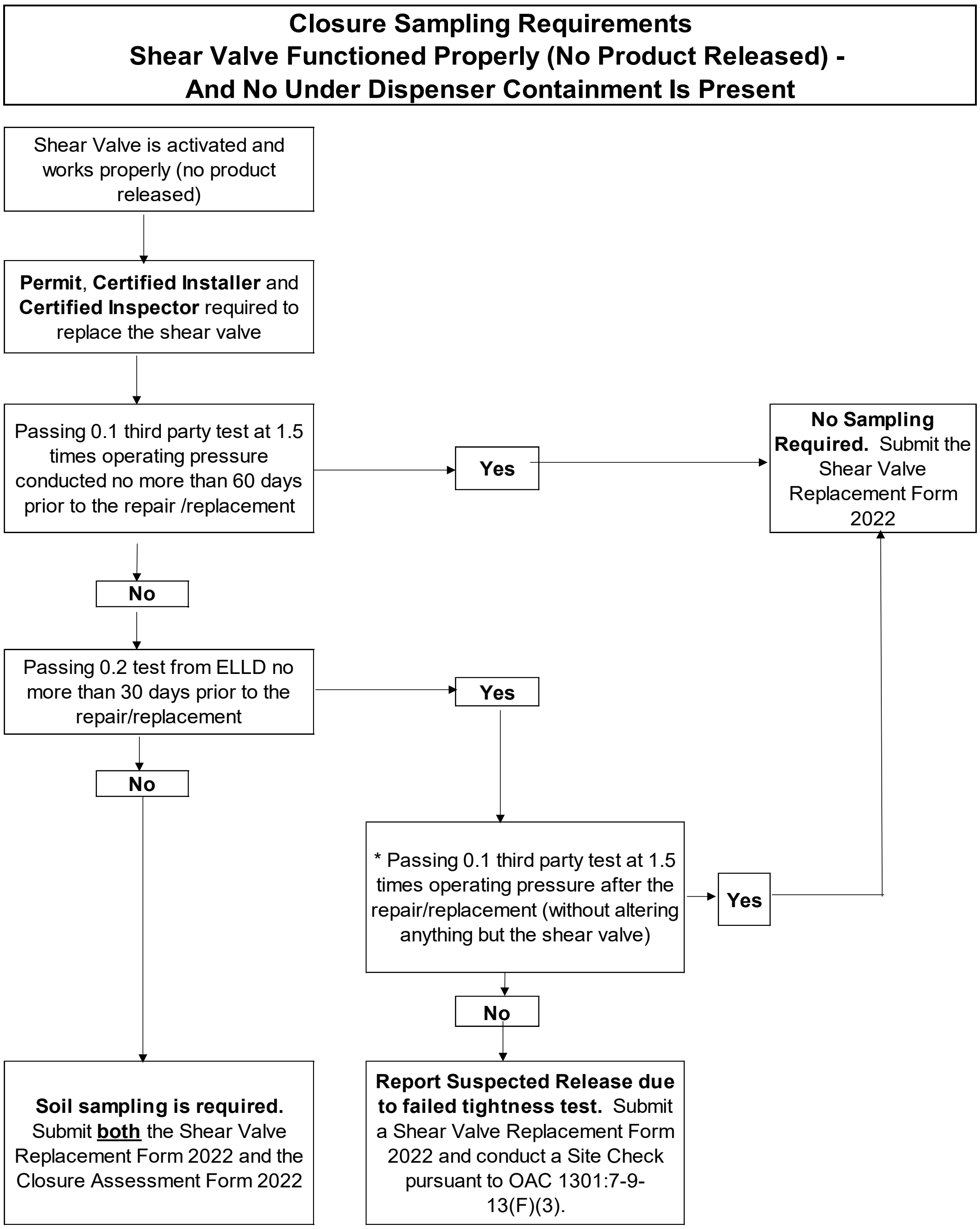


*** NOTE: THIS FLOW CHART IS ONLY FOR THE SAMPLING REQUIREMENTS WHEN A SHEAR VALVE IS REPLACED. THE 0.1 GPH TIGHTNESS TEST AT 1.5 TIMES THE OPERATING PRESSURE IS STILL REQUIRED AS PART OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK PRIOR TO THE PRODUCT LINE GOING BACK INTO SERVICE. THE ON-SITE ELECTRONIC LINE TESTING UNIT CANNOT BE USED IN PLACE OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK.**

Flow Chart 2.4: Shear Valve Malfunction and Free Product is Released



Flow Chart 2.5: Shear Valve Replacement Outside of a Secondary Containment System



*** NOTE: THIS FLOW CHART IS ONLY FOR THE SAMPLING REQUIREMENTS WHEN A SHEAR VALVE IS REPLACED. THE 0.1 GPH TIGHTNESS TEST AT 1.5 TIMES THE OPERATING PRESSURE IS STILL REQUIRED AS PART OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK PRIOR TO THE PRODUCT LINE GOING BACK INTO SERVICE. THE ON-SITE ELECTRONIC LINE TESTING UNIT CANNOT BE USED IN PLACE OF A FINAL INSPECTION FOR PERMIT DRIVEN WORK.**

2.6.3 Visual Site Evaluation

A visual site evaluation of the UST site should be performed and documented in the applicable closure assessment form. This evaluation should identify all evidence of past or present operational problems including, but not limited to the following:

- Surface soil staining, concrete or asphalt staining, or concrete patchwork); and
- Evidence of other sources of site contamination, such as areas where piping and pump islands appear to have existed.

2.6.4 Stockpile Soil Samples

All excavated soil and backfill materials generated during modifications are assumed to be PCS. Manage this soil and backfill material according to OAC 1301:7-9-16 and 17, unless analytical data demonstrates concentrations are less than re-use ALs. See Table 4.2 in Section 4.6. For instance, if a UDC is being installed below a dispenser, PCS will be generated during excavation and must be managed appropriately.

Excavated soil that is not stored on-site but is shipped directly to a licensed disposal facility following excavation shall be sampled and analyzed prior to shipment to the extent required by the licensed disposal facility receiving the soil.

Table 2.1 indicates the number of PCS samples that must be field screened and submitted for laboratory analysis if sampling is performed. If samples are not field screened, all grab samples must be submitted for laboratory analysis.

Table 2.1 - Stockpile Sampling

	Cubic Yards of Soil and Backfill Material Generated				
	<25*	**26-100**	**101-250**	**251-450**	**>450**
1. Minimum number of grab samples to collect and field screen	3	6	12	18	18 plus 1 sample per each additional 50 yd^3 (or fraction thereof)
2. Minimum number of grab samples to submit to the laboratory	2	3	6	8	8 plus 1 sample per each additional 100 yd^3 (or fraction thereof)

* For excavated soil in containers having a capacity of 55 gal. (0.27 yd^3) or less, one grab sample must be collected from the center at mid-depth of the soil in the container and submitted to the laboratory for analysis.

2.6.5 Piping Modification/Closure Assessment – Sampling Not Required Report

Within 90 days of completing field activities, a Piping Modification/Closure Assessment Form – Sampling Not Required 2022 report must be submitted to BUSTR describing the activities.

The Piping Modification/Closure Assessment – Sampling Not Required Form 2022 lists all information required to prepare a complete report. Typically, an environmental contractor or consultant is hired to conduct the closure assessment and prepare the report. BUSTR holds the O/O, not the consultant, responsible for the report's accuracy and completeness. Therefore, the UST O/O must sign, date, and ensure submission of the closure form to BUSTR. Before signing, the O/O should carefully review the report and ask the consultant to explain any unclear issues. BUSTR advises that the O/O maintain a copy of all reports and forms submitted.

2.7 Closure Assessment – Sampling Required

Excluding certain modifications discussed in Sections 2.5 and 2.6, a closure assessment must be performed if any portion of the UST system at or below the shear valve is:

- Permanently removed (including removals resulting from modifications of components that routinely contain product);
- Closed-in-place;
- Undergone a change-in-service; or
- OOS for more than 12 months with no permit or with an expired permit.

A closure assessment is not required if a variance from the timely submittal of an extension request for an OOS permit is granted by BUSTR or the Certified Fire Safety Inspector with delegated authority and the UST system is placed back into service within the allotted time. A variance will be reviewed on a case-by-case basis and may be granted if good cause exists (e.g., change in ownership).

If any portion of the system that routinely contains product is repaired or replaced during a modification, a closure assessment must be conducted and a Closure Assessment Form submitted to BUSTR. Modifications do not always require that a closure assessment be conducted. For instance, a closure assessment is not required if cathodic protection is added to the UST system or for replacing vent lines.

Routine maintenance and operational upkeep, as defined in OAC 1301:7-9-02(B)(56), do not require permits or closure assessments.

If the portion of the UST system being removed is also being assessed under OAC 1301:7-9-13, a closure assessment is required unless a demonstration is made to show that the portion of the UST system requiring closure assessment has been adequately evaluated. To make this demonstration, adequate documentation must be submitted to BUSTR for approval to eliminate that portion of the UST system from the closure assessment requirements.

2.7.1 UST Site Characterization

Site History

The site history section of the closure report should describe:

- A brief site history;
- Historical and current land-use of the site and surrounding properties;
- Previous closures, releases, and suspected releases;

- Date the UST system was last used and by whom, if known;
- Locations of current and former UST systems and the substances they stored; and
- Any OOS UST systems still existing on the site and the substance(s) stored during their use.

Visual Site Evaluation

A visual site evaluation of the UST site should be performed and documented in the applicable closure assessment form. This evaluation should identify all evidence of past or present operational problems including, but not limited to the following:

- Surface soil staining, concrete or asphalt staining, or concrete patchwork; and
- Evidence of other sources of site contamination, such as areas where piping and pump islands appear to have existed.

2.7.2 Sample Location and Field Screening Requirements

The following section identifies all locations where field screening samples must be collected during closure activities. Field screening determines which samples must be submitted to the laboratory. See Appendix A for sampling and field screening procedures.

Sample Location for Removal

Soil samples for field screening purposes must be biased towards the areas of greatest suspected contamination and taken at the following locations within 24 hours of completing the excavation (Appendix A):

- At both ends of each UST. If the UST is longer than 35 ft., collect an additional sample under the middle of each UST;
- From each sidewall of the UST cavity excavation using a ratio of one sample per 100 ft^2 rounded up. These samples must be biased towards areas with the highest contamination. For instance, if the excavation is 24 ft. wide by 36 ft. long and 13 ft. deep, the total sidewall area of the excavation is 1,560 ft^2. This would require 15.6 samples for field screening (round up to 16). The cavity is then divided into 16 equal sections and sampled. (NOTE: Sidewall samples must be collected even if groundwater recharges within the excavation, however, the number of soil samples required must be recalculated based on the surface area of soil above the water table);
- Every 10 ft. along piping runs that routinely contain regulated substances and under joints unless the sample location is within 2 linear ft. of another sample required in accordance with this section. **If the piping run is associated with an airport hydrant system, an alternate sampling plan shall be submitted for approval by the State Fire Marshal prior to conducting the closure assessment**;
- Below each dispensing unit where joints, elbows, and flex connectors are located, unless the dispenser is located directly above a tank that is being removed; and
- Below any remote fill pipe area greater than 10 ft. from the UST cavity.

An alternative sampling plan must be submitted for BUSTR approval if site conditions (e.g., bedrock) interfere with collecting samples. Such limitations may require the installation and sampling of one or more MWs.

Any water encountered in the excavation must be evacuated. If water recharges into the excavation within 24 hours of pumping, a groundwater sample must be collected. Collect groundwater samples from any dispenser, piping trenches, or tank cavity areas that contain groundwater. If no water recharges within 24 hours, only soil sampling is required. See Appendix A for sampling procedures.

2.7.3 Closure Samples Required for Laboratory Analysis

The following samples for complete or partial UST system removals must be submitted to an accredited laboratory for analysis:

- Two soil samples from each UST cavity including sidewall samples that have the highest field screening reading from each UST cavity. If the UST cavity excavation contained more than three USTs, add an additional soil sample for each multiple or fraction of three USTs. For example, if the cavity contained one, two, or three USTs, submit only two samples; if the cavity contained four, five, or six USTs, submit three samples;
- One soil sample for every five soil samples collected, or fraction thereof, from underneath all product piping at the site. Notwithstanding the one-to-five ratio, at least one sample from each distinct piping run that leads to a separate dispensing area or remote fill shall be submitted. See the Detailed Explanation of Piping Sample Selection below;
- One sample from each dispenser island that has the highest field screening reading. If a dispenser island contained more than three dispensing units, add an additional soil sample for each multiple or fraction of three dispensing units;
- One sample from each remote fill area that is greater than 10 ft. away from the UST system;
- All water samples collected (Appendix A); and
- Soil stockpile samples according to the volume of the stockpile (Table 2.1).

Detailed Explanation of Piping Sample Selection

The concept of "dispensing areas" will be used as the key criterion for selecting product piping closure samples for analysis. Typically, a "dispensing area" is a single dispenser or group of dispensers under a single canopy.

To determine which samples should be submitted for analysis, the following criteria should be utilized:

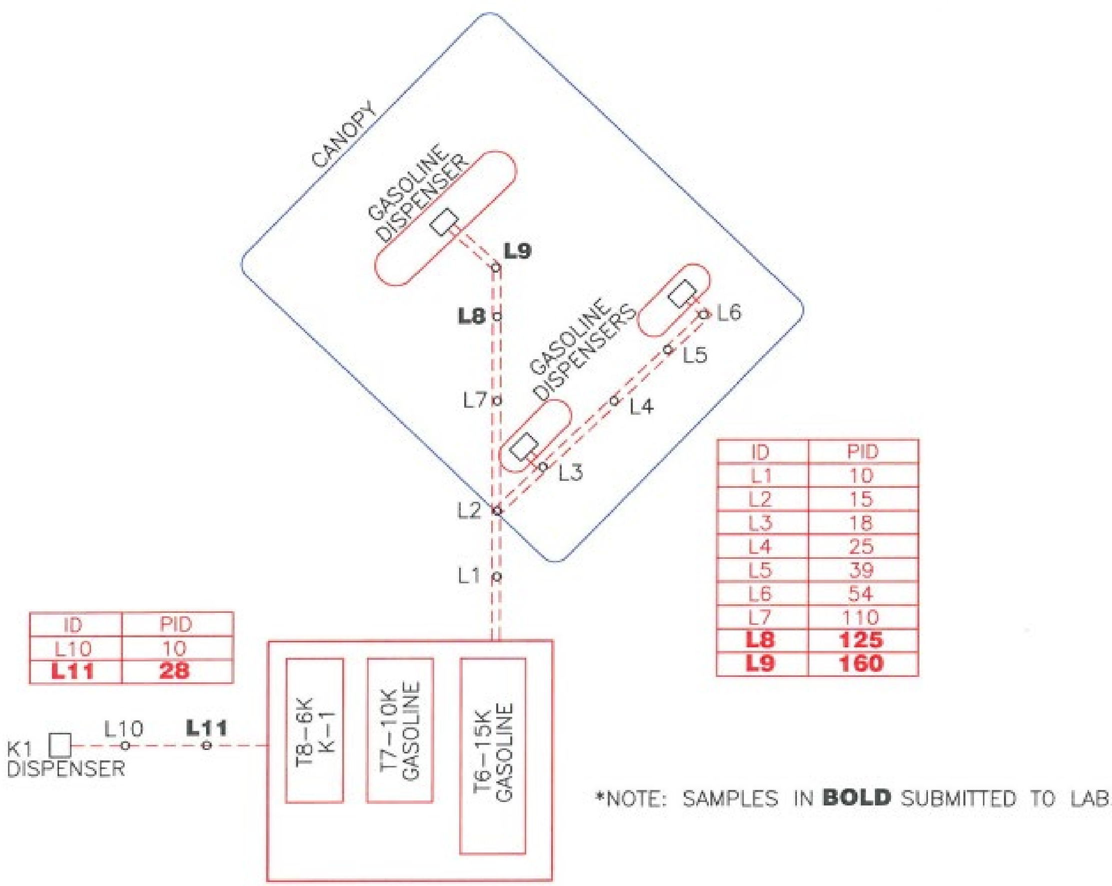
- Identify the separate dispensing areas and the product piping associated with each area;
- Submit for analysis the highest field screened piping sample from each separate dispensing area, including the piping that leads to each separate dispensing area; and
- Submit the remaining sample(s) with the highest field screening readings from all the product piping samples collected for the closure assessment to reach the total number of required samples (i.e., using the "one soil sample for every five soil samples collected" rule).

For example, Figure 2.3 depicts a facility with two separate dispensing areas. The gasoline area has a total piping length of approximately 90 ft. and is located north of the UST cavity. Samples L1 through L9 are from the gasoline dispensing area. The kerosene area has a total piping length of approximately 25 ft. located west of the UST cavity. Samples L10 and L11 are from the kerosene dispensing area. A total of 115 ft. of piping indicates that 11 samples will be collected for field screening, and a total of three samples will be submitted for lab analysis.

The **three** samples to be submitted will be based upon the following:

- Sample #1) – Select the sample with the highest field screening result from the piping trench associated with the kerosene dispensing area or the piping leading to the kerosene area. This is sample L11, which will be submitted for lab analysis.
- Sample #2) – Select the sample with the highest field screening result from the piping trench associated with the gas dispensing area or the piping leading to the gas dispensing area. This is sample L9, which will be submitted for analysis.
- Sample #3) – Select the remaining sample with the next highest field screening result, regardless of location. This is sample L8, which will be submitted for analysis.

Figure 2.3 - Example of Product Piping Sampling



Please note that **all** dispensing areas must be represented among the samples submitted for analysis, even if this means including more samples for analysis than the “one sample for every five collected” rule would indicate.

If field screening was not conducted, then all samples collected must be submitted for laboratory analysis. If no field screening readings are exhibited, the sample(s) submitted shall be biased toward the area(s) of greatest suspected contamination.

Please note that all soil samples are required to be analyzed on a dry-weight basis.

2.7.4 Chemicals of Concern

COCs must be identified based on the contents of the UST system. The different regulated substances have been divided into five analytical groups.

- Analytical Group 1: light distillates, including unleaded gasoline, leaded gasoline, naptha, gasoline blended with alcohol, racing fuel, and aviation gasoline;
- Analytical Group 2: middle distillates, including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, biodiesel blended with diesel, and jet fuels;
- Analytical Group 3: heavy petroleum distillates, including, but not limited to, lubricating and hydraulic oils;
- Analytical Group 4: used oil;
- Analytical Group 5: unknown petroleum products or petroleum products other than those listed in the four analytical groups above. If the contents of the UST system fall into Analytical Group 5, BUSTR must be consulted to determine the appropriate COCs and the associated analytical methods. These chemicals may be selected based on the properties of the stored chemical(s) and information provided on the safety data sheet (SDS) for the chemical.

COCs and their associated analytical methods must be selected based on the above analytical groups and Table 2.2.

Two lead scavengers were added to the list of COCs, namely 1,2-dibromoethane (EDB) and 1,2-dichloroethane (EDC). These two chemicals were added based on the USEPA memorandum on lead scavengers dated May 21, 2010.

During UST closure assessments, EDB and EDC shall be analyzed for automotive gasoline USTs that were in service prior to January 1, 1996. EDB and EDC do not need to be analyzed for automotive gasoline USTs installed on or after January 1, 1996. EDB and EDC shall be analyzed for all USTs containing aviation gasoline, racing fuel, and used oil, regardless of when the USTs were installed.

If the release contains both Group 1 and 2 COCs, naphthalene must be analyzed for both volatile and semi-volatile organic range and the highest concentration of the two should be reported.

Table 2.2 - Chemicals of Concern

	Analytical Group Number	**1**	**2**	**3**	**4**	**5**	**Analytical Methods**[7]	
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	**Soil** [4]	**Groundwater**
	Chemical							
Aromatics	Benzene	x	x		x		8021 or 8260	8021 or 8260
	Toluene	x	x		x			
	Ethylbenzene	x	x		x			
	o, m and p-Xylenes	x	x		x			
	Naphthalene	x			x			
	1,2,4 – Trimethylbenzene	x			x			
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		8021 or 8260	8021 or 8260
	1,2 – Dibromoethane (EDB) [5,6]	x			x		8260	8011
	1,2 – Dichloroethane (EDC) [5,6]	x			x		8260	8260
Polynuclear Aromatics[9]	Benzo(a)anthracene		x	x	x		8270, 8310	8270, 8310[8]
	Benzo(a)pyrene		x	x	x			
	Benzo(b)fluoranthene		x	x	x			
	Benzo(k)fluoranthene		x	x	x			
	Chrysene		x	x	x			
	Dibenz(a,h)anthracene		x	x	x			
	Indeno(1,2,3-c,d)pyrene		x	x	x			
	Naphthalene		x	x	x			
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		Full 8260	Full 8260
Total Petroleum Hydrocarbons [1]	TPH (C6 – C12)	x			x		8015	N/A
	TPH (C10 – C20)		x		x			
	TPH (C20 – C34)			x	x			
Others	Varies based on UST contents [2]			x	x	[3]		

1 TPH analysis is not required for groundwater samples.
2 Additional COCs should be based on Safety Data Sheets (SDS) and analyzed with an appropriate laboratory test method capable of meeting established target levels.
3 Refer to paragraph OAC 1301:7-9-13(H)(1)(c)(v) (described under Analytical Group 5).
4 Soil analytical results shall be reported on a dry weight basis.
5 EDB and EDC shall be analyzed for most automotive gasoline USTs that were in service prior to January 1, 1996 (see Section 3.8.1 for details).
6 EDB and EDC shall be analyzed for all USTs containing aviation gasoline, racing fuel, and used oil (regardless of when they were installed).
7 Alternate laboratory methods will be considered if the methods meet the quality control, performance and method detection level requirements.
8 Field filtering may be used for Methods 8270 and 8310.
9 PAH analysis should consist of 8 specific chemicals of concern.

2.7.5 Accredited Laboratories

BUSTR requires that the laboratory methods listed in Table 2.2 be used for analyzing samples collected during closure assessment activities. All samples must also be sent to a laboratory accredited by one of the following:

- The Ohio EPA Division of Drinking and Groundwater;
- Ohio EPA Voluntary Action Program;
- National Environmental Laboratory Accreditation Program;
- American Association of Laboratory Accreditation; or
- Another state environmental protection agency program recognized by the State Fire Marshal.
    - For a laboratory that is certified by another state to be accredited by BUSTR, a request must be submitted which includes a copy of the certification along with the specific methods and chemicals of concern that apply.

If a laboratory is certified by one of the above agencies and for **at least one** of the following USEPA methods: 8015, 8021, 8260, 8270, 8310, or 8011, BUSTR will consider the laboratory to be accredited. For example, if the laboratory is certified to only perform method 8260 for volatile organic compounds (VOCs), BUSTR will also accept all other total petroleum hydrocarbons (TPH) and semi-volatile organic compounds (SVOC) data (even if the laboratory is not certified for those methods). Likewise, if the laboratory is certified to only perform method 8015 for TPH, BUSTR will also accept all other VOC and SVOC data (even if the laboratory is not certified for those methods).

2.7.6 Action Levels for UST Closure

Table 2.3 provides most ALs applicable to the UST closure assessment. Assume the soil type to be Class 1 soil or submit laboratory geotechnical documentation of the soil type that best represents the soil under the UST site. Bedrock is included in the category of Class 1 soil.

The action levels for closure assume that the land-use is residential, groundwater underlying the UST site is a drinking water source and the depth to groundwater is less than 15 ft. If the product stored in the UST being closed is in Analytical Group 3, 4, and/or 5, then additional COCs may need to be evaluated (Section 2.7.4).

Action levels for COCs that are not listed in Table 2.3 can be derived from the BUSTR Spreadsheets. BUSTR spreadsheets already contain toxicity and chemical specific data for many VOCs and SVOCs. If any of the detected chemicals are not already included in BUSTR's spreadsheets, chemical specific data can be obtained from Ohio EPA-VAP (using their CIDARS database). If the data is not available on the BUSTR spreadsheet or in the CIDARS database, the specific COC does not need further evaluation. Additional directions on calculating COCs not in BUSTR spreadsheets can be found in Section 3.9.3 of this document.

Table 2.3 - Summary of Closure Action Levels

Drinking Water Action Levels*	Chemical of Concern (COC)	Soil Action Levels*		
		Class 1	**Class 2****	**Class 3****
0.005	Benzene	0.246	0.437	1.63
1	Toluene	70.7	168	850
0.7	Ethylbenzene	84.5	130	130
10	Total Xylenes	42.7	51.8	63.5
0.0014	Naphthalene	0.511	1.12	4.99
0.015	1,2,4 Trimethyl benzene	2.37	5.89	7.99
0.12	MTBE	1.58	2.67	11.5
0.00005	1,2 - Dibromoethane (EDB)	0.000982	0.00177	0.00734
0.005	1,2 - Dichloroethane (EDC)	0.101	0.177	0.714
0.00092	Benzo(a)anthracene	12	12	12
0.0002	Benzo(a)pyrene	1.2	1.2	1.2
0.00092	Benzo(b)fluoranthene	12	12	12
0.0092	Benzo(k)fluoranthene	120	120	120
0.092	Chrysene	1,200	1,200	1,200
0.000092	Dibenz(a,h)anthracene	1.2	1.2	1.2
0.00092	Indeno(1,2,3-c,d)pyrene	12	12	12
-	TPH C_6-C_{12}	1,000.0	5,000.0	8,000.0
-	TPH C_{10}-C_{20}	2,000.0	10,000.0	20,000.0
-	TPH C_{20}-C_{34}	5,000.0	20,000.0	40,000.0

* COC concentrations are expressed in parts per million (ppm) for soil and groundwater, and on a dry-weight basis for soil.
** The use of soil class 2 or 3 during the closure assessment requires geotechnical analysis to confirm the classification.

2.7.7 Stockpile Soil Samples

All excavated soil and backfill materials are assumed to be PCS. Manage this soil and backfill material according to OAC 1301:7-9-16 and 17, unless analytical data demonstrates concentrations are less than PCS re-use ALs (Chapter 4). Table 2.1 indicates the number of samples that must be field screened and submitted for laboratory analysis. If samples are not field screened, all grab samples must be submitted for laboratory analysis.

2.7.8 Closure Assessment Report

Upon completing the closure assessment and **within 90 days** after collecting the samples, a Closure Assessment report must be submitted to BUSTR on the appropriate BUSTR Closure Form.

- The Closure Assessment Form – 2022 must be submitted if a UST system or part of a UST system is removed.
- The Closure-In-Place Form – 2022 must be submitted if a UST system or portion of a UST system:
  - Is closed-in-place;
  - Undergoes a change-in-service;
  - Previously closed systems;
  - Is OOS for more than 12 months without a permit; or
  - Is OOS beyond the permitted extension period.

The BUSTR Closure forms list all information required to prepare a complete closure assessment report. Typically, an environmental consultant is hired to conduct the closure assessment and prepare the report. BUSTR holds the O/O, not the consultant, responsible for the report's accuracy and completeness. Therefore, the UST O/O must sign, date, and ensure submission of the closure form to BUSTR. Before signing, the O/O should carefully review the report and ask the consultant to explain any unclear issues. BUSTR advises that the O/O maintain a copy of all reports and forms submitted.

If the concentrations of COCs at any location on the UST site are above the ALs, a confirmed release must be reported to BUSTR within 24 hours of receiving analytical results. Corrective actions must be conducted as described in Chapter 3, Corrective Actions Requirements under OAC 1301:7-9-13. Conducting over-excavation of contaminated soil will require the completion of a Tier 1 Source Investigation.

If COC concentrations are below ALs and the Closure Assessment Form is complete, then no further action is required.

Chapter 3 - Corrective Action Requirements - OAC 1301:7-9-13

3.1 Purpose and Scope

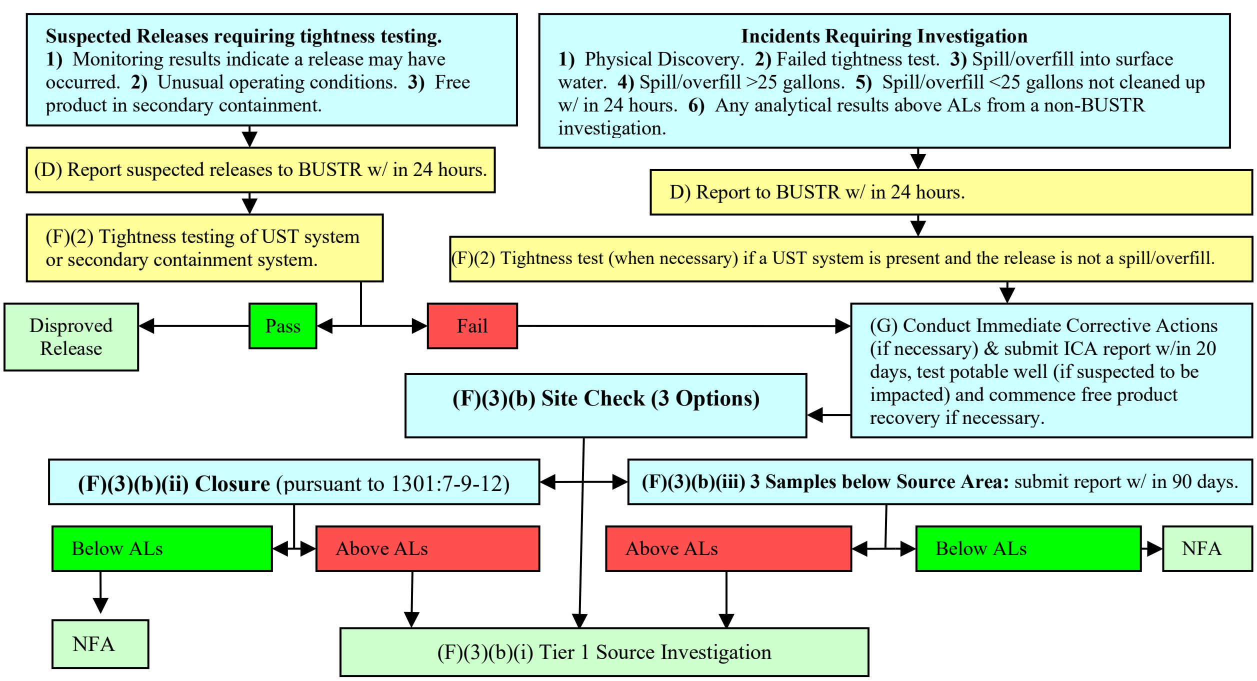
OAC 1301:7-9-13 describes the BUSTR required process for investigating a petroleum release, evaluating source area concentrations in comparison to AL concentrations, determining site-specific target level concentrations, and implementing appropriate monitoring or remediation activities at a UST site.

The BUSTR corrective action process described here includes, but is not limited to, the following:

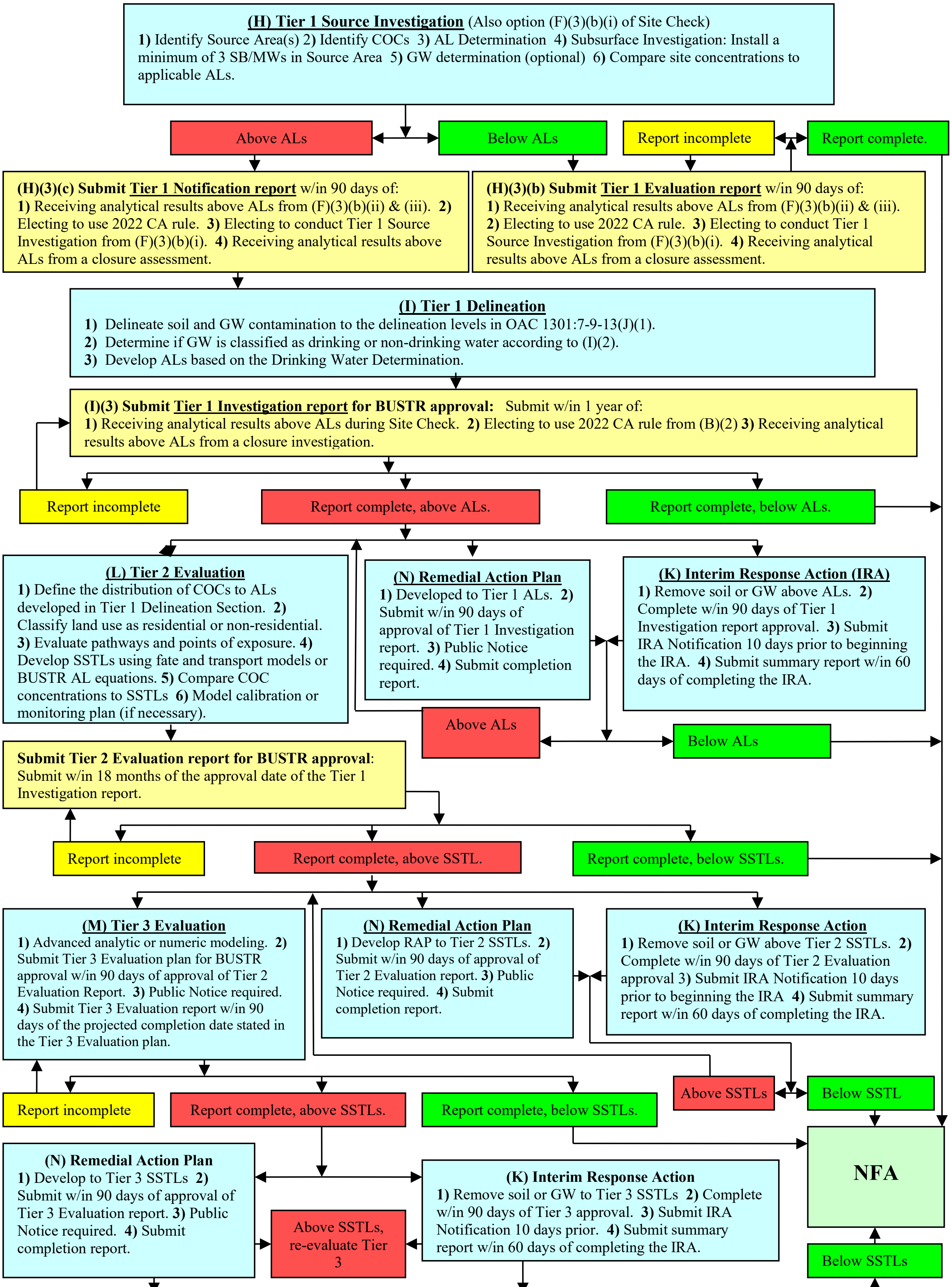
- Reporting suspected releases, releases and confirmed release of petroleum products from USTs;
- Cleaning up spills and overfills of petroleum products, and performing immediate corrective actions at UST sites;
- Investigating releases and suspected releases;
- Determining the extent of contamination, and evaluating the risks posed by the petroleum chemicals of concern released using the risk-based, tier evaluation process; and
- Performing remedial actions and monitoring at BUSTR-regulated sites to ensure that the chemicals released do not pose an unacceptable risk to human health or the environment.

To better understand the BUSTR corrective action process, see Flowchart 3.1:

Flow Chart 3.1: Corrective Action Process



Flowchart 3.1 continued on the following page.


(H) Tier 1 Source Investigation (Also option (F)(3)(b)(i) of Site Check)
1) Identify Source Area(s) 2) Identify COCs 3) AL Determination 4) Subsurface Investigation: Install a minimum of 3 SB/MWs in Source Area 5) GW determination (optional) 6) Compare site concentrations to applicable ALs.
Above ALs
Below ALs
Report incomplete
Report complete.
(H)(3)(c) Submit Tier 1 Notification report w/in 90 days of:
1) Receiving analytical results above ALs from (F)(3)(b)(ii) & (iii). 2) Electing to use 2022 CA rule. 3) Electing to conduct Tier 1 Source Investigation from (F)(3)(b)(i). 4) Receiving analytical results above ALs from a closure assessment.
(H)(3)(b) Submit Tier 1 Evaluation report w/in 90 days of:
1) Receiving analytical results above ALs from (F)(3)(b)(ii) & (iii). 2) Electing to use 2022 CA rule. 3) Electing to conduct Tier 1 Source Investigation from (F)(3)(b)(i). 4) Receiving analytical results above ALs from a closure assessment.
(I) Tier 1 Delineation
1) Delineate soil and GW contamination to the delineation levels in OAC 1301:7-9-13(J)(1).
2) Determine if GW is classified as drinking or non-drinking water according to (I)(2).
3) Develop ALs based on the Drinking Water Determination.
(I)(3) Submit Tier 1 Investigation report for BUSTR approval: Submit w/in 1 year of:
1) Receiving analytical results above ALs during Site Check. 2) Electing to use 2022 CA rule from (B)(2) 3) Receiving analytical results above ALs from a closure investigation.
Report incomplete
Report complete, above ALs.
Report complete, below ALs.
(L) Tier 2 Evaluation
1) Define the distribution of COCs to ALs developed in Tier 1 Delineation Section. 2) Classify land use as residential or non-residential. 3) Evaluate pathways and points of exposure. 4) Develop SSTLs using fate and transport models or BUSTR AL equations. 5) Compare COC concentrations to SSTLs 6) Model calibration or monitoring plan (if necessary).
(N) Remedial Action Plan
1) Developed to Tier 1 ALs. 2) Submit w/in 90 days of approval of Tier 1 Investigation report. 3) Public Notice required. 4) Submit completion report.
(K) Interim Response Action (IRA)
1) Remove soil or GW above ALs. 2) Complete w/in 90 days of Tier 1 Investigation report approval. 3) Submit IRA Notification 10 days prior to beginning the IRA. 4) Submit summary report w/in 60 days of completing the IRA.
Above ALs
Below ALs
Submit Tier 2 Evaluation report for BUSTR approval:
Submit w/in 18 months of the approval date of the Tier 1 Investigation report.
Report incomplete
Report complete, above SSTL.
Report complete, below SSTLs.
(M) Tier 3 Evaluation
1) Advanced analytic or numeric modeling. 2) Submit Tier 3 Evaluation plan for BUSTR approval w/in 90 days of approval of Tier 2 Evaluation Report. 3) Public Notice required. 4) Submit Tier 3 Evaluation report w/in 90 days of the projected completion date stated in the Tier 3 Evaluation plan.
(N) Remedial Action Plan
1) Develop RAP to Tier 2 SSTLs. 2) Submit w/in 90 days of approval of Tier 2 Evaluation report. 3) Public Notice required. 4) Submit completion report.
(K) Interim Response Action
1) Remove soil or GW above Tier 2 SSTLs. 2) Complete w/in 90 days of Tier 2 Evaluation approval 3) Submit IRA Notification 10 days prior to beginning the IRA 4) Submit summary report w/in 60 days of completing the IRA.
Above SSTLs
Below SSTL
Report incomplete
Report complete, above SSTLs.
Report complete, below SSTLs.
NFA
(N) Remedial Action Plan
1) Develop to Tier 3 SSTLs 2) Submit w/in 90 days of approval of Tier 3 Evaluation report. 3) Public Notice required. 4) Submit completion report.
(K) Interim Response Action
1) Remove soil or GW to Tier 3 SSTLs 2) Complete w/in 90 days of Tier 3 approval. 3) Submit IRA Notification 10 days prior. 4) Submit summary report w/in 60 days of completing the IRA.
Above SSTLs, re-evaluate Tier 3
Below SSTLs

3.2 Applicability

OAC 1301:7-9-13, effective September 1, 2022, (i.e., the 2022 Corrective Action [CA] Rule) applies to corrective actions performed at petroleum UST sites as follows:

- For releases reported on or after September 1, 2022, corrective actions must be conducted in accordance with the current corrective action rule.
- For releases reported prior to September 1, 2022, corrective actions can be conducted either:
  - In accordance with this rule by submitting a letter to the State Fire Marshal stating their election to conduct corrective actions in accordance with this rule; or
  - In accordance with the previous version of OAC 1301:7-9-13 under which corrective actions are currently being conducted. By failing to meet a compliance deadline while conducting corrective action under a previous version of this rule, the State Fire Marshal may, in his sole discretion, transfer the release to the current version of this rule.

An election as described in OAC 1301:7-9-13(B)(2)(a) can be made at any time. Once made, the election is permanent.

3.2.1 Transitioning from Previous Rule Versions to the 2022 CA Rule

This section describes the process for transitioning from previous versions of the corrective action rules to the 2022 corrective action rule.

The new corrective action rule (OAC 1301:7-9-13, effective September 1, 2022) has clarified requirements as to the deadlines and type of reports required to be submitted when a site moves into the new 2022 rule. The rule requires all sites that move into the new rule (voluntarily or transferred by the State Fire Marshal) to submit a Tier 1 Notification Form 2022 or Tier 1 Evaluation Form 2022 on fixed deadlines regardless of how far the site has progressed within the 1992, 1999, 2005, 2012 or 2017 rule process. A Tier 1 Source Investigation is required because of the significant differences between the previous rules and current rules.

In some cases, historical data may be used to meet the requirements of the 2022 corrective action rule. BUSTR anticipates that most releases will require additional data collection, including additional soil borings and monitoring wells, to fulfill all the rule requirements. Existing monitoring wells may be used for the collection of current groundwater data if the monitoring wells are located in the source area.

3.3 Regulated UST Systems and Exemptions

Please see Chapter 1 for the full discussion of regulated and exempt UST systems.

The following regulated UST systems are exempt from the 2022 corrective action rule (but may be subject to the closure rule):

- Any UST system holding hazardous wastes listed or identified under OAC Chapter 3745-51 or a mixture of such hazardous wastes and other regulated substances;

- Any wastewater **treatment** tank system that is part of a wastewater treatment facility regulated under Section 402 or 307(b) of the Federal Water Pollution Control Act (33 U.S.C.A. 1251 and following);
- Equipment or machinery that contains regulated substances for operational purposes such as hydraulic lift tanks and electrical equipment tanks;
- Any UST system whose capacity is 110 gallons or less;
- Any emergency spill or overflow containment UST system that is expeditiously emptied after use;
- Any UST system that contains a *de minimis* concentration of regulated substances; and
- Any UST system that contains hazardous substances listed under OAC 1301:7-9-03 that has had a confirmed release.

The following UST systems are exempt from the closure rule but releases from these systems are regulated under the 2022 corrective action rule:

- Wastewater **treatment** systems **not** regulated under Section 402 or 307(B) of the Federal Water Pollution Control Act (33 USCA 1251 and following) (e.g., some oil/water separators);
- Any UST system containing radioactive material that is regulated under the Atomic Energy Act of 1954 (42 USCA 2014 and following);
- Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the United States Nuclear Regulatory Commission;
- Above ground storage tanks associated with airport hydrant fuel distribution systems; and
- Above ground storage tanks associated with UST systems with field-constructed tanks.

3.4 Reporting of Suspected Releases, Releases and Confirmed Releases

A suspected release, release or confirmed release must be reported to BUSTR and the local fire department **within 24 hours** of discovery. During normal business hours (8 am-5 pm), please call the BUSTR main line at 614-752-7938 or 800-686-2878 and follow the prompts to speak to a duty officer. Alternatively, you may also complete the **Suspected Release Notification Form 2022 online or download the form** and email to web.bustr@com.ohio.gov and the site coordinator.

3.4.1 Clean-up of Spills and Overfills

If a spill or overfill occurs while transferring or attempting to transfer petroleum product into a UST system, it must be immediately contained and cleaned up to pre-spill/overfill conditions. In addition, a Site Check (Section 3.5.3) and Immediate Corrective Actions (Section 3.6) are required if any of the following occurs:

- A spill or overfill of 25 gallons or greater;
- A spill or overfill is not immediately cleaned up within 24 hours, regardless of the amount of product spilled/overfilled; or
- If a spill or overfill of any amount that reaches the environment or enters a nearby surface water body, stormwater system, monitoring well or observation well.

3.4.2. Suspected Release

A release is suspected [OAC 1301:7-9-13(C)(35)(a) through (e)] when *any* of these events occurs:

- Monitoring results**,** including investigation of an alarm, from a release detection method indicate that a release may have occurred unless:
  - The monitoring device is found to be defective, and is immediately repaired, recalibrated, or replaced, and additional monitoring does not confirm the initial result;
  - The leak is contained in the secondary containment and:
    - Any liquid in the interstitial space not used as part of the interstitial monitoring method is immediately removed, and
    - Any defective system equipment or component is immediately repaired or replaced;
  - In the case of an inventory control discrepancy or inconclusive statistical inventory reconciliation (SIR) results, a second month of data does not confirm the initial result, or the evaluation of the discrepancy determines that no release has occurred; or
  - The alarm was investigated and determined to be a non-release event (for example, from a power surge or caused by filling the tank during release detection testing).
- A failed tightness test on the parts of the UST system that routinely contain product (unless it is a preliminary tightness test during installation activities). Note that a failed tightness test of part of the secondary containment system is not a suspected release unless the test was conducted due to the presence of free product within the secondary containment;
- Unusual operating conditions are observed by the owners and operators. Unusual operating conditions include the erratic behavior of product dispensing equipment (e.g., slow flow associated with a mechanical line leak detector), the sudden loss of product from the UST system, liquid in the interstitial space of secondarily contained systems, and an unexplained presence of water in the UST.
- In the case of water in a UST, a demonstration must be made as to how the water entered the UST and demonstrate that product did not escape the UST. The situations listed above are considered suspected releases unless all the following apply:
  - The system equipment or component is found not to be releasing substances to the environment;
  - Any defective system equipment or component is immediately repaired or replaced; and
  - For secondarily contained systems, any liquid in the interstitial space not used as part of the interstitial monitoring method is immediately removed;
- The presence of free product discovered in the containment sump or interstitial space of the UST system, other than spill prevention equipment, on a UST site; or
- Physical discovery of a petroleum product is detected.
- Physical discovery is defined in OAC 1301:7-9-13(C)(21) and includes *one or more* of the following scenarios:
  - Free product is discovered during removal of any portion of a UST system, in an excavation on a UST site or on a property nearby a UST site;
  - Petroleum product and/or petroleum product vapors are discovered on a UST site or a nearby property. These locations include, but are not limited to, buildings, basements, drinking water wells, and other areas such as building foundations, pedestrian tunnels, utility vaults, and utility or sewer lines;
  - Free product is discovered in a monitoring or observation well located on or off-site;
  - The presence of petroleum products is observed on a surface water body and is suspected to have originated from the UST system;

- o Analytical results are received and are above ALs (using the assumptions that groundwater is drinking water, land-use is residential, and soils are Class 1 unless geotechnical data is obtained) for any non-BUSTR related activities (e.g., divestment assessment, phase II assessment); and
- o While conducting a closure assessment under the OAC 1301-7-9-12(I)(1)(c), discovering evidence of petroleum product in soil or fill material or discovering evidence that a component has leaked or is leaking.

Release

A release is defined as any spilling, leaking, emitting, discharging, escaping, leaching, or disposing of a petroleum product from a UST system into the groundwater, a surface water body, subsurface soil, or otherwise into the environment.

Confirmed Release

A confirmed release means COCs were found in subsurface soil or groundwater on a UST site found in concentrations above AL and confirmed through laboratory analysis of samples collected during a closure assessment or a Site Check activity. This definition includes instances where PCS above AL is returned to an unlined excavation(s) during closure activities.

3.5 Investigating Releases and Suspected Releases

The purpose of the Investigating Releases and Suspected Releases section is to determine if a UST system is leaking or has leaked, to identify the source or sources of a release, to determine if free product exists, and to determine if a confirmed release has occurred. Flowchart 3.1 may be used to better understand the investigation of releases and suspected releases.

3.5.1 UST System Evaluation

If a release is determined to have occurred, inspect for above-ground releases or exposed below-ground releases. This evaluation may include an inspection of product dispensers, product piping (i.e., flex connectors, joints, etc.), release detection equipment, spill and overfill buckets, and containment sumps.

If testing or other evidence confirms that a release has or continues to occur from the UST system, immediate corrective actions must be conducted to stop all further releases (Section 3.6).

3.5.2 Tightness Test

If a suspected release occurs, tightness testing must be conducted to determine if the UST system is leaking. The following activities must be performed:

- The tightness test **must be performed before repairs are made to the system**;
- The tightness test must be conducted within seven (7) days of the suspected release in accordance with OAC 1301:7-9-07(F);
- BUSTR must be notified of the results within 24 hours of completing a tightness test; and
- Within seven (7) days of the completed tightness test, a copy of the test results along with the Suspected Release – Tightness Test Form 2022 must be submitted to BUSTR.

If the system is repaired before performing a tightness test or if repairs of the UST system are needed to pass a tightness test, a Site Check must be conducted. The Site Check must be conducted even if the UST system tests tight.

If a release is suspected due to free product being present in a containment sump or interstitial space of the UST system, tightness testing must be conducted as outlined above. Testing results must show that the containment sump or interstitial space are tight. If repairs are made prior to tightness testing, a Site Check conducted pursuant to OAC 1301:7-9-13(F) must be completed.

See Section 2.5 for further details on the reporting requirements when modifications to the UST system are conducted.

3.5.3 Site Check

Site Checks are conducted to determine whether subsurface soil or groundwater on a UST site have concentrations of COCs that exceed applicable ALs. As required under OAC 1301:7-9-13 (F)(3)(a), a Site Check must be completed, and the appropriate report submitted to BUSTR **within 90 days** of any of the following:

- A release to the environment;
- A failed tightness test;
- Repairing a UST system before conducting a tightness test as part of a release or suspected release investigation;
- Failed tightness test of the secondary containment system or interstitial space;
- Physical discovery, or
- The occurrence of a spill/overfill requiring a Site Check.

BUSTR must be notified if a Site Check is discontinued for any reason.

The three options for a Site Check are:

1. Conduct a Tier 1 Source Investigation;
2. Close all or a portion of the UST system and conduct a closure assessment (BUSTR approval may be required); or
3. Collect a minimum of three soil samples from the native soil immediately below the source of the suspected release.

The appropriate option for a particular UST site will depend upon the site-specific circumstances.

Option 1: Conduct Tier 1 Source Investigation According to 1301:7-9-13(H)

A release or suspected release may be investigated by installing a minimum of three (3) SB/MWs in or as close to the **source area(s)** as possible (i.e., locations where the highest COC concentrations would most likely be present). Information known about the UST site, the source of the suspected release, and the likely distribution of COCs should be considered when determining the placement of SB/MWs. See Figures 3.1 through 3.5 below for examples of SB placement among several different release scenarios. The specific circumstances of the release or suspected release and UST site characteristics may warrant alternative placement and/or additional borings. See Appendix A for installation of SB/MWs.

If this option is selected, a Tier 1 Evaluation Form 2022 or Tier 1 Notification Form 2022 must be submitted to BUSTR **within 90 days** from the date the release or suspected release was reported.

Note: Refer to Section 3.7 for additional description of the requirements for a Tier 1 Source Investigation.

Figure 3.1 - Suspected Release from an Existing UST

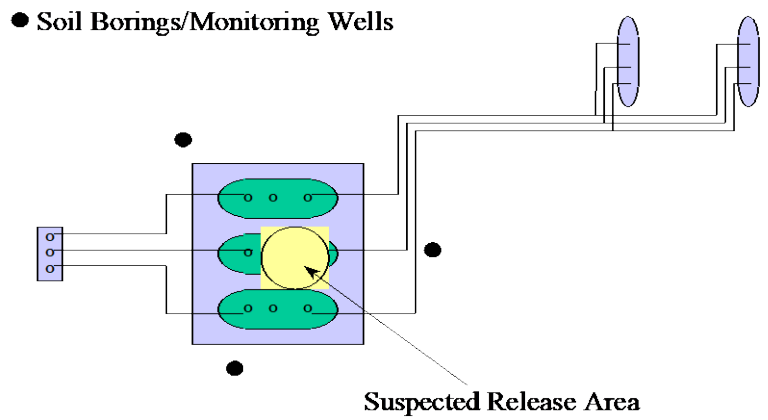


Figure 3.2 - Suspected Release from Existing Piping in Dispenser Area

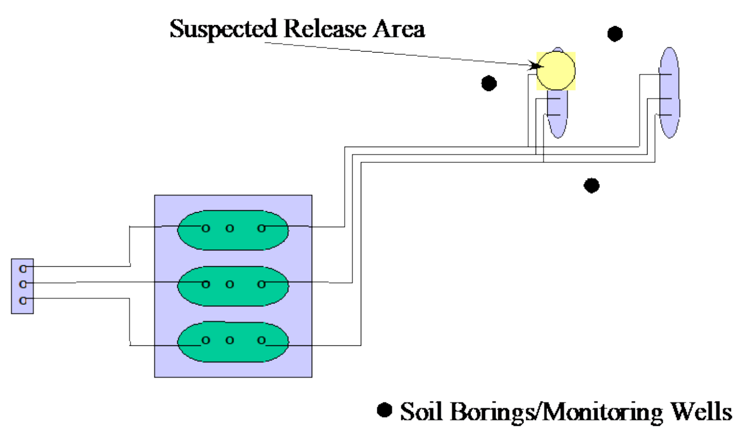


Figure 3.3 - Suspected Release from Existing Piping

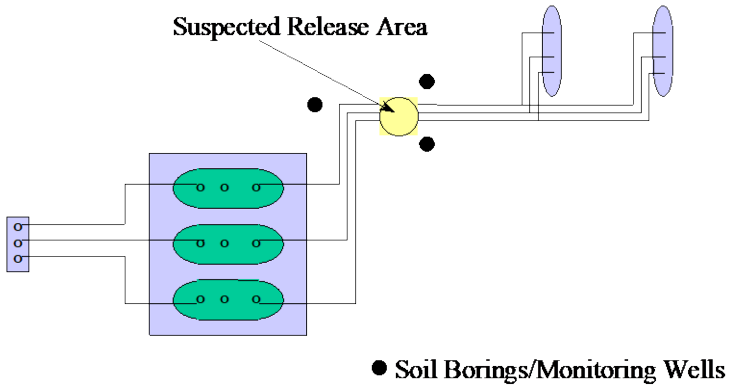
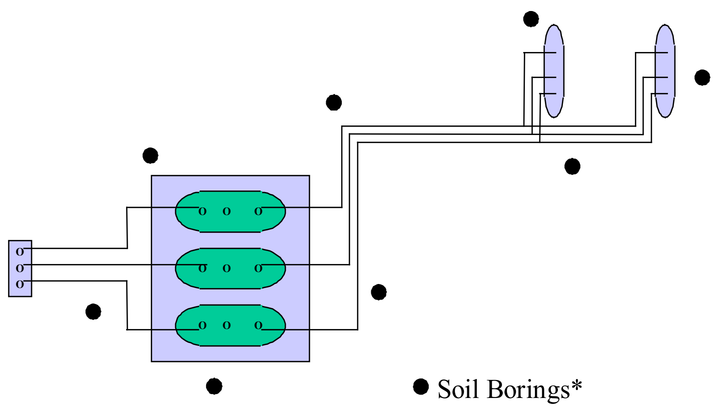
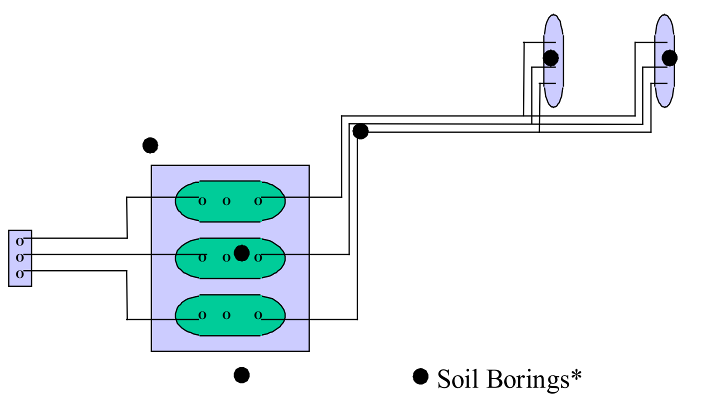


Figure 3.4 - Suspected Release from Unknown Source Area



*NOTE: a minimum of three SBs must be converted into MWs.

Figure 3.5 - Suspected Release from a Previously Removed System



*NOTE: a minimum of three SBs must be converted into MWs.

Option 2: Closure of All or a Portion of the UST System According to 1301:7-9-12

This option allows all or a portion of the UST system that is the potential source of the release or suspected release to be removed, and a closure assessment be conducted.

Prior approval must be obtained from BUSTR for the closure of the UST system, if *any* of the following conditions exist:

- Groundwater is known or suspected to contain COC concentrations;
- Free product is present;
- A receptor or surface water body is known to be impacted by the release;
- The UST site is in a Sole Source Aquifer;
- The UST site is in a DWSPA; or
- A potable well is located on the UST site.

This approval may require the collection of additional soil and groundwater samples. Contact BUSTR for guidance.

If this option is selected and prior approval is not required, a Closure Assessment Form 2022 must be submitted to BUSTR **within 90 days** from the date the release or suspected release was reported.

Where a UST closure is to be used to meet Site Check requirements, **at least one of the required samples must be taken from the suspected area** of highest COC concentration (i.e., sample any obvious areas of contamination). For example, if a piping release is identified, submit a sample from that location and from the 10 ft. intervals required in the closure rule. For purposes of the Site Check, BUSTR recommends that at least one sample be obtained from piping runs less than 10 ft. long.

If this option is selected, a Closure Assessment Form 2022 must be submitted to BUSTR **within 90 days** from the date the release or suspected release was reported.

Option 3: Collect Three Samples Below the Source of the Suspected Release

This option allows samples to be taken in the native soil immediately below the known source of the spill/overfill or suspected release to demonstrate that COC concentrations in the native soil are below ALs. **Please confer with BUSTR to determine if this option is appropriate for the release conditions.** Prior approval must be obtained from BUSTR to use Option 3, if *any* of the following conditions exist:

- Groundwater is known or suspected to contain COC concentrations;
- Free product is present;
- A receptor or surface water body is known to be impacted by the release;
- The UST site is in a Sole Source Aquifer;
- The UST site is in a DWSPA; or
- A potable well is located on the UST site.

This option may be utilized for, but is not limited to, suspected releases discovered under dispenser areas, in product piping runs less than 10 ft., a failed tightness test of a secondary containment system, or in product piping connections (i.e., joints, elbows, flex connectors).

All the following guidelines must be followed:

- Samples shall be biased towards the areas suspected to have the highest COC concentrations resulting from the suspected release;
- Samples from each SB or excavation shall be field screened and the sample with the highest field screening result from each SB or excavation must be submitted for laboratory analysis. SBs must be continuously sampled for field screening and extended to a minimum depth of 1 ft. into the native soil below the source of the suspected release (Appendix A);
- If groundwater is encountered in a SB or excavation, collect a groundwater sample from each location for analysis (Appendix A); and
- Submit all soil and groundwater samples for analysis for the appropriate COCs. See Section 3.7.2 for a list of the appropriate COCs.

If this option is selected, a Closure-in-Place Form 2022 must be submitted to BUSTR **within 90 days** from the date the release or suspected release was reported.

3.5.4 Confirmed Release Determination

After completing a Site Check option as listed in Section 3.5.3, COC concentrations must be compared to the appropriate ALs for the UST site to determine if a confirmed release has occurred. For all UST sites where Site Check investigations are conducted, assume groundwater is drinking water, soil class 1, and residential land use. See Section 3.9.2 for a list of ALs.

Geotechnical data (i.e., sieve analysis, particle size analysis) must be provided to support changing soil classification. The drinking water and land-use classification cannot be modified during the Site Check process.

If Option 1 was conducted and COC concentrations are above applicable ALs, submit a Tier 1 Notification report and proceed to Tier 1 Delineation (Section 3.8).

If Options 2 or 3 were conducted and site COC concentrations are above applicable ALs, a Tier 1 Source Investigation (Section 3.7) must be conducted.

If site COC concentrations are at or below applicable ALs under Option 1, 2, or 3, and the submitted report is complete, then no further action or disproved status will be issued by BUSTR, as appropriate.

3.6 Immediate Corrective Actions

3.6.1 Mitigating Releases from UST Systems

Once a release has occurred or continues to occur from the UST system, *all* the following must be initiated immediate corrective actions within 24 hours:

- Take immediate action to prevent any further release of petroleum from a UST system into the environment, including removal of petroleum from a UST system as necessary to prevent further release into the environment;

- If a receptor is impacted by the release, immediately identify and mitigate fire, explosion, vapor, and safety hazards associated with such releases and notify BUSTR by telephone or e-mail **within 24 hours** after starting such activities;
- Inspect for releases and take steps to prevent further migration of releases into surrounding soil, sewers, surface water, and groundwater through use of absorbent pads, absorbent booms, dikes, siphon dams, or similar items;
- Continue to monitor and mitigate any additional fire, health and safety hazards posed by vapors or petroleum products that have migrated to subsurface structures, such as basements, sewers, or similar locations;
- Manage contaminated materials that are generated in a manner that complies with applicable federal, state, and local requirements; and
- If a release is suspected to impact a drinking water well, the well must be tested for the appropriate COCs within three (3) days of discovery. BUSTR must be notified **within 24 hours** of receipt of test results and the results submitted to BUSTR **within seven (7) days**. If a drinking water well shows any impact, it must be reported to the local health department.

3.6.2 Immediate Corrective Action Report

BUSTR must receive an Immediate Corrective Actions Report Form 2022 documenting the mitigation activities **within 20 days** of starting any immediate corrective action. At a minimum, the report must contain *all* the following information:

- Date and time the release was discovered;
- Addresses and locations of buildings, sewers, surface water bodies, and any building or space affected by the release;
- An overview of activities leading to the discovery of free product;
- Type and amount of product released;
- A description of the UST system and operational status;
- A description of all completed and planned immediate corrective actions;
- Amount and disposition of any materials generated (e.g., soil and liquids), including any supporting documentation (e.g., copies of disposal receipts); and
- Copies of site maps, plans, photographs and other information that may assist in evaluating and/or investigating the release.

3.6.3 Free Product Removal and Reporting

Free product is defined as "a separate liquid hydrocarbon phase that has a measurable thickness of greater than 0.01 ft. (0.12 in.)". The presence of free product must be reported to BUSTR within 24 hours of discovery. The presence of free product must be evaluated during closure assessment, site check, and tier evaluation activities.

Where free product is present, a free product recovery (FPR) program must be implemented immediately that removes free product to the maximum extent practicable**, at minimum on a monthly basis**, while continuing other required corrective action activities. Free product must be removed in a manner that minimizes the spread of COCs into previously unimpacted zones. FPR includes activities such as manual bailing, skimming, pumping, or other removal technologies that effectively remove free product.

FPR is an immediate corrective action and pre-approval from BUSTR is not required. However, any permits required by federal, state, or local regulatory agencies must be secured and any flammable products managed in a safe and competent manner to prevent fires and explosions.

Free Product Recovery Report

Submit a Monthly Free Product Recovery Report Form 2022 until free product has been removed to the maximum extent practicable. At a minimum, the FPR reports must contain *all* the following:

- Name, address, and facility identification number of the UST site;
- Details of the FPR system (i.e., drawings, discharge locations, operations) *;
- A scaled site map that accurately shows the location of property boundaries, buildings, structures, utilities, monitoring wells and past and present UST systems. Aerial and satellite imagery cannot be used as a base for these figures*;
- Copies of installation, operation, treatment, and discharge permits granted*;
- A discussion of any FPR system malfunctions;
- Product thickness in wells, bore holes, and excavations;
- Gallons and type of free product recovered each month and to date;
- Gallons of water recovered each month and to date;
- Disposition of recovered free product and water; and
- A description of any changes or modifications to the FPR system.

* Denotes items only required for the initial monthly FPR report.

With prior approval from BUSTR, free product reports may be submitted quarterly using the Quarterly Free Product Recovery Report Form 2022. The request for approval must be submitted in writing, and include historical information concerning recovery locations, product thicknesses, quantities recovered, etc. If significant increases are encountered in the amount of product recovered from one month to the next during quarterly reporting, BUSTR should be notified immediately.

If any malfunction occurs to a FPR system and cannot be repaired within 24 hours of discovery, BUSTR and the local fire department must be notified immediately (i.e., by telephone, e-mail). The malfunction must be corrected, and the system placed back into service as promptly as is technically feasible.

FPR activities may be terminated once free product is no longer present on and off-site for three consecutive months or as otherwise directed (i.e., BUSTR may require additional recovery techniques or additional recovery wells in situations where receptors may be impacted). BUSTR must be notified within 30 days of termination of FPR activities.

If free product continues to be present one year after initiating FPR activities, BUSTR may require a written re-evaluation of recovery technique(s). The re-evaluation must include a discussion of the reliability, effectiveness, cost, and time needed for completing FPR.

If free product is greater than 0.01 ft. and has been recovered to the maximum extent practicable, a written request may be submitted to BUSTR to terminate FPR activities. This request must demonstrate that additional FPR is impractical. FPR activities shall continue until written approval from BUSTR has been received.

Termination of free product activities may be requested if all the following conditions are met:

- The site is not located in a DWSPA;
- The site is not located in a Sole Source Aquifer;
- No existing drinking water sources are identified within 300 ft. of the UST site;
- The free product has not migrated and has been sufficiently demonstrated that it will not migrate off the UST site;
- The source area for free product has been adequately assessed;
- The extent of free product has been adequately defined in all directions;
- The remaining free product lacks sufficient mobility to be recovered and lacks the toxicity necessary to be a threat to human health or the environment;
- Alternative forms of mitigation/removal have been attempted;
- Free product removal has been ongoing for at least two years;
- The area of the site where free product is located is more than 300 ft. from a surface water body;
- Concentrations of COCs in groundwater are below appropriate actions levels or site-specific target levels for the site; and
- Groundwater concentrations above action levels are confined to the site and have not migrated off-site.

If the site meets the above listed criteria, the request to terminate free product recovery activities must include the following documentation:

- The history of FPR activities;
- Techniques and technologies used to recover free product;
- Maps showing current and historical trends in free product thickness;
- The rationale for terminating FPR activities (e.g., non-drinking water determination, planned future use of the site and its surrounding area); and
- Distances to potential receptors (e.g., basements, utility conduits, sewers and storm lines, potable wells).

Upon review of the above information, BUSTR will either approve or deny the request in writing. If BUSTR approves the request, the approval may be dependent on additional investigation and/or actions, which may include:

- Completion of the Corrective Actions process;
- Performing periodic measurements of free product extent and thickness to assure free product is not migrating;
- Notifying the public and adjacent property owners that may be directly affected by the hazard; or
- Recording an Environmental Covenant on the site.

3.7 Tier 1 Source Investigation

The purpose of the Tier 1 Source Investigation is to determine the concentrations of the COCs in the source area(s) for a release, suspected release, or confirmed release. The Tier 1 Source Investigation consists of the source investigation, action level determination, and reporting.

3.7.1 Source Investigation

Identification of Potential Source(s)

All potential source(s) must be identified. These potential sources may include existing, closed-in-place, or removed underground storage tanks, piping systems, or dispensers. Any areas of known or suspected surface spills or overfills must also be identified. Areas exceeding ALs found during the closure assessment must also be evaluated.

If the source is unknown, all potential source(s) on the UST site must be investigated. This investigation should include a review of the current and historical uses of the site. Information sources may include site plans, personal interviews, fire department records, Sanborn maps, deeds, etc.

Identification of Potential Source Areas

A source area typically represents the location of highest concentrations of COCs in soil or groundwater at a UST site. In some cases, there may be multiple source areas.

Areas containing free product must be evaluated as potential source areas in addition to the location of the highest COCs in soil and/or groundwater.

3.7.2 Chemicals of Concern

Chemicals of concern must be identified based on the contents of the UST system. The different substances regulated during corrective actions have been divided into five analytical groups.

- Analytical Group 1: light distillates, including unleaded gasoline, leaded gasoline, naptha, gasoline blended with alcohol, racing fuel, and aviation gasoline;
- Analytical Group 2: middle distillates, including diesel, light fuel oils, stoddard solvents, mineral spirits, kerosene, biodiesel blended with diesel, and jet fuels;
- Analytical Group 3: heavy petroleum distillates, including, but not limited to, lubricating and hydraulic oils;
- Analytical Group 4: used oil;
- Analytical Group 5: unknown petroleum products or petroleum products other than those listed in the four analytical groups above. If the contents of the UST system fall into Analytical Group 5, BUSTR must be consulted to determine the appropriate COCs and the associated analytical methods. These chemicals may be selected based on the properties of the stored chemical(s) and information provided on the SDS for the chemical.

COCs and their associated analytical methods must be selected based on the above analytical groups and Table 3.1.

Two lead scavengers were added to the 2017 corrective action rule, 1,2-dibromoethane (EDB) and 1,2-dichloroethane (EDC). These two chemicals were added based on the USEPA memorandum on lead scavengers dated May 21, 2010.

EDB and EDC must be analyzed in all soil and groundwater samples during corrective action for gasoline USTs installed prior to January 1, 1986. For USTs containing aviation gas, racing fuel or used oil, EDB and EDC must be analyzed regardless of when the UST system was installed.

If the UST was installed after January 1, 1996, analysis for EDB and EDC are not required.

For gasoline USTs installed between January 1, 1986 and January 1, 1996, the following paragraphs apply (Flow Chart 3.3).

Gasoline UST systems installed between January 1, 1986 and January 1, 1996

The retail sale of leaded gasoline was phased out during the period between 1986 and 1996. As such, BUSTR will not always require that samples be analyzed for EDB and EDC at BUSTR corrective action release sites with UST systems installed during this time period.

For UST systems in service on or before January 1, 1996 undergoing a closure assessment pursuant to the closure rule or as an option under a Site Check, all samples must be analyzed for EDB and EDC. If closure sampling results indicate the presence of EDB or EDC, they must be evaluated in all future corrective actions for that release.

EDB and EDC may be eliminated as COCs in the following scenarios:

- If closure sampling results indicate that EDB and/or EDC are below laboratory detection limits and the detection limits are below ALs, EDB and EDC may be eliminated from future corrective actions provided the following criteria are met:
    - The site is not located within a DWSPA;
    - The site is not located in a Sole Source Aquifer;
    - No existing drinking water sources are found within 1,500 ft. of the site (demonstrated by conducting an ODNR well log search).
- If corrective actions are required, except for the closure assessment option as part of a Site Check, or for sites transitioning into the 2022 corrective action rule, EDB and EDC may be eliminated as COCs provided all the above criteria are met.

Information documenting that the above criteria have been met must be submitted to BUSTR as an Alternate Technology Request (Section 3.16), and written permission must be received from BUSTR prior to the commencement of the assessment activities to exclude EDB and EDC as COCs for assessment of UST systems that were installed between January 1, 1986 and January 1, 1996.

Subsurface Investigation

During the subsurface investigation, major geologic, hydrogeologic, and physical characteristics of the UST site and surrounding area that may influence the migration of COCs must be identified. At a minimum, the following must be evaluated:

- Direction and gradient of groundwater flow (if groundwater is encountered);
- Faults, fissures, fractures, or geologic transport routes (based on published data from ODNR or USGS);
- Identified soil type(s) based on field observations and/or laboratory analysis (soil survey maps are not appropriate);
- Depth to groundwater; and
- Location of any man-made structures such as sewer lines, water lines, electrical conduits, or drainage tiles.

Flow Chart 3.3: EDB/EDC Flowchart for Rule 13 Corrective Actions

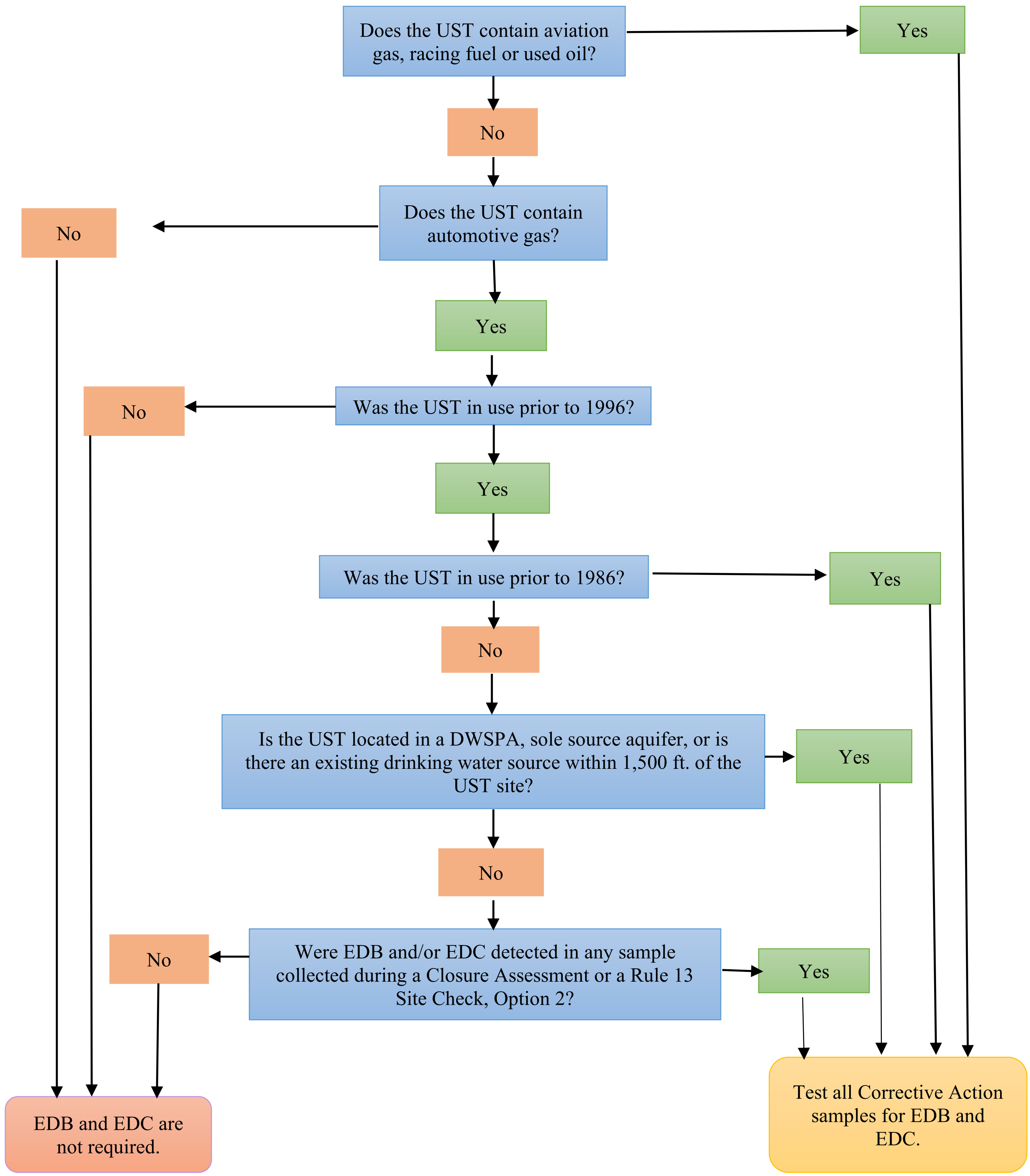


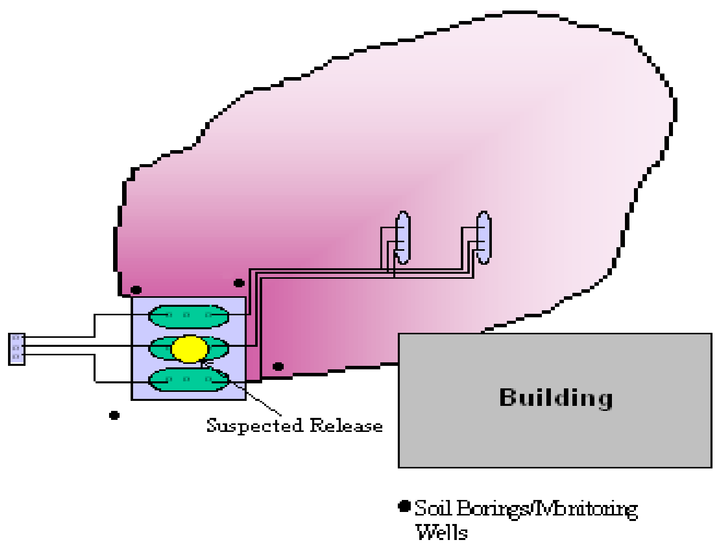
Table 3.1 - Chemicals of Concern

	Analytical Group Number	1	2	3	4	5	Analytical Methods[7]	
		Light Distillates	Middle Distillates	Heavy Distillates	Used Oil	Unknowns & Others	**Soil [4]**	**Groundwater**
	Chemical							
Aromatics	Benzene	x	x		x		8021 or 8260	8021 or 8260
	Toluene	x	x		x			
	Ethylbenzene	x	x		x			
	o, m and p-Xylenes	x	x		x			
	Naphthalene	x			x			
	1,2,4 - Trimethylbenzene	x			x			
Additives	Methyl tertiary-butyl ether (MTBE)	x			x		8021 or 8260	8021 or 8260
	1,2 – Dibromoethane (EDB) [5,6]	x			x		8260	8011
	1,2 – Dichloroethane (EDC) [5,6]	x			x		8260	8260
Polynuclear Aromatics[9]	Benzo(a)anthracene		x	x	x		8270, 8310	8270, 8310[8]
	Benzo(a)pyrene		x	x	x			
	Benzo(b)fluoranthene		x	x	x			
	Benzo(k)fluoranthene		x	x	x			
	Chrysene		x	x	x			
	Dibenz(a,h)anthracene		x	x	x			
	Indeno(1,2,3-c,d)pyrene		x	x	x			
	Naphthalene		x	x	x			
Chlorinated Hydrocarbons	Volatile Organic Hydrocarbons				x		Full 8260	Full 8260
Total Petroleum Hydrocarbons [1]	TPH (C6 – C12)	x			x		8015	N/A
	TPH (C10 – C20)		x		x			
	TPH (C20 – C34)			x	x			
Other	Varies based on UST contents [2]			x	x	[3]		

1 TPH analysis is not required for groundwater samples.
2 Additional COCs should be based on SDS and analyzed with an appropriate laboratory test method capable of meeting established target levels.
3 Refer to OAC 1301:7-9-13(H)(1)(c)(v) (described under Analytical Group 5).
4 Soil analytical results shall be reported on a dry weight basis.
5 EDB and EDC shall be analyzed for automotive gasoline USTs that were in service prior to January 1, 1996.
6 EDB and EDC shall be analyzed for all USTs containing aviation gasoline, racing fuel, and used oil, regardless of when they were installed.
7 Alternate laboratory methods will be considered if the methods meet the quality control, performance, and method detection level requirements.
8 Field filtering may be used for Methods 8270 and 8310.
9 PAH analysis should consist of 8 specific chemicals of concern.

The physical investigation of the source area should include the installation of a minimum of three SB/MWs within, or as close as possible to, the source area to determine the highest concentration for each COC. The location of potential sources, potential source areas, and the likely distribution and temporal variations in COC concentrations in soil and groundwater should be considered when determining placement. If a portion of the source area is not accessible, at least one SB/MW must be installed in an area immediately down gradient of the source area. **More than three SB/MWs may be necessary to characterize the source area.** See Appendix A for guidance on SB/MW installation and sampling.

Figure 3.6 - Typical Well Placement for Tier 1 Source Investigation



Groundwater Determination

The saturated zone must be evaluated to determine if it meets the definition of groundwater. The encountered saturated zone is assumed to be groundwater or the site's groundwater yield and *in situ* hydraulic conductivity can be evaluated. If the saturated zone can yield at least 1.5 gal./8 hours and has an *in situ* hydraulic conductivity greater than 5.0×10^{-6} cm/sec., then the saturated zone is groundwater. However, if the initial field study for one of the criteria fails to meet the definition of groundwater, then additional evaluation is not required. See Appendix A for more information on yield determination and yield adjustments.

3.7.3 Action Level Determination

As part of the Tier 1 Source Investigation, the appropriate ALs for each environmental medium and exposure pathway must be evaluated. The site feature determination consists of *all* the following:

- Identify the COCs based on the petroleum product released (Table 3.1);
- Assume residential land-use exposures;

- Determine if the saturated zone is groundwater in accordance with Section 3.8.2. The saturated zone is assumed to be groundwater (unless a determination has been made to show the zone is not groundwater);
- Select a soil type that best represents the soil under the UST site and is most appropriate to the specific exposure pathway. For purposes of the Tier 1 Source Investigation, classify bedrock as a Class 1 soil type (Table 3.2); and
- Determine the depth to groundwater using site-specific data. If groundwater depth is unknown, then assume a depth of less than 15 ft.

Determine ALs by applying the groundwater determination, depth to groundwater, and soil class information to the action level tables. See Section 3.10.2 to determine the applicable pathways and ALs.

Point(s) of Exposure

A point of exposure (POE) is the point at which an individual or population may be exposed to COCs originating from a UST site. In the Tier 1 Source Investigation, it is assumed that any identified current or potential future drinking water source in the surrounding area is within the source area(s).

3.7.4 Tier 1 Source Investigation Reporting

Prepare and submit a completed Tier 1 Evaluation Form 2022 or a Tier 1 Notification Form 2022 to BUSTR within 90 days of *any* of the following:

- Receiving analytical results which exceed ALs during Options 2 or 3 of a Site Check (OAC 1301:7-9-13F(3)(b)(ii) and (F)(3)(b)(iii)). BUSTR will use the date of the analytical report as the date of notification.;
- Electing to conduct a Tier 1 Source Investigation as part of a Site Check;
- Electing to conduct corrective action under the 2022 corrective action rule for releases reported prior to September 1, 2022;
- Receiving analytical results, which exceed ALs, from a closure assessment as part of the closure rule. BUSTR will use the date of the analytical report as the date of notification; and
- Receiving written notification from the SFM moving the release into the 2022 corrective action rule.

Prepare and submit the Tier 1 Evaluation Form 2022 if COC concentrations are **at or below** applicable ALs upon completion of the investigation.

Prepare and submit the Tier 1 Notification Form 2022 if the COC concentrations are **above applicable** ALs upon completion of the investigation.

3.8 Tier 1 Delineation

The purpose of the Tier 1 Delineation is to ensure adequate investigation of the source area(s), regardless of the land and groundwater use determination. The Tier 1 Delineation requires the completion of all the following:

- Define the vertical and horizontal extent of COCs in soil and groundwater to at or below the delineation levels in all directions. (Sections 3.8.1 and 3.9.1)
- Determine the potential drinking water use at the site and surrounding area. (Section 3.8.2)
- Determine appropriate ALs based on the potential drinking water use for the UST site. (Sections 3.9.2 and 3.9.3)

3.8.1 Assessment and Delineation of Chemicals of Concern

Additional investigation must be conducted to determine the distribution of COCs by conducting the following:

- Determine the horizontal and vertical distribution of COCs to the delineation levels listed in Table 3.3. In areas of high groundwater recharge, where pumping wells exist, or where other indicators of elevated vertical gradients are present, additional wells may be required to evaluate vertical distribution of COCs if site conditions warrant. Analysis of COCs required in the Tier 1 Source Investigation cannot be eliminated, regardless of their exclusion from the delineation level table. BUSTR reserves the right to request delineation of any additional COCs not listed in Table 3.3 (e.g., TPH, compounds required for analytical groups 3, 4, and 5) See Figure 3.7 for an example of SB/MW locations;
- Install SBs and groundwater MWs in accordance with BUSTR procedures (Appendix A);
- Determine the geologic, hydrogeologic, and physical characteristics of the UST site and the surrounding area that may influence the migration and transport of COCs; and
- Obtain off-site access if the COC plume is determined to have migrated to off-site areas. Off-site access agreements must be obtained from the affected property owner. **Off-site access denial documentation must be submitted to BUSTR within 45 days of receipt.**

Figure 3.7 - Typical Well Placement for Delineation of Chemicals of Concern

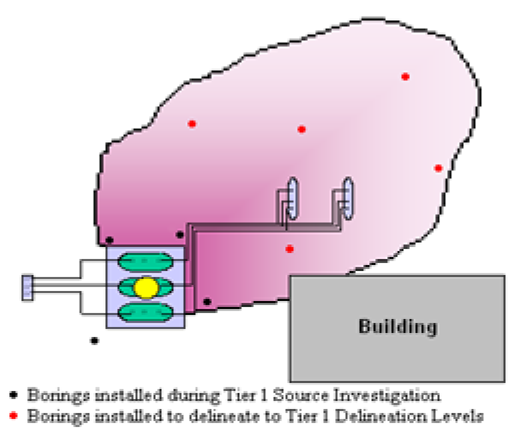


Table 3.2 - BUSTR Soil Classification Form

Major Divisions			Letter Symbol	Typical Description	Soil Class
Coarse Grained Soils (More than 50% of material is retained on #200 sieve)	**Gravel and Gravelly Soils** (More than 50% of coarse fraction retained on #4 sieve)	**Clean Gravels** (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	**Class 1**
			GP	poorly-graded gravels, gravel-sand mixtures, little or no fines	
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	
			GC	Clayey gravels, gravel-sand-clay mixtures	
	Sand and Sandy Soils (More than 50% of coarse fraction passes through #4 sieve)	**Clean Sand** (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	
			SP	Poorly-graded sands, gravelly sands, little or no fines	
		Sands with Fines (Appreciable amount of fines)	SM	Silty-sands, sand-silt mixtures	
			SC	Clayey sands, sand-clay mixtures	**Class 2**
Fine Grained Soils (More than 50% of material passes through #200 sieve)	**Silts and Clays** Liquid limit <50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
			CL	Inorganic clays of low-to-medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
			OL	Organic silts and organic silty clays of low plasticity	
	Silts and Clays Liquid limit >50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils	
			CH	Inorganic clays of high plasticity, fat clays	**Class 3**
			OH	Organic clays of medium-to-high plasticity, organic silts	
Highly Organic Soils			PT	Peat, humus, swamp soils with high organic contents	

Pathway	Symbol	Pathway	Symbol
Soil to drinking water (DW) leaching		**Groundwater (GW) to indoor air**	
Soil to indoor air		**Soil to non-DW leaching**	

3.8.2 Potential Drinking Water Use

Evaluate the current and potential future use of groundwater underlying the UST site and within 1,500 ft. of the UST system (surrounding area) to determine whether groundwater is a drinking water source. During this evaluation, assume that:

- Groundwater use being evaluated is the upper-most saturated zone underlying the UST site. If any evidence suggests that COCs are present in lower saturated zones, they must also be evaluated; and
- Any identified current or potential future drinking water source in the surrounding area is assumed to be within the source area(s).

In the Tier 1 Delineation, a drinking water determination must be made. Groundwater underlying the UST site can be assumed to be drinking water to avoid the costs associated with this determination. However, this assumption can lead to more conservative action levels. Flowchart 3.4 may be used to better understand the drinking water use determination.

Drinking Water Evaluation – Current and Potential Future Usage

During Tier 1 Delineation, groundwater underlying the UST site will always be considered a drinking water resource if *any* of the following applies:

- The UST site or surrounding area is located in a DWSPA;
- The UST site is in a Sole Source Aquifer;
- A surface water body is located within 300 ft. of the UST system(s) being evaluated;
- An existing drinking water source in the groundwater is identified within 1,500 ft. of the UST system(s) being evaluated.

A drinking water source (e.g., private or public potable well) is considered to "exist" if it is currently in use or could potentially be used in the future.

If a potable well log exists for a property, but its physical presence cannot be confirmed, an affidavit must be provided by the current property owner (Appendix D) stating that no known drinking water well exists on the property and the property is connected to a municipal water source or a municipal water supply is readily available.

If a drinking water well has been formally abandoned, BUSTR would no longer consider this to be an existing source; however, an ODNR Water Well Sealing Report must be provided to BUSTR to make this demonstration.

If the groundwater underlying the UST site does not meet the drinking water requirements as listed above, then it may be considered non-drinking water if *any* of the following apply:

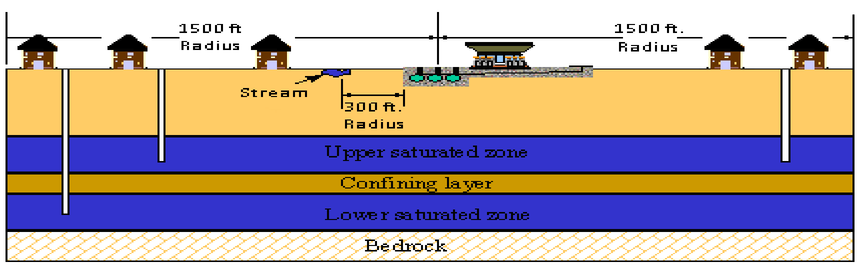
- Groundwater in the upper saturated zone yields less than 3 gal./min., as adjusted (Appendix A);
- Groundwater in the upper saturated zone has a background level of total dissolved solids of 3,000 mg/L or greater, as determined by laboratory results;
- The UST site is within an Urban Setting Designation. Refer to Ohio EPA, DERR VAP, to determine if the UST site is located within an Urban Setting Designation;

- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* a local ordinance *requires* a mandatory tie-in to a municipal water system for all properties within 1,500 ft.;
- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* a local ordinance *prohibits* the installation of potable water wells at all properties within 1,500 ft. or
- No potable wells are located within 300 ft. of the UST site based on a physical survey *and* 100% of the properties within 300 ft. of the UST site area are connected to a municipal water source or a municipal source is readily available.

For sites greater than 5 acres, the distances should be measured from the UST system being evaluated.

If groundwater is not considered a drinking water resource using the first set of criteria (four bullets above), and groundwater cannot be classified as a non-drinking water resource using the second set of criteria (six bullets above), then groundwater must be considered drinking water. Action levels must be determined by applying the groundwater determination, depth to groundwater, and soil class information (Section 3.9). An action level must be identified for each environmental medium and exposure pathway. See Figure 3.8 for an example of a drinking water use scenario.

Figure 3.8 - Example of Drinking Water Use Scenario



Drinking Water Source Protection Area

DWSPA means the surface and subsurface area surrounding a public water supply well(s) supplying a community public water system, non-community non-transient public water system or a non-community transient public water system which will provide water from an aquifer to the well(s) within five years as delineated or endorsed by Ohio EPA under Ohio's Wellhead Protection and Source Water Assessment and Protection Programs.

DWSPA information is available by accessing the Ohio EPA Division of Drinking and Groundwater Division's website at https://epa.ohio.gov/monitor-pollution/maps-and-advisories/drinking-water-source-protection-areas. Click Launch and search for your location using the search bar in the upper left corner.

Flow Chart 3.4: Drinking Water Pathway Evaluation in Tier 1

Groundwater Determination

Saturated zone is groundwater.

Saturated zone is not groundwater (is not capable of yielding a minimum of 1.5 gal. of water within 8 hrs. of purging and has an *in situ* hydraulic conductivity less than 5.0 x 10^{-6} cm/sec).

Potential Drinking Water Determination

1. The UST site or surrounding area is located in a Drinking Water Source Protection Area
2. The UST site is located in or within 300 ft. of a Sole Source Aquifer
3. An existing drinking water source is located within 1,500 ft. of the UST system.
4. A surface water body is within 300 ft. of the UST system.

One of the above is true.

None of the above are true.

1. Groundwater in the upper saturated zone yields less than 3 gpm;
2. Groundwater has a background level of total dissolved solids of 3,000 mg/L or greater;
3. The site is located in an Urban Setting Designation;
4. No potable wells are located within 300 ft.* of the site based on a physical survey AND an ordinance requires mandatory tie into a municipal water system for all properties in the surrounding area;
5. No potable wells are located within 300 ft.* of the site based on a physical survey AND an ordinance exists that prohibits the installation of potable water wells at all properties in the surrounding area;
6. No potable wells are located within 300 ft.* of the site based on a physical survey AND one of the following is true: 100% of occupied properties within 300 ft.* of the UST site are tied into a municipal water source OR a municipal water source is readily available.

* If the UST site is greater than 5 acres, this distance should be measured from the UST system(s).

None of the above are true.

One (or more) of the above is true.

Drinking water ingestion pathway must be evaluated in Tier 2, RAP, or IRA.

Drinking water ingestion pathway is not considered complete.

Sole Source Aquifer Areas

Sole source aquifer has been designated by the administrator of the United States Environmental Protection Agency pursuant to Section 1424(e) of the Safe Drinking Water Act (42 U.S.C. 300h-3, as amended at the time of the effective date of this rule). Sole source aquifer information is available by accessing the Ohio EPA Division of Drinking and Groundwater Division's website at https://data-oepa.opendata.arcgis.com/maps/sole-source-aquifers. Search your location by clicking the grey magnifying glass icon in the upper right-hand corner.

If your site is located in the sole source aquifer or within 300 ft. of a sole source aquifer, groundwater is considered drinking water.

Surface Water

Surface water body is defined as a body of water greater than one acre in size or a river, creek, or stream. To determine if a body of water within 300 ft. of the UST system(s) is considered a river, creek, or stream by BUSTR definition, perform the following:

- Reference the OAC 3745-1-01 through 54;
- Search 7.5-minute United States Geological Survey (USGS) quadrangle maps; and
- Conduct a physical survey.

If a body of water is identified in any of the above, it will be considered a river, creek, or stream by BUSTR. The site conceptual exposure model assumes that groundwater is discharging into a surface water body if the surface water body is within 300 ft. of the UST system(s).

BUSTR has a Fact Sheet with more details on how to evaluate surface water bodies.

Well Log Search

Identify the source(s) of potable water for the UST site and the surrounding area (within 1,500 ft. of the site), including documentation of all public and private drinking water wells and public water supply sources. This evaluation may be conducted by contacting the Ohio EPA, the ODNR, health departments, and public water supply organizations.

The well log search in Tier 1 Delineation is not to identify a point of exposure; it is used to determine if groundwater is or has the potential to become drinking water.

The following section clarifies the requirements for locating potential drinking water sources (i.e., potable wells, dug wells or irrigation wells) within the 1,500 ft. area surrounding the UST system.

Consider these factors before attempting to locate water wells:

- When attempting to eliminate the drinking water pathway, perform a thorough search (as discussed below) for drinking water sources within the surrounding area;
- If an existing drinking water source is identified within the surrounding area, groundwater is drinking water;
- Assume any identified current or potential future drinking water source on the UST site is within the source area;

- Assume that wells completed in lower saturated zones are hydraulically connected to the upper saturated zone;
- If the location of an existing potable well cannot be conclusively determined to be beyond the surrounding area, groundwater is drinking water.

Standard Well Log Search

Most searches for drinking water sources begin at the ODNR Division of Water. Well logs can be found using their website located at https://waterwells.ohiodnr.gov/search.

To conduct a well log search, begin by opening the website listed above. Select either the interactive search or the classic search.

Each well log should be reviewed to ensure it has been geolocated properly.

Interactive Search

The best method to locate identified wells in the interactive search is to utilize the buffer tool. There are a total of five buffer tools to use (Points & Radius, Rectangle, Circle, Polygon, and Freehand Shape). The two most commonly used methods are the “points & radius” and the “polygon” methods. First find the UST site on the map either by zooming into the correct location or using the search window at the top of the screen. To use the buffer tool, click the “select” tool on the left-hand menu and choose “Points & Radius.” Select “Feet” as your unit and type “1500” as your distance and click “Start.” Drop your marker on the UST site. The “polygon” buffer is used similarly, besides utilizing multiple points to outline the UST site boundary. Be sure to finalize the shape by clicking the first point to close the shape.

The results of the search will present in a table at the bottom of the page. This list can then be exported as a PDF, CSV, or GIS Shape File. Due to the large quantities of data, this method may take some time to load.

Submit a copy of the map with identified well locations and a copy of each well log to BUSTR. If no wells are present within the 1,500 ft area, a copy of the ODNR well map must still be submitted.

Classic Search

Using the classic search provides multiple options for locating the site and selecting the applicable wells. The easiest method is to select “Radius Search.” Input “1500 feet” for the Size of Radius and input the “latitude” and “longitude” of the UST site.

This search will populate a list of all the located wells in the radius from the UST site. This list can then be exported as a PDF, CSV, or GIS Shape File.

Submit a copy of each well log to BUSTR. BUSTR requires that a map be provided for the well log search. When using Classic Search to create a list of well logs, be sure to submit an image of the map generated by the Interactive Search method. If no wells are present within the 1500 ft area, a copy of the ODNR well map must still be submitted.

BUSTR may require additional well information to be collected from local health departments and public water supply organizations.

Unlocated Wells

Not all wells catalogued with ODNR have been properly geolocated when records migrated to a digital format. However, these wells are still entered into the database with information regarding the county and township in which they were installed. These potential wells must be evaluated to see if they may be within the surrounding area of the UST site.

Unlocated wells can be found by using the Interactive Search method. Using the search box in the upper right-hand corner, select "Advanced Search." Input the county and township that the UST site is located within and click "ADD" on the right. This applies this search criteria to the search. Select the blue search button. Two lists will populate under the tabs at the bottom of the page, "Well Logs" and "Well Logs Unlocated." Use the "Well Logs Unlocated" list to identify any other potential wells which may be with the surrounding area of the UST site. These wells will not show on the map. Many of the logs will contain street names which may be referenced with street names in the radius zone around the UST site. Other resources such as physical survey may be required to adequately review all unlocated wells.

Submit a copy of each identified well log as well as a map identifying their location to BUSTR. If the location of an unlocated well cannot be determined, the well is assumed to be within the surrounding area. Any well that is identified through this method should be reported to ODNR.

Physical Survey

A physical survey of all properties within 300 ft. of the release site property boundaries may be necessary when trying to eliminate groundwater as a drinking water resource. If the UST site is greater than 5 acres, this distance should be measured from the UST system(s) being evaluated.

The survey must include, but is not limited to, the Water Well Survey for Investigation of Petroleum Release form letters (Appendix D) from all property owners within 300 ft. of the UST site property boundaries, or within 300 ft. of the UST system if the UST site is greater than 5 acres. The information submitted to BUSTR should include a map of all properties within 300 ft. of the UST site or the UST system, as appropriate, and documentation of all correspondence from the physical survey.

If such correspondence is inconclusive or less than 75% of the surrounding properties respond to the survey, BUSTR may require that additional survey methods (i.e., phone call, door-to-door) be conducted. BUSTR will evaluate overall survey results for each site on a case-by-case basis.

Local Ordinances

Local ordinances requiring a mandatory tie-in to the municipal water supply system or prohibiting the installation of potable water wells must be promulgated by the municipality or by municipalities with jurisdiction over all properties within the surrounding area of the UST system.

Municipal Water Availability

The local municipality must be contacted to determine whether the UST site and 100% of the properties within 300 ft. of the UST site are currently receiving municipal water. If the UST site is greater than 5 acres in size, this distance should be measured from the UST system(s) being evaluated. Undeveloped properties must have a water main within 50 ft. of the property boundary to be considered a readily available water source.

Figure 3.9 - Example of ODNR Well Log Interactive Search

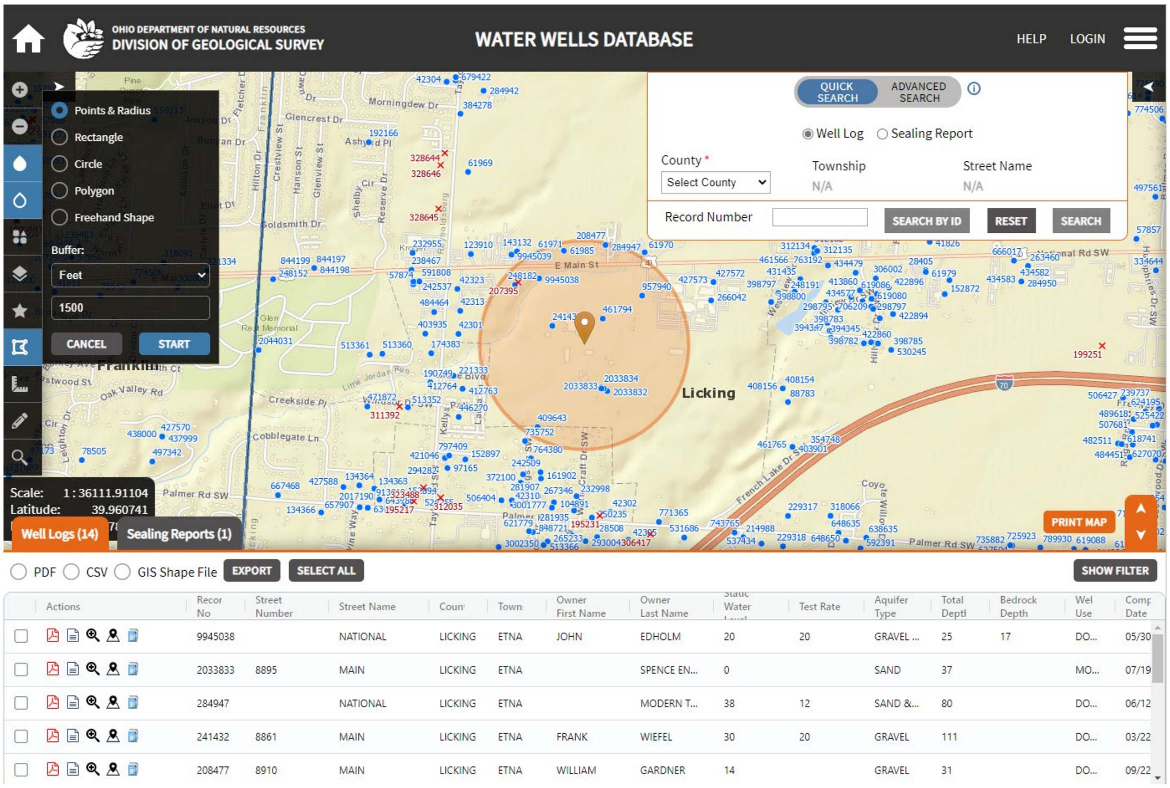


Figure 3.10 - Example of ODNR Well Log Classic Search

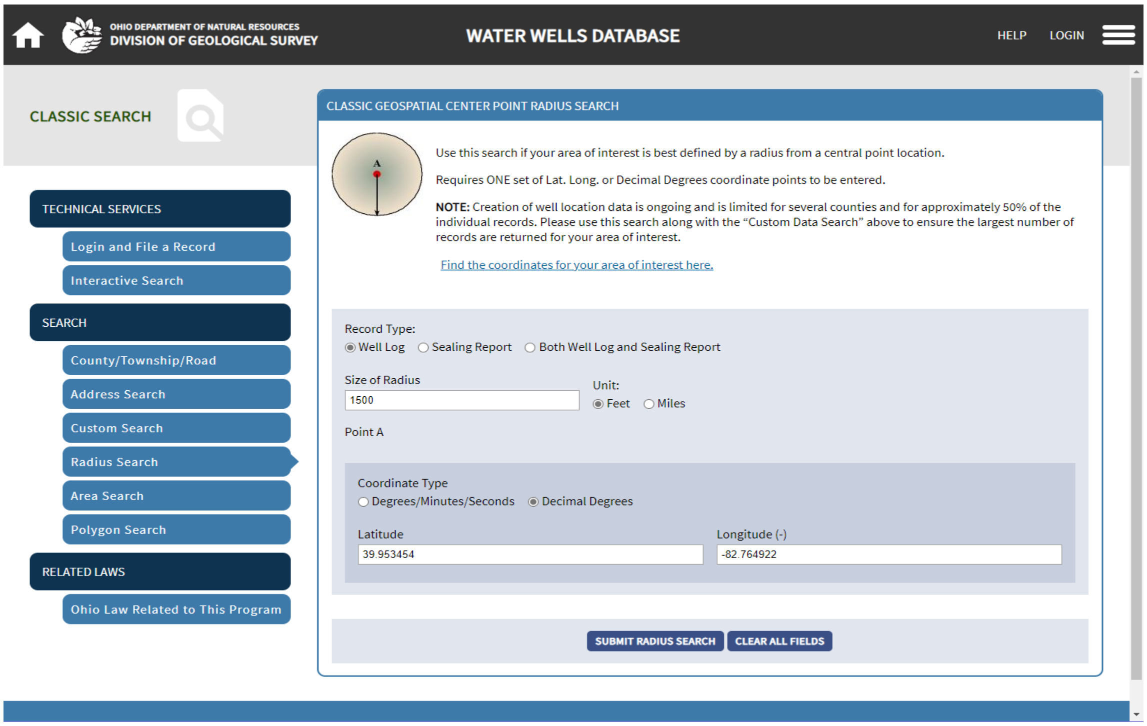
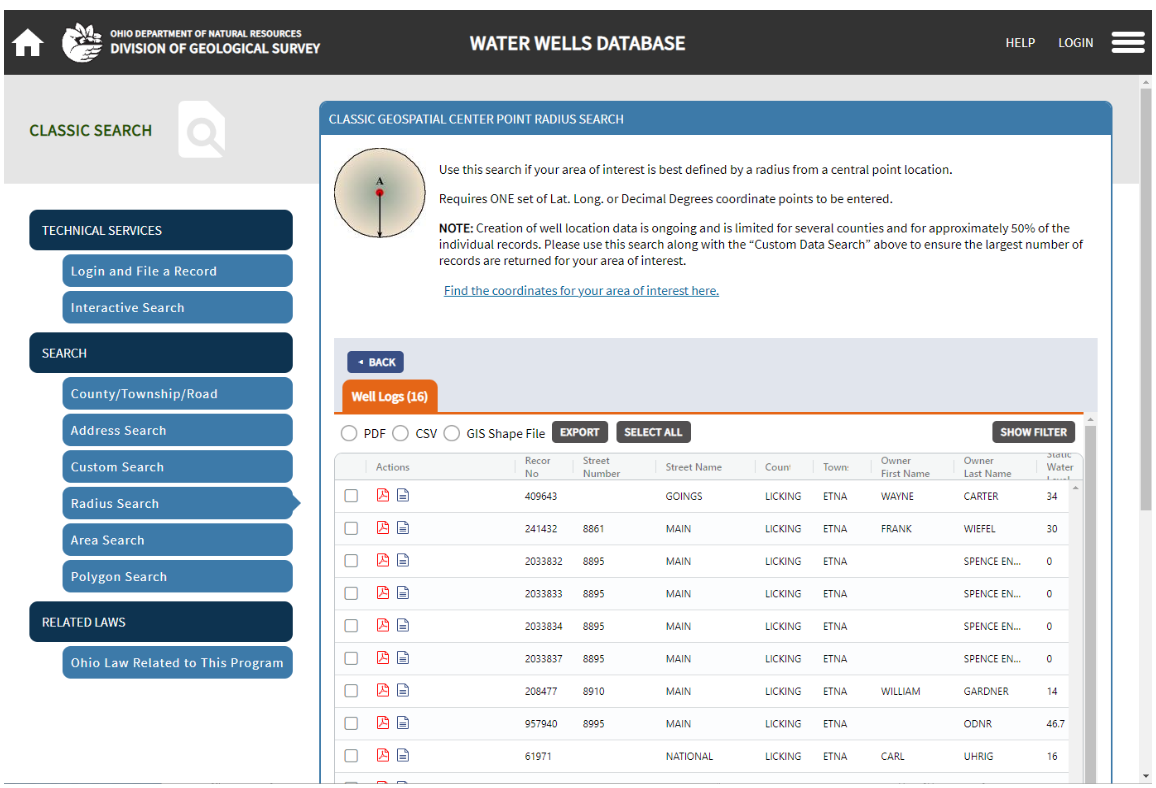


Figure 3.10 - Example of ODNR Well Log Classic Search (cont.)



3.8.3 Tier 1 Source Investigation and Delineation Reporting

The purpose of the Tier 1 Investigation report is to summarize the Tier 1 Source Investigation and Tier 1 Delineation activities. The form provides an outline to be followed when completing the Tier 1 Investigation report. The report must be submitted **within one year** of any of the following:

- Receiving analytical results that exceed ALs when conducting a Site Check. BUSTR will use the date of the analytical report as the date of notification;
- Electing to conduct corrective actions under the 2022 corrective action rule for releases reported prior to September 1, 2022;
- Receiving analytical results that exceed ALs from a closure assessment as part of the closure rule. BUSTR will use the date of the analytical report as the date of notification; or
- Receiving written notification from the SFM moving the release into the 2022 corrective action rule.

3.8.4 Tier 1 Investigation Decision

Upon submission of the Tier 1 Investigation Form 2022, BUSTR will evaluate the report for completeness. If the concentrations of all COCs are at or below the ALs for all applicable pathways, then no further action status is required. If the concentrations of a particular COC are at or below the ALs, then no further evaluation is necessary for that COC and its corresponding exposure pathway. However, that particular COC must continue to be analyzed during subsequent investigations.

For Analytical Groups 4 or 5, a multiple chemical adjustment (MCA) must be conducted according to Section 3.9.4. when 10 or more non-carcinogenic or 10 or more carcinogenic COCs are present, and the results submitted as part of the Tier 1 Investigation Report.

If the concentration of one or more COC is above the applicable AL and upon approval of the Tier 1 Investigation report, *one or a combination* of the following must be conducted:

- Conduct an Interim Response Action (IRA) in accordance with OAC 1301:7-9-13(K), as discussed in Section 3.10;
- Conduct a Tier 2 Evaluation in accordance with OAC 1301:7-9-13(L), as discussed in Section 3.11; or
- Submit a Remedial Action Plan (RAP) in accordance with OAC 1301:7-9-13(N), as discussed in Section 3.13. **Note: BUSTR will require delineation to Tier 1 ALs prior to RAP approval.**

3.9 Delineation and Action Levels

3.9.1 Delineation Levels

Delineation levels **are not action levels** but are designed to assist in defining the extent of investigation through the Tier 1 process. Soil delineation levels were chosen from the lowest action level from the following pathways:

- Soil to indoor air;

- Soil to non-drinking water; and
- Direct contact.

Groundwater delineation levels were calculated by dividing the groundwater to indoor air action level by a factor of 10. If the calculated delineation level is less than the groundwater ingestion number (e.g., xylenes), then the groundwater ingestion number was used. The delineation levels are not risk-based and may not be revised. The delineation levels in soil and groundwater for COCs are listed in Table 3.3.

Drinking Water Scenario

If groundwater is determined to be drinking water, then compare the highest concentration of each of the COCs in soil and groundwater to the ALs for the following pathways:

- Groundwater Ingestion;
- Groundwater to Indoor Air;
- Groundwater to Outdoor Air;
- Direct Contact;
- Soil to Drinking Water Leaching;
- Soil to Indoor Air; and
- Soil to Outdoor Air.

In addition to the above-mentioned pathways, TPH concentrations in soil must also be compared to the action levels in Table 3.8.

Non-Drinking Water Scenario

If groundwater is determined to be non-drinking water, then compare the highest concentration of each of the COCs in soil and groundwater to the ALs for the following pathways:

- Groundwater to Indoor Air;
- Groundwater to Outdoor Air;
- Direct Contact;
- Soil to Non-Drinking Water Leaching;
- Soil to Indoor Air; and
- Soil to Outdoor Air.

In addition to the above-mentioned pathways, TPH concentrations in soil must also be compared to the action levels in Table 3.8.

Table 3.3 - Delineation Levels

Chemicals of Concern	Groundwater (mg/l)	Soil (mg/kg)
Benzene	0.417	1.67
Toluene	217	1,240
Ethylbenzene	41.6	406
o, m and p-xylenes	10	42.7
Naphthalene	1.68	52.7
1,2,4 – Trimethylbenzene	0.417	5.35
Methyl tertiary-butyl ether (MTBE)	134	150
1,2 – Dibromoethane (EDB)	0.09	0.154
1,2 – Dichloroethane (EDC)	0.59	1.01
Benzo(a)anthracene	20.6	12
Benzo(a)pyrene	18.3	1.2
Benzo(b)fluoranthene	162	12
Benzo(k)fluoranthene	169	120
Chrysene	681	1,200
Dibenz(a,h)anthracene	22.5	1.2
Indeno(1,2,3 –c,d)pyrene	112	12
Light Distillate Fraction (C_6-C_{12})	N/A	1,000
Middle Distillate Fraction (C_{10}-C_{20})	N/A	2,000
Heavy Distillate Fraction (C_{20}-C_{34})	N/A	5,000

No Groundwater Scenario

If no groundwater has been encountered (based on yield and/or hydraulic conductivity), then compare the highest concentration of each of the COCs in soil to the ALs in the following pathways:

- Direct Contact;
- Soil to Indoor Air; and
- Soil to Outdoor Air.

In addition to the above-mentioned pathways, TPH concentrations in soil must also be compared to the action levels in Table 3.8.

3.9.2 Action Level Tables

Table 3.4 - Groundwater Ingestion Action Levels

Chemicals of Concern	Action Levels
Benzene	0.005
Toluene	1
Ethylbenzene	0.7
o, m and p-Xylenes	10
Naphthalene	0.0014
1,2,4 – Trimethylbenzene	0.015
Methyl tertiary-butyl ether (MTBE)	0.120
1,2 – Dibromoethane (EDB)	0.00005
1,2 – Dichloroethane (EDC)	0.005
Benzo(a)anthracene	0.00092
Benzo(a)pyrene	0.0002
Benzo(b)fluoranthene	0.00092
Benzo(k)fluoranthene	0.0092
Chrysene	0.092
Dibenz(a,h)anthracene	0.000092
Indeno(1,2,3-c,d)pyrene	0.00092

All chemical concentrations expressed in milligrams per liter (mg/L).

Table 3.5 - Groundwater to Indoor Air Action Levels

Soil Class 1

Chemicals of Concern	Groundwater to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.
Benzene	4.17	26.1	4.18	26.1	4.24	26.5	4.31	27.0
Toluene	2,170	35,200	2,170	35,300	2,210	35,800	2,240	36,400
Ethylbenzene	416	6,760	417	6,760	423	6,860	430	6,980
o, m and p-Xylenes	50.7	822	50.7	823	51.5	835	52.4	849
Naphthalene	16.8	105	16.8	105	17.1	107	17.4	109
1,2,4 – Trimethylbenzene	4.17	67.6	4.17	67.6	4.23	68.7	4.31	69.8
MTBE*	1,340	8,360	1,340	8,370	1,360	8,500	1,380	8,660
1,2 – Dibromoethane (EDB)	0.908	5.68	0.909	5.69	0.923	5.78	0.940	5.88
1,2 – Dichloroethane (EDC)	5.90	36.9	5.91	37.0	6.00	37.6	6.11	38.2
Benzo(a)anthracene	206	1,290	206	1,290	210	1,310	214	1,340
Benzo(a)pyrene	183	1,140	183	1,150	191	1,190	200	1,250
Benzo(b)fluoranthene	1,620	10,100	1,620	10,200	1,680	10,500	1,750	11,000
Benzo(k)fluoranthene	1,690	10,600	1,690	10,600	1,760	11,000	1,830	11,500
Chrysene	6,810	42,600	6,820	42,700	6,970	43,600	7,150	44,700
Dibenz(a,h)anthracene	225	1,410	226	1,420	244	1,520	264	1,650
Indeno(1,2,3-c,d)pyrene	1,120	7,030	1,130	7,040	1,150	7,220	1,190	7,430

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 2

Chemicals of Concern	Groundwater to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.
Benzene	4.18	26.2	4.19	26.2	4.27	26.7	4.38	27.4
Toluene	2,180	35,300	2,180	35,300	2,220	36,100	2,280	36,900
Ethylbenzene	417	6,770	418	6,780	426	6,920	437	7,080
o, m and p-Xylenes	50.8	824	50.8	825	51.9	842	53.2	862
Naphthalene	16.9	106	16.9	106	17.3	108	17.7	111
1,2,4 – Trimethylbenzene	4.18	67.7	4.18	67.8	4.27	69.2	4.37	70.9
MTBE*	1,340	8,380	1,340	8,390	1,370	8,580	1,410	8,800
1,2 – Dibromoethane (EDB)	0.910	5.69	0.911	5.70	0.931	5.83	0.955	5.98
1,2 – Dichloroethane (EDC)	5.92	37.0	5.93	37.1	6.05	37.9	6.21	38.8
Benzo(a)anthracene	207	1,290	207	1,300	212	1,330	218	1,360
Benzo(a)pyrene	183	1,140	183	1,150	191	1,190	200	1,250
Benzo(b)fluoranthene	1,620	10,100	1,620	10,200	1,690	10,600	1,760	11,000
Benzo(k)fluoranthene	1,690	10,600	1,690	10,600	1,760	11,000	1,840	11,500
Chrysene	6,830	42,700	6,840	42,800	7,030	44,000	7,260	45,400
Dibenz(a,h)anthracene	224	1,400	225	1,400	237	1,480	252	1,580
Indeno(1,2,3-c,d)pyrene	1,130	7,050	1,130	7,060	1,160	7,280	1,200	7,540

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 3

Chemicals of Concern	Groundwater to Indoor Air							
	<15 Feet		15-30 Feet		31-50 Feet		>50 Feet	
	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.	Residential	Non-Resid.
Benzene	4.29	26.8	4.31	27.0	4.69	29.3	5.14	32.1
Toluene	2,230	36,200	2,240	36,400	2,440	39,600	2,670	43,300
Ethylbenzene	428	6,940	430	6,980	468	7,590	512	8,310
o, m and p-Xylenes	52.1	845	52.4	849	56.9	924	62.4	1,010
Naphthalene	17.3	108	17.4	109	19.0	119	20.9	130
1,2,4 – Trimethylbenzene	4.28	69.5	4.30	69.8	4.68	75.9	5.13	83.2
MTBE*	1,370	8,600	1,380	8,650	1,510	9,440	1,660	10,400
1,2 – Dibromoethane (EDB)	0.934	5.84	0.939	5.88	1.02	6.41	1.12	7.04
1,2 – Dichloroethane (EDC)	6.07	38.0	6.11	38.2	6.66	41.7	7.32	45.8
Benzo(a)anthracene	210	1,310	210	1,320	223	1,400	238	1,490
Benzo(a)pyrene	181	1,130	181	1,130	184	1,150	188	1,180
Benzo(b)fluoranthene	1,610	10,100	1,610	10,100	1,640	10,300	1,680	10,500
Benzo(k)fluoranthene	1,680	10,500	1,680	10,500	1,710	10,700	1,740	10,900
Chrysene	6,830	42,700	6,840	42,800	7,060	44,200	7,310	45,700
Dibenz(a,h)anthracene	220	1,380	220	1,380	224	1,400	227	1,420
Indeno(1,2,3-c,d)pyrene	1,120	7,040	1,130	7,050	1,160	7,230	1,190	7,450

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Table 3.6 - Groundwater to Outdoor Air Action Levels

Soil Class 1

Chemicals of Concern	Groundwater to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	788	496	5,370
Toluene	431,000	704,000	912,000
Ethylbenzene	86,100	141,000	182,000
o, m, and p-Xylenes	9,280	15,200	19,600
Naphthalene	843	531	2,500
1,2,4 - Trimethylbenzene	781	1,280	1,650
MTBE*	84,100	53,000	>1E+6
1,2 – Dibromoethane (EDB)	42.3	26.7	864
1,2 – Dichloroethane (EDC)	506	319	2,680
Benzo(a)anthracene	5,960	3,750	121,000
Benzo(a)pyrene	12,900	8,140	264,000
Benzo(b)fluoranthene	96,100	60,600	>1E+6
Benzo(k)fluoranthene	106,000	66,800	>1E+6
Chrysene	249,000	157,000	>1E+6
Dibenz(a,h)anthracene	27,900	17,600	570,000
Indeno(1,2,3-c,d)pyrene	46,200	29,100	943,000

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 2

Chemicals of Concern	Groundwater to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	828	522	5,650
Toluene	452,000	739,000	956,000
Ethylbenzene	90,100	147,000	191,000
o, m, and p-Xylenes	9,780	16,000	20,700
Naphthalene	1,020	640	3,020
1,2,4 - Trimethylbenzene	821	1,340	1,740
MTBE*	97,800	61,600	>1E+6
1,2 – Dibromoethane (EDB)	51.7	32.6	1,050
1,2 – Dichloroethane (EDC)	566	356	3,000
Benzo(a)anthracene	8,130	5,120	166,000
Benzo(a)pyrene	12,900	8,110	263,000
Benzo(b)fluoranthene	104,000	65,200	>1E+6
Benzo(k)fluoranthene	111,000	70,200	>1E+6
Chrysene	319,000	201,000	>1E+6
Dibenz(a,h)anthracene	20,600	13,000	420,000
Indeno(1,2,3-c,d)pyrene	57,000	35,900	>1E+6

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Soil Class 3

Chemicals of Concern	Groundwater to Outdoor Air		
	Residential	Non-Residential	Excavation Worker
Benzene	1,300	821	8,880
Toluene	698,000	>1E+6	>1E+6
Ethylbenzene	137,000	224,000	290,000
o, m, and p-Xylenes	15,500	25,400	32,900
Naphthalene	2,990	1,880	8,880
1,2,4 - Trimethylbenzene	1,300	2,120	2,740
MTBE*	255,000	161,000	>1E+6
1,2 – Dibromoethane (EDB)	158	99.4	3,220
1,2 – Dichloroethane (EDC)	1,260	794	6,680
Benzo(a)anthracene	21,000	13,200	428,000
Benzo(a)pyrene	5,100	3,210	104,000
Benzo(b)fluoranthene	49,900	31,500	>1E+6
Benzo(k)fluoranthene	50,300	31,700	>1E+6
Chrysene	347,000	219,000	>1E+6
Dibenz(a,h)anthracene	5,170	3,260	106,000
Indeno(1,2,3-c,d)pyrene	48,100	30,300	982,000

All chemical concentrations expressed in milligrams per liter (mg/L).
*Methyl tertiary-butyl ether

Table 3.7 - Direct Contact Action Levels

Chemicals of Concern	Direct Contact		
	Residential	Non-Residential	Excavation Worker
Benzene	26	140	1,200
Toluene	820	820	820
Ethylbenzene	130	480	480
o, m and p-Xylenes	260	260	260
Naphthalene	90	450	560
1,2,4 – Trimethylbenzene	160	220	220
MTBE*	1,100	5,700	8,900
1,2 – Dibromoethane (EDB)	0.83	4.4	38
1,2 – Dichloroethane (EDC)	11	56	480
Benzo(a)anthracene	12	58	1,200
Benzo(a)pyrene	1.2	5.8	120
Benzo(b)fluoranthene	12	58	1,200
Benzo(k)fluoranthene	120	580	12,000
Chrysene	1,200	5,800	120,000
Dibenz(a,h)anthracene	1.2	5.8	120
Indeno(1,2,3-c,d)pyrene	12	58	1,200

All chemical concentrations are expressed in milligrams per kilogram (mg/kg).
*Methyl tertiary-butyl ether

Table 3.8 - TPH Action Levels

Petroleum Fraction	Soil Class 1	Soil Class 2	Soil Class 3
Light Distillate Fraction (C_6-C_{12})	1,000	5,000	8,000
Middle Distillate Fraction (C_{10}-C_{20})	2,000	10,000	20,000
Heavy Distillate Fraction (C_{20}-C_{34})	5,000	20,000	40,000

All chemical concentrations expressed in milligrams per kilogram (mg/kg).

Table 3.9 - Soil to Indoor Air, Drinking Water Leaching and Non-Drinking Water Leaching

Soil Class 1

Chemicals of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	1.67	10.5	52.7	33.2	359	0.246	20.5
Toluene	1,240	20,200	39,200	64,000	82,900	70.7	15,300
Ethylbenzene	406	6,590	12,800	20,900	27,100	84.5	5,020
o, m and p-Xylenes	42.7	693	1,350	2,200	2,850	1,030	524
Naphthalene	52.7	330	1,670	1,050	4,950	0.511	613
1,2,4 – Trimethylbenzene	5.35	86.7	169	275	356	2.37	65.8
MTBE*	150	940	4,740	2,990	96,800	1.58	1,760
1,2 – Dibromoethane (EDB)	0.154	0.961	4.86	3.06	99.1	0.000982	1.78
1,2 – Dichloroethane (EDC)	1.01	6.33	31.9	20.1	169	0.101	11.9
Benzo(a)anthracene	72,800	456,000	>1E+6	>1E+6	>1E+6	38.1	854,000
Benzo(a)pyrene	213,000	>1E+6	>1E+6	>1E+6	>1E+6	29.2	>1E+6
Benzo(b)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	136	>1E+6
Benzo(k)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	1,270	>1E+6
Chrysene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	3,870	>1E+6
Dibenz(a,h)anthracene	853,000	>1E+6	>1E+6	>1E+6	>1E+6	46.6	>1E+6
Indeno(1,2,3-c,d)pyrene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	1,020	>1E+6

All chemical concentrations are expressed in milligrams per kilogram (mg/kg).
*Methyl tertiary-butyl ether

Soil Class 2

Chemicals of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	1.95	12.2	86.2	54.3	587	0.437	36.6
Toluene	1,470	23,900	65,100	106,000	138,000	168	36,700
Ethylbenzene	491	7,960	21,700	35,400	45,800	163	9,720
o, m and p-Xylenes	51.8	841	2,290	3,740	4,840	1,950	993
Naphthalene	65.8	412	2,910	1,830	8,650	1.12	1,350
1,2,4 – Trimethylbenzene	6.54	106	289	472	611	5.89	164
MTBE*	167	1,050	7,400	4,660	151,000	2.67	2,980
1,2 – Dibromoethane (EDB)	0.178	1.11	7.87	4.96	161	0.00177	3.22
1,2 – Dichloroethane (EDC)	1.16	7.26	51.3	32.3	272	0.177	20.9
Benzo(a)anthracene	91,200	571,000	>1E+6	>1E+6	>1E+6	1,480	>1E+6
Benzo(a)pyrene	267,000	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Benzo(b)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Benzo(k)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	57,500	>1E+6
Chrysene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	45,000	>1E+6
Dibenz(a,h)anthracene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Indeno(1,2,3-c,d)pyrene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6

All chemical concentrations are expressed in milligrams per kilogram (mg/kg).
*Methyl tertiary-butyl ether

Soil Class 3

Chemicals of Concern	Soil to Indoor Air		Soil to Outdoor Air			Soil to Drinking Water Leaching	Soil to Non-Drinking Water
	Residential	Non-Residential	Residential	Non-Residential	Excavation		
Benzene	2.39	15.0	451	284	3,070	1.63	140
Toluene	1,790	29,100	338,000	552,000	715,000	850	189,000
Ethylbenzene	596	9,670	112,000	184,000	238,000	639	39,100
o, m and p-Xylenes	63.5	1,030	12,000	19,600	25,300	7,490	3,900
Naphthalene	80.8	505	15,000	9,430	44,500	4.99	6,160
1,2,4 – Trimethylbenzene	7.99	130	1,510	2,460	3,190	31.1	886
MTBE*	236	1,480	44,100	27,800	899,000	11.5	13,100
1,2 – Dibromoethane (EDB)	0.239	1.49	44.1	27.8	899	0.00734	13.7
1,2 – Dichloroethane (EDC)	1.54	9.65	289	182	1,530	0.714	86.7
Benzo(a)anthracene	111,000	691,000	>1E+6	>1E+6	>1E+6	275,000	>1E+6
Benzo(a)pyrene	318,000	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Benzo(b)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Benzo(k)fluoranthene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Chrysene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Dibenz(a,h)anthracene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6
Indeno(1,2,3-c,d)pyrene	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6	>1E+6

All chemical concentrations are expressed in milligrams per kilogram (mg/kg).
*Methyl tertiary-butyl ether

3.9.3 Calculating Action Levels for COCs

Action levels for COCs not included on Tables 3.4 through 3.9 must be obtained for Analytical Groups 4 or 5. Consult the most current Chemical Information Database and Applicable Regulatory Standards (CIDARS) tables for the physical, chemical and toxicity data found on the Ohio EPA's website at https://epa.ohio.gov/divisions-and-offices/environmental-response-revitalization/guides-and-manuals/guidance under the "Risk Assessment" tab labeled "*Chemical Information Database and Applicable Regulatory Standards* (CIDARS)". This information is then input into the BUSTR pathway specific spreadsheets. **Include a reference to the specific version of the CIDARS table used on the BUSTR spreadsheets in the "Reference" column**. If the specific physical, chemical, or toxicity data is not included in CIDARS, then the specific COC needs no further evaluation.

Direct Contact

For direct contact values, the action levels should be obtained from the Direct-Contact Soil Standards section of the CIDARs tables. BUSTR's rules use the Residential Single Chem GDCSS column for a single chemical in the VAP Rule, which is the lowest value from the Residential Soil Standard Non-Cancer, Residential Soil Standard Cancer, and Soil Saturation columns. The Residential Single Chemical GDCSS value is utilized in BUSTR's Closure Assessment and Tier 1 Investigation. For Tier 2 Evaluations, if appropriate, the lowest value from the Commercial-Industrial Soil Standard Non-Cancer, Commercial/Industrial Soil Standard Cancer, and Soil Saturation columns is located in the Commercial/Industrial Single Chem GDCSS column.

For example, the direct contact value for xylenes listed in BUSTR's rule for residential land-use is 260 mg/kg.

Figure 3.11 – Example Direct Contact Values from Ohio VAP CIDARS (version 11/2020)

Chemical	CAS Number	DIRECT-CONTACT SOIL STANDARDS			
		Residential Soil Std.		Res. Single	Soil Saturation
		Non-Cancer (mg/kg)	Cancer (mg/kg)	Chem GDCSS (mg/kg)	Standard (mg/kg)
Trichlorophenoxypropionic acid, -2,4,5	93-72-1	1,000	NA	1,000	NA
Trichloropropane, 1,2,3-	96-18-4	12	0.1	0.1	1,400
Triethylamine	121-44-8	290	NA	290	28,000
Trifluralin	1582-09-8	950	1,400	950	NA
Trimethylbenzene, 1,2,3-	526-73-8	760	NA	290	290
Trimethylbenzene, 1,2,4-	95-63-6	690	NA	220	220
Trimethylbenzene, 1,3,5-	108-67-8	620	NA	180	180
Trinitrobenzene, 1,3,5-	99-35-4	1,100	NA	1,100	NA
Trisodium phosphate	7601-54-9	1,000,000	NA	1,000,000	NA
Urethane	51-79-6	NA	11	11	NA
Vanadium Compounds	7440-62-2	780	NA	780	NA
Vinyl Acetate	108-05-4	620	NA	620	2,700
Vinyl Bromide	593-60-2	11	3	3	2,500
Vinyl Chloride	75-01-4	160	1.3	1.3	3,900
Warfarin	81-81-2	38	NA	38	NA
Xylenes	1330-20-7	1,300	NA	260	260
Zinc and Compounds	7440-66-6	47,000	NA	47,000	NA
Zinc Cyanide	557-21-1	7,800	NA	7,800	NA

Soil and Water Inhalation Values

Several inputs must be obtained from Chronic Toxicity Values from CIDARs to use in the inhalation BUSTR spreadsheet:

- Henry's Law Constant (H');
- Organic Carbon / Water Coefficient (K_{oc} in L/kg);
- Air Diffusivity (D^{air});
- Water Diffusivity (D^{wat});
- Inhalation Slope Factor (SFi); and
- Inhalation Reference Dose (RfDi).

Both the inhalation slope factor (SFi) and the inhalation reference dose (RfDi) must be calculated before inserting them into the spreadsheet. A common mistake is using the wrong toxicity values because of the units presented in the CIDARS database. To obtain the correct values, the inhalation unit risk (IUR) and reference concentration (RfC) values will need to be converted and used in the BUSTR spreadsheets. If a chemical shows "NA" under both the IUR and RfC columns, the inhalation pathway is considered incomplete.

Figure 3.12 – Example Chronic Toxicity Values from CIDARS (version 11/2020)

Chemical	CAS Number	Chronic Toxicity Values							
		SF (mg/kg-day)$^{-1}$	key	IUR (μg/m^3)$^{-1}$	key	RfD (mg/kg-day)	key	RfC (mg/m^3)	key
Benz[a]anthracene	56-55-3	1.0E-01	I	6.0E-05	I	NA	NA	NA	NA
Benzene	71-43-2	5.5E-02 (b)	I	7.8E-06 (b)	I	4.0E-03	I	3.0E-02	I
Benzenethiol	108-98-5	NA	NA	NA	NA	1.0E-03	P	NA	NA
Benzidine	92-87-5	2.3E+02	I	6.7E-02	I	3.0E-03	I	NA	NA

Amended screenshot of Ohio VAP CIDARS (version 11/2020)

To calculate the SFi, convert the IUR values to the correct units using equation 3.1.

Equation 3.1 Calculation of Inhalation Slope Factor

$$\text{Inhalation Slope Factor } \frac{\text{ug}}{\text{kg}}/\text{day} = \frac{\text{IUR}\,\frac{\text{ug}}{\text{m}^3}\,(70\text{ kg})}{20\ \frac{\text{m}^3}{\text{day}}} \text{ x } 1000\,\frac{\text{ug}}{\text{mg}}$$

To calculate the RfDi, convert the RfC value to the correct units using equation 3.2.

Equation 3.2 Calculation of Inhalation Reference Dose

$$\text{Inhalation Reference Dose } \frac{\text{mg}}{\text{kg}}/\text{day} = \frac{\text{RfC}\,\frac{\text{mg}}{\text{m}^3}\,(20\ \frac{\text{m}^3}{\text{day}})}{70\text{ kg}}$$

Soil Leaching to Groundwater

To create ALs, several values must be calculated or obtained from CIDARs for use in BUSTR spreadsheets:

- Action Level;
  - o When groundwater is drinking water, use the MCL value listed under the Unrestricted Potable Use Standards column as the input value. If the chemical shows "NA" under this column, then the "VAP UPUS" value should be used;
  - o When groundwater is not drinking water, the calculated groundwater to indoor air action level must be used.
- Organic Carbon / Water Coefficient (Koc in L/kg);
- Henry's Law Constant (H').

Half-life/Degradation Rate

These values are also chemical specific. The groundwater half-life values can be found in "Handbook of Environmental Degradation Rates" by Howard, Philip et. al, 1991. If a chemical is not published in this handbook, "no degradation" should be assumed. A small value like 1E-10 can be used in the spreadsheet.

To calculate the degradation rate, use the "high" groundwater half-life value for the specified COC then convert the units from hours to days. Divide 0.693 by the converted half-life value to find the soil leaching degradation rate.

Equation 3.3 – Calculating Groundwater Degradation Rate

$$\text{Degradation Rate} = \frac{0.693}{t_{1/2}\ \text{days}}$$

Example 3.4 – Calculating Benzene Groundwater Degradation Rate

1. Benzene Groundwater Half Life Value: 17,280 hours to 240 hours.
2. 17,280 hours/24 = 720 days
3. 0.693/720 days = 9.6 E^{-4}
4. Benzene Degradation Rate = 9.6 E^{-4}

3.9.4 Multiple Chemical Adjustments

A multiple chemical adjustment calculation needs to be conducted when 10 or more non-carcinogenic or 10 or more carcinogenic COCs are present when analyzing for Analytical Groups 4 and/or 5. Table E.6 in Appendix E, contains a list of chemicals along with their associated toxicological data. Toxicological data for COCs not listed in Appendix E can be obtained from the most recent version of CIDARS. If the data is not included in CIDARS, then the specific COC does not need further evaluation.

For COCs having carcinogenic effects, a cancer risk ratio for each chemical must be determined by dividing the maximum concentration of each carcinogenic chemical identified on the UST site by the appropriate action level/site-specific target level for a specific exposure pathway (e.g., soil to indoor air, groundwater to indoor air). The cancer risk ratios for all the carcinogenic chemicals identified at the UST site must be added using a multiple chemical adjustment calculation to calculate a cumulative risk ratio for each individual exposure pathway.

Example:
The soil to indoor air action level (for a residential receptor, Soil Class 1 scenario) is 1.67 mg/kg for benzene, 213,000 mg/kg for benzo(a)pyrene, and 4.06 mg/kg for tetrachloroethylene. If the maximum soil concentration is 0.6 mg/kg for benzene, 1.0 mg/kg for benzo(a)pyrene, and 2.0 mg/kg tetrachloroethylene, the multiple chemical adjustment calculation is as follows:

$$\underset{\text{benzene}}{\frac{0.6}{1.67}} + \underset{\text{benzo(a)pyrene}}{\frac{1.0}{213{,}000}} + \underset{\text{tetrachloroethylene}}{\frac{2.0}{4.06}} + \ldots \; = < 1$$

NOTE: the example above only shows three of the ten or more COCs that would be included in the actual calculation.

For COCs having non-carcinogenic effects, the non-carcinogenic action level/site-specific target level must be calculated using the BUSTR spreadsheets by changing the slope factor to "ND." Then, the risk ratio for each chemical must be determined by dividing the maximum concentration of each chemical identified on the UST site by the appropriate non-carcinogenic action level/site-specific target levels for a specific exposure pathway. The non-cancer risk ratios for all the non-carcinogenic COCs must be added to calculate a cumulative risk ratio for each individual exposure pathway. The calculation is similar to the carcinogenic risk ratio calculation previously described.

If the sum of either the carcinogenic or non-carcinogenic risk ratios exceeds 1.0, further corrective actions are required. All COCs are assumed to affect the same target organ.

For situations where a COC poses both a carcinogenic and non-carcinogenic risk, the COC must be evaluated using the multiple chemical adjustment calculation for both the carcinogenic and non-carcinogenic effects.

A multiple chemical adjustment calculation shall be made for each of the following pathways:

- Groundwater Ingestion;
- Groundwater to Indoor Air;
- Direct Contact; and
- Soil to Indoor Air.

Each pathway is considered separately, and the resulting risk ratios of the individual exposure pathways are not additive.

3.10 Interim Response Action

If an IRA is selected, it must be implemented within 90 days of the completion and approval of a Tier 1 Investigation, a Tier 2 Evaluation, or a Tier 3 Evaluation. After implementing an IRA, the pathway subject to the IRA must be re-evaluated to determine if concentrations of COCs are **at or below** the appropriate action levels or site-specific target levels for that environmental media. The IRA may include source removal or short-term actions not exceeding three months. Examples of an IRA include, but are not limited to, enhanced fluid recovery (EFR), over excavation, and pump-and-treat. IRA activities do not include injection of chemicals, surfactants, or substances to increase biological activity or to chemically degrade COCs in the subsurface. These activities should be proposed and submitted to BUSTR for approval within a Remedial Action Plan.

An IRA Notification Form 2022 must be submitted to BUSTR **at least 10 days** before beginning the IRA (Appendix D). All permits must be secured, and any flammable or combustible materials managed in accordance with Federal, state, or local regulatory agencies.

Prior approval from BUSTR must be obtained if *any* of the following situations exist:

- Combined total volume of soil to be excavated is greater than 800 yd^3;
- Combined anticipated time to initiate and complete the IRA is greater than three months; or
- More than one IRA will be conducted (for all tier evaluations).

If during a soil excavation IRA, it is determined that the volume of soil will exceed the 800 yd^3 limit, the State Fire Marshal must be contacted for approval to remove additional soil.

An IRA requiring approval must include *all* the following:

- Description of the activities to be conducted;
- Site map identifying the limits of soil excavation (if applicable);
- Estimation of soil and groundwater volumes to be managed;
- Estimation of the anticipated time to completion;
- Confirmatory sampling plan; and
- Comparison of the selected IRA technology to other corrective action options, including an evaluation of costs.

Confirmatory Sampling

After completing an IRA, a sufficient number of samples must be collected to determine the concentration of COCs remaining in the soil or groundwater. All COC concentrations remaining in the soil or groundwater must be at or below the ALs or the SSTLs to receive an NFA letter.

Confirmatory Sampling for Soil

Collect soil samples from the excavation's sidewalls and bottom using a ratio of one sample per 100 ft^2. A minimum of one soil sample must be collected from each sidewall and from the bottom of the excavation. These samples must be biased towards areas with the highest contamination.

If the excavation is less than 400 yd^3, a minimum of one soil sample per wall and one from the bottom of the excavation (total of five samples) must be submitted to the laboratory for analysis. The five soil samples submitted to the laboratory shall be selected based on the highest field screening results.

If the excavation is greater than 400 yd^3, a minimum of two soil samples per wall and two from the bottom of the excavation (total of ten samples) must be submitted to the laboratory for analysis. The ten soil samples submitted to the laboratory shall be selected based on the highest field screening results.

Contaminated soils removed during the IRA because of previous results above ALs or SSTLs must be sent to a landfill for disposal or treatment.

Confirmatory Sampling for Groundwater

If the IRA addressed localized groundwater contamination, a groundwater sampling program must be developed to demonstrate that the IRA was effective. This may require the re-installation of monitoring wells destroyed during the IRA process. At a minimum, collect a groundwater sample from each MW within the affected area. At least two quarters of confirmatory groundwater sampling must be conducted in the previously contaminated areas. BUSTR may require additional confirmatory sampling in the previously contaminated area.

IRA Reporting

Prepare and submit the Interim Response Action Form 2022 within 60 days of completing the IRA activities.

3.11 Tier 2 Evaluation

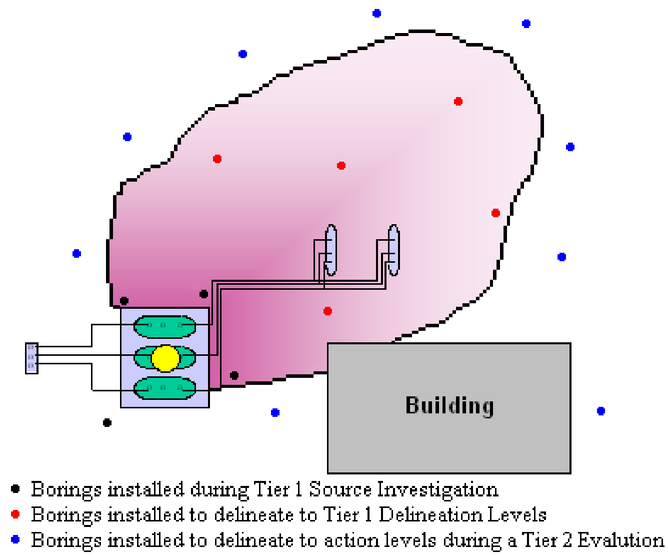
Conduct a Tier 2 Evaluation when COC concentrations are above applicable ALs and upon approval of completeness of the Tier 1 Investigation report. The purpose of Tier 2 Evaluation is to:

- Define the distribution of COCs to applicable Tier 1 ALs;
- Determine the current and potential future land-use of the UST site and surrounding properties;
- Action level determination;
- Develop a site conceptual exposure model (SCEM); and
- Develop SSTLs using spreadsheets and models approved by BUSTR.

3.11.1 Determination of the Distribution of Chemicals of Concern

The likely distribution of COCs must be defined according to the lowest applicable Tier 1 AL determined for the UST site for each identified environmental medium. To determine the distribution of COCs in soil and groundwater, SBs and groundwater MWs must be installed to delineate contamination in all directions (regardless of groundwater flow direction). Figure 3.13 provides an example of where to place SB/MWs to determine the likely distribution of COCs.

Figure 3.13 - Typical Well Placement for Delineation of COCs During a Tier 2 Evaluation



If an AL cannot be developed for a particular COC or that COC is below detection limits (BDL) and detection limits are below ALs, then it may be excluded from evaluation.

If the distribution of COCs is determined to have migrated to off-site areas above action levels, the O/O (or volunteer conducting corrective actions) shall use their best efforts to obtain permission to investigate these areas. At a minimum, the affected property owners must be contacted at least three (3) times within a 90-day period to complete the off-site access requirements**. Off-site access denial documentation must be submitted to BUSTR within 45 days of receipt or within 45 days of the third consecutive unsuccessful attempt to gain off-site property access.**

3.11.2 Land-Use Determination

The Tier 1 ALs assume that the current and future land-use for the UST site and the adjacent properties is residential. During the Tier 2 Evaluation, the land use for the site may be re-evaluated. Land use at the site shall be residential unless one of the following is true:

- The UST site is non-residential and 75% of the area within 300 ft. of the UST site's property boundary is non-residential land-use. The area of the UST site is not included in land-use calculations. The surface area of all roadways within the 300 ft. area must be included in the land-use calculations. Roadways must be divided in half and counted towards the land-use of the adjoining property. For example, if a roadway separates residential and non-residential properties, half of the roadway will be counted as residential land-use and half as non-residential land-use. Figure 3.14 shows an example of land-use determination; or
- A land-use restriction **as approved by BUSTR** for the UST site has been implemented and recorded in the county where the UST site is located, or the O/O or volunteer conducting the corrective action has entered into an environmental covenant with BUSTR (Appendix C).

Land-use for the UST site and adjacent properties shall be determined as residential or non-residential using reasonably available information based on the following:

- Historical and current land-use of the UST site and adjacent properties; and
- Historical and current zoning or planning designation for the UST site and adjacent properties.

Residential Land-use

Examples of residential land-uses include, but are not limited to, housing (single and multiple dwellings), educational facilities, day care facilities, agricultural land, prisons, and custodial or long-term health care facilities.

Residential land-use assumes that- adults and children are full-time residents living and sleeping on the property. The residents are potentially subject to inhalation of vapors, both indoors and outdoors, direct contact with surface soil (i.e., ingestion, inhalation of vapors, dermal contact, and inhalation of particulates), and ingestion of drinking water from a well on the property (Section 3.11.4).

Non-Residential Land-use

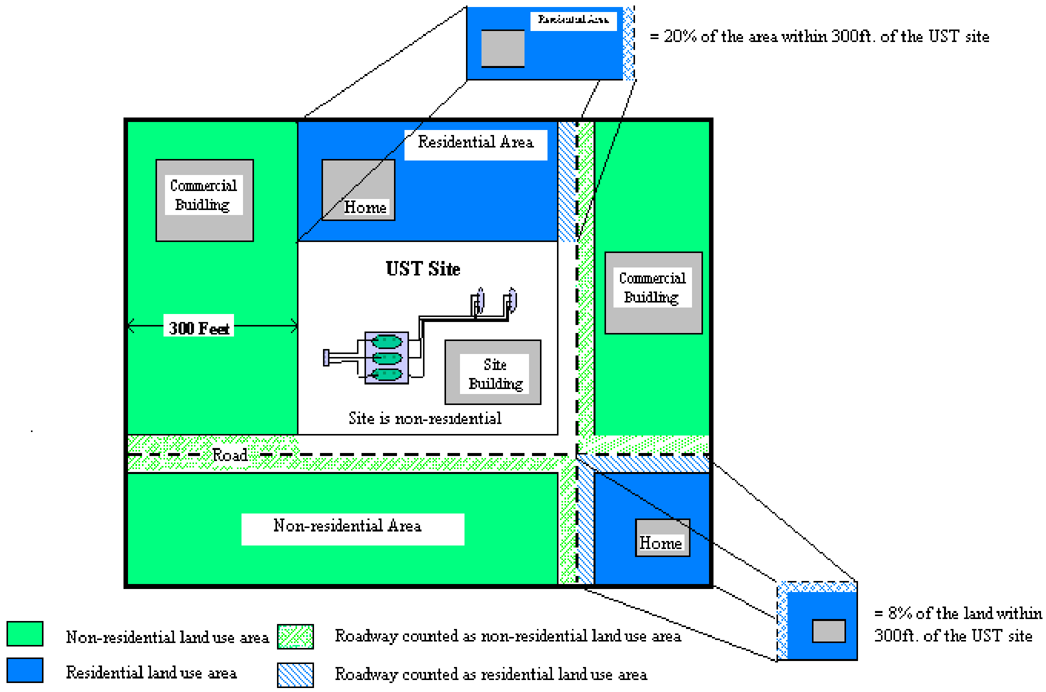
Non-residential land-use includes, but is not limited to, commercial and industrial land. Examples include facilities that supply goods and/or services and are open to the public, such as warehouses, retail gasoline stations and automobile service facilities, office buildings, retail businesses, hospitals, religious institutions, hotels, fire departments, parks, golf courses, and parking facilities.

Non-residential land-use assumes that adult workers spend a typical work week on the property. The commercial worker is potentially subject to inhalation of vapors, both indoors and outdoors, and to direct contact with surface soil (i.e., ingestion, inhalation of vapors, dermal contact, inhalation of particulates).

Land-Use Survey

A land-use survey of all properties within 300 ft. of the UST site property boundaries is necessary to determine non-residential land-use for the UST site. The survey must include, but not be limited to, the Land Use Survey for Investigation of Petroleum Release Letter (Appendix D), from all property owners within 300 ft. of the UST site property boundaries. The survey information submitted to BUSTR should include a map of all properties within 300 ft. of the UST site and documentation of all correspondence from the Land-Use Survey Template. **If such correspondence is inconclusive or less than 75% of the surrounding properties respond to the survey, BUSTR may require additional survey methods (i.e., phone call, door-to-door) be conducted**. BUSTR will evaluate overall survey results for each site on a case-by-case basis.

Figure 3.14 - Example of Land-use Determination



NOTE: Because 28% of the area within 300 ft. of the UST site is classified as residential, the UST site is classified as residential.

3.11.3 Action Level Determination

Residential Action Levels

If the UST site does not meet the non-residential land-use determination, the COC concentrations must be compared to the appropriate residential soil ALs and groundwater use ALs.

A Site Conceptual Exposure Model (SCEM) based on residential land-use (Section 3.11.4) must be developed.

Non-residential Action Levels

If the UST site meets a non-residential land-use determination, the COC concentrations must be compared to the appropriate non-residential soil ALs and groundwater use ALs, as follows:

- If all COC concentrations are at or below the ALs for all applicable pathways, then no further action status can be requested;
- If the maximum concentration of a specific COC is at or below the applicable AL, then no further evaluation is necessary for that COC and for the corresponding complete exposure pathway; or
- If one or more of the COC concentrations are above non-residential land-use and/or groundwater use ALs then all applicable pathways must be evaluated.

A SCEM based on non-residential land-use (Section 3.11.4) must be developed.

Offsite Impacts

If COCs have migrated off the UST site, ALs must be developed for each impacted property according to the corresponding land-use. For example, if a neighboring, impacted property is classified as a residential land-use, then residential exposure scenarios must be evaluated starting at that property's boundary.

3.11.4 Site Conceptual Exposure Model

The generic exposure model used in the Tier 1 Evaluation is based on a very specific exposure scenario that could not be modified. In the Tier 2 Evaluation, the exposure model(s) may be modified by considering such site-specific characteristics as activity and land-use, types of receptors, media, and transport mechanisms.

During a Tier 2 Evaluation, a SCEM must be developed to clearly describe the points and pathways through which exposure to COCs may occur. A SCEM is required if *any* of these conditions exist:

- One or more of the COC concentrations is above the applicable groundwater use ALs;
- One or more of the COC concentrations is above the non-residential land-use ALs; or
- One or more of the COC concentrations is above the residential land-use ALs, and the site is classified as residential.

3.11.5 Pathway Evaluation

Exposure Pathway Identification

The Tier 2 Pathway Evaluation must identify all exposure pathways that exceed applicable ALs including all receptors, media, transport mechanisms and routes of exposure. The SCEM must include *all* the following steps:

1. Evaluate *all* current and potential future receptors that may be exposed to the release, including:

    a. Adults and children for residential scenarios;
    b. Adults for non-residential scenarios;
    c. Adults for excavation worker scenarios; and
    d. Aquatic life and recreational receptors in a surface water body within 300 ft.

2. Include *all* environmental media that are likely to contain COC concentrations identified for evaluation. Evaluate the following environmental media, as appropriate:

    a. Soil;
    b. Groundwater;
    c. Surface water;
    d. Indoor air; and
    e. Outdoor air.

3. Identify *all* fate and transport mechanisms for all COCs including:

    a. Atmospheric dispersion;
    b. Volatilization;
    c. Enclosed space vapor accumulation;
    d. Soil leaching; and
    e. Groundwater transport.

4. Evaluate routes of exposure including:

    a. Ingestion;
    b. Inhalation; and
    c. Direct contact.

Pathway Completeness

Evaluate exposure pathways to determine if the pathways identified in the SCEM are complete. An exposure pathway is considered incomplete when *any* of the following criteria are true:

- There is no POE for a COC in an identified environmental media;
- Site-specific data demonstrates that there is no transport mechanism in the identified environmental media to move COCs from the source areas to the POE;
- Site-specific data demonstrates that there are no routes of exposure for the identified receptor;
- POEs are eliminated by groundwater use restrictions enforceable by local government, regulatory agencies, or an environmental covenant with BUSTR; and
- POEs are eliminated by land-use restrictions enforceable by local government, regulatory agencies, or an environmental covenant with BUSTR.

Environmental media, routes of exposure, and transport mechanisms may be eliminated by mechanisms which include, but are not limited to, environmental covenants or engineering controls (e.g., slurry walls, capping, vapor control, point of use water treatment) that are maintained by environmental covenants. Engineering controls must be designed, implemented, and approved in a Remedial Action Plan (Section 3.13), and maintained through an environmental covenant.

A potable water well may be eliminated as a POE, if that well is properly sealed (i.e., a sealant report is submitted). If the well is not in existence and a sealant report cannot be obtained, an affidavit may be submitted to eliminate that well as the POE. Although this affidavit (Appendix D) has eliminated this well as a POE, other POEs must be evaluated. A template for the environmental covenant can be found in Appendix C.

Land-use Restrictions

Where points of exposure are to be eliminated based on a land-use restriction, the O/O or the volunteer conducting corrective actions must enter into an environmental covenant with BUSTR to restrict the land-use. This may include, but is not limited to, a restriction on the installation of a basement or the prohibition of building on certain portions of the UST site.

Groundwater Use Restrictions

Where points of exposure are to be eliminated based on a groundwater use restriction, the O/O or the volunteer conducting corrective actions must enter into an environmental covenant with BUSTR to restrict the drinking water use.

Pathway Evaluation Conclusions

If an exposure pathway is determined to be complete, all the POEs must be evaluated.

If an exposure pathway is determined to be incomplete, there is no further evaluation required for that exposure pathway. An incomplete exposure pathway must be fully documented and based on information and data collected during the Tier 1 and Tier 2 Evaluations.

If an exposure pathway determination is inconclusive, then the exposure pathway must be considered as complete in the Tier 2 Evaluation.

Points of Exposure

Collect sufficient data to determine if the concentrations of COC at the POE are above or are likely to be above the appropriate ALs. This may require the installation of SBs or MWs at each POE. In some cases, samples may be collected from existing drinking water wells. Identify all POEs based on the current and future land-use for the UST site and those properties that may be affected by the release. The POE closest to the source area will be used in the evaluation (Flowchart 3.5).

POE for Groundwater Ingestion and Soil Leaching to Drinking Water Pathway

Where groundwater is determined to be drinking water, the POE shall be *one* of the following, whichever is closest to the source area(s):

- Any potable well located on the UST site;
- The property line when a potable well exists within 300 ft. of the UST site;
- The property line when the UST site is located in a DWSPA;
- The DWSPA boundary if a DWSPA is within 300 ft. of the UST site;
- The property line, unless *one* of the following can be demonstrated;
  - No potable wells are located on or within 300 ft. of the UST site, based on a physical survey, and an ordinance requiring a mandatory tie-in to a public water supply for all properties within the surrounding area exists;
  - No potable wells are located on or within 300 ft. of the UST site, based on a physical survey, and an ordinance prohibiting the installation of potable water wells at all properties within the surrounding area exists; or
  - No potable wells are located on or within 300 ft. of the UST site, based on a physical survey, and 100% of the properties within 300 ft. of the UST site are connected to a municipal water source or a municipal source is readily available.
- If the POE is determined to be the property line and a roadway or railroad separates the source area from a property where a potable well could be installed, the POE may be extended across the roadway or railroad to the property line of that property;
- Surface water where a surface water body exists within 300 ft. of the UST site. The POE must be the point where the groundwater containing COC concentrations discharges to the surface water, or

- If a POE has not been identified using the above criteria, the POE must be 300 ft. from the source area(s) or an alternate POE approved by BUSTR. Also, BUSTR may require additional investigation of POE other than those listed above.

Figures 3.15 through 3.22 give examples of the points of exposure discussed above.

Figure 3.15 - Example of POE When a Potable Well Exists on the UST Site

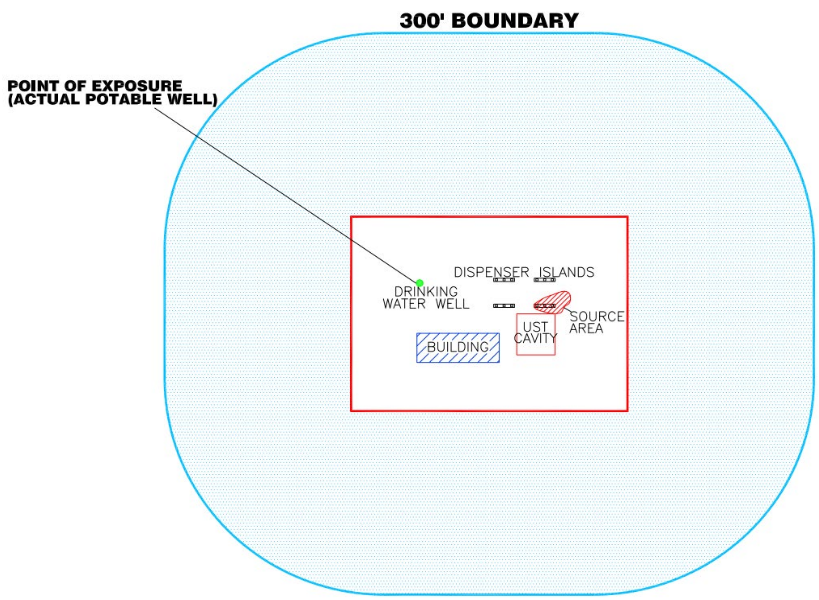
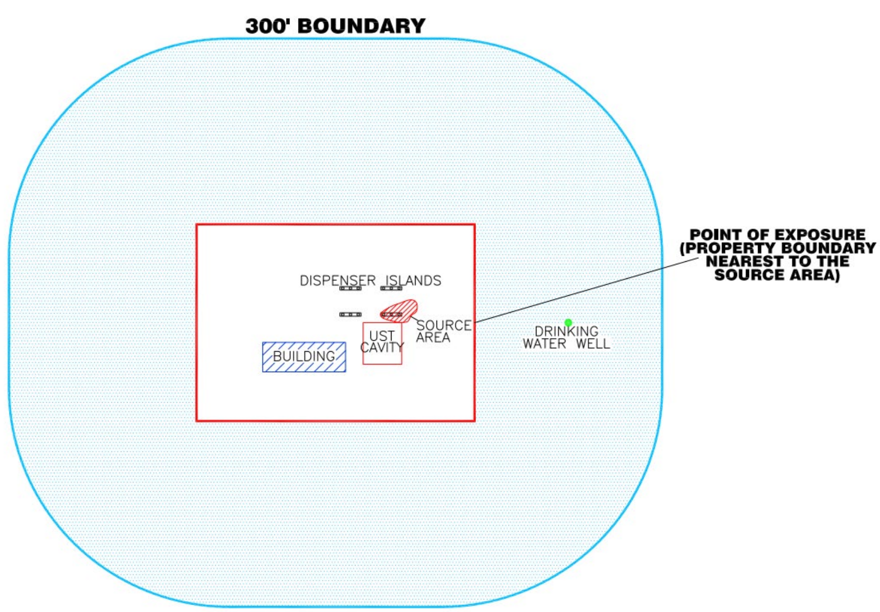


Figure 3.16 - Example of POE When a Potable Well Exists Within 300 ft. of the UST Site



Flow Chart 3.5: Points of Exposure

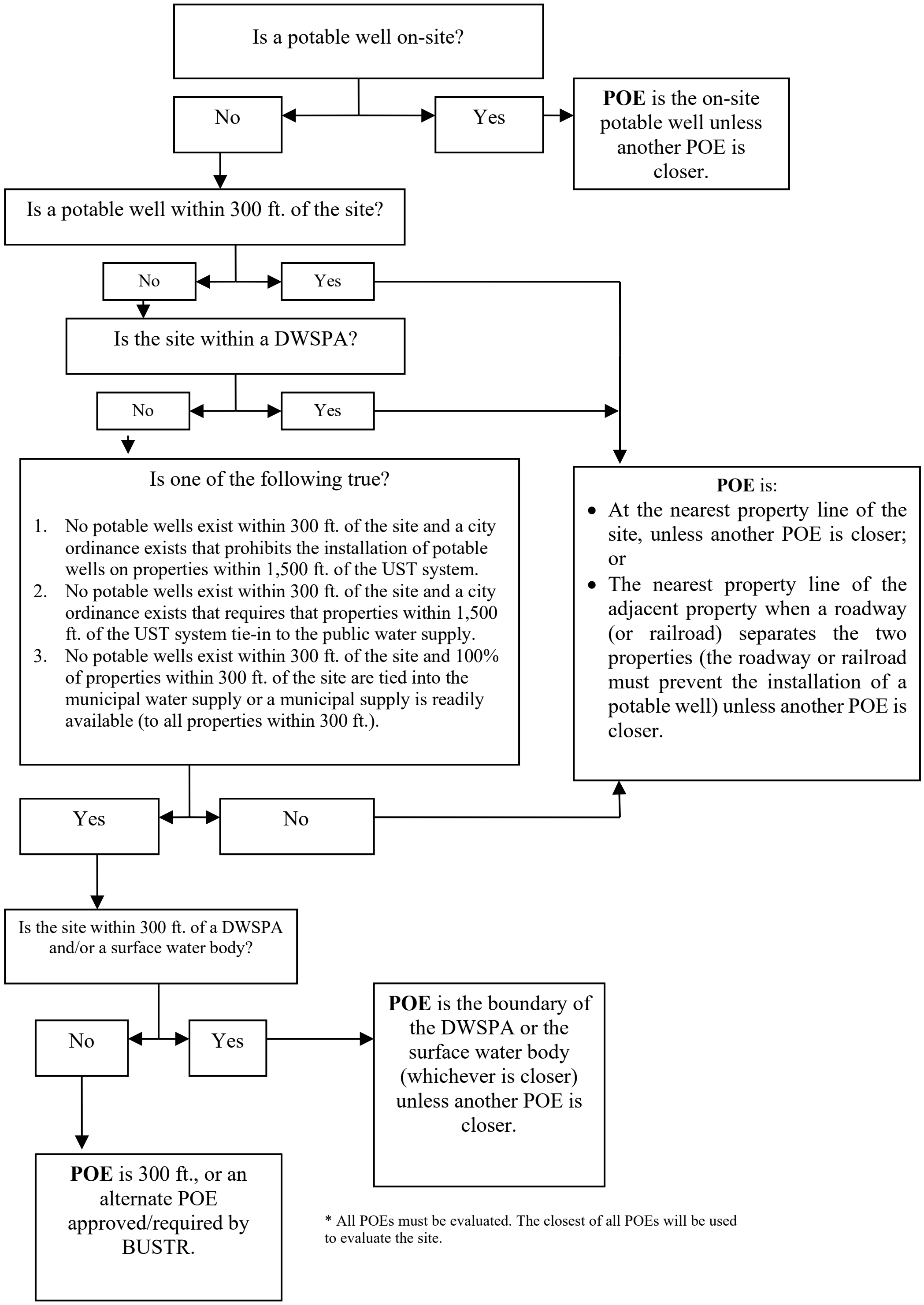


Figure 3.17 - Example of POE When the UST Site is in a DWSPA

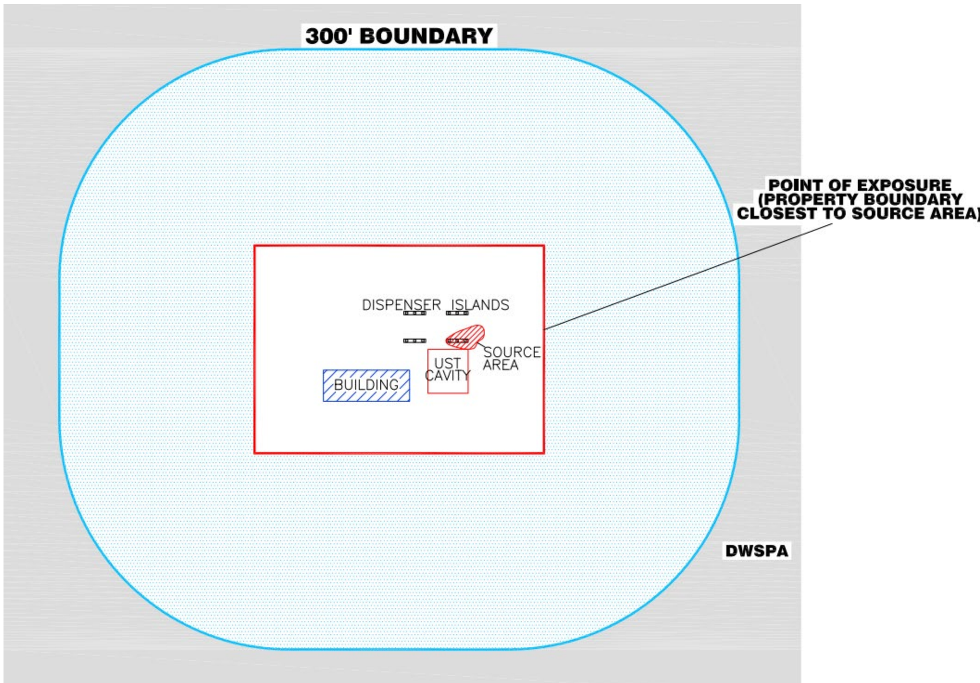


Figure 3.18 - Example of POE When a DWSPA Exists Within 300 ft. of the UST Site

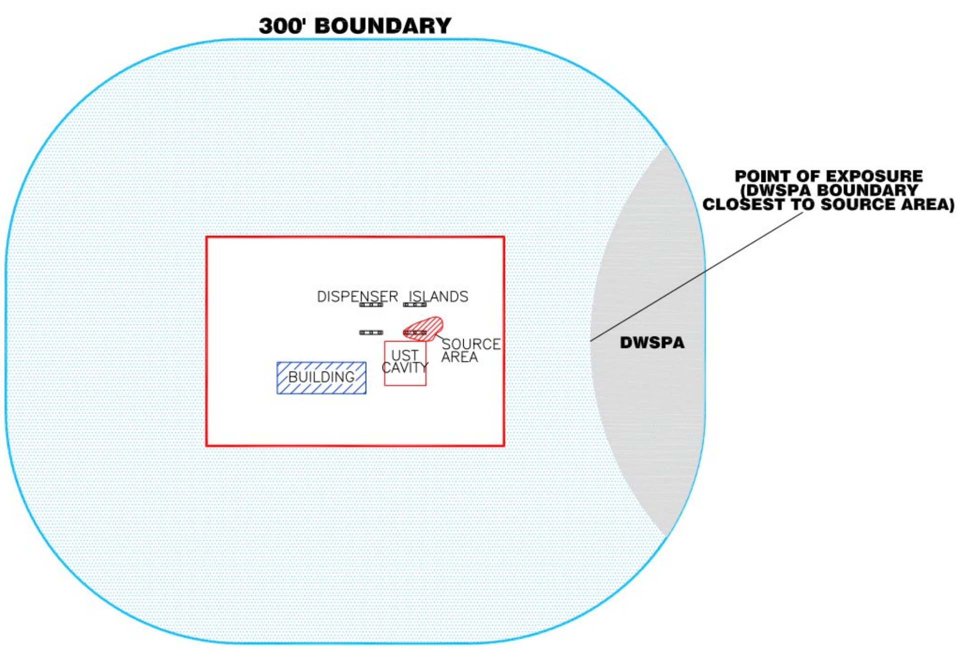


Figure 3.19 - Example of POE When No Potable Wells Exist on or Within 300 ft. of the UST Site and None of the Following Is True:

- An ordinance exists that requires a mandatory tie-in to the municipal water supply for all properties within 1,500 ft. of the UST system;
- An ordinance exists that prohibits the installation of potable water wells at all properties within 1,500 ft. of the system; and
- 100% of the properties within 300 ft. are connected to a municipal water source or a municipal water source is readily available.

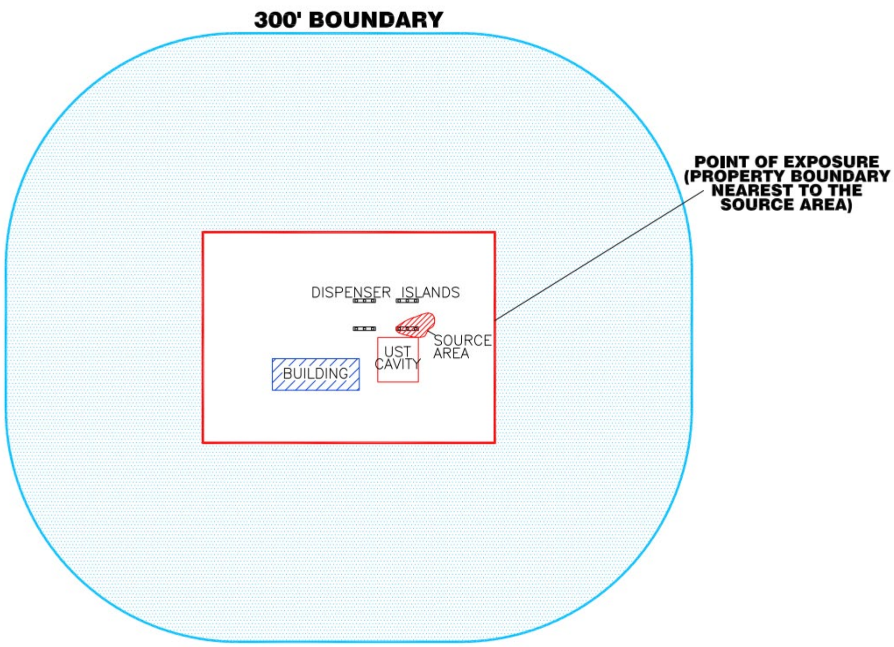


Figure 3.20 - Example of POE Where a Roadway Separates the Source Area from the Property Where a Potable Well Can Be Installed

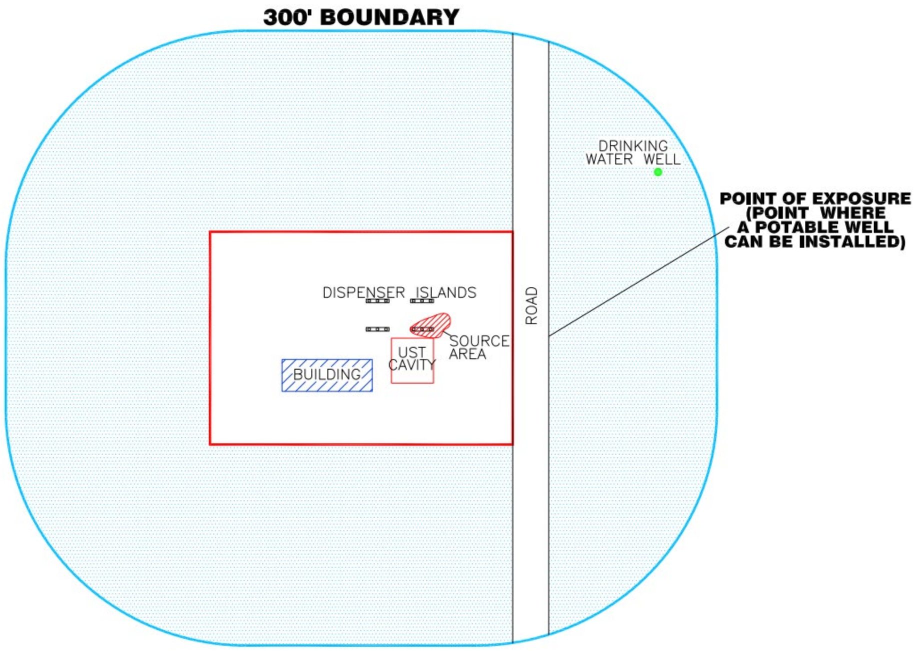


Figure 3.21 - Example of POE When No Other POE Has Been Identified

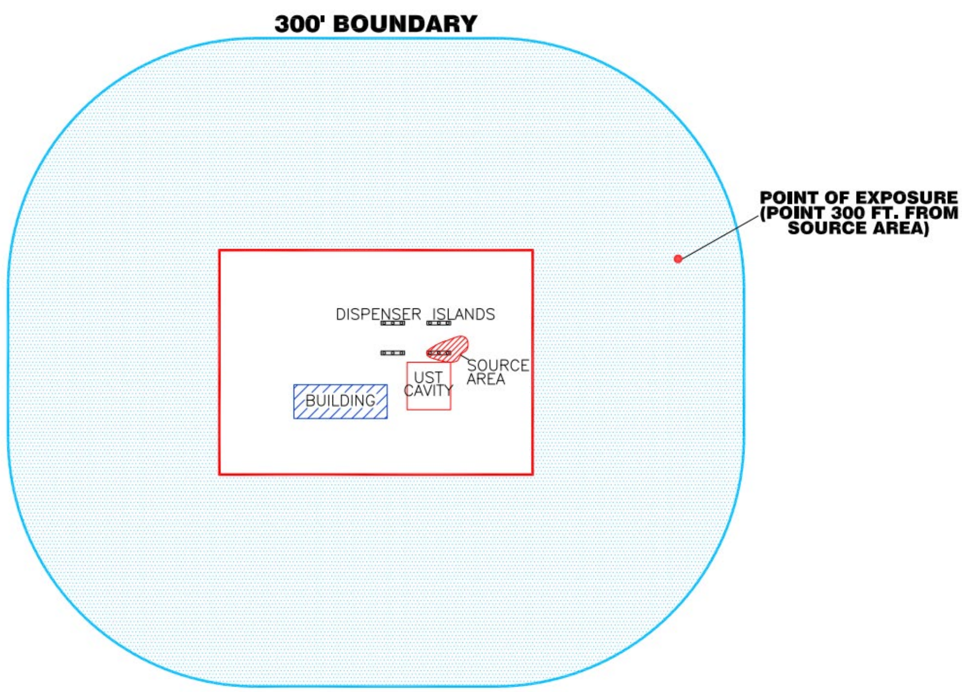


Figure 3.22 - Example of POE When a Surface Water Body Exists Within 300 ft. of the UST Site

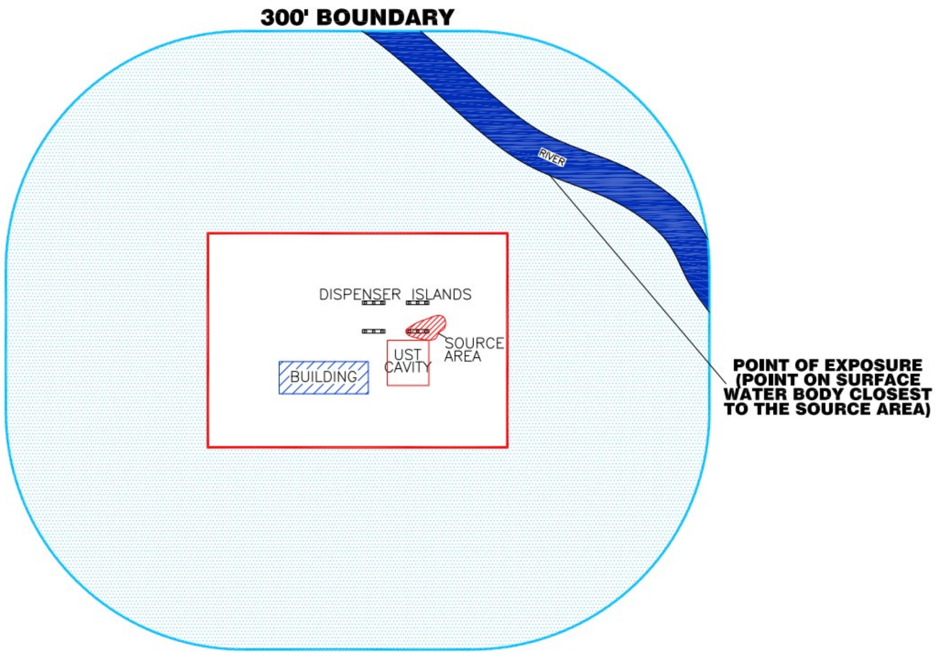
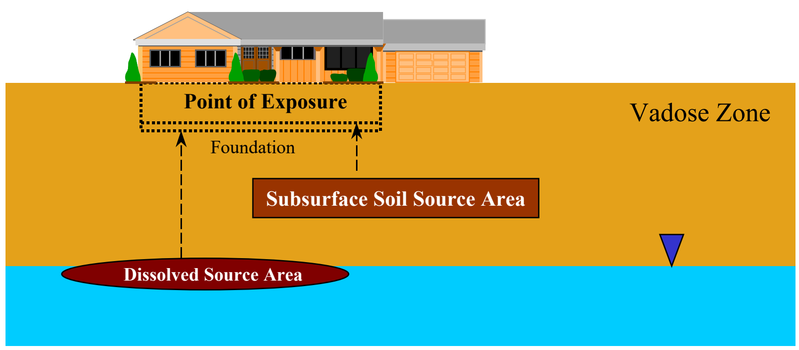


Figure 3.23 - Point of Exposure Where a Building Is to Be Located Directly Above the Source Area



POE for Direct Contact Pathway (surface and subsurface soil)

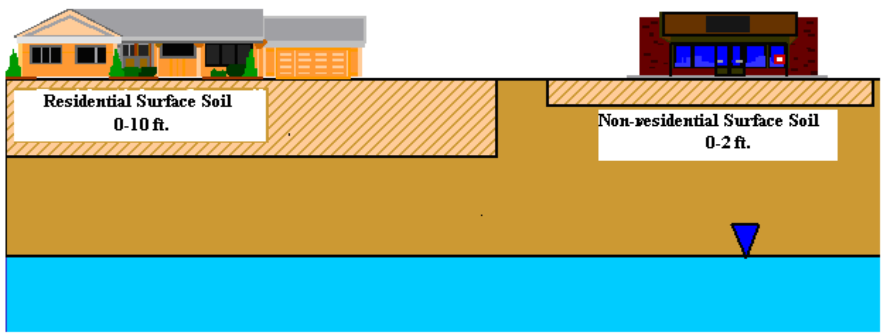
- 0 - 10 feet - When the land-use has been determined to be residential; or
- 0 - 2 feet - When the land-use has been determined to be non-residential.

Excavation worker direct contact POE will be evaluated on a case-by-case basis.

POE for Indoor Air Pathways (soil and groundwater)

- Residential and/or other buildings located or anticipated to be located above soil or groundwater containing COC concentrations. In certain instances, it may be appropriate to evaluate the horizontal movement of vapors in the soil (e.g., contaminated soil located under a building set-back area); or
- For subsurface structures, such as utility manways and underground tunnels located or anticipated to be located directly above COC concentrations, the POE is the area within the subsurface structures.

Figure 3.24 - POE for Residential and Non-residential Surface Soil (Direct Contact Pathway)



If the distribution of COCs cannot be defined on properties that are impacted or potentially impacted by the release, the concentrations of the COCs at the affected property boundary line(s) must meet the appropriate ALs based on the land-use of the adjacent property.

3.11.6 Site-Specific Target Level Development

BUSTR spreadsheets must be used to evaluate COC fate and transport when the COC concentrations exceed ALs for complete exposure pathways. The fate and transport of COCs may be evaluated by conducting *one or a combination* of the following three options:

1. Develop site-specific target levels (SSTLs) by replacing default values with site-specific data in the BUSTR Spreadsheets;
2. Utilize analytical fate and transport modeling (i.e., BUSTR-Screen) to predict COC concentrations in groundwater at each POE; and/or
3. Back calculate SSTLs by utilizing a combination of BUSTR-Screen and BUSTR Spreadsheets.

Copies of the BUSTR spreadsheets are located on the State Fire Marshal website at https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up or by contacting BUSTR at (614) 752-7938.

SSTL Development in BUSTR Spreadsheets (Option 1)

SSTLs can be calculated by replacing the default values used in action level calculations with site-specific values for certain geological and hydrogeological parameters. Site-specific values may *only* be substituted for the following parameters:

- Total porosity in vadose zone;
- Volumetric water content in vadose zone;
- Volumetric air content in vadose zone;
- Volumetric air content in capillary fringe soil;
- Volumetric water content in capillary fringe soil;
- Fraction organic carbon;
- Dry bulk density;
- Saturated hydraulic conductivity (vertical hydraulic conductivity).

NOTE: All field methods and calculations used to obtain site-specific values must be clearly documented and referenced in all reports submitted to BUSTR. Also, if site-specific data is obtained, it must be used for all future SSTLs calculations.

Other values that were determined during the Tier 1 and Tier 2 investigations, such as depth to groundwater, soil type, building type, depth from source to groundwater, and land-use classification, may be changed with supporting documentation. Exposure parameters can only be changed from residential to non-residential based upon the land-use determination.

Please note that the building type (residential or non-residential) must match the land-use determination in the spreadsheets.

When developing SSTLs based on the land-use determination and/or surface water quality standards, assume that the exposure pathways identified in the Tier 1 Investigation report apply, and compare the SSTL to the highest concentration for each COC for each exposure pathway. As in the Tier 1 Investigation report, assume that the SSTLs are applied at the POE. This approach is also appropriate for calculating SSTLs for chemicals that have no calculated Tier 1 action levels.

BUSTR spreadsheets include soil to indoor air, soil to outdoor air, groundwater to indoor air, groundwater to outdoor air, and soil leaching to groundwater (or drinking water) pathways.

Direct contact and TPH values are listed in OAC 1301:7-9-13(J)(2)(d) and (J)(2)(e). Direct contact and TPH values cannot be recalculated using site-specific data; therefore, a combination of an IRA, RAP, or Tier 3 Evaluation must be conducted. For chemicals not listed in the direct contact table, reference Ohio EPA, DERR VAP, generic direct contact standards and supplemental generic direct contact standards. These standards can be found in OAC 3745-300-08.

Fate and Transport Modeling Using BUSTR-Screen (Option 2)

BUSTR-Screen may be used to predict COC concentrations at each point of demonstration (POD) and/or POE for groundwater ingestion and groundwater to indoor air pathways.

BUSTR-Screen is a groundwater fate and transport model combining a user interface with BIOSCREEN, a Microsoft® Excel based modeling program created by the USEPA. The purpose of the BUSTR-Screen interface to the BIOSCREEN model is to simplify presentation of input parameters and output results for BUSTR corrective action sites. BIOSCREEN and BUSTR-Screen are modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen model are identical to those used in the BIOSCREEN model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if groundwater fate and transport modeling is performed during the Tier 2 Evaluation process (OAC 1301:7-9-13, effective September 1, 2022.).

The BUSTR-Screen model can be downloaded from the State Fire Marshal website at https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up. For additional information, see Appendix F.

Modeling with Free Product

When free product is present, a Tier 2 Evaluation report which evaluates all pathways must be submitted within 18 months of the Tier 1 Investigation approval date. However, pathways affected by the presence of free product (i.e., groundwater pathways such as groundwater ingestion, groundwater to indoor air and soil leaching to drinking water) will not be evaluated/approved by BUSTR until free product has been recovered to the maximum extent practicable. The Tier 2 Evaluation report must identify which pathways are affected by the presence of free product.

As part of the free product recovery activities, BUSTR may require that monitoring wells, without free product, be sampled to evaluate groundwater contaminant levels during free product recovery activities. These sampling events may be used as part of the BUSTRScreen modeling requirements.

After free product is recovered to the maximum extent practicable, BUSTR will complete its review of pathways that have been affected by the presence of free product. In addition, BUSTR may require additional groundwater monitoring events to verify groundwater contaminant levels in the locations where free product is present.

Following termination of the free product recovery activities, all remaining pathways (i.e., groundwater pathways such as groundwater ingestion, groundwater to indoor air, and soil leaching to drinking water) must be re-evaluated and a Tier 2 Evaluation Addendum submitted.

If free product is present when the Tier 2 Evaluation is submitted the following items must be described and evaluated in an appendix of the Tier 2 Evaluation Form:

- Locations of free product and potential receptors (ingestion and indoor air);
- Distances from the source area to the potential receptors;
- Site map showing the monitoring wells where free product will be recovered and the monitoring wells where groundwater samples will be collected for lab analyses;
- Site and surrounding area conditions (e.g., locations of free product, DWSPA, nearby potable wells, residential dwellings, preferential pathways, etc.);
- Availability of a municipal water source and other information from the Tier 1 Drinking Water Determination; and
- The frequency and duration of the groundwater monitoring, sampling, analysis, and reporting program.

Back Calculation Using BUSTR Spreadsheets and BUSTR-Screen (Option 3)

Another option for calculating SSTLs is using a combination of the BUSTR Spreadsheets and BUSTR-Screen to evaluate the fate and transport of COCs in the environmental media for leaching or volatilization pathways. For example, a combination of the soil to groundwater leaching spreadsheet and BUSTR-Screen spreadsheet may be used to predict acceptable soil and groundwater SSTLs in the source area which are protective of the POE. This would be done by first predicting the maximum COC concentration in the groundwater in the source area which would still be protective of the POE, and then using that predicted maximum COC concentration as the action level in the leaching spreadsheet. As stated above, these modeling results will not be evaluated by BUSTR if free product is present at the site.

Surface Water Quality Standards

If there is a surface water body within 300 ft. of the UST site (as described in Section 3.9.2), it must determine whether the surface water body is used as a public water supply. The POE for surface water is the point where groundwater discharges to or potentially discharges to the surface water body. This determination is made by evaluating information under the Ohio EPA Surface Water Standards Program (https://epa.ohio.gov/divisions-and-offices/surface-water/reports-data/water-quality-standards-program).

To determine whether the surface water body is used as a public water supply:

1. Use the "Beneficial Use Designation" tab found on the Ohio EPA Surface Water Standards Program website. The index identifies all water bodies listed in OAC 3745-1-01 through 3745-1-30 and identifies their respective drainage basins. Use the name of the surface water body and determine which drainage basin contains the water body of interest.
2. Once the drainage basin has been identified, use the specific rule (e.g., OAC 3745-1-08 for the Hocking River Drainage Basin) and determine whether any portion of that water body is used for public water supply.
3. If no portion of that water body is used for public water supply, then public water supply standards (listed in OAC 3745-1-33) do not apply. Human health (fish consumption) standards (listed in OAC 3745-1-34) apply at the POE.
4. If any portion of that water body is used for public water supply, then determine whether the public water supply intake point (based on the "river mile" information in the Use Designation Table of Ohio EPA's rule) is within 1,500 feet of the POE.
    a. If the POE is within 1,500 feet of the intake point, then public water supply standards apply at the POE.
    b. If the POE is not with 1,500 feet of the intake point, then human health (fish consumption) standards apply at the POE.

Therefore, if the surface water body is used as a public water supply, then the chemical concentrations listed in OAC 3745-1-33 must be used as the POE concentrations. If it is not used as a public water supply, then the human health (fish consumption) concentrations listed in OAC 3745-1-34 apply and must be used as the POE concentrations. The concentrations listed in OAC 3745-1-34 are based on protection of human health (fish consumption). The water quality criteria listed in OAC 3745-1-35 (aquatic life and wildlife criteria) and OAC 3745-1-37 (water quality criteria for recreation use designations and aesthetic conditions) do not apply.

Lakes, ponds, and reservoirs greater than one acre in size may not be listed in OAC 3745-1-08 through 3745-1-30, but they are considered surface water bodies under BUSTR regulations. These water bodies should be considered as potential public water supplies. Therefore, the concentrations listed in OAC 3745-1-33 must be used as the POE concentrations, unless it can be reasonably demonstrated that only the human health (fish consumption) concentrations listed in OAC 3745-1-34 apply.

During the Tier 2 fate and transport modeling process, note the following:

- BUSTR considers the POE to be the point where groundwater discharges to the surface water body, prior to mixing with the water body. Additional mixing calculations may not be used.
- The concentrations listed in OAC 3745-1-33 and OAC 3745-1-34 are centerline concentrations, and not averaged across the plume. These shall be considered POE concentrations at the point of discharge into the surface water body.
- The site conceptual exposure model assumes that groundwater is discharging into the surface water body if the surface water body is within 300 feet of the UST site.
- At sites where the groundwater ingestion and surface water pathways are both considered complete, both pathways (and the corresponding POEs, POE distances, and action levels) must be evaluated during the Tier 2 Evaluation.
- Documentation identifying the "designated use" of the surface water body being evaluated must be submitted along with the Tier 2 Evaluation report (i.e., specific rule reference and a print-out of the use designation page in OAC 3745-1-08 through 3745-1-30).

Land and Groundwater Use Restrictions

Where SSTLs have been developed based on land-use other than residential land-use and non-residential land-use could not be established in accordance with Section 3.11.2, an environmental covenant must be entered into and approved by BUSTR (Appendix C).

Where SSTLs have been developed based on groundwater use other than drinking water use and non-drinking water use is not established in accordance with Section 3.8.2, an environmental covenant must be entered into and approved by BUSTR.

3.11.7 Tier 2 Decisions

The calculated SSTLs must be compared to the maximum COC concentrations for each complete exposure pathway. This comparison must be documented in the Tier 2 Evaluation Form 2022.

Upon submission, BUSTR will evaluate the Tier 2 Evaluation Form 2022 for completeness.

For Analytical Groups 4 or 5, an MCA must be conducted according to Section 3.9.4. when 10 or more non-carcinogenic or 10 or more carcinogenic COCs are present, and the results submitted as part of the Tier 2 Evaluation Report.

If all COC concentrations are at or below the ALs or SSTLs for all applicable pathways and no monitoring is required, then no further action is required.

If fate and transport modeling with BUSTR-Screen was used in the Tier 2 Evaluation process, it may be necessary to submit a Monitoring Plan to validate the modeling results. The monitoring plan must be submitted with the Tier 2 Evaluation Form 2022.

If the maximum concentration of a particular COC is at or below the AL or SSTL for a particular pathway, then no further evaluation is necessary for that COC and its corresponding exposure pathway.

If any COC concentrations are above Tier 2 SSTLs or ALs for one or more exposure pathways, **one or a combination** of the following must be conducted to address those COCs and the corresponding complete exposure pathway:

- Interim Response Action;
- Remedial Action Plan;
- Tier 3 Evaluation Plan; and/or
- A plan submitted to BUSTR for approval to calibrate or disprove the assumptions used in the BUSTR-Screen fate and transport model. The Calibration Plan must be submitted with the Tier 2 Evaluation Form (Appendix F).

3.11.8 Tier 2 Evaluation Report

A completed Tier 2 Evaluation Form 2022 must be prepared and submitted **within 18 months** from the approval of the Tier 1 Investigation report. BUSTR will approve the Tier 2 Evaluation if it is determined to be complete. The Tier 2 Evaluation Form 2022 provides an outline to be followed when completing this report.

3.12 Tier 3 Evaluation

SSTLs can be developed beyond the scope of a Tier 2 Evaluation using a Tier 3 Evaluation. The Tier 3 Evaluation Plan must be submitted to BUSTR **with 90 days** of the approval of the Tier 2 Evaluation. Advanced SSTLs may be calculated using:

- Site-specific evaluation of TPH as outlined in Appendix G;
- Complex aquifer studies (e.g., pumping tests to evaluate the connectivity of two aquifers) *; or
- Analytical fate and transport modeling not used in the Tier 2 Evaluation;

*When completing complex aquifer studies reference Ohio EPA, *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring*, February 1995, et seq.

The Tier 3 Evaluation plan must include, but is not limited to, the following:

- Description of the objective and activities to be conducted in the Tier 3 Evaluation;
- Discussion of the effectiveness, cost, and the rationale for selecting the Tier 3 Evaluation compared to other remedial action alternatives; and
- Implementation schedule and projected completion date.

3.12.1 Tier 3 Model Selection

Fate and transport modeling helps describe the distribution and movement of COCs in the environmental media and can be used to predict COC concentrations at the source, PODs and POEs. Models used in a Tier 3 Evaluation must be selected by considering environmental media, geometric constraints, temporal variability, transport mechanisms, exposure pathways, and other factors such as assumptions used in the model and limitations of the model. Models used in a Tier 3 Evaluation must be publicly available and generally accepted by the USEPA.

Many input parameters in fate and transport models relate to site-specific dimensions and characteristics. Fate and transport models should use site-specific data whenever practical, but default values may be used for the input parameters that have not been measured. Default values are typically used for chemical and physical properties of COCs and for some properties of the environmental media. BUSTR default values are preferred, but other default values may be used when properly justified.

BUSTR requires that a sensitivity analysis be performed with all Tier 3 models. Sensitivity testing is performed to determine critical input parameters and how the output of a fate and transport model changes as these critical values of the input parameters are changed. A model is considered *sensitive* to a given input parameter if the model's output changes significantly when the value of the input parameter is changed slightly. For models that are highly sensitive to an input parameter, the model must use site-specific data or present sufficient justification to support the use of literature or default values.

All Tier 3 models must be reproducible by BUSTR. Copies of all models and spreadsheets must be included in the report, regardless of the final output. Calibration and verification monitoring should be proposed in the Tier 3 Evaluation Plan.

3.12.2 Public Notice

For each release where a Tier 3 Evaluation is submitted to BUSTR, public notice must be provided to those members of the public directly affected by the release in a format approved by BUSTR. The notice may include, but is not limited to, public notice in local newspapers, block advertisements, public service announcements, letters to individual households, or personal contacts by field staff.

At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the proposed Tier 3 activities, and the unit of local government. Letters sent to neighboring properties and city officials must be sent certified mail. Copies of the certified mail receipts should be provided as proof of public notice. BUSTR will accept written comments for 21 days following the publication period or receipt of the certified letter before the Tier 3 is approved.

If sufficient public interest exists, or for any other reason, BUSTR may hold a public meeting to consider comments on the proposed Tier 3 Evaluation before approving it.

Upon approval of the Tier 3 Evaluation Plan, the activities must be conducted in accordance with the approved plan.

3.12.3 Tier 3 Decisions

If all COC concentrations are at or below the ALs or SSTLs for all applicable pathways and no additional monitoring is required, then no further action status is required.

If the maximum concentration of a particular COC is at or below Tier 3 SSTLs, then no further evaluation is necessary for that COC and for the corresponding complete exposure pathway.

If necessary, a Monitoring Plan must be developed for groundwater to validate advanced groundwater modeling. The results of the Monitoring Plan must be submitted with the Tier 3 Evaluation report to demonstrate that COC concentrations will remain at or below Tier 3 SSTLs.

If COC concentrations are above Tier 3 SSTLs, **one or a combination** of the following must be conducted to eliminate a complete exposure pathway or to reduce COC concentrations at the source area to below the SSTLs:

- Interim Response Action; or
- Remedial Action Plan.

3.12.4 Tier 3 Evaluation Report

Within 90 days of the projected completion date stated in the approved Tier 3 Evaluation Plan, a report summarizing the activities conducted in accordance with the Tier 3 Evaluation Plan and the results of the Tier 3 decisions must be submitted to BUSTR for approval.

3.13 Remedial Action

Remedial actions may be required to address COCs above ALs or SSTLs beyond the tier evaluation process. A method must be selected that would effectively achieve the appropriate ALs or SSTLs. More than one remedial action may be appropriate for a particular UST site based on the exposure pathways and COCs to be addressed by the remedial action.

Remedial options include:

- Source removal,
- Design and installation of clean-up equipment,
- Natural attenuation processes, and
- Engineering controls.

3.13.1 Remedial Action Plan

A RAP must be prepared and submitted to BUSTR within 90 days of the approval of the Tier 1 Investigation report, approval of the Tier 2 Evaluation report, or approval of the Tier 3 Evaluation report. If the RAP is submitted following a Tier 1 Investigation, delineation of the COCs to Tier 1 ALs may be required. The O/O must also submit the RAP for cost pre-approval to the Petroleum Underground Storage Tank Release Compensation Board (PUSTRCB) for sites that are eligible for reimbursement. The RAP must include, at minimum, *all* the following information:

- Description of the remedial activities to be implemented;
- Proposed target levels, identified by COCs, exposure pathway, and environmental media;
- Conceptual design of the remedial action system; detailed engineering drawings are not necessary;
- Brief description of remedial action alternatives considered, including a discussion of reliability, effectiveness, cost, and time needed for completion, and the rationale for the selected program;
- Monitoring Plan;
- Description of reporting frequency and proposed content of reports;

- Description of all permits or other governmental approval required for implementation of the plan;
- Description of activities and studies, if any, required to be performed prior to implementation of the proposed remedial action; and
- Implementation schedule, projected completion time based on number of days from approval, and the submittal of the completion report of the proposed remedial action. All project deadlines should be based on the approval date of the RAP.

3.13.2 Public Notice

For each release where a RAP is submitted to BUSTR, public notice must be provided to those members of the public directly affected by the release in a format approved by BUSTR. The notice may include, but is not limited to, public notice in local newspapers, block advertisements, public service announcements, letters to individual households, or personal contacts by field staff.

At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the proposed RAP, and the unit of local government. Letters sent to neighboring properties and city officials must be sent certified mail. Copies of the certified mail receipts should be provided as proof of public notice. BUSTR will accept written comments for 21 days following the publication period or receipt of the certified letter before the RAP is approved.

If sufficient public interest exists, or for any other reason, BUSTR may hold a public meeting to consider comments on the proposed RAP before approving it. Upon receiving documentation of the public notice requirement, evaluating all comments from the public, and determining if the RAP is complete, BUSTR will issue a letter approving or denying the plan.

If an approved RAP is not achieving its established clean-up levels and BUSTR is considering termination of that plan, public notice must be issued.

3.13.3 Implementation of Remedial Action Plans

Upon approval of the RAP, the plan must be implemented according to the approved actions. The RAP must be monitored, evaluated, and the results of the implementation efforts reported to BUSTR.

If the approved RAP is unable to reduce the COC concentrations to at or below ALs or SSTLs, the following must be performed:

- Re-evaluate and revise the remedial action alternatives, assumptions, and parameters, and submit a revised RAP; or
- Re-evaluate the assumptions and parameters used to develop the SSTLs as appropriate. Submit a RAP summary report and conduct a Tier 2 Evaluation or Tier 3 Evaluation, as appropriate.

3.13.4 Completion Report

Following implementation of the RAP, a completion report must be prepared and submitted by the date provided in the approved plan. The completion report must show that the RAP objectives have been met and contain documentation supporting termination.

Upon review of the report, BUSTR may issue no further action status.

3.14 Monitoring Plan

3.14.1 Purpose

BUSTR may require a monitoring plan to demonstrate that COCs remain below ALs and SSTLs in order to approve no further action status. A monitoring plan is required to:

- Verify fate and transport model assumptions and predictions related to the development of groundwater SSTLs; and
- Demonstrate that the remedial action has achieved the required target levels.
- Demonstrate that no further action status is appropriate following the completion of Tier 2 and Tier 3 Evaluation activities.

Monitoring Plan Contents

When developing a monitoring plan, the data collection approach must consider the spatial distribution of sampling locations, temporal variations of the COC concentrations, and COC concentrations in the environmental media. The monitoring plan must include, at a minimum, *all* the following:

- Description of the purpose and objective of the monitoring activity;
- Description of planned monitoring activities, including those conducted to implement and to verify the effectiveness of engineering controls, remedial actions, etc.;
- Locations of the POD(s) and POE(s);
- Summary of the sampling procedures;
- Description of the anticipated length and frequency of the monitoring activity;
- Identification and description of the termination criteria for remedial or monitoring activities, as appropriate; and
- Operation and maintenance data for equipment and engineering controls.

If the objectives of the monitoring plan have been met, submit a completion report **within 90 days** of receiving analytical results from the last sampling event.

If the objectives of the monitoring plan are not met, conduct **one or more** of the following **within 90 days** of receiving analytical results from the last sampling event:

- Continue monitoring activities;
- Conduct an Interim Response Action;
- Develop a Remedial Action Plan; and/or
- Re-evaluate assumptions and parameters used to develop SSTLs.

3.14.2 Point(s) of Demonstration

PODs are used to monitor the progress of a RAP and verify predictions of a fate and transport model as part of a Tier 2 Evaluation. The POD(s) must be located between the source area(s) and the POE. The POD(s) must be located sufficiently up-gradient from the POE to act as an early warning for continuing COC migration and to validate the fate and transport model. PODs should contain detectable concentrations of COCs to verify that they are located within the expected plume migration pathway. If a POD with detectable concentrations cannot be installed, contact BUSTR to discuss alternatives.

Selection of the POD must consider the following:

- The POE location(s), including the receptor and exposure route;
- The transport mechanism (e.g., groundwater migration, vapor migration); and
- The estimated travel time from the source to the POE.
- In cases where the POE is located within the source area (the area of highest concentration of the COCs), the POD and the POE will be the same.

Historical data may be used in some cases to verify model assumptions and predictions or to reduce the time period of the monitoring plan. Groundwater monitoring conducted after the historical contaminant levels are encountered may be used to validate the fate and transport model assumptions.

3.14.3 Completion Report

Following completion of monitoring, prepare a completion report that demonstrates the objectives have been met. Upon review of the report for completeness, BUSTR may issue no further action status.

3.15 Requests for Extensions

If additional time is needed to complete the required corrective action activities, an extension of time can be requested by submitting an Extension Request Form 2022. The completed Extension Request Form 2022 must be submitted prior to the original due date. BUSTR may grant, modify, or deny any extension request at its sole discretion.

3.16 Alternative Methodologies and Technologies

Technologies, procedures, or methods other than those specified in the Rule or TGM *may* be used with approval by BUSTR. A written request to use the alternative method must be submitted before the actual implementation of the technology, procedure, or methods. The request should demonstrate that the alternate method or technology is at least as effective as the original. BUSTR may apply conditions to the approval.

BUSTR may approve the alternative methodology or technology for use at a specific UST site or for use at all UST sites. If BUSTR approves an alternative methodology or technology for use at all UST sites, any conditions imposed by BUSTR must be universally used.

Chapter 4 - Petroleum Contaminated Soil Requirements - OAC 1301:7-9-16 and 17

4.1 Introduction

OAC 1301:7-9-16 and 17 (effective September 1, 2022) rules govern petroleum contaminated soil PCS generated from UST systems regulated by BUSTR. PCS is defined as soil, including pea gravel that contains COC concentrations that exceed one or more of the re-use ALs and **excludes** soil defined as hazardous waste. OAC 1301:7-9-16 establishes standards for reporting, characterizing, storing, transporting, handling, treating, disposing, and re-using PCS. OAC 1301:7-9-17 establishes standards for sampling and analyzing excavated soil from UST systems containing petroleum substances.

4.2 Applicability

The PCS rules apply to soil generated at petroleum UST sites regulated by BUSTR. PCS may be encountered during the following activities:

- UST removals;
- UST upgrades;
- Soil boring (SB) and MW installations;
- Immediate and interim response actions; or
- Corrective action activities (e.g., excavating, remedial system trenching).

Soil generated from excavation activities at the UST systems that are listed as exempt in Section 1.4 are exempt from the PCS rules.

Although PCS rules only apply to O/O's, BUSTR recommends any party handling PCS do so in accordance with OAC 1301:7-9-16 and 17. Volunteers who choose not to use the PCS rules must consult with Ohio EPA's Division of Solid and Hazardous Waste for proper disposal of excavated soil.

4.3 Characterization

Excavated soil must be managed as PCS unless analytical data proves otherwise. PCS must also be characterized and sampled within 48 hours of completing excavation activities. For PCS disposed of at a licensed disposal facility, characterization is not required by BUSTR but may be required by the disposal facility.

Characterization is required to determine whether the soil is PCS or a hazardous waste. The Ohio EPA, Division of Hazardous Waste Management must be contacted when evaluating soil as a potential hazardous waste.

OAC 1301:7-9-17 requires separating the soil based on the "apparent degree of contamination." Soil piles with the same apparent degree of contamination may be combined. Each pile must be characterized and sampled, including soil piles that are combined. When two or more laboratory results are required from one soil pile, the highest analytical result must be used to determine the proper disposition for the entire stockpile. In addition, excavated soil from different facilities may be combined for purposes of characterizing the soil pile. If one or more of the COCs exceed re-use ALs, the soil must be disposed of at a licensed disposal facility or treated in accordance with Section 4.7.

4.3.1 Calculating Stockpile Volume

The volume of excavated soil for each soil pile or container must be calculated to determine the number of soil samples required for compliance with OAC 1301:7-9-17. *In-situ* soil volume must be converted to excavated soil volume by multiplying the *in-situ* volume by an expansion factor of 1.25.

Any of the following methods can be used to calculate stockpile volume.

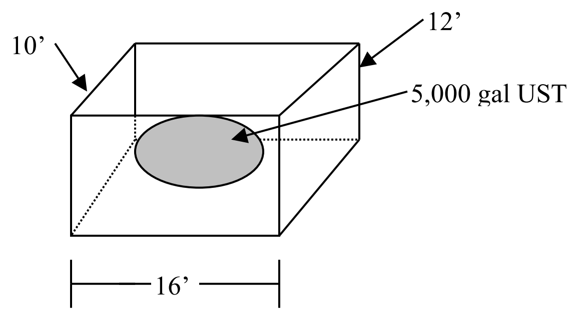
Method 1 – Rectangular-Shaped UST Cavity

The following steps are required for calculating the volume of a rectangular-shaped UST cavity:

- Measure the size of the excavation;
- Calculate the total volume of the cavity in cubic yards;
    - Length x width x depth = volume of cavity;
- Calculate the total volume of the UST in cubic yards;
- Subtract the total volume of all USTs removed from the excavation;
    - Volume of cavity – total volume of all USTs = in-situ volume of soil in cubic yards;
- In-situ volume removed x 1.25 (expansion factor) = total stockpile volume in cubic yards.

Conversion Factors
27 ft^3 = 1 yd^3
1 U.S. gal. = 0.1337 ft^3
1 U.S. gal. = 0.00495 yd^3

Example 4.1 – Calculating Stockpile Volume from Cavity Dimensions



16 ft. x 10 ft. x 12 ft. = 1,920 ft^2
1,920 ft^3 x (1 yd^3/27 ft^3) = 71.1 yd^3
5,000 gal. x (0.00495 yd^3/1 U.S. gal.) = 24.75 yd^3 occupied by tank

71.1 cubic yards – 24.75 cubic yards = 46.35 cubic yards removed (in-situ volume)
46.35 cubic yards x 1.25 expansion factor = 57.94 cubic yards stockpiled

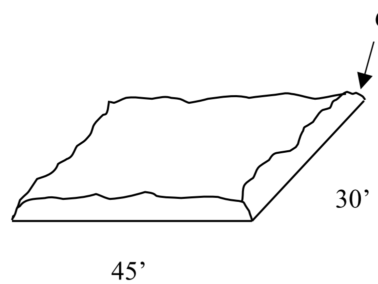
Method 2 – Rectangular or Conical-Shaped Soil Stockpile

Rectangular Stockpile

The following steps are required for calculating the volume of a rectangular-shaped soil stockpile:

- Calculate the total volume of material;
  - Length x width x depth = volume of the stockpile in cubic feet.
- Convert cubic feet into cubic yards;
  - Volume of stockpile in cubic feet x (1 yd^3/ 27 ft^3) = total volume of stockpile in yd^3

Example 4.2 - Calculating Stockpile Volume from Rectangular Stockpile



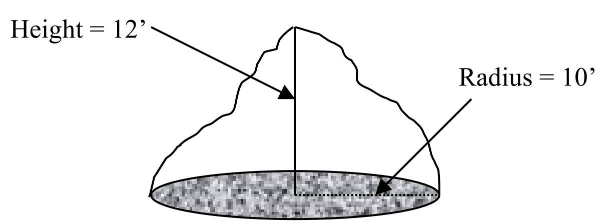
Volume = length x width x height
8,100 ft^3 = 45 ft. x 30 ft. x 6 ft.
8,100 ft^3 x (1 yd^3 / 27 ft^3) = 300 yd^3

Conical Shaped Stockpile

The following steps are required for calculating the volume of a conical-shaped soil stockpile:

- Calculate the total volume of material;
  - Volume of stockpile in cubic feet = ($\frac{1}{3}\pi$) x ($radius^2$) x (height)
- Convert cubic feet into cubic yards;
  - Volume of stockpile in ft^3 x (1 yd^3 / 27 ft^3) = total volume of stockpile in cubic yards.

Example 4.3 - Calculating Stockpile Volume from Conical Stockpile



Volume = ($\frac{1}{3}\pi$) x ($radius^2$) x (height)
Volume (ft^3) = (1.047)(10^2)(12) = 1,256 ft^3
Volume (yd^3) = 1,256 ft^3 x (1 yd^3 / 27 ft^3) = 46.52 yd^3

NOTE: $\frac{1}{3}\pi$ = 1.047

4.3.2 Sampling Requirements

After calculating the volume of the soil stockpile, Use Table 4.1 to determine the number of soil samples to collect, field screen, and submit for laboratory analysis.

To determine the locations of the samples to be collected for field screening, visually divide the stockpile into sections equal to the number of soil samples required in Row 1 of Table 4.1. Collect individual soil samples from the center of each stockpile section at a minimum depth of 12 in. below the surface of the stockpile. Submit the appropriate number of samples with the highest field screening level samples for laboratory analysis. The minimum number of soil samples submitted for laboratory analysis is presented in Row 2 of Table 4.1.

If field screening is not conducted, all collected soil samples must be submitted for laboratory analysis.

Table 4.1 - Stockpile Sampling Requirements

	Cubic Yards of Soil and Backfill Material Generated				
	<25*	**26-100**	**101-250**	**251-450**	**>450**
1. Minimum number of grab samples to collect and field screen	3	6	12	18	18 plus 1 sample per each additional 50 yd^3 (or fraction thereof)
2. Minimum number of grab samples to submit to the laboratory	2	3	6	8	8 plus 1 sample per each additional 100 yd^3 (or fraction thereof)

* For excavated soil in containers having a capacity of 55 gal. (0.27 yd3) or less, one grab sample must be collected from the center at mid-depth of the soil in the container and submitted to the laboratory for analysis.

4.4 Re-Use of Excavated Soil

If excavated soil that is sampled and analyzed does not exceed the re-use ALs (Table 4.2) the soil may be used for any lawful purpose. This paragraph may not be interpreted as an authorization to use such soil for purposes prohibited or otherwise restricted by any applicable Federal, State, or local laws and regulations.

In the case where analytical results from an accredited laboratory exceed the re-use ALs or where the analytical results have not been received, then:

- If excavated soil sampled does not exceed the applicable ALs but exceeds the re-use ALs on Table 4.2, then the excavated soil may be deposited in the original excavation without further treatment. Following placement in the excavation, the soil shall be covered with a minimum of one foot of clean fill;
- Following approval from the State Fire Marshal, excavated soil that exceeds the applicable ALs may be deposited in the original excavation for the purpose of remediation according to the corrective action requirements;

- When soil samples have been collected, but the analytical results have not been received, the excavated soil may be deposited in the original excavation, if the excavation is lined with a synthetic liner having a minimum thickness of 0.01 in. (10 mil thick);
- If closure assessment samples collected are below ALs and PCS which was deposited in the lined original excavation is determined to be above ALs, one of the following must be conducted:
  - Submit a PCS Treatment Plan; or
  - Excavate and properly dispose of the PCS within 90 days of collecting closure assessment samples;
- **If PCS above action levels is deposited in the unlined original excavation, a Tier 1 Source Investigation must be conducted**.

4.5 Storage of Petroleum Contaminated Soil

PCS may be stored either on or off the UST site. The PCS Form must be submitted **within 10 days** of PCS storage on or offsite. Once excavated, PCS may be stored on-site in properly labeled portable containers for **no more than 180 days** or in properly protected stockpiles for **no more than 120 days**. PCS may be stored off-site for **no more than 90 days** from the date of excavation.

On- or off-site PCS storage areas must be inspected monthly for damage or unauthorized removal of drums, drum lids, labels, covers, berms, fences, barriers, or signs used to deter unauthorized entry. A written log of these inspections must be kept and produced within 24 hrs., if requested by BUSTR. Records of the estimated excavated soil volume being stored and the date the soil was originally containerized or placed in a stockpile must be maintained for a period of five years for each PCS storage area.

4.6 Disposal of Petroleum Contaminated Soil

PCS is subject to the following conditions:

- Excavated PCS shall not be disposed of on-site or off-site without first being treated to reduce COCs in accordance with this rule unless the soil is disposed of at a licensed disposal facility.
- Following disposal of PCS at a licensed disposal facility, O/Os shall prepare a report that describes the final disposition of the excavated soil on the PCS Form.
- All excavated PCS containing COC concentrations must be managed to comply with applicable Federal, state, and local requirements.

A Petroleum Contaminated Soil Form must be submitted to document the disposition of each stockpile generated, regardless of whether it was disposed on- or off-site.

Table 4.2 - Re-Use Action Levels

CHEMICAL OF CONCERN	ACTION LEVEL
Benzene	0.0246
Toluene	7.07
Ethylbenzene	8.45
o, m, and p Xylenes	42.7
Naphthalene	0.051
1,2,4 Trimethyl benzene	0.237
Methyl tertiary butyl ether (MTBE)	0.158
1,2 - Dibromoethane (EDB)	0.000982
1,2 - Dichloroethane (EDC)	0.0101
Benzo(a)anthracene	12
Benzo(b)fluoranthene	12
Benzo(k)fluoranthene	120
Benzo(a)pyrene	1.2
Chrysene	1,200
Dibenz(a,h)anthracene	1.2
Indeno(1,2,3-cd)pyrene	12
TPH (C_6-C_{12})	1,000
TPH (C_{10}-C_{20})	2,000
TPH (C_{20}-C_{34})	5,000

All chemical concentrations expressed in milligrams per kilogram (mg/kg)

4.7 Treatment of Petroleum Contaminated Soil

PCS may be remediated either on-site or off-site. On-site treatment is limited to the UST site or any adjoining parcels of land owned or under the control of the O/O or volunteer. Off-site treatment must occur at a *designated facility* which is land not open to the public and owned or under the control of the UST O/O or volunteer. Each treatment zone may contain PCS from only one UST site where the PCS was excavated.

Treatment options include, but are not limited to:

- Landfarming - the spreading of PCS in a layer over the treatment zone that is tilled into the native soil; the soil should be spread during the summer months and periodically be tilled during the year;
- Biopiles – the treatment of PCS above ground in piles to stimulate microbial activity through aeration and/or minerals, nutrients, and moisture;
- Low-temperature thermal desorption (LTTD) – the treatment of PCS by means of applying heat to achieve temperatures sufficient to cause COCs to desorb and volatilize from the soil;
- Other treatments - including alternative methodologies (e.g., road base and asphalt batching, soil shredding, soil washing, high temperature thermal desorption).

Please reference the most recent USEPA publication titled "*How to Evaluate Alternative Clean-up Technologies for Underground Storage Tank Sites.*"

Prior to treatment, BUSTR must approve a PCS Treatment Plan. At the conclusion of treatment, a document demonstrating that COC concentrations have been reduced to a level at or below the re-use ALs must be submitted to BUSTR.

4.7.1 PCS Treatment Plans

The PCS Treatment Plan must be submitted to BUSTR within 90 days of the UST system removal date or the date of generating the PCS stockpile. Treatment target concentrations shall be the re-use ALs, unless a variance is granted by BUSTR. The PCS Treatment Plan shall include, at minimum, *all* the following information:

- Name of owner or operator of the UST site;
- Name, address, and facility number of the UST site;
- Address of the designated facility;
- Contact person for the PCS Treatment Plan;
- Volume, in cubic yards, of soil to be treated;
- Description of the PCS treatment process to be implemented;
- Conceptual design of the PCS treatment system (detailed engineering drawings are not necessary);
- Brief description of the treatment alternatives considered, including a discussion of reliability, effectiveness, cost, time needed for completion, and the rationale for the selected program;
- Monitoring plan that describes the monitoring to be used to determine whether treatment target concentrations are being achieved;
- Description of the reporting frequency and proposed content of reports;
- Description of any permits (e.g., air emission, water discharge) or other governmental approvals required for implementation of the plan;
- Implementation schedule and the projected completion date of the proposed PCS treatment activities;
- Site maps or drawings that accurately depict the location of the designated facility, the property boundaries, street locations, above ground structures, underground structures and utilities, soil stockpiles, PCS treatment areas, and other pertinent features including drainage ditches, creeks, roads, potable wells, and residential dwellings.

In addition to the criteria and evaluation described in the USEPA publication above, *all* the following landfarming requirements and restrictions apply and must be met and included in the PCS Treatment Plan:

- Landfarming cannot be conducted in residential areas or near daycare, long term health care, or educational facilities;
- Landfarming cannot be conducted in a DWSPA or a Sole Source Aquifer;
- Soils from Analytical Groups 4 & 5 (used oil, unknowns, and others) cannot be land farmed;
- Multiple applications of PCS in the same treatment zone are not permitted;
- The PCS shall be mixed by tilling a maximum of 6 in. of PCS into the top 4 to 6 in. of native soil within 48 hours of application. Application to frozen ground is prohibited;
- Soil profiles, organic carbon content, and depth to groundwater must be determined by an on-site investigation;

- Drainage and field tiles must be plugged;
- Plans to control drainage and soil erosion (run-off and run-on) are to be included in the design. If a vegetative cover crop is used, the cover crop may not be used for human or livestock consumption;
- The potential for and abatement of odors, vapors, or nuisance conditions must be addressed;
- The treatment plan must demonstrate that the leaching of contaminants from the soil will not impact groundwater. Otherwise, monitoring wells must be installed on the site and a Groundwater Monitoring Plan must be submitted (Section 3.14);
- If multiple treatment zones exist at the site, groundwater MWs must be able to monitor the potential migration of COCs from each treatment zone; and
- A confirmation soil sampling plan for the treatment zone and the native soil under the treatment zone must be included with the treatment plan.
- If a groundwater sample from a monitoring well indicates COCs above action levels a Tier 1 Source Investigation will be required.

If the PCS is treated using non-landfarming techniques, in addition to the criteria and evaluation described in the USEPA publication above, the following additional requirements and restrictions apply and **are required** to be included in the PCS Treatment Plan:

- The treatment zone must be designed to prevent the discharge of leachate, vapors, odors, and soils;
- Confirmatory sampling must include the treated soil and any areas where the impermeable surface has been breached. If the impermeable surface is a synthetic liner or cannot be inspected after treatment, then confirmatory sampling of the native soils will be required;
- The treatment zone must be in an area not open to the public and have restricted access; and
- The site must have signs posted that identify the O/O or volunteer, an emergency contact phone number, and the treatment area.
- If soil samples taken from below an impermeable barrier indicate that COCs above action levels exist, a Tier 1 Source Investigation will be required.

4.7.2 Public Notice

For each release where a PCS Treatment Plan is submitted to BUSTR, public notice must be provided to those members of the public directly affected by the release in a format approved by BUSTR. The notice may include, but is not limited to, public notice in local newspapers, block advertisements, public service announcements, letters to individual households, or personal contacts by field staff.

At a minimum, public notice must include notification to all adjacent property owners, all owners of properties impacted by the release, all properties impacted by the proposed PCS Plan, and the unit of local government. Letters sent to neighboring properties and city officials must be sent certified mail. Copies of the certified mail receipts should be provided as proof of public notice. BUSTR will accept written comments for 21 days following the publication period or receipt of the certified letter before the PCS Plan is approved.

If sufficient public interest exists, or for any other reason, BUSTR may hold a public meeting to consider comments on the proposed PCS Treatment Plan before approving it. Upon receiving documentation of the public notice requirement, evaluating all comments from the public, and determining if the PCS Treatment Plan is complete, BUSTR will issue a letter approving or denying the plan.

4.7.3 Implementation and Reporting

The O/O or volunteer must monitor, evaluate, and report to BUSTR implementation efforts in accordance with the reporting requirements contained in the PCS Treatment Plan. If the treatment technology approved by BUSTR has been operated for a minimum of one year and is unable to reduce the COC concentrations to a level at or below applicable ALs, the following must be included:

- Re-evaluate the assumptions and parameters used in the PCS Treatment Plan;
- Re-evaluate the treatment alternatives; and
- Submit a revised PCS Treatment Plan.

If treatment can reduce COC concentrations to a level at or below the applicable ALs, then no further treatment is required, and a PCS Treatment Completion report must be submitted to BUSTR. The PCS Treatment Completion report must include *all* applicable items listed in Section 4.7.1. In addition, the description of the final disposition of the excavated soil must be submitted on the PCS Form prescribed by BUSTR.

4.8 Releases from PCS Treatment and Storage Facilities

When directed by BUSTR, the soil and groundwater under any designated facility or UST site must be assessed if the treatment or storage of PCS poses a current or potential threat to human health or the environment.

Upon the discovery of a petroleum impact suspected to be the result of the treatment or storage of PCS, *all* the following must be conducted:

- Cease all additional applications of PCS until otherwise instructed by BUSTR;
- Notify BUSTR within 24 hours of the discovery of the soil or groundwater contamination; and
- Perform immediate corrective action in accordance with OAC 1301:7-9-13(G) and continue with the corrective action process, as necessary, to contain and clean up the release.

4.9 PCS Variances

A variance request may be submitted to BUSTR to deviate from any method or requirements specified in this section by demonstrating the proposed variance is at least as effective as those required by this section. BUSTR may grant, modify, or deny any variance request in writing.

Appendix A: Data Collection

For additional information concerning many of these topics, see the Ohio EPA *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring*.

A.1 Drilling Technologies

When selecting the primary drilling method used to investigate UST release sites, consider the following factors:

- Hydrogeological and geological conditions;
- Contaminant type and concentrations;
- Scope of the investigation;
- Future use of the boring as a monitoring well; and
- Physical site limitations (e.g., overhead obstructions, subsurface utilities, service station canopies).

If a drilling method is selected other than hollow stem auger, direct push, or air rotary, an alternate technology request must be submitted to the BUSTR for approval.

Hollow Stem Augers

Hollow-stem augers (HSA) are a common choice for subsurface investigations of UST release sites involving the installation of monitoring or recovery wells. When applying this technique, soil samples must be collected by using clean split-spoon samplers driven through the hollow-stem augers according to ASTM D1586/1586M-18e1: *Standard Method for Penetration Test and Split-Barrel Sampling of Soil*. Split-spoon samplers should be driven continuously throughout the depth of the borehole. For closure and corrective action sites, soil samples must be collected using a 2 ft. sample interval must be used (i.e., 0 to 2 ft., 2 to 4 ft.).

Direct Push

Direct push technology (e.g., Geoprobe®, Powerprobe®, hand-held sampling systems) is used for evaluating soil and water during a subsurface investigation where accelerated assessment is applicable, and recovery wells will not be necessary. For closure and corrective action sites, soil samples must be collected using a 2 ft. sample interval (i.e., 0 to 2 ft., 2 to 4 ft.). Rod refusal with this technology does not necessarily mean bedrock has been encountered (i.e., auger refusal). An auger rig might be required to confirm bedrock/auger refusal. If soil borings are converted to groundwater monitoring wells, construction must conform to pre-packed well installation requirements in accordance with ASTM D6725-01: *Standard Practice for Direct Push Installation of Pre-packed Screened Wells in Unconsolidated Aquifers*.

Air Rotary Drilling

Air rotary or rock coring methods must be used to conduct subsurface investigations involving the installation of monitoring or recovery wells into bedrock. Use caution when considering air rotary drilling, as this specialized type of drilling requires personnel with substantial experience in air rotary methods. Installation of boring/monitoring wells using air rotary or rock coring methods must be conducted in accordance with ASTM D5782-95: *Standard Guide for Use of Direct Air*

Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water Quality Monitoring Wells.

Bedrock Coring (Optional)

When diamond-bit drilling is used to retrieve a continuous sample, it can show the characteristics of a specified interval. However, core losses can occur in relatively consolidated materials when the rock that is being cored is highly fractured and broken, or when a fragment of the rock becomes wedged in a portion of the core bit or barrel. Carefully monitor every core run to determine the percent (%) recovery; amount and location of core loss; and the actual depth at the beginning and end of each core run.

During coring activities, keep a core log that contains all relevant information obtained during the drilling and coring, and a field description of the core. Core log forms are more specialized than standard soil boring log forms, and generally will contain columns for recording percent (%) core recovery, rock quality designation (RQD), and number and orientation of fractures.

After removing each core from the core barrel, it must be inspected, logged, and carefully placed into a properly labeled core box. Include the following information: depth to top and bottom of core, core loss zones, and identification of fractures.

Fractures made after removing the core from the core barrel should be distinguished from fractures that are interpreted as in-place fractures. Place spacers inside the core boxes to mark ends of core runs and the positions of core loss zones.

A.2 Soil Boring/Monitoring Well Installation

During the corrective action, SB and MWs are used to investigate the source and the extent of contamination for a release or suspected release. Soil borings shall be installed to bedrock, the uppermost-saturated zone, or 50 ft., whichever is encountered first (Figure A.1 Examples A, B and C). If groundwater is known to contain chemical(s) of concern, soil borings shall extend to groundwater regardless of the depth (Figure A.1 Example E). Please note that groundwater pathways will require evaluation even if groundwater is not encountered above 50 ft.

If bedrock is encountered, soil borings and monitoring wells must be installed as follows:

- If COCs exceed soil to drinking water leaching action levels, a minimum of one MW must be installed in the source area(s) to a maximum depth of 50 ft. (Figure A.1 Example D);
- If the saturated zone is known to contain concentrations of COCs, a minimum of one MW must be installed in the source area(s), regardless of depth (Figure A.1 Example E);
- If a known drinking water source is located within the surrounding area, BUSTR reserves the right to request a bedrock MW at depths greater than 50 ft.;

During the installation of **all** soil borings, data must be collected and documented as follows:

- Soil borings must be continuously sample SBs. Describe the stratigraphy on boring logs for each SB;
- Characterize soil encountered during drilling according to ASTM D2488-17E1: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)* or the Unified Soil Classification System (USCS);

- For monitoring wells, include data collection that at minimum includes the depth to free product, free product thickness, depth of water below the top of casing, and elevation of top of casing; and/or
- Extend MWs at least 5 ft. into the saturated zone and screen them to the bottom of the saturated zone to accommodate seasonal fluctuations in the groundwater table.

Monitoring Well Installation

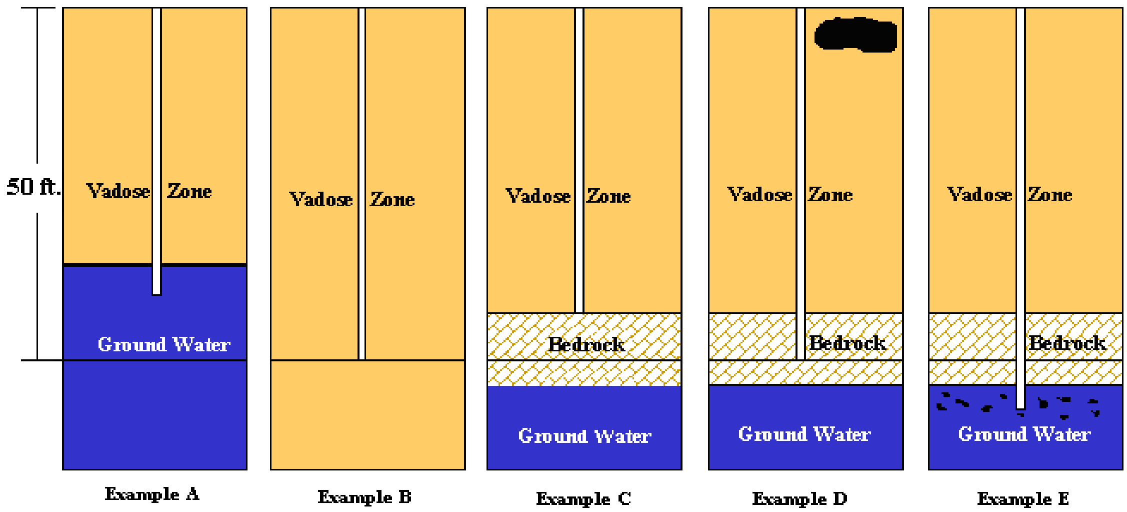
When installing a monitoring well, details must be provided describing well installation materials, techniques used, and the field conditions encountered via "as-built" MWs construction diagrams. In the corresponding report, the actual MW installation procedures must be included. Additionally, Ohio Revised Code requires that all boring logs and construction diagrams for all monitoring wells installed be submitted to the ODNR Division of Water. For additional information concerning this requirement and the applicable Well Log Form, please contact ODNR.

Upon completing the borehole to the required depth, the following well installation procedures must be used:

- If necessary, the hole must be backfilled with 1 ft. of sand/gravel prior to installing the screen and casing into the borehole;
- Assemble the well screen and casing and lower the assembled well to the necessary depth. Keep the well screen casing plumb in the hole. Threaded joints are required because glued or solvent welded joints might alter the chemistry of future water samples. The well screen should be new, machine-slotted (typically 0.010 in. slot size) or continuously wrapped wire wound, and should be composed of Schedule 40 polyvinyl chloride (PVC) material;
- Install a sand/gravel pack (with a grain size appropriate for the well screen) in the annular space between the well and the side of the borehole. Install the sand/gravel pack 2 ft. above the top of the well screen;
- Place a 1 ft. (minimum) bentonite/cement seal above the sand/gravel pack to form a seal;
- Fill the remaining annular space in the borehole with bentonite/cement grout to a depth of approximately 1 to 2 ft. below the ground surface;
- Seal the well from surface contamination with a 1 to 2 ft. concrete layer;
- Place a water-resistant, bolt-down manhole cover or protective casing within a 2 ft. x 2 ft. square concrete pad overlying the well location; and
- Cap the top of the well casing with a tightly fitted, locking well cap to prevent vandalism; and to prevent surface water, debris, and/or other contaminants from entering the well.

Examples of SB and MW installations are shown in Figure A.1.

Figure A.1 - Examples of Soil Boring and MW Installation



Pre-Packed Wells Installed Using Direct Push

Pre-packed MWs greater than or equal to one-inch inner diameter is an approved method for obtaining groundwater samples. Pre-packed wells allow for an accelerated assessment of the release site and can be installed in areas where access is restricted. However, use of these wells is limited to collecting groundwater samples, measuring water levels, and observing wells during pump tests. These wells are not recommended for use in determining hydraulic conductivity (i.e., slug tests). The one-inch, pre-packed wells must be installed according to manufacturers' recommendations. BUSTR must approve the use of pre-packed wells less than one inch in diameter. A request to use alternate technology must be submitted to BUSTR for approval.

Labeling of Monitoring Wells

For newly installed MWs, each MW must be clearly labeled with an identification that corresponds to the identifications on the site maps. BUSTR recommends that all newly installed MWs be numbered consecutively (i.e., MW-1, MW-2, MW-3) and the corresponding MW designation be placed on the well in a manner that will allow it to remain clearly marked for the duration of the corrective action activities.

A.3 Soil Boring Sampling

Subsurface Soil Sampling

Wear clean protective gloves (i.e., nitrile) when handling soil samples retrieved from the borehole. All samples must be undisturbed, discrete samples. Samples from each interval must be split into two representative soil samples. Each split sample should be placed in a jar or small, sealable plastic bag and used for field screening. The other sample must be immediately placed into a laboratory-supplied glass jar (with a Teflon-lined lid) and preserved on ice to 39°F (4°C). The sample containers must be filled completely and submitted for laboratory analysis. Affix sample labels to each jar; labels must correspond to the site sample log and chain-of-custody. This process must be completed for all sampling locations. Upon the completion of the sampling activities, either deliver the sample jars directly or send via overnight shipper to a laboratory using standard chain-of-custody procedures.

If groundwater is encountered:

- Submit the sample from directly above the soil/water interface, exhibiting the highest headspace reading/ concentration plus a sample from immediately above the soil/groundwater interface as encountered during drilling;
- If the highest headspace reading is the sample immediately above the soil/groundwater interface, submit the highest and the second highest samples from above the soil/groundwater interface; or
- If no soil samples exhibit headspace readings above background for the headspace technique, submit a sample from immediately above the soil/water interface as encountered during drilling.

If groundwater is **not** encountered:

- Submit the sample with the highest headspace readings plus the sample from the bottom of the boring; or
- If no soil samples exhibit headspace readings above background for the headspace technique, submit the sample from the bottom of the boring only.

Establish data quality objectives consistent with the intended use of the analytical data (e.g., low detection limits to demonstrate meeting action levels or higher detection limits for screening samples).

Subsurface Soil Re-sampling

When re-sampling an area of historical soil contamination to determine current concentrations of COCs, soil borings must be installed and sampled as follows:

If Active Remediation Has Occurred at The Site:

The reason for re-sampling in this instance may be because active remediation has occurred at the site and a demonstration is needed showing the remedial technology has reduced the petroleum COC concentrations at the point of the original soil boring location.

In this instance, if the reason for installing a boring(s) next to the original is to show that no additional remediation (i.e., samples are below action/SSTL levels) or "no further action" is necessary, then a minimum of one boring located two feet or less from the original sample must be installed.

In certain cases, however, it may be necessary to install **more than one** boring near the original boring in this scenario. Some factors that must be taken into consideration when this occurs are as follows:

- Concentration of the sample(s) from the original soil boring vs. the sample(s) from the new boring. (i.e., have the concentrations dropped dramatically for the type of technology used at the site?)

- Length of time of the remedial technology used to reduce the petroleum concentrations at the original boring location. (i.e., has the remedial technology been used long enough for the concentrations to be reduced to the new levels observed from resampling?)

If Active Remediation Has Not Occurred at The Site:

The reason for re-sampling in this instance may be because original soil sampling data is too old and newer data is needed, the site is moved from an older rule into the 2022 corrective action rule, or natural attenuation is used as a passive remedial technology.

In these instances, if the UST owner/operator's reason for installing a boring(s) next to the original is to show no remediation (i.e., samples are below action/SSTL levels) or "no further action" is appropriate, then a minimum of two borings located two feet or less from the original sample must be installed.

If it is uncertain where the exact location of the original sample was located, then a minimum of three borings must be installed in the area of the original sample.

In both cases, re-sampling should occur according to the procedures outlined below:

- Install the SB/MW as described in Section A.2;
- Follow field screening procedures as described in Section A.5;
- Submit samples for laboratory analysis as described in Section A.3; and
- Collect one soil sample from the same depth(s) that are being re-evaluated, regardless of current groundwater depth, and submit it for laboratory analysis.

A.4 Open Excavation Sampling

Excavation Groundwater Sampling

When conducting a closure, any water encountered in the excavation should be evacuated. However, if water is not evacuated from an excavation, it will be considered groundwater and must be sampled. If the water recharges within 24 hours, then a groundwater sample must be collected. Collect groundwater samples from any dispenser and piping trenches or tank cavity areas that contain groundwater. If no water recharges within 24 hours, then only soil sampling is required.

Before collecting a water sample from a closure excavation or trench, first recover any free product or sheen, and dispose of it properly. Use a bailer to collect groundwater samples from an excavation. Alternately, lower a container into the water in a horizontal position and slowly turn it upright just under the surface of the water. Collect the sample within the first 6 in. of the water surface. Carefully fill the sample jar to minimize turbulence and to minimize the amount of soil and foreign matter obtained.

Excavation Soil Sampling

Wear clean, protective gloves to handle soil samples retrieved from the excavation. Use a clean hand trowel to remove three to four inches of native soil from the bottom and/or sidewalls of the excavation. Collect undisturbed and discrete soil samples (i.e., no composites) from the exposed area using a stainless-steel spoon or a sampling tube. Split each sample into two representative soil samples. Place one split sample into a jar or small, sealable plastic bag used for field screening.

Immediately place the other half of the sample into a laboratory-supplied glass jar (with a Teflon®-lined lid); preserve it on ice to 39° F (4°C). Completely fill sample containers submitted for laboratory analysis. Affix sample labels to each jar; labels must correspond to the site sample log and chain-of-custody. Either deliver the sample jars directly or send via overnight shipper to a laboratory; use standard chain-of-custody procedures.

A.5 Field Screening

A headspace analysis using a photo ionization detector (PID) or flame ionization detector (FID) must be used when site investigation activities include soil sampling and/or field screening. Samples must be split from each interval into two representative soil samples. Place one split sample in a jar or small, sealable plastic bag for field screening. This container should be no more than half full and sealed to prevent the loss of volatiles. Allow this container with the soil sample to stand for a minimum of 10 - 15 min. at a minimum temperature of 70° F. Insert a calibrated field screening instrument probe into the container, being careful not to lose volatiles. Record the highest field screening reading. The highest field screening reading must be submitted for laboratory analysis. Sampling requirements vary with the investigation being performed.

Immediately place the other half of the sample into a laboratory-supplied glass jar (with a Teflon-lined lid); preserve on ice to a temperature of 39°F (4°C). Completely fill sample containers submitted for laboratory analysis. Affix sample labels to each jar; labels must correspond to the site sample log and chain-of-custody. Either deliver the sample jars directly or send via overnight shipper to a laboratory; use standard chain-of-custody procedures.

If field screening is not performed, submit all samples for laboratory analysis.

A.6 Monitoring Well Sampling

Well Development and Maintenance

To ensure that representative groundwater samples are collected, MWs must be properly developed. Well development improves the hydraulic interface with subsurface strata and removes particulates produced during the well installation. Develop the wells by using clean disposable bailers and dedicated polypropylene rope, a properly decontaminated centrifugal or submersible pump, or other suitable equipment. For development with a pump, initially use a bailer to remove accumulated sediments. It is suggested that well development occur at a minimum of 24 hours after installation.

Development and purged fluids generated from the well should be containerized in United States Department of Transportation (DOT)-approved 17-H or 17-E 55-gallon drums and disposed of according to federal, state, and local regulations.

MWs must be periodically redeveloped to ensure that representative samples can be collected. Maintenance should include inspections of hydraulic performance, and a comparison to baseline data. If hydraulic performance is diminished, redevelop the well. Perform frequent (monthly or quarterly) sampling or implement a well maintenance program to ensure appropriate well monitoring and sample integrity.

Groundwater Sampling from Monitoring Wells

Prior to sampling activities, perform appropriate measurements (i.e., static water level, total well depth, detection of free product or gases). Depth measurements must be accurate to within 0.01 ft. Additionally, survey all wells using a survey reference point (i.e., benchmark).

Characterize and record the presence and thickness of any free product. Measure free product thickness using an oil/water interface probe. If free product is not detected, collect a groundwater sample and submit it to the laboratory for analysis.

MWs must be properly purged prior to sampling to ensure that representative groundwater samples are collected. Use a clean hand bailer or other suitable equipment to purge the MW of a minimum of three times its calculated volume of water. Allow the well to recover to near static water levels prior to collecting the sample, but sample as soon as possible. To avoid cross contamination of MWs, use dedicated or disposable bailers.

Peristaltic and bladder pumps (for low-flow sampling) are generally acknowledged as good groundwater sampling devices, but the need for a power source or compressed air limits their use. BUSTR approves the use of peristaltic pumps and low-flow sampling techniques for groundwater sampling. Field filtering may also be used for PAHs but not for other COCs. Bottom-draining bailers are most commonly used for sampling groundwater. Bailers should be lowered and raised slowly (not dropped) into the well to minimize disturbance and aeration of the groundwater. Submerge bailers into the water only as far as necessary to collect the sample volume and minimize aeration. Place the sample into the appropriate laboratory supplied container and place it in a cooler with ice.

Properly identify each sample with the appropriate location before submitting it to the laboratory. At a minimum, field logging should include the identification and location of the samples; the number and quantity of well purging volumes; the date and time of sampling; and the results of pH, temperature. and conductivity field measurements.

Collect a groundwater sample from each MW. Analyze the samples for COCs using one or more standard laboratory analytical methods.

A.7 Sample Quality Assurance/Quality Control

BUSTR requires that all samples be analyzed by an accredited laboratory for the results to be considered valid. Laboratory accreditation can be issued by Ohio EPA Division of Drinking and Groundwater, Ohio EPA Voluntary Action Program, National Environmental Laboratory Accreditation Program, American Association of Laboratory Accreditation or another state environmental protection agency program approved by the State Fire Marshal. If samples are not analyzed by an accredited laboratory, the data will not be considered valid by BUSTR and will need to be re-sampled and sent to an accredited laboratory. The accredited laboratory should enter the appropriate information on BUSTR's "Laboratory Analysis QA/QC Summary Form."

Soil sample results are required to be reported on a dry-weight basis by the laboratory.

Data Quality Objectives

Quality assurance (QA) and quality control (QC) procedures help to minimize sources of errors and the potential for cross-contaminating samples and help to maximize the quality of the data collected. Establish data quality objectives that will be consistent with the intended use of the data (e.g., low detection limits to demonstrate meeting action levels or higher detection limits for screening samples). Data quality objectives should:

- Define the most appropriate types of samples to collect;
- Determine the most appropriate conditions to sample;
- Define the quality and quantity of required samples; and
- Define the quality and quantity of samples needed to support the sampling strategy.

Sample QA/QC

Blanks

Use field and trip blanks as controls for detecting field-introduced contamination of water samples or contamination occurring during transit to or from the sampling site. In situations where laboratory analytical data is suspect or inconsistent, use control samples (i.e., blanks) to validate/document the appropriate sampling and preservation methods.

Trip Blanks

Prepare trip blanks as samples of organic-free water, which must be prepared at the same location and time as the sample bottles. Keep trip blanks with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Upon return to the laboratory, trip blanks will be analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Field Blanks

Prepare field blanks by filling sample containers with deionized water at the site and preserving them with an appropriate reagent(s). Upon return to the laboratory, field blanks are analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Equipment Blanks

Prepare equipment blanks by pouring deionized water over or through the decontaminated sample collection device and collecting this water in a sample container. Upon return to the laboratory, equipment blanks will be analyzed as if they were a regular sample. If these samples are accidentally opened, this must be recorded on the chain-of-custody form.

Sample Preservation

Proper soil and water sample preservation is important for maintaining sample integrity and analytical data validity. Seal samples in glass jars that are tightly capped with Teflon-lined lids. Properly label and identify all sample containers. Once in containers, immediately place samples for laboratory analysis on ice, in a refrigerator, or in cooler maintained to a temperature of 39°F

(4°C) for transport. Please contact the laboratory for information on the appropriate container sizes and preservation methods for the desired analyses. Improper sample handling, such as excessive holding times, might alter the analytical results and invalidate the data. Consult with the laboratory for the holding times as they can vary according to the constituent being analyzed and the laboratory protocols.

Chain-of-Custody

A chain-of-custody record tracks the transfer of custody for a sample from the time of its collection to its delivery to the laboratory. Fill out a chain-of-custody form immediately after collecting the samples. The person who is collecting, relinquishing, and receiving the samples must sign a chain-of-custody form each time the samples change hands. Most laboratories can provide a copy of a standard chain-of-custody form. Appropriate forms should include sample identification; sample type; date and time collected; analysis requested for each sample; preservation; and, in the case of soil samples, depth and location.

A.8 Decontamination Procedures

The main purposes of decontamination are to ensure that valid, representative samples are collected and to prevent cross-contamination among sample locations.

At a minimum, steam-clean or wash all sampling equipment (e.g., drill augers and rods, split spoons, bailers) in an area specifically set aside for decontaminating equipment (i.e., decon pad). Clean the sampling equipment before beginning to sample and between collecting each sample. Scrub soil sampling equipment with non-phosphatic soap and water, and rinse with distilled/deionized water. Collect/contain all decontamination fluids (rinsates) properly and transfer to labeled 55 gal. DOT-approved 17-H or 17-E steel drums. Characterize all contaminated soil and rinsates and dispose of them (as necessary) according to federal, state, and local regulations.

A.9 Geotechnical Sampling

Soil Sampling for Vadose Zone Geotechnical Analysis

Site-specific soil characteristics may be necessary during Tier 2 and Tier 3 Evaluations. If geotechnical analysis is necessary, select one or more soil boring locations (as appropriate) and collect a sample from each representative soil class above the saturated zone in each boring. Geotechnical data should be collected from depths appropriate to the pathway being evaluated (for example: for the soil to indoor air pathway, a sample should be collected between the source depth and the surface). Analyze samples to determine the following parameters shown in Table A.1.

Soil samples for geotechnical analysis may be obtained by using split-spoon samplers, Shelby Tubes, California Samplers, or direct push sample tubes. However, analyses for many of these parameters require the collection of undisturbed soil using a thin-walled sampling device (e.g., Shelby Tube) according to ASTM D1587-00: *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*.

Table A.1 - Geotechnical Parameters

PARAMETER	TYPICAL TEST METHODS
Atterberg limits	ASTM D4318
Unified Soil Classification System (USCS) classification	ASTM D2487; ASTM C136 Sieve Analysis; ASTM D422;
Dry bulk density	Army Corps of Engineers EM-1110-2-1906
Grain size analysis	ASTM D422; ASTM C136 Sieve Analysis
Specific gravity	ASTM D854
Moisture content	ASTM D2216
Total porosity	Army Corps of Engineers EM-1110-2-1906
Volumetric air content	Army Corps of Engineers EM-1110-2-1906
Volumetric water content	Army Corps of Engineers EM-1110-2-1906
Vertical hydraulic conductivity	ASTM D5084; ASTM D2434
Total organic carbon (a.k.a. Fraction of Organic Carbon [FOC])	Walkley-Black Method; ASTM D2974-87 Method C (Total Organic Matter must be converted to FOC) *

* If a percentage of **organic matter** is obtained through laboratory analysis (such as ASTM D2974), the **organic matter** value must be multiplied by a conversion factor of 0.58 to estimate the value for **organic carbon**.

Soil samples must also be classified according to USCS or ASTM D2488-17e1: *Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)*. In some cases, samples must be analyzed in a laboratory via ASTM D2487-1: *Standard Practice for Classification of Soils for Engineering Purposes.* For example, ASTM D2487-1 must be used when electing to use a soil type other than sand/gravel in closure assessments or when providing site-specific geotechnical data for Tier 2 pathway evaluations. Soil boring logs and MW construction diagrams should include, at minimum, the information listed in Appendix B.

Geotechnical samples must be collected from uncontaminated areas of the site.

A.10 Yield Determination and Adjustments

Yield Determination for Groundwater Classification

To determine if a saturated zone meets the definition of groundwater, the site's groundwater yield and *in situ* hydraulic conductivity of the saturated zone must be evaluated. If the saturated zone can yield at least 1.5 gal./8 hours and has an *in situ* hydraulic conductivity greater than 5.0×10^{-6} cm/sec., then the saturated zone is groundwater. However, if the initial field study for one of the criteria fails to meet the definition of groundwater, then additional evaluation is not required.

If a saturated zone less than 5 ft. thick is encountered and is determined to yield less than 1.5 gal./8 hr., then BUSTR may require a groundwater determination of the lower saturated zone.

Yield Determination for Drinking Water Classification

If the UST site is not in a DWSPA, sole source aquifer, does not have a drinking water source within the surrounding area, or does not have a surface water body within 300 ft., yield determination may be used to classify groundwater as drinking or non-drinking water.

To determine if groundwater is a drinking water source, pumping tests may be performed to determine whether a yield of more than 3 gal./min. can be sustained. However, the minimum pumping rate might need to be adjusted to account for seasonal fluctuations, well diameter, and partial penetration of the saturated zone. See examples of such adjustments below. A yield determination cannot be performed using slug test data.

Yield Determination

MWs must be extended to the bottom of the saturated zone or to at least 5 ft. into the saturated zone, whichever is less. Screen MWs to make sure they can accommodate seasonal fluctuations in the groundwater table. However, MWs installed only 5 ft. into a saturated zone might not provide suitable observation points, unless the appropriate yield adjustments are made to the minimum rate of 3 gal./min which is discussed below.

Conduct yield tests in properly located and installed wells. For wells used as observation points, the well depth, length and slot size of the screen, and the distribution of the filter pack must be known. The materials comprising the screened interval must be characterized (i.e., thickness and grain size).

Before conducting the field pump test, calculate any appropriate adjustments to the minimum pump rate. Determine the actual yield after the draw down stabilizes at the calculated (adjusted) pump rate. To satisfy the yield requirements for groundwater, the calculated pump rate must be maintained for 15 min. Regardless of what the yield determination shows, all appropriate test data, including the actual pump rate, must be submitted for review.

If any MWs installed during the Tier evaluation exceed the minimum pump rate for the yield determination, other MWs do not need to be tested. All wastewater generated during the yield determination must be characterized and disposed of in accordance with state and federal regulations.

Yield Adjustments

Review the following factors to determine the appropriate minimum yield rate for the evaluation. Make potential adjustments as follows:

- If the yield determination is performed during high water level (March through May, per Ohio EPA VAP), then no adjustment is needed. However, if the determination is made during the low water level (June through February), then an adjustment will be necessary. The recommended default multiplier (for the 3 gal./min. rate) will be 0.65, which reduces the minimum pump rate to 1.95 gal./min. This seasonal adjustment must also be made for the groundwater determination (i.e., 1.5 gal./8 hours), as appropriate;
- 4-in. wells are preferred, however, if 2-in. diameter wells have been installed then a 0.85 adjustment factor must be used. Therefore, the minimum pump rate would be reduced to 2.6 gal./min; and/or
- If a well is installed only 5 ft. into a saturated zone for the yield determination, then make an adjustment to the yield target rate on a site-specific basis. Use the Walton & Butler equation (Walton, W. C., "Selected Analytical Methods for Well and Aquifer Evaluation," *Illinois State Water Survey*, Bulletin No. 49, 1962) to determine a multiplier by dividing the length of the saturated zone screen by the thickness of the aquifer. If the thickness cannot be determined, then use a default thickness of 25 ft. Therefore, if 5 ft. of a saturated zone is screened and the 25 ft. default thickness is used, the multiplier would be 0.2. That

would reduce the minimum pump rate from 3 gal./min. to 0.6 gal./min. Although various equations can be used to make this adjustment, apply the Walton & Butler equation as the default equation.

Note that one or more of these adjustments might be appropriate. Ensure that all the wells are evaluated and compared to the appropriately adjusted value. Contact BUSTR when using site-specific criteria or equations other than the default.

A.11 Boring/Well Abandonment

Borehole Abandonment/Well Decommissioning

To prevent the potential downward migration of surface contaminants, properly abandon boreholes not completed as wells and wells on release sites that have received no further action status.

Borehole Abandonment

Borehole abandonment should consist of grouting the borehole. The basic equipment for most abandonment procedures is the same as for tremie-grouting of a MW. Use a grout mixer or other method of mixing the grout and a positive displacement pump to deliver the mixture with positive pressure to the bottom of the borehole.

There are several alternative methods for borehole abandonment:

- Place bentonite pellets through a conductor pipe into water-filled, uncased boreholes;
- Use direct gravity placement in boreholes that are free of water and in deeper boreholes that have sufficient open diameter to prevent bridging; and
- With special precautions, bentonite pellets/chips may be used to abandon deep water-filled boreholes that have sufficient open diameter to prevent bridging. Removing all the fines should prevent the development of drilling mud that impedes proper settling of the bentonite chunks.

To be effective, a sealing material should not react with any contaminants, should form a tight seal with the borehole wall, should be resistant to cracking/shrinking, and should have an effective hydraulic conductivity less than the native materials. Two principal grouting materials, neat cement and bentonite, best meet the needs for abandonment.

Well Decommissioning

Measure the well’s depth before it is sealed and record static water levels. This is completed to ensure that no obstructions might interfere with effective sealing.

To properly seal a well:

- Remove (pull or over-drill) or drill through the well casing with hollow stem augers); and
- Cut off casing 2 ft. below grade and grout in place.

Removal is the preferred method for well abandonment.

Use bentonite, neat cement, or a bentonite/cement mixture as the primary sealing material. Use a single, continuous operation to place such material upward from the bottom of the well to within 2 ft. of the surface. Backfill the remaining 2 ft. of annular space with materials that match the existing surface conditions (i.e., soil, asphalt, concrete).

The Ohio Revised Code requires a Water Well Sealing Report be filed with the ODNR Division of Water. BUSTR must be contacted prior to abandoning and/or decommissioning wells at sites still undergoing corrective action.

Appendix B: Data Presentation

B.1 Site Figures

This suggested list of figures may be included in the reports, as applicable:

- Topographic Map;
- Site Map;
- Sample Location Map;
- Soil Analytical Data Map;
- Groundwater Analytical Data Map;
- Potentiometric Surface Map
- Soil Boring Logs and Monitoring Well Construction Diagrams.
- Cross Section Location Map.
- Cross Section; and
- Site and Area Within 300 Feet Map.

Aerial photographs or satellite imagery should not be used as the base map for these figures due to reproducibility issues.

Each map should include the following general information:

- Title (i.e., for what information the map is detailing);
- Site name and location (i.e., address, city, county);
- BUSTR Facility or Release Number;
- North directional arrow;
- Legend;
- Scale bar (i.e., 1 in. = 20 ft.);
- Preparation date; and
- Signature or initials of the person who prepared the map.

B.2 Topographic Map

- USGS 7.5 min. topographic map with site location identified.

See Figure B.1- Topographic Map for an example.

B.3 Site Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations;
- The location of the suspected release source;
- Site structure and surface cover (i.e., buildings, asphalt, concrete, grass);
- Nearby buildings, street names, and business name(s);
- Buried and overhead utility locations on or adjacent to the UST release site;

- The location of other potential release sources, such as nearby service stations; and
- Exact locations of drinking water wells within 50 ft. of the UST system.

See Figure B.2, Site Map, for an example.

B.4 Sample Location Map

- Property boundaries of release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- Nearby streets with names, buildings, and building use;
- Onsite structures and surface cover (i.e., buildings, asphalt, concrete, grass);
- Buried and overhead utility locations on or adjacent to the UST release site;
- UST system locations (i.e., tanks, piping, dispensers) and any former UST system locations;
- Exact locations of drinking-water wells within 50 ft. of the UST system;
- Sample locations;
- The limits of any excavations;
- Any utilities uncovered as part of the excavation process;
- All soil boring, trench, and MW locations, marked and designated appropriately (e.g., MW-l or SB-3);
- All soil and water sample collection points within an excavation marked and designated appropriately.

See Figure B.3, Sample Location Map, for an example. A Closure Sample Location Map is a type of sample location map, and an example can be seen on Figure B.5.

B.5 Potentiometric Surface Map

- Property boundaries of release site;
- Nearby streets with names, buildings, and building use;
- Onsite structures and surface cover (i.e., buildings, asphalt, concrete, grass);
- Buried and overhead utility locations on or adjacent to the UST release site;
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- Exact locations of drinking water wells within 50 ft. of the UST system;
- The limits of any excavations;
- All soil boring, trench, and MW locations, marked and designated appropriately (e.g., MW-l or SB-3);
- All soil and water sample collection points within an excavation marked and designated appropriately;
- Groundwater flow direction; and
- Data points and potentiometric surface contour lines.

See Figure B.6, Potentiometric Surface Map, for an example.

B.6 Soil Analytical Data Map

- Property boundaries of release site;
- Nearby streets with names, buildings, and building use;
- Onsite structures and surface cover (i.e., buildings, asphalt, concrete, grass);
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- The limits of any excavations;
- All soil boring, trench, and MW locations, marked, and designated appropriately (e.g., MW-l or SB-3);
- All soil sample collection points within an excavation marked and designated appropriately;
- Current and historical soil analytical results in tabular form for each sample location with sample depths and dates.

See Figure B.7, Soil Analytical Data Map, for an example.

B.7 Groundwater Analytical Data Map

- Property boundaries of release site;
- Nearby streets with names, buildings, and building use;
- Onsite structures and surface cover (i.e., buildings, asphalt, concrete, grass);
- UST system locations (i.e., tanks, piping, dispensers) and former UST system locations with dimensions noted;
- Exact locations of drinking water wells within 50 ft. of the UST system;
- All soil boring, trench and MW locations, marked and designated appropriately (e.g., MW-l or SB-3);
- The limits of any excavations;
- All water sample collection points within an excavation marked and designated appropriately; and
- Current and historical groundwater analytical results in tabular form for each sampling point with sampling dates.

See Figure B.8, Groundwater Analytical Data Map, for an example.

B.9 Soil Boring Logs and Monitoring Well Construction Diagrams

Use detailed diagrams to show soil boring logs and MW construction. Soil boring and MW logs should include the following information, as appropriate:

- Boring/well identification number;
- Site name and address;
- Latitude and longitude (e.g., global positioning system - GPS);
- Drilling and well installation dates, including dates started and completed;
- Name of person logging the boring/well;
- Name of drilling company;

- Type and size of drilling/sampling equipment (i.e., 4.25 in. ID hollow-stem augers (HSA), 24 in. split spoons);
- Type and size of well construction material (i.e., 2 in. ID Schedule 40 PVC casing and 0.010 slot PVC screen);
- Type of grout used to backfill the boring/well annulus;
- Detailed description of the soil sample for each interval, including soil type, color, moisture content, presence of fracturing, and any other pertinent observations and comments (i.e., staining, odors);
- Detailed description of bedrock samples collected, including rock type, color, bedding thickness, approximate dip angle and fracturing, moisture content, extent of weathering/competency, and any other pertinent observations or comments;
- Standard penetration test (i.e., blow count) data for each sampling interval;
- Sample recovery from each sampling interval;
- Results of field screening for each sample;
- Depth at which groundwater was encountered during drilling;
- Static water depth after the well has been developed (including date(s) of measurement);
- Ground surface elevation at the wellhead, and the elevation at the top of the well casing, measured from a marked point on the north side of the well. All MW elevation measurements should be surveyed to within 0.01 ft. Ground surface elevations should be surveyed to within 0.1 ft.;
- Graphical representation of well construction details;
- Graphical representation of soil/rock types as encountered;
- Identification of soil sample(s) submitted for laboratory analysis;
- Notable occurrences during drilling (i.e., the presence of heaving sand in the augers, difficult drilling conditions); and
- Any information associated with geotechnical soil characterization.

See Figure B.9, Soil Boring Log and Monitoring Well Construction Diagram, for an example.

B.10 Cross Sections

The term, "cross section", refers not only to cross sections constructed from boring logs and other information, but also to drawings of trench or tank cavity walls.

Cross sections should include the following information:

- Site name and address;
- Cross section name (i.e., A-A');
- Legend for any symbol used;
- Graphical representation of soil/bedrock encountered;
- The location of any samples collected;
- Field screen readings corresponding to sample intervals;
- Underground utilities;
- Static and encountered groundwater elevations; and
- Horizontal and vertical scales.

See Figure B.10, Cross Section Location Map and Figure B.10, Cross Section, for examples.

B.10 Site and Area Within 300 Feet Map

- Property boundaries of the release site; Nearby streets with names, buildings, and building use;
- Onsite structures and surface cover (i.e., buildings, asphalt, concrete, grass);
- UST system locations (i.e., tanks, piping, dispensers) and any former UST system locations;
- Exact locations of drinking-water wells within 300 ft. of the UST system
- The location of the suspected release source;
- Depiction of the current and reasonably anticipated land-use of the UST site and all properties within 300 ft. of the property boundary (i.e., historical and current land-use of the UST site and adjacent properties, historical and current zoning or planning designation for the UST site and adjacent properties);
- Roadways within 300 ft. of the property boundary, including centerlines;
- Total area calculations of all properties within 300 ft. of the property boundary, including percentages; and
- Lakes, streams, rivers, and surface water bodies within 300 ft.

See Figure B.11- Site and Area within 300 Feet Map, for an example.

Figure B.1 - Topographic Map

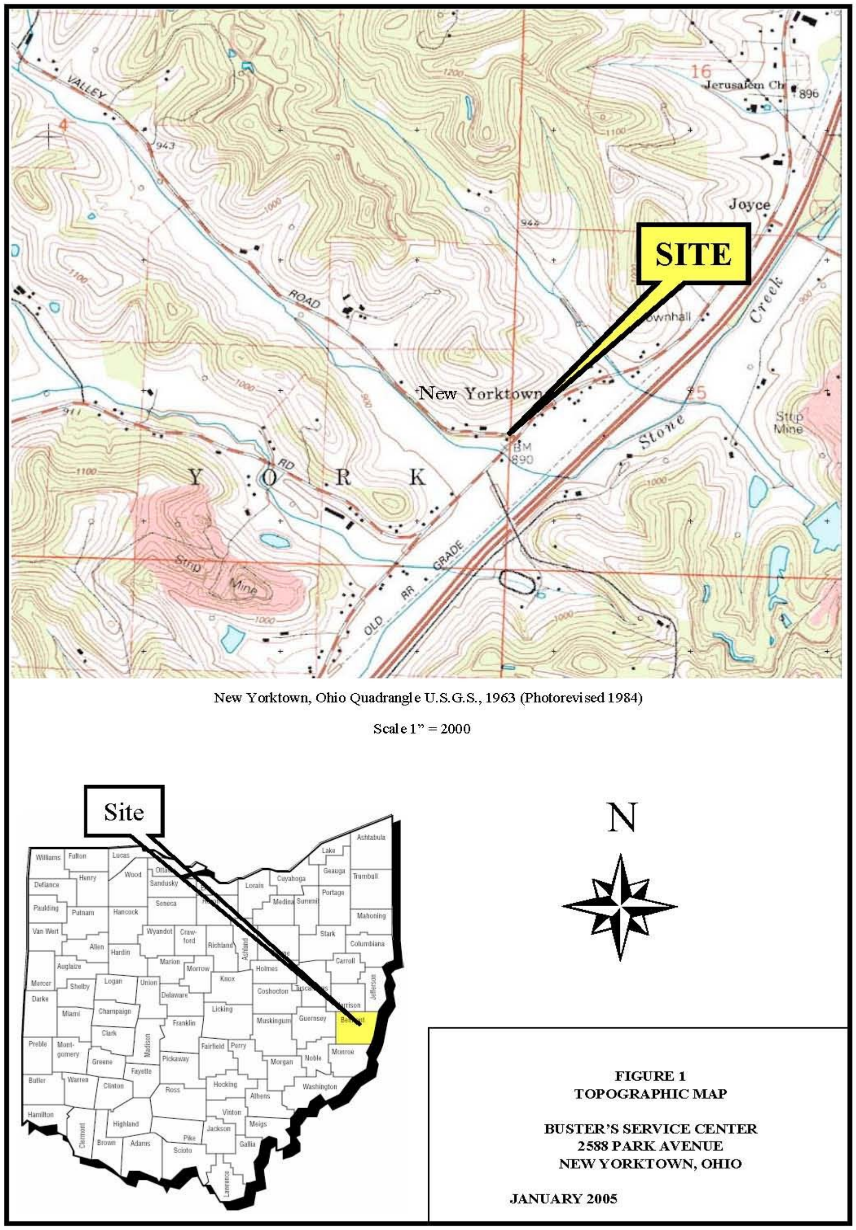


Figure B.2 - Site Map

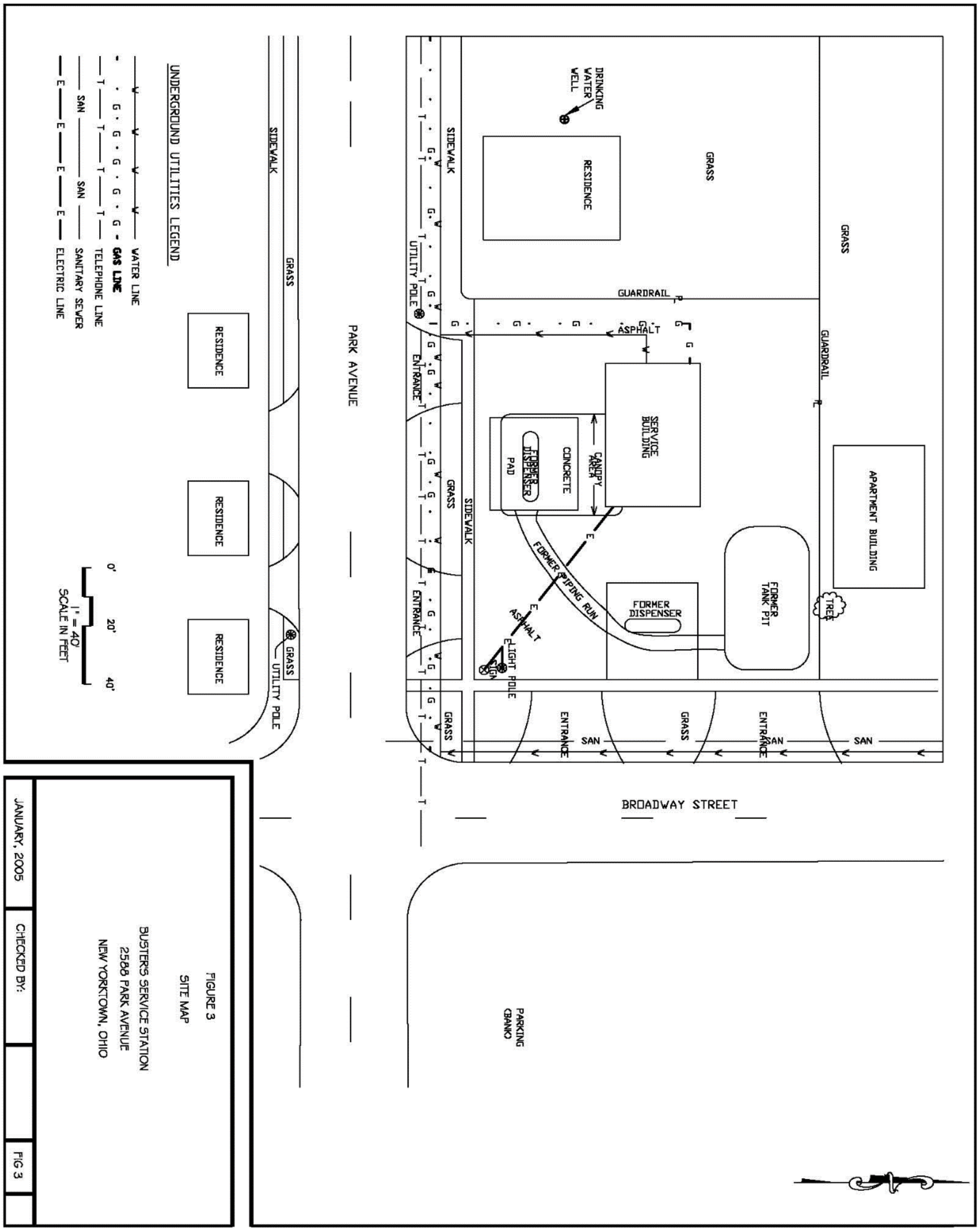


Figure B.3 - Sample Location Map

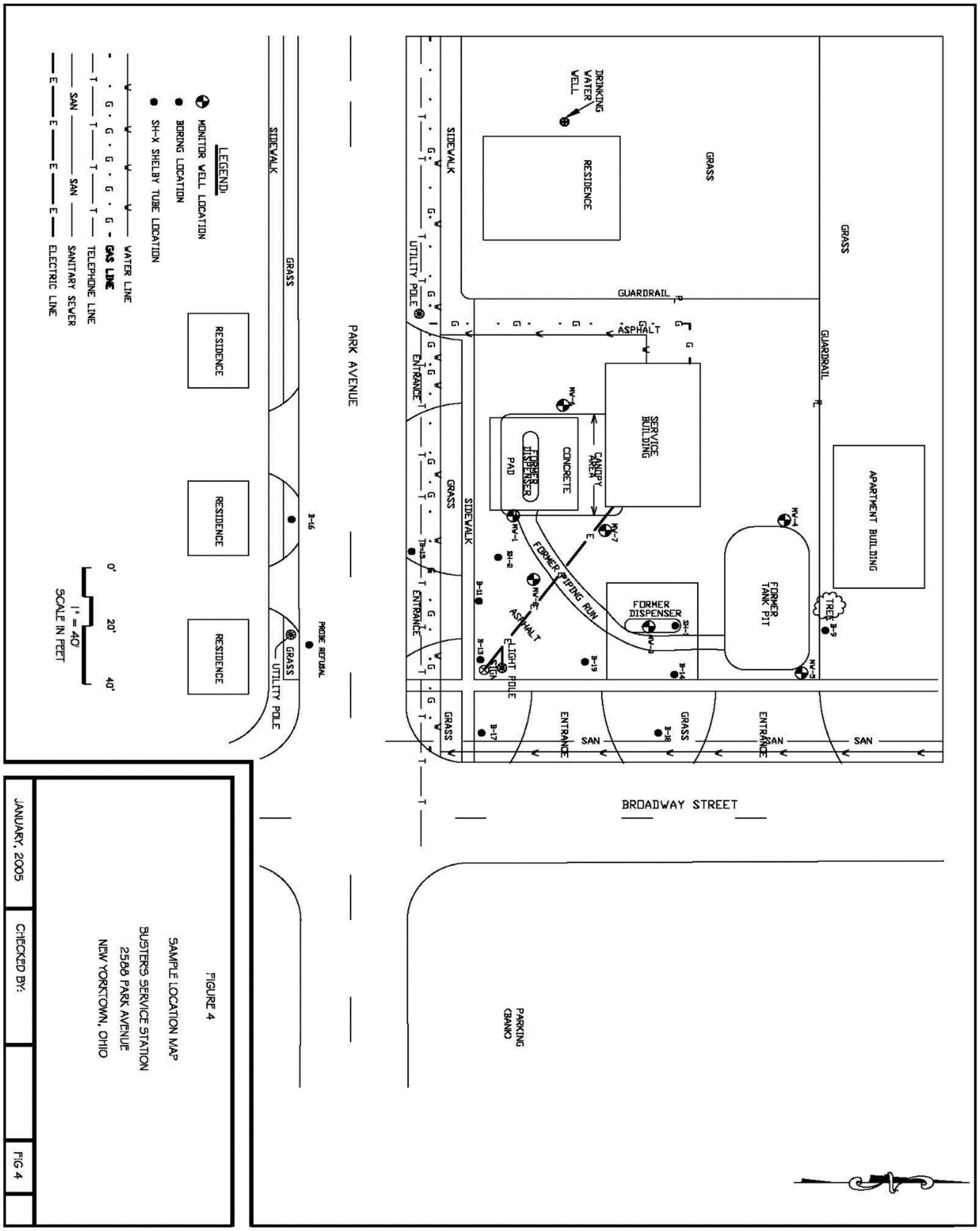


Figure B.4 - Closure Sample Locations Map

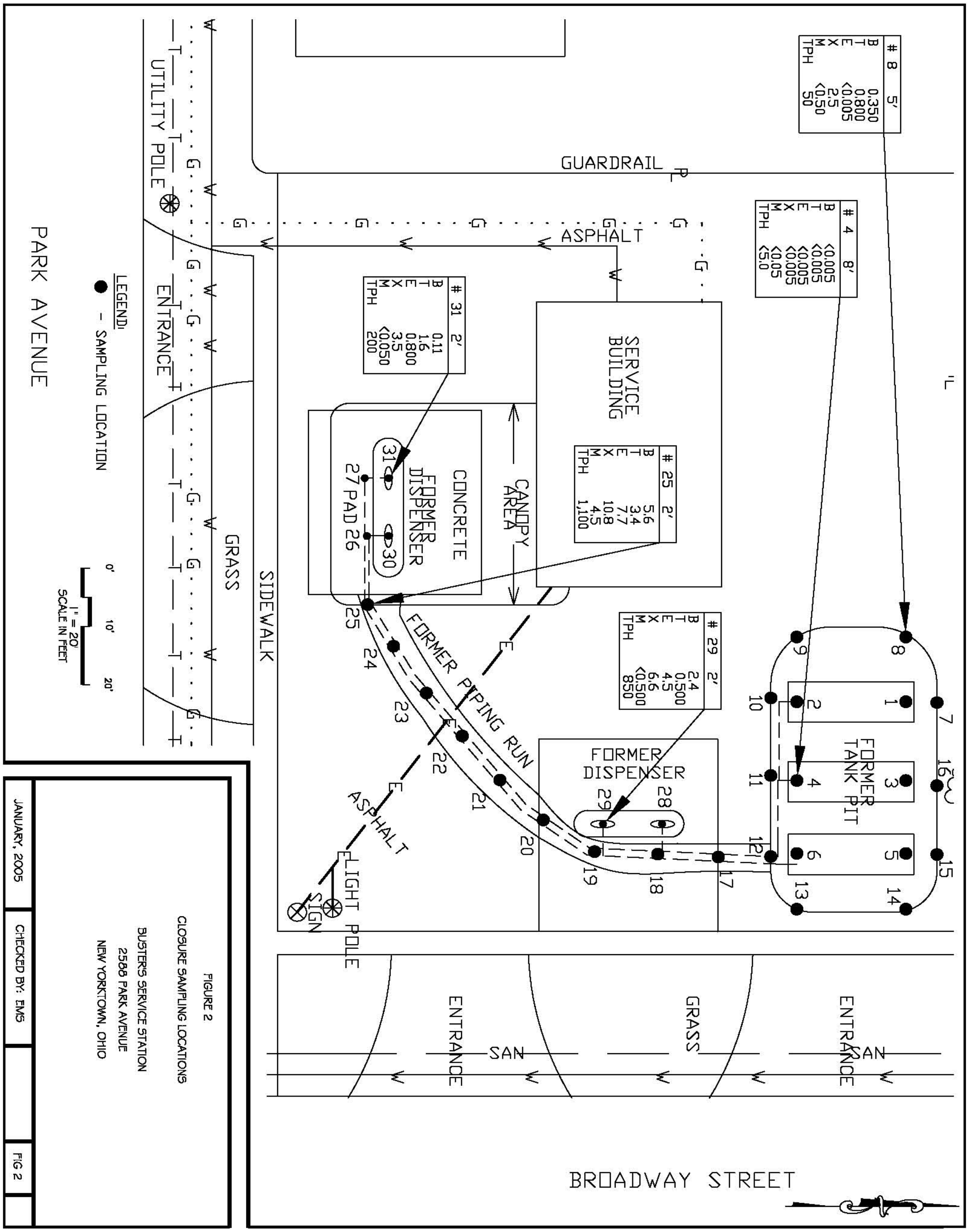


Figure B.5 - Potentiometric Surface Map

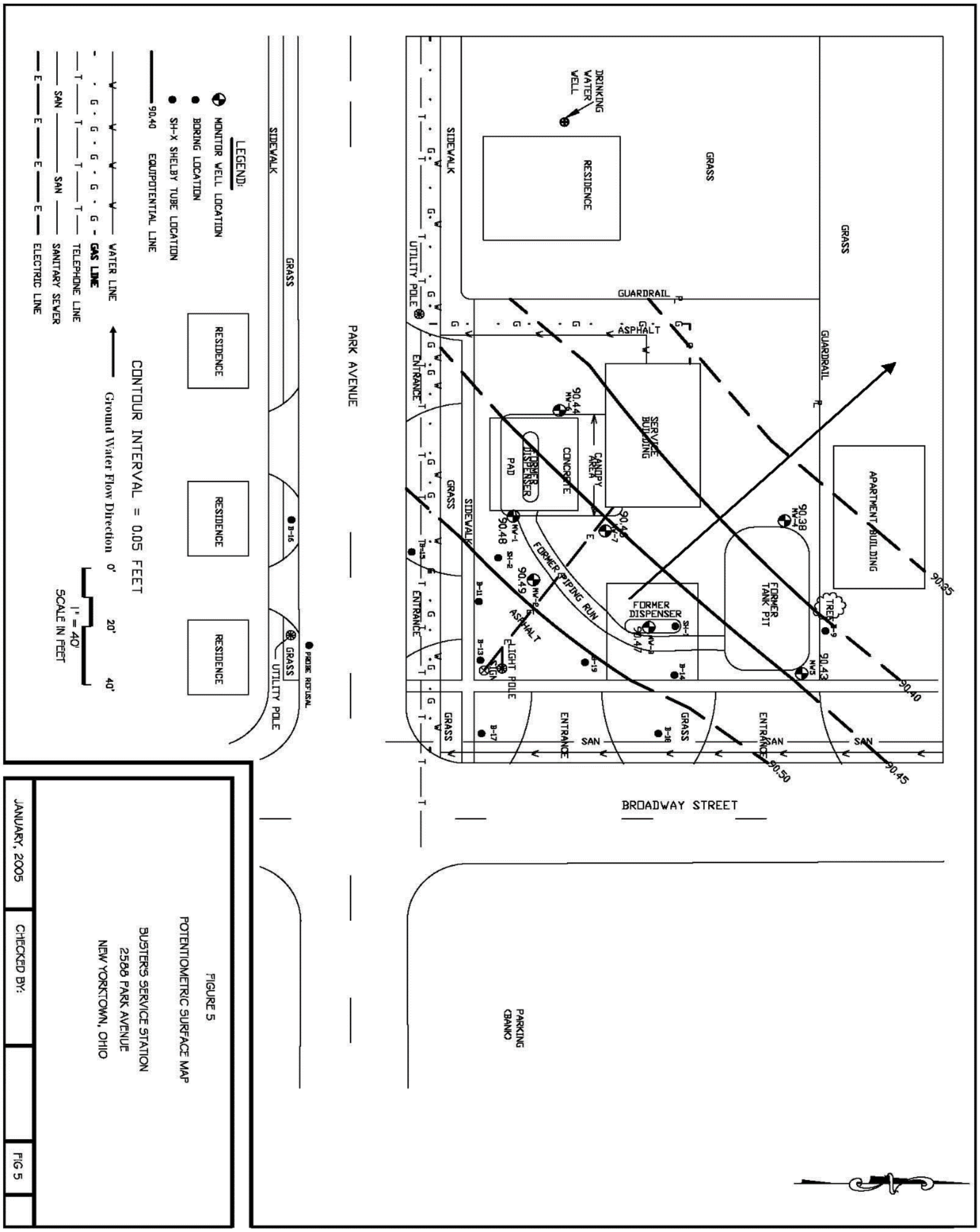


Figure B.6 - Soil Analytical Data Map

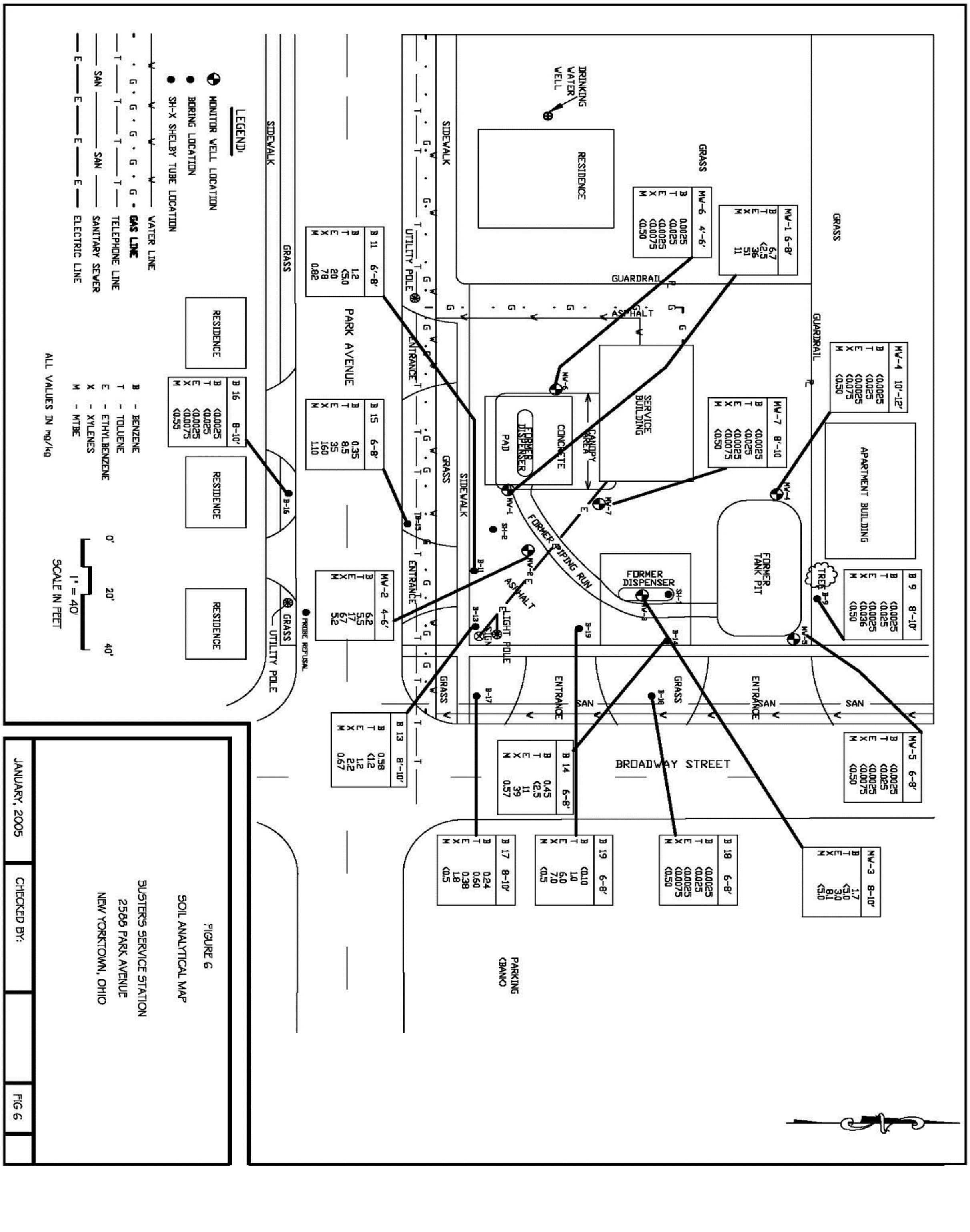


Figure B.7 - Groundwater Analytical Data Map

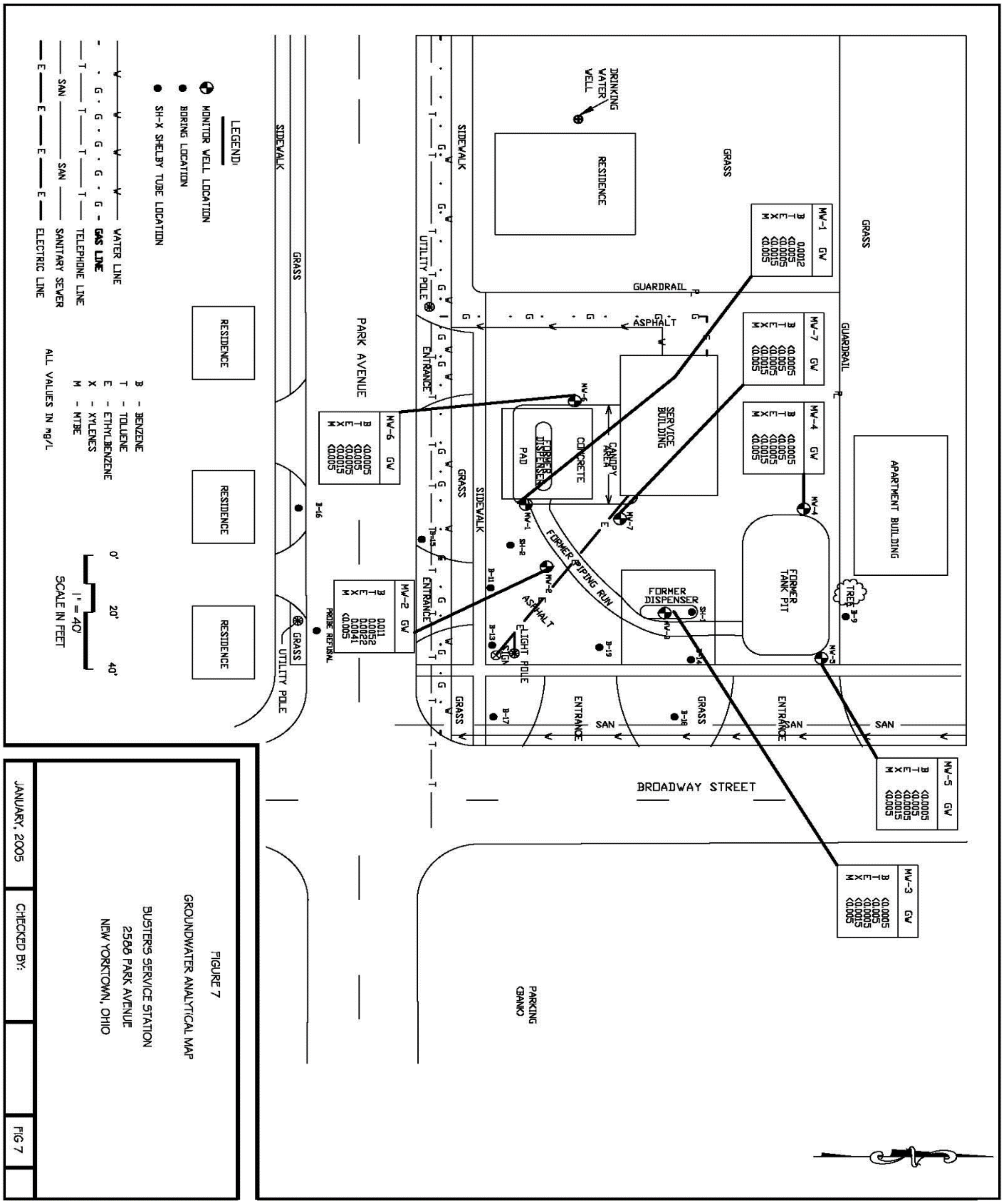
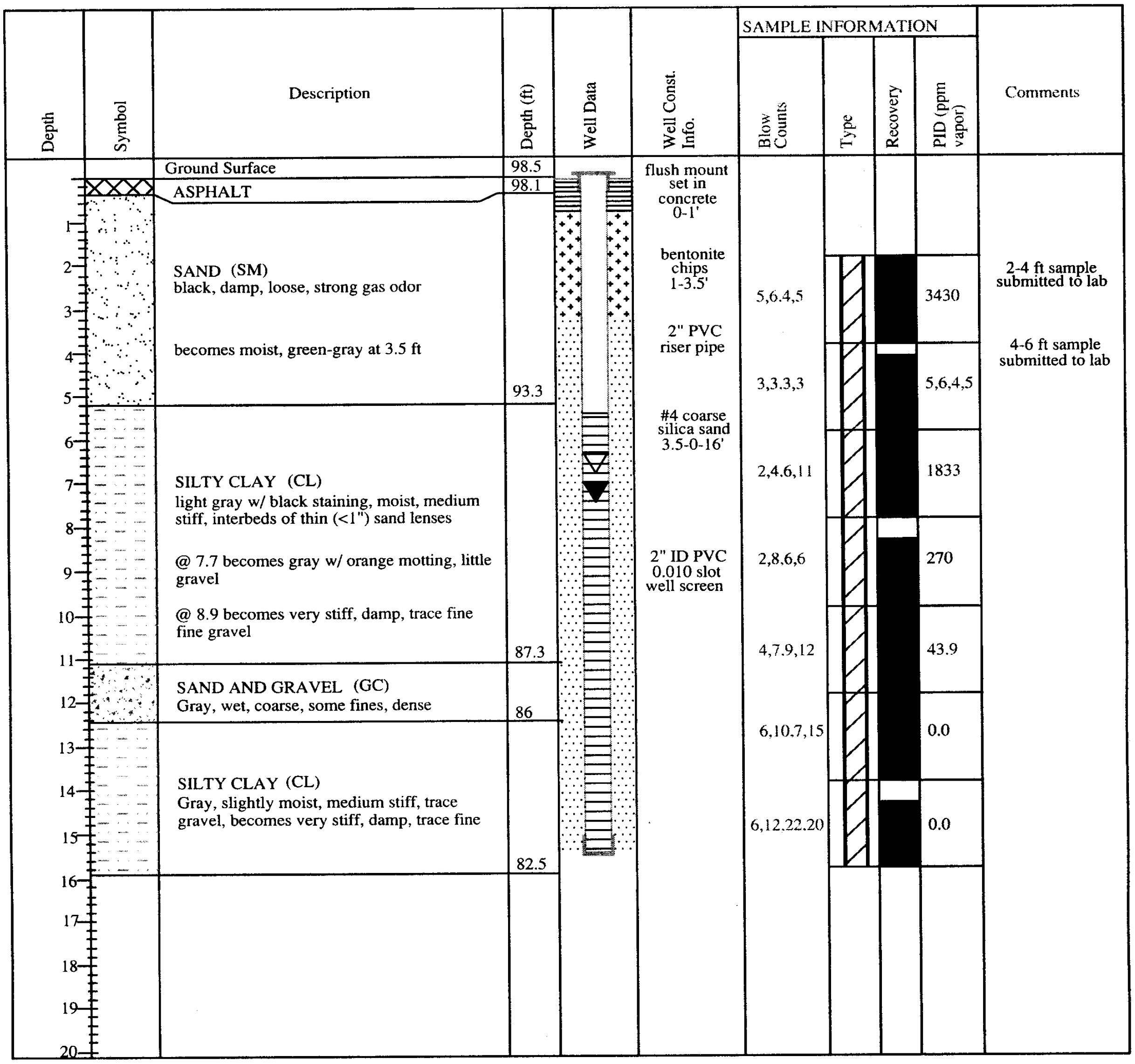


Figure B.8 - Soil Boring Log and Monitoring Well Construction Diagram

BORING LOG/ WELL CONSTRUCTION DIAGRAM



Comments:

Drilling Company: Drilling Co.
Drilling Method: 4.25-inch HSA
Drilling Date: 1-01-01

Consulting, Inc.
Avenue
Anytown, Ohio 42286
Phone No. (555)555-5555

Hole Size: 8.25" OD
Casing Elevation: 98.47
Water Elevation: 90.65

SOIL BORING/WELL #:

▽ Depth Water Uncontoured
▼ Static Water Level

Client: ABC Service Station
Location: Main Street, Anytown, Ohio
Project: Tier 1 Evaluation
Project Number: 01-01-000000

Logged By:
Reviewed By:

Figure 8

Figure B.9 - Cross Section Location Map

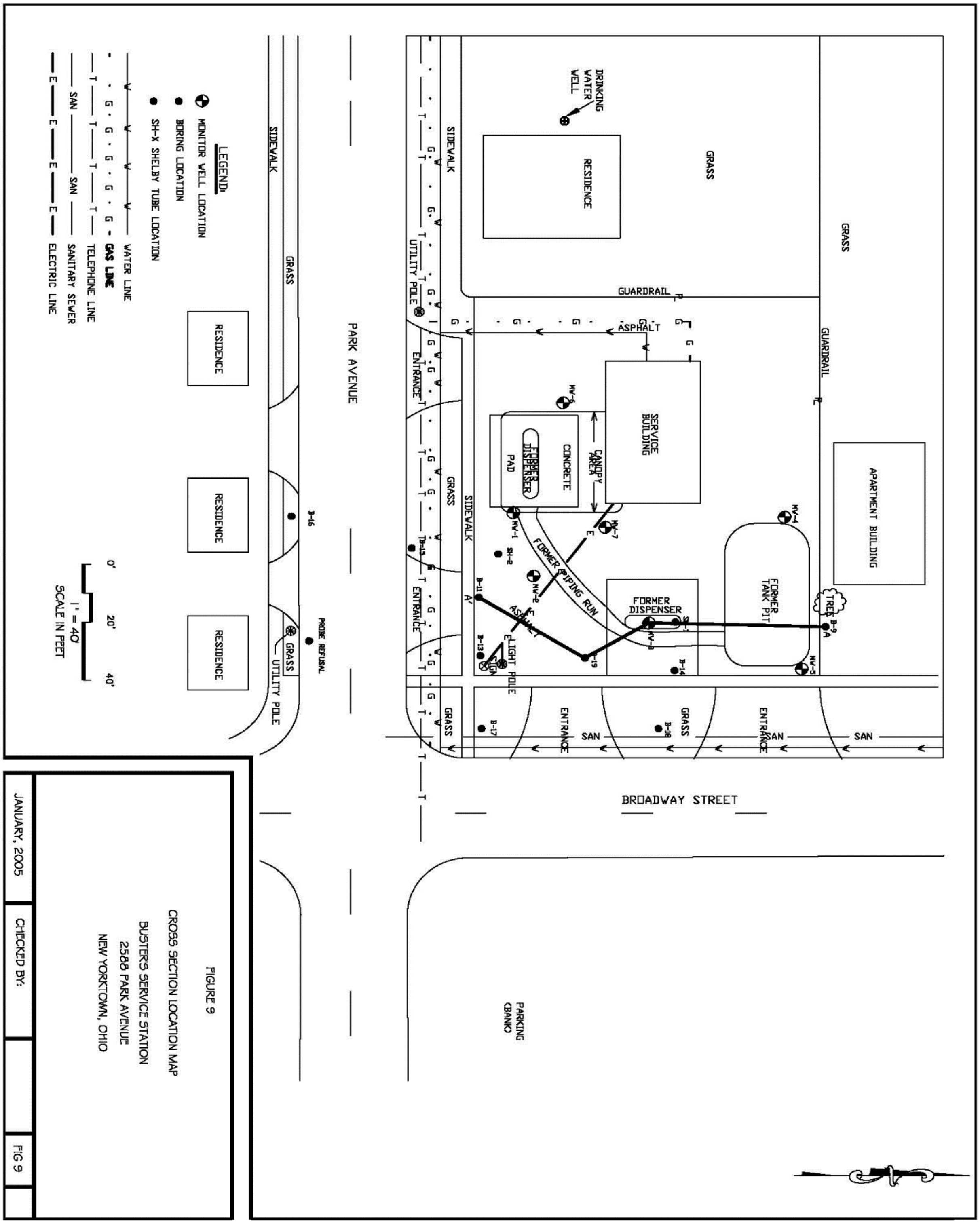


Figure B.10 - Cross Section

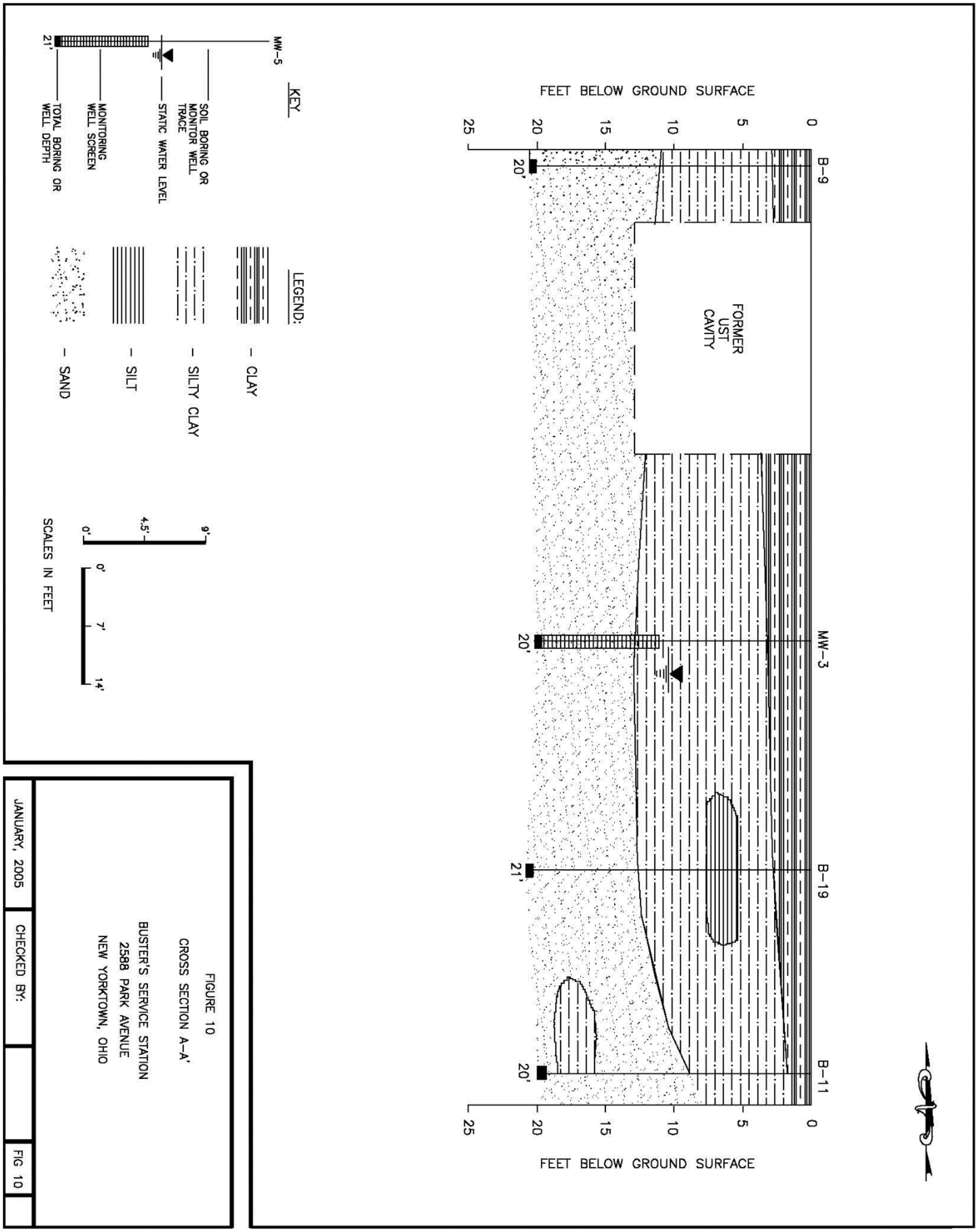
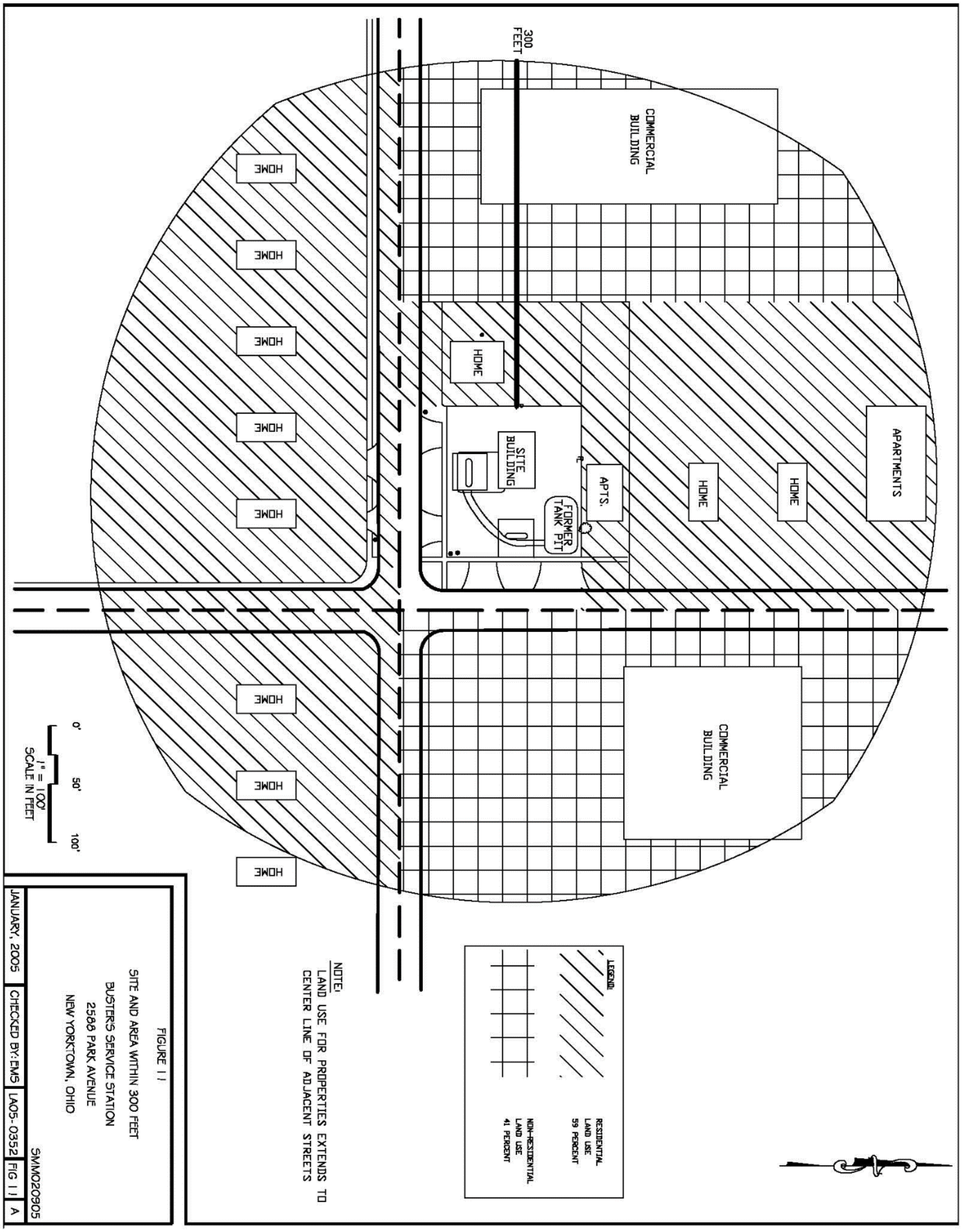


Figure B.11 - Site and Area within 300 Feet Map



B.12 Tables

Use tables whenever possible to efficiently display analytical data. Include notes or comments below the table. Present data as an actual concentration or as less than the reporting limit, such as less than .005 ppm (parts per million). **Do not use notations such as below detection limit (BDL), below quantitation limit (BQL), and not detectable (ND).** See Tables B.1 and B.2 for examples.

Tables should include the following information:

- Site name and address;
- Media sampled;
- Date of sampling;
- Sample identification (i.e., MW-3, SB-l);
- Sample depth;
- Actual concentration of contaminants in ppm (parts per million); and
- Field screening measurement, if applicable.

B.13 Laboratory Analytical Reports

Submit copies of actual laboratory analytical results with each report. Table B.3 - Laboratory Analytical report shows an example of an appropriate laboratory analytical report.

Laboratory analytical reports should include the following:

- Site name and address;
- Name, address, and phone number of the laboratory;
- Client name;
- Sample matrix (i.e., soil, water, air);
- Sample identification;
- Date of sample collection;
- Date of sample receipt by laboratory;
- Date of sample analysis;
- Analytical method used to analyze sample;
- Analyte (e.g., benzene, toluene);
- Concentration and units of analyte(s) present;
- Quantitation limit and units; and
- Name of analyst.

Table B.1 - Field Screening Results

ABC Service Station
900 Main Street
Anytown, Ohio

Sample Interval	**Sampling Date**	**SB-1 (ppm)**	**SB-2 (ppm)**	**SB-3 (ppm)**
0-2’	3-10-05	0.0	0.0	0.0
2-4’	3-10-05	**75.0**	**87.0**	**99.0**
4-6’	3-10-05	32.0	35.0	53.0
6-8’	3-10-05	43.0	12.0	18.0
8-10’	3-10-05	22.0	31.0	33.0
10-12’	3-10-05	**55.0**	**67.0**	**78.0**

Bold= Submitted for laboratory analysis.

Table B.2 - Soil Analytical Results

ABC Service Station
900 Main Street
Anytown, Ohio

Sample	**Depth (ft.)**	**Sampling Date**	**Benzene mg/kg**	**Toluene mg/kg**	**Ethylbenzene mg/kg**	**Xylenes mg/kg**	**MTBE mg/kg**
SB-1	2-4	4-10-01	<0.005	0.035	0.254	0.476	0.062
SB-1	10-12	4-10-01	0.054	0.037	0.027	0.092	0.354
SB-2	2-4	4-10-01	0.140	0.365	<0.005	0.486	0.197
SB-2	10-12	4-10-01	**0.356**	0.476	0.957	0.746	1.376
SB-3	2-4	4-10-01	0.046	0.736	0.366	<0.010	0.286
SB-3	10-12	4-10-01	0.098	0.228	0.336	1.900	0.098
Soil to Drinking Water Leaching			0.246	70.7	84.5	1,030	1.58
Soil Direct Contact			26.0	820	130	260	1,100
Soil to Indoor Air			1.67	1,240	406	42.7	150
Soil to Outdoor Air			52.7	39,200	12,800	1,350	4,740
Delineation Level			1.67	1,240	406	42.7	150

Bold= Above action levels

Table B.3 - Laboratory Analytical Report

Water and Soil Labs, Inc.
12345 Elm St., Anytown, OH 12345, (123) 456-7890

Client Name: ABC Service Station
Address: 900 Main Street
Anytown, OH

Client Sample Identification: SGC-019248B
Sample Matrix: Soil
Date Sample Collected: 10-March-05
Date Sample Received: 11-March-05
Date Sample Analyzed: 12-March-05

Purgeable Aromatics
Analytical Results

Lab No. 90979A Laboratory Certification OHIO EPA VAP #1234
Sample ID# SB-1 (10-12')

Analyte	Concentration (mg/kg)	Quantitation Limit (mg/kg)
Benzene	0.054	<0.002
Toluene	0.037	<0.002
Ethylbenzene	0.027	<0.002
Total Xylenes	0.092	<0.002
MTBE	0.354	<0.002
Surrogate- a,a,a-Trifluorotoluene	95%	

Analytical method: SW 846 Method 8021, reported on a dry-weight basis.

Analyst: Jane Doe
Verified: 12-March-05
Date Reported: 12-March-05

Appendix C: Use Restrictions

C.1 Introduction

An Environmental Covenant is a legal device that defines restrictions on uses of a property and requirements for the use, operation, and maintenance of engineering controls. It is often used in connection with risk-based cleanups to control the potential risks presented by that residual contamination. The restrictions and engineering controls in the Environmental Covenant are used to prevent exposure of contaminants to people by limiting pathways of the contaminants such as the use of groundwater on site as drinking water or the exposure to vapors in a basement of a residential structure, etc. Environmental Covenants should be submitted during the Tier 2 Evaluation process.

Environmental Covenants are created by a written and signed agreement in which the parties (known as "holders") demonstrate their intent to bind themselves and the future successors of the land to the conditions or restrictions of land-use in the Environmental Covenant. An Environmental Covenant is created and defined by statute in ORC § 5301.80 through § 5301.92.

An Environmental Covenant is not always necessary and is not always approved. It is used by BUSTR in situations where a property cannot meet the typical requirements under the BUSTR corrective action rule to be automatically classified as a restricted use property (i.e., non-residential, non-drinking uses.). Typically, these are situations where the property is just outside of the parameters defining non-residential or non-drinking water site classifications according to the BUSTR corrective action rule or where engineering controls such as vapor barriers are used. An Environmental Covenant may be an appropriate device to use at a particular site to impose legal limitations of non-residential use or groundwater use.

The following are a few examples of when an Environmental Covenant may be implemented:

- If the site cannot meet the 75% non-residential land use scenario in accordance with Section 3.12.2, Land Use Determination, *Non-Residential Land Use,* the O/O or the volunteer conducting corrective actions may use an Environmental Covenant to eliminate the residential exposure scenarios;
- If the soil to indoor air point of exposure cannot be eliminated, an Environmental Covenant may be used to eliminate the point of exposure by preventing the installation of a basement on the property; or
- If an engineering or institutional control is used, then an Environmental Covenant is to be recorded to ensure the maintenance of the engineering or institutional control.

BUSTR requires an Environmental Covenant to be used instead of a Deed Restriction. However, this does not invalidate Deed Restrictions that were previously used.

Below is an example of an Environmental Covenant template, as used by BUSTR. BUSTR recommends the use of an attorney experienced in Ohio property law and/or environmental law for drafting and implementing an Environmental Covenant under the BUSTR rules.

Use of the language below does not guarantee that a property complies with BUSTR rules or applicable standards. You may want to discuss with the BUSTR Coordinator which activity and use limitations (land use, groundwater use) are needed for the specific site prior to submitting an Environmental Covenant. Once the proposed Environmental Covenant is submitted to the BUSTR site coordinator and reviewed, it will be signed by the State Fire Marshal and returned for proper recording with the Recorder's Office in the county where the property is located.

C.2 Covenant

Template Usage

The following template contains the basic requirements needed for BUSTR to approve the Environmental Covenant. It is strongly encouraged to discuss any substantive changes made to the template language with the agency's legal counsel or technical revisions with the BUSTR Coordinator prior to submission. Substantive changes made to the Environmental Covenant template may result in denial.

Applicable Statutes

If the preparer of the Environmental Covenant is not familiar with the legal requirements of an Environmental Covenant, please review Ohio Revised Code ("ORC") § 5301.80 through § 5301.92. The State Fire Marshal is authorized to enter into an Environmental Covenant by ORC §3737.88 and §3737.882. The Environmental Covenant is to be filed with the appropriate County Recorder's office (county in which the UST property is located) and is to be filed in a similar manner as a deed (in accordance with ORC § 317.08). For the document to be accepted for filing in a County Recorder's office, the document should conform to the requirements specified in ORC § 317.114 (eff. 7-1-09). These requirements specify size of paper, measurement of margins, and other elements the document must have to be accepted for filing. It is the responsibility of the preparer or submitter to draft the document with these specifications prior to review, approval, and signature of the State Fire Marshal.

Procedures

Before an Environmental Covenant is reviewed by legal counsel and subsequently signed by the Fire Marshal, you must first obtain PRIOR APPROVAL from the BUSTR Site Coordinator. You may want to discuss with the BUSTR Coordinator which activity and use limitations (land use, groundwater use) are needed for the specific site. Additionally, the Environmental Covenant option is expressed in rule during the Tier 2 Evaluation process. If you have questions as to when you should submit the Environmental Covenant, please contact the BUSTR Coordinator. **Per rule, the recorded Environmental Covenant should be submitted as part of a Tier 2 Evaluation Report. See OAC 1301:7-9-13(L)(7).**

After the BUSTR site coordinator reviews the Environmental Covenant, he or she will submit the document to Legal Counsel for review. If there are revisions needed to the Environmental Covenant draft, BUSTR will advise the preparer. If revisions are required, the preparer may submit the revised Environmental Covenant to Legal Counsel or the BUSTR Site Coordinator.

Once approved, the State Fire Marshal or his designee will sign the Environmental Covenant. BUSTR will then return the document to the submitter/preparer for additional signatures, if needed, and for proper recording with the County Recorder's Office. **The submitter must return a TIME-STAMPED COPY of the Environmental Covenant from the RECORDER'S OFFICE to the BUSTR site coordinator.** An NFA letter will NOT be issued before a time-stamped, recorded Environmental Covenant copy is received by BUSTR. For more questions regarding the approval process, please contact BUSTR.

Template Usage

The template contains the basic requirements that must be used in an Environmental Covenant for it to be approved as required by the Division of the State Fire Marshal and BUSTR. It is strongly encouraged to discuss any substantive changes made to the template language with Legal Counsel or technical revisions with the BUSTR Coordinator *prior* to submission. Substantive changes made to the Environmental Covenant template may result in denial.

Please note the *blue italicized segments* in the attached template. These italicized sentences or phrases are either instructions for the preparer to follow OR sections that need modified to reflect site specific data. **Please alter or remove, if appropriate, ALL the italicized portions before submitting the final draft.** To further demonstrate this, an example of a finished Environmental Covenant is also available.

The property description that is attached as Exhibit A must be a full legal property description that expresses the property dimensions or boundaries in metes and bounds, degrees of cardinal directions, or other listing as typically included in a land deed. It cannot be the abbreviated property description found on the Property Card or the Auditor's online database.

Note: Use of the language in the template does not guarantee that the Fire Marshal will approve the use of an Environmental Covenant or that the property relating to the BUSTR release complies with BUSTR's rules or applicable standards.

(PLEASE REMOVE ALL INSTRUCTION PAGES BEFORE SUBMITTING FINAL ENVIRONMENTAL COVENANT DRAFT)

(Note: Per ORC § 317.114, the first page is required to have a 3-inch top margin and subsequent pages to have a 1½ inch top margin)

To be recorded with Deed Records in accordance with ORC § 317.08
Format of document to conform to requirements of ORC § 317.114

Environmental Covenant

This Environmental Covenant is entered into by ________________ ("**Owner**") *[list all Owners of the Property]*, the State Fire Marshal of Ohio, *[add other "Holders"**, if any]* pursuant to Ohio Revised Code ("ORC") § 5301.80 to 5301.92 for the purpose of subjecting the Property to the activity and use limitations set forth herein.

(***Note**: Additional parties, without an interest in the property, may be added to the covenant and will be considered an additional "Holder" to the covenant. This is useful especially in cases where the Responsible Party is not the property owner OR parties wish to include a lessee of the property and/or the operator of the Underground Storage Tanks.)*

Preparer, TYPE in the following site-appropriate background information here:

1. **Site Description:** *Identify the "site" or "facility." (Type in the Name and Facility Number)*
2. **Environmental Project Description**: *Describe the "environmental response project," which is 'the work performed for environmental assessment and/or remediation of the property (corrective actions) conducted pursuant to Ohio Revised Code 3737.88 and 3737.882. (Questions on this requirement, See ORC § 5301.80(E)(1)(e))*
3. **Nature of Contamination**: *Describe the nature of the contamination on or underlying the property and its remedy, including the contaminants of concern, the pathways of exposure, limits on exposure, and the location and extent of the contamination. (Questions on this requirement, See ORC § 5301.82(B)(2)).* ***The description should not be simply a recitation as to the various reports received.***
4. **Administrative Records**: *Identify the agency and location of the administrative record for the project. (Questions on this requirement, See ORC § 5301.82(A)(8))*

Please insert the following language:

All administrative records regarding the petroleum release and corrective action process, pursuant to Chapter 3737 of the Ohio Revised Code, that occurred at the Property that is the subject of this Environmental Covenant may be obtained through a public records request by requesting information on [Type in Name of Facility and BUSTR Release Number]:

> ***Bureau of Underground Storage Tank Regulations***
> Division of State Fire Marshal
> Attention: Public Information Clerk
> 8895 East Main Street
> Reynoldsburg, OH 43068

NOW THEREFORE, the Owner(s) (*List all the Owners of the Property and add other "Holders," if any)* **and the State Fire Marshal of Ohio agree to the following**:

1. Environmental Covenant. This instrument is an environmental covenant developed and executed pursuant to ORC §§ 5301.80 to 5301.92.

2. Description of Property. This Environmental Covenant concerns [choose either: an approximately ____ acre tract of real property OR real property, Parcel Number(s)________] owned by ____________________________, located at _____, _________, __________, in County, Ohio, and more particularly described in Exhibit "A" attached hereto and hereby incorporated by reference herein ("Property").

(Note: For purposes of this Environmental Covenant, the Subject Property shall be further defined in Exhibit "A", which shall contain a sufficient Legal Description of Subject Property i.e., in metes and bounds. Exhibit "A" must be attached with the Environmental Covenant draft in order for it to be approved. BUSTR recommends attaching the most recent deed for the property as Exhibit "A" in order to expedite review by BUSTR of ownership, legal description, etc.)

3. Owner(s). _______________ ("**Owner**") (*Choose either… "who resides" OR "which is located"*) at *(Address)* , *(City)* , *(State)* is the owner of the Property.

4. Holder(s). The Owner(s), whose address(es) [*is/are*] listed above and [*if there are additional holders such as different responsible parties, then list Holders' names and addresses*] are the ("**Holders**") of this Environmental Covenant.

5. Activity and Use Restrictions. As part of the corrective action at the Subject Property and in consideration for the State Fire Marshal's forbearance to require unrestricted land use for the Subject Property and to issue a no further action status, Owner hereby imposes and agrees to comply with the following activity and use limitations:

[Preparer, insert the limitations appropriate for the Property. Several limitations may be appropriate. Each type of limitation must be **considered on a site-specific basis and with the pre-approval of the BUSTR Coordinator** to determine which limitation or combination of limitations is suitable for the particular circumstances of the site or facility, based on the nature of contamination, the affected media and the potential exposures. Limitations generally must include the ENTIRE facility/property. The types of limitations include:]

Prohibition Against Extraction of Groundwater. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum in groundwater located at or underlying the Property described herein, no person shall extract the groundwater located at or underlying the Property or any portion thereof for any purpose, potable or otherwise, except for groundwater investigation or remediation.

Land Use Restriction. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum on and underlying the Property described herein, the Property and any portion thereof is hereby restricted to Non-Residential Use only, as that term is defined in Ohio Administrative Code

("OAC") 1301:7-9-13(C)(18). (effective September 1, 2022). See Ohio Administrative Code ("OAC") 1301:7-9-13(C)(27) for the definition of Residential Use (effective September 1, 2022).

Prohibition against Basements. As a portion of the remedy under the State Fire Marshal's Bureau of Underground Storage Tank Regulations ("BUSTR") program to protect against exposure to petroleum on and underlying the Property described herein, no basement or other permanent subsurface or underground structure designed for routine human occupancy shall be constructed at the property.

6. Running with the Land. This Environmental Covenant shall be binding upon the Owner and all assigns and successors in interest, including any Transferee, and shall run with the land, pursuant to ORC § 5301.85, subject to amendment or termination as set forth herein. The term "Transferee," as used in this Environmental Covenant, shall mean any future owner of any interest in the Property or any portion thereof, including, but not limited to, owners of an interest in fee simple, mortgagees, easement holders, and/or lessees.

7. Compliance Enforcement. Compliance with this Environmental Covenant may be enforced pursuant to ORC § 5301.91. Failure to timely enforce compliance with this Environmental Covenant or the use limitations contained herein by any party shall not bar subsequent enforcement by such party and shall not be deemed a waiver of the party's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict the Ohio State Fire Marshal from exercising any authority under applicable law.

8. Rights of Access. Owner(s) hereby grants to State Fire Marshal, its agents, contractors, and employees as well as the *[**LIST** applicable local units of government including **County and City, Township, or Village**], and [add additional "Holders", if any],* the right of access to the Property for implementation or enforcement of this Environmental Covenant. *(Questions on this requirement, See ORC §§ 5301.82(A)(6) and 5301.91(A))*

9. Notice upon Conveyance. Each instrument hereafter conveying any interest in the Property, or any portion of the Property shall contain a notice of the activity and use limitations set forth in this Environmental Covenant and provide the recorded location of this Environmental Covenant. The notice shall be substantially in the following form:

"THE INTEREST CONVEYED HEREBY IS SUBJECT TO AN ENVIRONMENTAL COVENANT, DATED________, 20___, RECORDED IN THE DEED OR OFFICIAL RECORDS OF THE _______COUNTY RECORDER ON ___________, 20___, IN [DOCUMENT _____, *or* BOOK____, PAGE ____]. THE ENVIRONMENTAL COVENANT CONTAINS THE FOLLOWING ACTIVITY AND USE LIMITATIONS: … [insert language]**"**

*(**NOTE:** Preparer, unless you elect to, you do not need to reiterate all of the specific activity or use restrictions to this portion. FUTURE document preparers; however, must reinsert the activity and use limitations exactly as they appear in paragraph 5 of this Environmental Covenant to any subsequent conveyances)*

Owner, or its assigns or successors in interest (including any Transferee who conveys the Property) shall notify the State Fire Marshal *[and any "Holders" other than the Owner]* **within thirty (30) days after each conveyance of an interest in any portion of the Property**. The notice shall include the name, address, and telephone number of the Transferee who acquires the Property, a copy of the deed or other documentation evidencing the conveyance, and a survey map that shows the boundaries of the property being transferred.

10. Compliance Reporting. Owner(s) or any Transferee shall submit to the State Fire Marshal, every five (5) years, written documentation verifying that the activity and use limitations remain in place and are being complied with. The first five (5) year period shall commence from the Effective Date as defined in this Environmental Covenant. (See Paragraph 17)

11. Non-complying Use. If the Property or any portion of the Property is put to a use that does not comply with this Environmental Covenant, then the No Further Action (NFA) status issued for the Property by the State Fire Marshal, pursuant to Chapter 3737 of the Ohio Revised Code and the regulations promulgated thereunder, is void on and after the date of the commencement of such non-complying use.

12. Representations and Warranties. Owner(s) hereby represents and warrants to the other signatories hereto that Owner has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder; that the Owner holds fee simple title which is free, clear and unencumbered; that the Owner has identified all other parties that hold any interest (e.g., encumbrance) in the Property and notified such parties of the Owner's intention to enter into this Environmental Covenant; that this Environmental Covenant will not materially violate or contravene or constitute a material default under any other agreement, document or instrument to which Owner is a party or which Owner may be bound or affected.

13. Amendment or Termination. This Environmental Covenant may be amended or terminated by consent of all of the following: the Owner or a Transferee; [*other "Holders," if any;*] and the State Fire Marshal,[1] pursuant to ORC § 5301.90 and other applicable law. The term, "Amendment," as used in this Environmental Covenant, shall mean any changes to the Environmental Covenant, including the activity and use limitations set forth herein, or the elimination of one or more activity and use limitations when there is at least one limitation remaining. The term, "Termination," as used in this Environmental Covenant, shall mean the elimination of all activity and use limitations set forth herein and all other obligations under this Environmental Covenant.

This Environmental Covenant may be amended or terminated only by a written instrument duly executed by the Ohio State Fire Marshal and the Owner or Transferee *[and other "Holders," if any]* of the Property or portion thereof, as applicable. Within thirty (30) days of signature by all requisite parties on any amendment or termination of this Environmental Covenant, the Owner or Transferee shall file such instrument for recording with the *(Insert Name of County)* County Recorder's Office and shall provide a file- and date-stamped copy of the recorded instrument to State Fire Marshal.

14. Severability. If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired.

15. Governing Law. This Environmental Covenant shall be governed by and interpreted in accordance with the laws of the State of Ohio.

[1] See ORC § 5301.82 (B) (3), which allow for "limitations on amendment or termination."

16. Recordation. Within **thirty (30) days** after the date of the final required signature upon this Environmental Covenant, Owner shall file this Environmental Covenant for recording, in the same manner as a deed to the Property, with the _*(Insert Name of County)*_ County Recorder's Office.

17. Effective Date. The effective date of this Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded as a deed record for the Property with the _*(Insert Name of County)*_ County Recorder.

18. Distribution of Environmental Covenant. The Owner shall distribute a file- and date stamped copy of the recorded Environmental Covenant to: State Fire Marshal; the _________, *[must send a copy to the local units of government including **County and City, Township, Village]***; __________ [*must insert each person who signed the Environmental Covenant such as other holders*] and ________ [*must insert all parties **holding a recorded interest in the Property such as a lessee, etc.***]. (*Per ORC § 5301.83, State Fire Marshal or BUSTR may request other person(s) or parties to be sent a copy*)

19. Notice. Any document or communication required by this Environmental Covenant shall be submitted to:

Bureau of Underground Storage Tank Regulations ("BUSTR")
Division of State Fire Marshal
8895 East Main Street
Reynoldsburg, OH 43068

The Undersigned Owner (or) Representative of the Owner (*if the owner is a corporation*) *[and other "Holders," if any]* represent[*s*] and certif[*y/ies*] that *[he/she/they]* [*is/are*] authorized to execute this Environmental Covenant.

IT IS SO AGREED:

[INSERT NAME OF OWNER(S)]

____
Signature of (*Type in Name of Owner or Owner Representative*)

______________________________ ____________________
Print Name and Title Date

For Notary to complete the following portion:

1. FOR SIGNATURE(S) OF A CORPORATION REPRESENTATIVE, USE…

State of Ohio :
: ss
County of ___________________ :

Before me, a notary public, in and for said county and state, personally appeared ________________________, a duly authorized representative of ___________________, who acknowledged to me that *[he/she]* did execute the foregoing instrument on behalf of ______________________.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this day of ______________, 20 ___.

____
Signature of Notary Public

____
Commission Expires

or

2. *FOR SIGNATURES OF INDIVIDUALS, USE…*

State of Ohio :
:
County of ___________________ :

Before me, a notary public, in and for said county and state, personally appeared ____________, the Property Owner, who acknowledged to me that [*he/she*] did execute the foregoing instrument on [*his/her*] behalf.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this day of ______________________, 20___.

____
Signature of Notary Public

____
Commission Expires

STATE FIRE MARSHAL OF OHIO

____
(Signature) xxxxxx, State Fire Marshal of Ohio

____
Date

[*Preparer, please make sure you have inserted the name of the CURRENT State Fire Marshal or his designee. To obtain the name of the current State Fire Marshal, you may visit our website at http://www.com.ohio.gov/fire/ or call us at 614-752-7938. Remove this paragraph from the final submitted copy.*]

SFM Notary to complete the following portion:

State of Ohio :
:
County of Licking :

Before me, being a notary public, in and for said county and state, did personally observe the appearance of xxxxxxxx, State Fire Marshal of Ohio, who acknowledged to me that he did execute the foregoing instrument on behalf of the State of Ohio, Department of the State Fire Marshal, Bureau of Underground Storage Tank Regulations (BUSTR).

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this _____________day of _______________, 20_____.

____
Signature of Notary Public

____
Commission Expires

(ONLY IF APPLICABLE, ADD THE FOLLOWING)

[Insert Name of Additional Holder(s), if Required]

____
Signature of ***[Insert Name of Holder]***

______________________________ ________________________
Print Name and Title Date

State of ______________________ :

County of_____________________ :

Before me, a notary public, in and for said county and state, personally appeared________ a duly authorized representative of _________________, who acknowledged to me that *[he/she]* did execute the foregoing instrument on behalf of _______________.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this day of _______________, 20 _____ .

____
Signature of Notary Public

____
Commission Expires

Document prepared by:

Insert Preparer's Information

PLEASE INCLUDE EXHIBIT "A" WITH YOUR ENVIRONMENTAL COVENANT DRAFT SUBMISSION. (The Covenant will NOT be approved if Exhibit "A" is missing or inadequate.

ATTACH EXHIBIT(S) AFTER THE SIGNATURE PAGES.

Appendix D: Forms

This appendix includes a list of the forms that must be used for the reporting, notification, and documentation requirements of OAC 1301:7-9-12, 1301:7-9-13, 1301:7-9-16, and 1301:7-9-17, and provides the basic guidelines and content requirements. Please check the BUSTR resource website https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up for updated versions of the following forms:

Class C Determination Request Form
Closure Assessment Form 2022
Closure-In-Place Form 2022
Extension Request Form 2022
Immediate Corrective Actions Form 2022
Interim Response Action Form 2022
Interim Response Action Notification Form 2022
Laboratory Analysis QA/QC Summary Form 2022
Monthly Free Product Recovery Form 2022
Petroleum Contaminated Soil Form 2022
Piping Modification and Closure Assessment Form No Sampling Required 2022
Quarterly Free Product Recovery Form 2022
Release VAP Eligibility Request Form
Shear Valve Replacement Form 2022
Soil Classification Form 2022
Suspected Release Notification Form
Suspected Release - Tightness Test Form 2022
Tier 1 Evaluation Form 2022
Tier 1 Investigation Form 2022
Tier 1 Notification Form 2022
Tier 2 Evaluation Form 2022

In addition, the following helpful templates are provided:

300 ft. Survey Letter Template
Land Use Survey Letter Template 2022
Owner-Operator Affidavit 2022
Potable Water Well Affidavit 2022

Appendix E: Action Level Development

E.1 Tier 1 Action Levels

The ALs published in the OAC 1301:7-9-13 were developed using the assumptions, parameters, and algorithms provided in this Appendix. BUSTR's ALs have been developed for the most common COCs using the most conservative assumptions for the exposure pathways typically encountered at a UST site. Specifically, ALs assume that the receptors will be children and adults living at the site and that all exposures will occur at the source of the highest COC concentrations.

E.2 Tier 2 Site-Specific Target Levels

The BUSTR Spreadsheets must be used to evaluate COC fate and transport when the COC concentrations exceed ALs for complete exposure pathways. The fate and transport of COCs may be evaluated by conducting *one or a combination* of the following three options:

1. Develop SSTLs by replacing default values with site-specific data in the BUSTR Spreadsheets;
2. Utilize analytical fate and transport modeling (i.e., BUSTR-Screen) to predict COC concentrations in groundwater at each POE; and/or
3. Back-calculate SSTLs by utilizing a combination of BUSTR-Screen and BUSTR Spreadsheets.

Spreadsheets are found at https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up or by contacting BUSTR at (614) 752-7938.

E.2.1 SSTL Development in BUSTR Spreadsheets (Option 1)

SSTLs can be calculated by replacing the default values used in AL calculations with site-specific values for certain geological and hydrogeological parameters. Site-specific values may *only* be substituted for the following parameters:

- Total porosity in vadose zone;
- Volumetric water content in vadose zone;
- Volumetric air content in vadose zone;
- Volumetric air content in capillary fringe soil;
- Volumetric water content in capillary fringe soil;
- Total organic carbon;
- Dry bulk density;
- Saturated hydraulic conductivity; and
- Other values that were determined during the Tier evaluation process, such as depth to groundwater, soil type, depth from source to groundwater, and land-use classification, may be changed with supporting documentation.

Site specific geotechnical data may be used in BUSTR's spreadsheets to calculate SSTLs. Maximum contaminant levels for each pathway must be compared to the site-specific target levels.

Please note that the building type (residential or non-residential) must match the land-use determination in the spreadsheets.

BUSTR Spreadsheets evaluate the following pathways:

- Soil to indoor air;
- Soil to outdoor air;
- Groundwater to indoor air;
- Groundwater to outdoor air; and
- Soil leaching to drinking water or groundwater.

Direct contact and TPH values Tables 3.7 and 3.8, respectively, **cannot** be recalculated using site-specific data. For chemicals not listed in the direct contact table, reference the Ohio EPA DERR VAP generic direct contact standards and supplemental generic direct contact standards (OAC 3745-300-08).

E.2.2 Fate and Transport Modeling Using BUSTR-Screen (Option 2)

BUSTR-Screen is a groundwater fate and transport model, based on the USEPA's BIOSCREEN Model, that may be used to predict COC concentrations at each POD or POE for groundwater ingestion and groundwater to indoor air pathways.

The purpose of the BUSTR-Screen is to simplify presentation of input parameters and output results for BUSTR CA sites.

BIOSCREEN and BUSTR-Screen are Microsoft® Excel based modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen model are identical to those used in the BIOSCREEN Model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if groundwater fate and transport modeling is performed during the Tier 2 Evaluation process.

The BUSTR-Screen model can be downloaded from the SFM/BUSTR website at https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up. For additional information, see Appendix F.

E.2.3 Back Calculation Using BUSTR Spreadsheets and BUSTR-Screen (Option 3)

Another option for calculating SSTLs is using BUSTR Spreadsheets and BUSTR-Screen to evaluate the fate and transport of COCs in the environmental media for the soil leaching, groundwater transport, and/or volatilization pathways. A combination of the soil to groundwater leaching and BUSTR-Screen spreadsheets may be used to predict acceptable soil and groundwater SSTLs that are protective at the POE.

E.3 Default Parameters

Tables E.1 – E.4 provide the default input and exposure parameters used in developing the Tier 1 action levels and the recommended parameters for developing Tier 2 SSTLs. Less conservative, site-specific values may be substituted for many of these default parameters. **Whenever a site-specific input parameter is substituted for a default parameter, provide supporting documentation to BUSTR**. Do not modify the default exposure parameters, as listed in Table E.1.

Table E.1 - Default Exposure Parameters

			Residents				**Workers**			
Parameter	**Symbol**	**Units**	**Child**		**Adult**		**Non-residential**		**Excavation**	
Target Risk	TR	unitless	1.00E-05	a	1.00E-05	a	1.00E-05	a	1.00E-05	a
Target Hazard Quotient	THQ	unitless	1	a	1	a	1	a	1	a
Averaging Time (carcinogens)	AT_c	years	70	a	70	a	70	a	70	a
Averaging Time (non-carcinogens)	AT_n	years	6	a	17	a	25	b	1	c
Body Weight	BW	Kg	15	a	70	a	70	b	70	c
Exposure Duration	ED	years	6	a	17	a	25	b	1	c
Exposure Frequency	EF	Days	350	a	350	a	250	b	120	c
Skin surface area	SA	cm^2	NA	f	NA	f	NA	f	3,300	c
Soil to skin adherence factor	M	unitless	NA	f	NA	f	NA	f	1	d
Ingestion Rate	IR_{soil}	mg/day	NA	f	NA	f	NA	f	200	c
Inhalation Rate (indoor)	IR_{air}	m^3/hr	0.625	a	0.625	a	0.833	b	NA	f
Inhalation Rate (outdoor)	IR_{air}	m^3/hr	0.833	b	0.833	b	0.833	b	1.00	c
Exposure time (indoor)	ET	hours	16	a	16	a	8	e	NA	f
Exposure time (outdoor)	ET	hours	2	e	2	e	8	e	8	c,e

a. Values used in development of Tier 1 action levels.
b. ASTM RBCA standard default exposure.
c. VAP Voluntary Action Program (construction worker guidance).
d. U.S. EPA Supplemental Risk Assessment Guidance for Superfund.
e. U.S. EPA Exposure Factors Handbook.
f. Not applicable.

Table E.2 - Default Soil Parameters

Parameter	**Symbol**	**Units**	**Class 1 Soil**	**Class 2 Soil**	**Class 3 Soil**
Total Porosity in vadose zone	Θ_T	cm^3/cm^3	0.43	0.43	0.43
Volumetric water content in vadose zone	Θ_{ws}	cm^3/cm^3	0.12	0.15	0.25
Volumetric air content in vadose zone	Θ_{as}	cm^3/cm^3	0.31	0.28	0.18
Volumetric air content in capillary fringe soil	Θ_{acap}	cm^3/cm^3	0.043	0.043	0.043
Volumetric water content in capillary fringe soil	Θ_{wcap}	cm^3/cm^3	0.387	0.387	0.387
Thickness of capillary fringe	h_{cap}	Cm	5	5	5
Fraction organic carbon	F_{oc}	g oc/ g soil	0.002	0.0025	0.003
Bulk density	ρ_s	g/cm^3	1.4	1.6	1.8
Saturated hydraulic conductivity	K_s	cm/sec	5.83E-03	4.17E-05	1.67E-05
Wetting front suction head	Ψ	Cm	-4.95	-21.85	-31.63
Infiltration rate	I	cm/year	31.75	20.32	6.35
Ponding depth	H	Cm	0	0	0

Table E.3 - Default Building Parameters

Parameter	Symbol	Units	Residential	Non-Residential
Enclosed space air exchange rate	ER	1/sec	1.39E-04	2.30E-04
Enclosed space volume/infiltration area ratio	L_B	Cm	487.68	487.68
Enclosed space foundation or wall thickness	Lcrack	Cm	15	15
Areal fraction of cracks in foundation/walls	η	cm^2/cm^2	0.001	0.001
Volumetric air content in foundation/wall cracks	Θ_{acrack}	cm^3/cm^3	0.25	0.25
Volumetric water content in foundation/wall cracks	Θ_{wcrack}	cm^3/cm^3	0.19	0.19

Table E.4 - Default Groundwater and Atmospheric Parameters

Parameter	Symbol	Units	Value
Groundwater Darcy velocity	U_{gw}	cm/yr.	2500
Groundwater mixing zone thickness	δ_{gw}	cm	200
Ambient air mixing zone height	δ_{air}	cm	200
Wind speed above ground surface in ambient mixing zone	U_{air}	cm/sec	225
Width of source area parallel to wind direction	W	cm	1500

E.3.1 Default Physical, Chemical, and Toxicological Properties for COCs

Tables E.5 and Table E.6 provide COC specific input parameter values for deriving ALs; additional COCs also are provided below. Contact BUSTR for assistance if a COC specific input parameter value is not provided on these tables or in these references.

Table E.5 - Reference Table of Physical and Chemical Properties

Chemical of Concern	Molecular Weight g/mol	Reference	Solubility 20°-25° mg/L	Reference	Vapor Pressure 20°-25° mmHg(sat)	Reference	Henry's Law Constant Dimensionless	Reference	Soil-Water Partition Coeff. K_{oc} (L/kg)	Reference
Aromatic Hydrocarbons										
Benzene	78.11	q	1.79E+03	q	9.52E+01	h	2.27E-01	q	1.46E+02	q
Toluene	92.14	q	5.26E+02	b	2.84E+01	h	2.71E-01	q	2.34E+02	q
Ethylbenzene	106.17	q	1.69E+02	b	9.60E+00	h	3.22E-01	q	4.46E+02	q
xylenes, total	106.17	q	1.06E+02	q	8.84E+00	h	2.12E-01	q	3.83E+02	q
1,2,4 trimethylbenzene	120.2	s	5.70E+01	s	2.03E+00	a	2.52E-01	q	6.14E+02	q
Additives										
1,2 dibromoethane, EDB	187.86	q	3.91E+03	q	1.12E+01	h	2.66E-02	q	3.96E+01	q
1,2 dichloroethane, EDC	98.96	q	8.6E+03	q	7.89E+01	h	4.82E-02	q	3.96E+01	q
methyl tert butyl ether, MTBE	88.15	q	5.10E+04	q	2.49E+02	h	2.40E-02	q	1.16E+01	q
Polynuclear Aromatic Hydrocarbons										
Acenaphthene	154.21	q	3.90E+00	q	2.30E-03	a	7.52E-03	q	5.03E+03	q
Anthracene	178.24	q	4.34E-02	q	2.67E-06	h	2.27E-03	q	1.64E+04	q
benzo(a)anthracene	228.3	a	9.40E-03	b	3.05E-08	h	4.91E-04	q	1.77E+05	q
benzo(b)fluoranthene	252.32	q	1.50E-03	b	5.00E-07	h	2.69E-05	q	5.99E+05	q
benzo(k)fluoranthene	252.32	q	8.00E-04	b	9.65E-10	h	2.39E-05	q	5.87E+05	q
benzo(g,h,i)perylene	276.34	s	2.60E-04	s	1.01E+00	a	1.35E-05	q	1.95E+06	q
benzo(a)pyrene	252.32	q	1.62E-03	q	5.49E-09	a	1.87E-05	q	5.87E+05	q
Chrysene	228.3	a	2.00E-03	q	6.23E-09	h	2.14E-04	q	1.81E+05	q
Dibenz(a,h)anthracene	278.36	q	2.49E-03	q	1.00E -10	h	5.76E-06	q	1.91E+06	q
Fluoranthene	202.26	q	2.60E-01	q	1.23E-08	h	3.62E-04	q	5.55E+04	q
Fluorene	166.22	q	1.69E+00	q	8.42E-03	h	3.93E-03	q	9.16E+03	q

Table E.5 - Reference Table of Physical and Chemical Properties (continued)

Chemical of Concern	Molecular Weight g/mol	Reference	Solubility 20°-25° mg/L	Reference	Vapor Pressure 20°-25° mmHg(sat)	Reference	Henry's Law Constant Dimensionless	Reference	Soil-Water Partition Coeff. K_{oc} (L/kg)	Reference
Naphthalene	128.18	q	3.10E+01	b	8.50E-02	h	1.80E-02	q	1.54E+03	q
Pyrene	202.26	q	1.35E-01	b	2.45E-06	h	4.87E-04	q	5.43E+04	q
Volatile Organics										
carbon tetrachloride	153.82	q	7.93E+02	q	1.15E+02	a	1.13E+00	q	4.39E+01	q
Chlorobenzene	112.56	q	4.98E+02	q	1.20E+01	h	1.27E-01	q	2.34E+02	q
Chloroform	119.38	q	7.95E+03	q	1.97E+02	h	1.50E-01	q	3.18E+01	q
1,1 dichloroethane	98.96	q	5.04E+03	q	2.27E+02	a	2.30E-01	q	3.18E+01	q
1,1 dichloroethylene	96.94	q	2.42E+03	q	6.00E+02	h	1.07E+00	q	3.18E+01	q
cis 1,2 dichloroethylene	96.94	q	6.41E+03	q	2.01E+02	h	1.67E-01	q	3.96E+01	q
trans 1,2 dichloroethylene	96.94	q	4.52E+03	q	3.31E+02	h	1.67E-01	q	3.96E+01	q
methylene chloride	84.93	q	1.30E+04	b	4.35E+02	h	1.33E-01	q	2.17E+01	q
Styrene	104.15	q	3.10E+02	b	6.40E+00	h	1.12E-01	q	4.46E+02	q
1,1,2,2 tetrachloroethane	167.85	q	2.83E+03	q	4.62E+00	h	1.50E-02	q	9.49E+01	q
tetrachloroethylene (PCE)	165.83	q	2.06E+02	q	1.86E+01	a	7.24E-01	q	9.49E+01	q
1,1,1 trichloroethane	133.41	q	1.29E+03	q	1.24E+02	a	7.03E-01	q	4.39E+01	q
1,1,2 trichloroethane	133.41	q	4.59E+03	q	2.30E+01	h	3.37E-02	q	6.07E+01	q
trichloroethylene (TCE)	131.39	q	1.28E+03	q	6.90E+01	a	4.03E-01	q	6.07E+01	q
vinyl chloride	62.5	a	8.80E+03	q	2.98E+03	h	1.14E+00	q	2.17E+01	q

a. Montgomery, J. H., 1996. Groundwater Chemicals Desk Reference, 2nd. Edition. CRC Press, Inc. Boca Raton, FL.
b. USEPA, 1996. *Soil Screening Guidance*, EPA540/R-96/018.
f. Henry's Law Constant (HLC) (atm-m^3/mol) is calculated from HCL (dimensionless) by dividing by 41. HLC (dimensionless) is calculated from HLC (atm-m3/mol) by multiplying by 41(Soil Screening Guidance).
h. Howard and Meylan, 1997. *Handbook of Physical Properties of Organic Chemicals*.
j. K_{oc} value is converted from log K_{oc} given in Reference a.
q. Ohio EPA - Voluntary Action Program CIDARS - Revised 6-15-15.
s. Hazardous Substance Data Bank (HSDB)

Table E.5 - Reference Table of Physical and Chemical Properties (continued)

Chemical of Concern	Degradation Rate (Half-Life) high end to low end range day^{-1},(days)	Reference	Air Diffusivity $D_{i,a}$ (25°C) cm^2/s	Reference	Water Diffusivity $D_{i,w}$ (25°C) cm^2/s	Reference
Aromatic Hydrocarbons						
Benzene	7.00E-02(10) - 9.60E-04(720)	d	8.95E-02	q	1.03E-05	q
Toluene	0.1(7) -0.025(28)	d	7.78E-02	q	9.20E-06	q
Ethylbenzene	0.1(6) -0.00304(228)	d	6.85E-02	q	8.46E-06	q
xylenes, total	0.050(14) -0.0019(360)	d	8.47E-02	q	9.90E-06	q
1,2,4 trimethylbenzene	4.50E-02(15) - 1.23E-02(56)	d	6.07E-02	q	7.92E-06	q
Additives						
1,2 dibromoethane, EDB	0.0354(19.6) - 0.0058(120)	d	4.30E-02	q	1.04E-05	q
1,2 dichloroethane, EDC	0.007(100) -0.0019(360)	d	8.57E-02	q	1.10E-05	q
methyl tert butyl ether, MTBE	0.012(56) -0.0019(360)	d	7.53E-02	q	8.59E-06	q
Polynuclear Aromatic Hydrocarbons						
Acenaphthene	0.0282(24.6) - 0.00340(204)	d	5.06E-02	q	8.33E-06	q
Anthracene	0.007(100) -0.00075(920)	d	3.90E-02	q	7.85E-06	q
benzo(a)anthracene	0.00340(204) - 0.000510(1360)	d	5.09E-02	q	5.94E-06	q
benzo(b)fluoranthene	0.00096(720) - 0.000568(1220)	d	4.76E-02	q	5.56E-06	q
benzo(k)fluoranthene	0.0003898(1778) - 0.000162(4280)	d	4.76E-02	q	5.56E-06	q
benzo(g,h,i)perylene	0.0005873(1180) - 0.0005331(1300)	d	4.48E-02	q	5.23E-06	q
benzo(a)pyrene	0.00608(114) - 0.000654(1060)	d	4.76E-02	q	5.56E-06	q
Chrysene	0.000934(742) - 0.0003(2000)	d	2.61E-02	q	6.75E-06	q
Dibenz(a,h)anthracene	0.000960(722) - 0.000369(1880)	d	4.46E-02	q	5.21E-06	q
Fluoranthene	0.0025(280) - 0.00079(880)	d	2.76E-02	q	7.18E-06	q
Fluorene	0.011(64) -0.0058(120)	d	4.40E-02	q	7.89E-06	q

Table E.5 - Reference Table of Physical and Chemical Properties (continued)

Chemical of Concern	Degradation Rate (Half-Life) high end to low end range day^{-1},(days)	Reference	Air Diffusivity $D_{i,a}$ (25°C) cm^2/s	Reference	Water Diffusivity $D_{i,w}$ (25°C) cm^2/s	Reference
naphthalene	0.7(1) -0.00269(258)	d	6.05E-02	q	8.38E-06	q
Pyrene	0.0017(420) - 0.00018(3800)	d	2.78E-02	q	7.25E-06	q
Volatile Organics						
carbon tetrachloride	0.1(7) -0.0019(360)	d	5.71E-02	q	9.78E-06	q
chlorobenzene	0.0051(136) -0.002(300)	d	7.21E-02	q	9.48E-06	q
Chloroform	0.012(56) -0.0004(1800)	d	7.69E-02	q	1.09E-05	q
1,1 dichloroethane	0.011(64) -0.0019(360)	d	8.36E-02	q	1.06E-05	q
1,1 dichloroethylene	0.012(56)-0.005(132)	d	8.63E-02	q	1.10E-05	q
cis 1,2 dichloroethylene	0.0124(56) - 0.000241 (2875)	d	8.84E-02	q	1.13E-05	q
trans 1,2 dichloroethylene	0.0124(56) - 0.000241 (2875)	d	8.76E-02	q	1.12E-05	q
methylene chloride	0.050(14) -0.012(56)	d	9.99E-02	q	1.25E-05	q
Styrene	0.025(28) -0.003(210)	d	7.11E-02	q	8.78E-06	q
1,1,2,2 tetrachloroethane	1.550(.446) -0.015(45)	d	4.89E-02	q	9.29E-06	q
tetrachloroethylene (PCE)	0.0019(360) -0.00096(720)	d	5.05E-02	q	9.46E-06	q
1,1,1 trichloroethane	0.005(140) -0.0013(546)	d	6.48E-02	q	9.60E-06	q
1,1,2 trichloroethane	0.0051(136) -0.00095(730)	d	6.69E-02	q	1.00E-05	q
trichloroethylene (TCE)	0.0022(321) -0.0004(1653)	d	6.87E-02	q	1.02E-05	q
vinyl chloride	0.012(56) - 2.41E-04(2875)	d	1.07E-01	q	1.20E-05	q

a. Montgomery, J. H., 1996. Groundwater Chemicals Desk Reference, 2nd. Edition. CRC Press, Inc. Boca Raton, FL.
b. USEPA, 1996. *Soil Screening Guidance*, EPA540/R-96/018.
d. Howard, P., et al., 1991. *Handbook of Environmental Degradation Rates*, Lewis Publishers Inc., Chelsea, MI.
Half-life values are given in days for groundwater and include a high-end range and low-end range.
j. K_{oc} value is converted from log K_{oc} given in Reference a.
q. Ohio EPA - Voluntary Action Program CIDARS - Revised 6-15-15.
s. Hazardous Substance Data Bank (HSDB)

Table E.6 - Reference Table of Toxicological Properties

Chemical of Concern	Slope Factor Ingestion 1/(mg/kg-d)	Reference	Slope Factor Inhalation (p) 1/(mg/kg-d)	Reference	Reference Dose Ingestion mg/kg-d	Reference	Reference Dose Inhalation (p) mg/kg-d	Reference
Aromatic Hydrocarbons								
Benzene	5.50E-02	q	2.73E-02	k	4.00E-03	q	8.57E-03	q
Toluene	no data		no data		8.00E-02	q	1.43E+00	q
Ethylbenzene	1.10E-02	q	no data		1.00E-01	q	2.86E-01	q
xylenes, total	no data		no data		2.00E-01	q	2.86E-02	q
1,2,4 trimethylbenzene	no data		no data		no data		2.00E-03	q
Additives								
1,2 dibromoethane, EDB	2.00E+00	q	2.10E+00	q	9.00E-03	q	2.57E-03	q
1,2 dichloroethane, EDC	9.10E-02	q	9.10E-02	q	no data		2.00E-03	q
methyl tert butyl ether, MTBE	1.80E-03	q	9.10E-04	q	no data		8.57E-01	q
Polynuclear Aromatic Hydrocarbons								
Acenaphthene	no data		no data		6.00E-02	q	no data	
Anthracene	no data		no data		3.00E-01	q	no data	
benzo(a)anthracene	7.30E-01	q	3.85E-01	q	no data		no data	
benzo(b)fluoranthene	7.30E-01	q	3.85E-01	q	no data		no data	
benzo(k)fluoranthene	7.30E-02	q	3.85E-01	q	no data		no data	
benzo(g,h,i)perylene	no data		no data		3.00E-02	q	no data	
benzo(a)pyrene	7.30E+00	q	3.85E+00	q	no data		no data	
Chrysene	7.30E-03	q	3.85E-02	q	no data		no data	
Dibenz(a,h)anthracene	7.30E+00	q	4.20E+00	q	no data		no data	
Fluoranthene	no data		no data		4.00E-02	q	no data	
Fluorene	no data		no data		4.00E-02	q	no data	

Table E.6 - Reference Table of Toxicological Properties (continued)

Chemical of Concern	Slope Factor Ingestion 1/(mg/kg-d)	Reference	Slope Factor Inhalation (p) 1/(mg/kg-d)	Reference	Reference Dose Ingestion mg/kg-d	Reference	Reference Dose Inhalation (p) mg/kg-d	Reference
Indeno(1,2,3-cd)pyrene	7.30E-01	q	3.85E-01	q	no data		no data	
Naphthalene	no data		1.19E-01	q	2.00E-02	q	8.57E-04	q
Pyrene	no data		no data		3.00E-02	q	no data	
Volatile Organics								
carbon tetrachloride	7.00E-02	q	2.10E-02	q	4.00E-03	q	2.86E-02	q
Chlorobenzene	no data		no data		2.00E-02	q	1.43E-02	q
Chloroform	3.10E-02	q	8.05E-02	q	1.00E-02	q	2.80E-02	q
1,1 dichloroethane	5.70E-03	q	5.60E-03	q	2.00E-01	q	no data	
1,1 dichloroethylene	no data		no data		5.00E-02	q	5.71E-02	q
cis 1,2 dichloroethylene	no data		no data		2.00E-03	q	no data	
trans 1,2 dichloroethylene	no data		no data		2.00E-02	q	1.71E-02	q
methylene chloride	2.00E-03	q	3.50E-05	q	6.00E-03	q	1.71E-01	q
Styrene	no data		no data		2.00E-01	q	2.86E-01	q
1,1,2,2 tetrachloroethane	2.00E-01	q	2.03E-01	q	2.00E-02	q	no data	
tetrachloroethylene (PCE)	2.10E-03	q	9.10E-04	q	6.00E-03	q	1.14E-02	q
1,1,1 trichloroethane	no data		no data		2.00E+00	q	1.43E+00	q
1,1,2 trichloroethane	5.70E-02	q	5.60E-02	q	4.00E-03	q	no data	
trichloroethylene (TCE)	4.60E-02	q	1.44E-02	q	5.00E-04	q	5.71E-04	q
vinyl chloride	7.20E-01	q	1.54E-02	q	3.00E-03	q	2.86E-02	q

k. Integrated Risk Information System (IRIS).
p. Inhalation reference dose (RfD) values in this table may have been converted from a given reference concentration (RfC). The RfC (in mg/m3) is converted to a RfD (in mg/kg/d) by multiplying the RfC by 20 m3/d (inhalation rate) and dividing by 70 kg (body weight).
q. Ohio EPA - Voluntary Action Program CIDARS - Revised 6-15-15.

E.4 Groundwater Ingestion Pathway

E.4.1 Tier 1

The groundwater ingestion AL for most COCs is derived from the maximum contaminant level (MCL) established by the USEPA under the National Primary Drinking Water Regulations (40 CFR Part 141) and the National Secondary Drinking Water Regulations (40 CFR Part 143).

For COCs that do not have MCLs, ALs are based on a Generic Unrestricted Potable Use Standard (GUPUS) calculated by Ohio EPA DERR VAP. These action levels are listed in OAC 3745-300-08 Appendix, Table VII.

E.4.2 Tier 2

When groundwater/surface water can be used as drinking water, it is assumed that the adult and/or child receptor can ingest the dissolved COCs, regardless of the land-use determination. Therefore, SSTL's cannot be calculated for the groundwater ingestion pathway during a Tier 2 Evaluation. It will be necessary to model groundwater contamination from the source area to the POE and the action level at the POE will be the MCL.

If a MCL is not available for a COC, the GUPUS action level calculated by the Ohio EPA DERR VAP must be used.

If a MCL or GUPUS is not available for a COC, BUSTR must be consulted.

E.5 Direct Contact with Soil Pathway

E.5.1 Tier 1

Direct contact evaluates the following exposure routes for adult or child receptor in a residential setting:

- Incidental ingestion;
- Dermal contact;
- Inhalation of volatile organic compounds; and
- Inhalation of particulates.

The direct contact AL for each COC are listed in the Ohio EPA DERR VAP rule OAC 3745-300-08 Appendix Table I: *Generic Numerical Direct Contact Soil Standards (Residential Land Use Category)*.

E.5.2 Tier 2

Residential

Residential direct contact action levels are listed in OAC 3745-300-08 Appendix Table I: *Generic Numerical Direct-Contact Soil Standards (Residential Land Use Category).* Direct contact action levels cannot be recalculated using site specific information.

Non-Residential

Non-residential land use direct contact action levels are listed in the Ohio EPA DERR VAP rule OAC 3745-300-08 Appendix Table II: Generic Numerical Direct-Contact Soil Standards (Commercial/Industrial Land Use Category). Direct contact action levels cannot be recalculated using site specific information.

Construction and Excavation Worker

The construction and excavation workers direct contact pathway must be evaluated whenever all soil pathways required in Tier 1 have been eliminated. The POE will be evaluated on a case-by-case basis. Excavation worker direct contact action levels are listed in the Ohio EPA DERR VAP rule OAC 3745-300-08 Appendix Table IV: Generic Numerical Direct-Contact Soil Standards (Construction Activities Category). Direct contact action levels cannot be recalculated using site specific information.

E.6 Indoor Air Inhalation Pathway

The indoor air SSTL is the acceptable concentration of a COC that a receptor may be exposed to within a home or other building.

E.6.1 Assumptions

Residential Land Use

Calculate the residential indoor air concentrations for carcinogenic COCs with a combined adult and child exposure that averages life spans. This assumption suggests that a resident spends some of that time as a child and the remainder as an adult. The combined approach results in more conservative ALs/SSTLs as opposed to evaluating adults or children individually.

Calculate the residential indoor air concentrations for non-carcinogenic COCs with only the child's exposure. These assumptions were made for the non-carcinogen case because during the child's exposure, the body weight values are low and the inhalation rates are equal to the adult values, resulting in more conservative action levels/SSTLs.

Non-Residential Land Use

Calculate the non-residential indoor air concentrations for both carcinogenic and non-carcinogenic COCs for the adult worker. Although residents may be exposed at non-residential properties, their exposures are assumed to be infrequent and of short duration. Adult workers are the maximally exposed receptor group, resulting in more conservative SSTLs.

E.6.2 Algorithms

Calculate the SSTLs for vapor to indoor air using Equations E.1, E.2, and E.3, which are found in the *Risk Assessment Guidance for Superfund*.

Equation E.1 - Carcinogenic Chemicals of Concern (Non-Residential Only)

$$SSTL_{air\text{-}c} = \frac{TR \text{ x } BW \text{ x } AT_c \text{ x } 365 \frac{days}{year} \text{ x } 10^3 \frac{ug}{mg}}{SF_i \text{ x } IR_{air} \text{ x } ET \text{ x } EF \text{ x } ED}$$

Equation E.2 - Non-Carcinogenic Chemicals of Concern

$$SSTL_{air\text{-}h} = \frac{THQ \text{ x } RfD \text{ x } BW \text{ x } AT_c \text{ x } 365 \frac{days}{year} \text{ x } 10^3 \frac{ug}{mg}}{IR_{air} \text{ x } ET \text{ x } EF \text{ x } ED}$$

Equation E.3 - Carcinogenic Chemicals of Concern (Residential Only) Input Parameters

$$SSTL_{air\text{-}c} = \frac{TR \text{ x } AT_c \text{ x } 365 \frac{days}{year} \text{ x } 10^3 \frac{ug}{mg}}{SF_i \text{ x } ET \text{ x } EF \text{ x } \left[\frac{ED_{child} \text{ x } IR_{child}}{BW_{child}} + \frac{ED_{adult} \text{ x } IR_{adult}}{BW_{adult}}\right]}$$

See the Default Parameters Section of this Appendix for the input parameters for Equations E.1, E.2, and E.3. There are no input parameters unique to these algorithms.

E.7 Soil to Indoor Air Pathway

Where a soil source area exists below a building, COCs adsorbed to soil can volatilize into the soil pore spaces; travel through the soil, and into the cracks in a foundation of a building, ultimately mixing with the air inside of the building.

E.7.1 Algorithms

Calculate the SSTLs for vapor to indoor air from soil sources using Equation E.4, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation E.4 - SSTL Soil to Indoor Air

$$SSTL_{soil\text{-}air} = \frac{SSTL_{air}}{VF} \text{ x } 10^{-3} \frac{mg}{ug}$$

E.7.2 Input Parameters

$SSTL_{air}$ is the SSTL for indoor air inhalation for a COC used in Equations 1, 2, and 3.

VF (also referenced as VF_{sesp}) is the volatilization factor for a COC in subsurface soil migrating to indoor air that is used in Equation E.5.

E.7.3 Volatilization Factor for a COC in Subsurface Soil to Indoor Air (VF_{sesp})

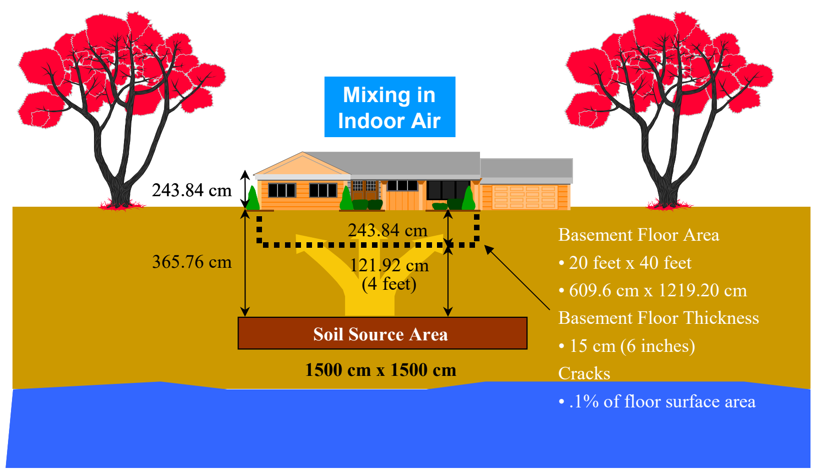
The VF for COCs in subsurface soil to indoor air relates the concentration of a COC in soil vapor to its concentration in soil. It describes the diffusion for COCs through the soil and cracks in a building's foundation.

E.7.4 Assumptions

When calculating Tier 1 action levels, it is assumed that:

- The house is a one-story structure with a full basement;
- The house is located directly over the soil source area;
- Vapors will infiltrate through the basement floor only; and
- The house dimensions are 40 ft. (1219.20 cm) by 20 ft. (609.6 cm) by 16 ft. (487.68 cm) in height (i.e., the combined height of the basement and the first floor) (Figure E.1).

Figure E.1- Soil to Indoor Air Assumptions



E.7.5 Algorithms

Calculate the volatilization factor (VF_{sesp}) for COCs in subsurface soil to indoor air using Equation E.5, which is from the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a heuristic model presented by Johnson and Ettinger.

Equation E.5 - Volatilization Factor for Subsurface Soil to Indoor Air

$$VF_{sesp} = \frac{\dfrac{H \text{ x } \rho_s}{[\Theta_{ws} + (K_s \text{ x } \rho_s) + (H \text{ x } \Theta_{as})]} \text{ x } \left[\dfrac{D_s^{eff} / L_s}{ER \text{ x } L_B}\right]}{1 + \left[\dfrac{D_s^{eff} / L_s}{ER \text{ x } L_B}\right] + \left[\dfrac{D_s^{eff} / L_s}{\left(D_{crack}^{eff} / L_{crack}\right) \text{ x } h}\right]} \text{ x } 10^3$$

Calculating the VF requires the calculation of an effective diffusion coefficient for the vapor phase chemical in soil (D_s^{eff}) and an effective diffusion coefficient for the vapor phase chemical through foundation cracks (D_{crack}^{eff}). The diffusion coefficients are functions of the vadose zone soil porosity (Θ_T), the water-filled porosity of the vadose zone soil (Θ_{ws}) and the air-filled porosity (Θ_{as}). During Tier 2, based on the site data, the identification of the properties of more than one soil layer in the vadose zone might be required. If this is the case, then the effective diffusion coefficient in soil would include contributions from each of the soil layers.

Calculate the effective diffusion coefficient in soil (D_s^{eff}) using Equation E.6, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation E.6 - Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentrations

$$D_s^{eff} = D^{air} \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{ws}^{3.33}}{\theta_T^2}$$

Calculate the effective diffusion coefficient through foundation cracks (D_{crack}^{eff}) using Equation E.7, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation E.7 - Effective Diffusion Coefficient through Foundation Cracks

$$D_{crack}^{eff} = D^{air} \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^{wat} \frac{1}{H} \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$$

E.7.6 Input Parameters

See the Default Parameters Section of this Appendix for default input parameter values for calculating VF_{sesp}, D_s^{eff}, and D_{crack}^{eff}. Two parameters unique to these algorithms are L_s and L_B, which derive from Equations E.8 and E.9, respectively.

Equation E.8 - Depth to Top of Subsurface Source from Bottom of Basement or Foundation

$$L_s = (\textit{depth of subsurface source}) - (\textit{depth to bottom of basement})$$

Equation E.9 - Enclosed Space Volume/Infiltration Ratio

$$L_B = \frac{Length\ of\ basement\ \text{x}\ \ Width\ of\ basement\ \text{x}\ (Height\ of\ basement + Height\ of\ house)}{Length\ of\ basement\ \text{x}\ \ Width\ of\ basement}$$

When calculating the VF_{sesp}, the following default input parameter values must be used and should only be modified with prior approval from BUSTR:

- Aerial fraction of cracks in foundation/walls (η);
- COC-specific input parameter values (H, K_{oc}, D^{air}, D^{wat});
- Volumetric air content in foundation/wall cracks (Θ_{acrack}); and
- Volumetric water content in foundation/wall cracks (Θ_{wcrack}).

Many common COC-specific input parameters can be found in Section E.3 of this Appendix. Consult these tabulated values and the references used to define the default COCs for any additional COCs. Contact BUSTR if a COC-specific input parameter value is not available.

Input Parameters That Might Be Site-Specific

There are four groups of site-specific input parameters that may be modified when calculating the VF_{sesp} during Tier 2:

1. Physical Dimensions of the Building

The length, width, and height of the building must be accurately estimated because the model used to calculate indoor air concentration assumes that concentrations of COCs are evenly mixed throughout the building. Never assume that the height of the building is more than one story or 8 ft. (243.84 cm). If there is no basement for the building, then assume that the basement height is zero. Additionally, the enclosed space foundation/wall thickness (L_{crack}) may also be modified based on the actual thickness of the basement floor or building slab (if no basement exists). Modifications to the physical dimensions of the building may require a re-calculation of the volume/infiltration area ratio (L_B) **and/or** institutional controls (i.e., Environmental Covenant) to ensure that the building configuration is maintained and protective of future land use.

2. Physical Dimensions of the Subsurface Source Area

The soil thickness between the bottom of the basement and top of the source (L_s) may be changed. If the depth to the bottom of the basement is below the top of the subsurface soil source, then use a value of 1 cm for L_s. This assumes that the subsurface foundation of the building could be placed directly onto the source of COCs.

3. Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the bottom of the basement may be used if sufficient data is collected to demonstrate that these values represent soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (f_{oc});
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as}); and
- Total soil porosity in the vadose zone (Θ_T).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

E.8 Groundwater to Indoor Air Pathway

Where a groundwater source area exists below a building, COCs dissolved in groundwater can volatilize into the soil pore spaces, travel through the soil, and into the cracks in a foundation of a building and mix with the air inside the building. An adult or child receptor can inhale COCs that have volatilized into the air.

E.8.1 Algorithms

Calculate the SSTLs for vapor to indoor air from a groundwater source using Equation E.10, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Site*.

Equation E.10 - COCs in Groundwater Vapor to Indoor Air

$$SSTL_{water\text{-}air} = \frac{SSTL_{air}}{VF} \text{ x } 10^{-3}\,\frac{mg}{ug}$$

E.8.2 Input Parameters

$SSTL_{air}$ is the SSTL for indoor air inhalation for the COCs shown in Equations E.1, E.2, and E.3.

VF (also referred to as VF_{wesp}) is the volatilization factor for a COC in groundwater migrating to indoor air as presented in Equation E.11.

E.8.3 Volatilization Factor for a COC in Groundwater to Indoor Air - (VF_{wesp})

The VF for COCs in groundwater to indoor air relates the COC concentration in indoor air to its concentration in groundwater and accounts for diffusion through the soil and cracks in the foundation of a building.

E.8.4 Assumptions

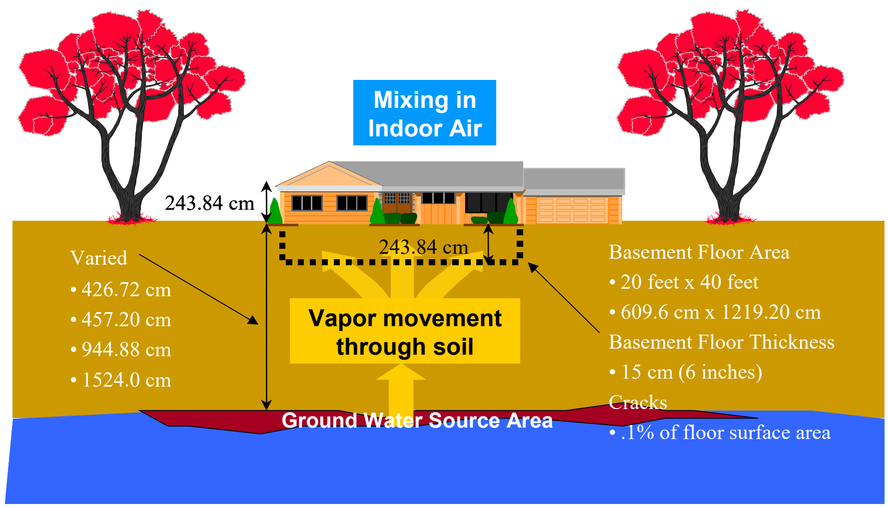
When calculating Tier 1 action levels, assume:

- The house is a one-story structure with a full basement directly over the groundwater source area. Vapors are assumed to infiltrate through the basement floor only.
- The house is 40 ft. (1,219.20 cm) in length by 20 ft. (609.6 cm) in width by 16 ft. (487.68 cm) in height (i.e., the combined height of the basement and the first floor) (Figure E.2).

In Tier 1, the variable depth to groundwater would fall into one of these categories:

- Less than 15 ft. uses 14 ft. (426.72 cm);
- 15 to 30 ft. uses 15 ft. (457.20 cm);
- 31 ft. to 50 ft. uses 31 ft. (944.88 cm); or
- Greater than 50 ft. uses 50 ft. (1,524.0 cm).

Figure E.2 - Groundwater to Indoor Air Assumptions



E.8.5 Algorithms

Calculate the volatilization factor (VF_{wesp}) for COCs in groundwater migrating to indoor air using Equation E.11, which is from the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model developed by Johnson and Ettinger.

Equation E.11 - Volatilization Factor for Groundwater to Indoor Air

$$VF_{WESP} = \frac{H\left[\frac{\frac{D_{ws}^{eff}}{L_{GW}}}{ER \text{ x } L_B}\right]}{1 + \left[\frac{\frac{D_{ws}^{eff}}{L_{GW}}}{ER \text{ x } L_B}\right] + \left[\frac{\frac{D_{ws}^{eff}}{L_{GW}}}{\left(\frac{D_{crack}^{eff}}{L_{crack}}\right)\eta}\right]} \text{ x } 10^3 \frac{L}{m^3}$$

Calculating the VF factor requires the calculation of an effective diffusion coefficient (D_{ws}^{eff}) for the vapor phase chemical from the groundwater surface through the capillary fringe (h_{cap}) and through the vadose zone (h_v) soil, and an effective diffusion coefficient (D_{crack}^{eff}) for the vapor phase chemical through foundation cracks. The diffusion coefficients are functions of the vadose zone soil porosity (Θ_T), the water-filled porosity of the vadose zone soil (Θ_{ws}), the air-filled porosity (Θ_{as}), the water-filled porosity of the capillary fringe (Θ_{wcap}), and the air-filled porosity of the capillary fringe (Θ_{acap}). Assume that the total soil porosity in the capillary fringe is the same as the vadose zone, but with different assumptions for the air-filled fractions and water-filled fractions. In the capillary fringe, the water content is higher than in the remainder of the vadose zone. The capillary fringe is thicker in finer grained soil, with smaller pore sizes than in coarser grained soil. This provides greater resistance to vapor phase movement.

Calculate the effective diffusion coefficient for the vapor phase chemical from the groundwater surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}) using Equation E.12, which is found in *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equivalent diffusion coefficient (D_{ws}^{eff}) for the resistances in series is given by the harmonic average of the effective diffusion coefficients for the individual layers weighted by their thicknesses.

Equation E.12 - Effective Diffusion Coefficient between Groundwater and Bottom of the Basement or Foundation

$$D_{\text{ws}}^{\text{eff}} = \left(h_{\text{cap}} + \mathrm{h}_v\right)\left[\frac{h_{\text{cap}}}{D_{\text{cap}}^{\text{eff}}} + \frac{h_v}{D_s^{\text{eff}}}\right]^{-1}$$

D_s^{eff} is the effective diffusion coefficient in the vadose zone soil based on vapor-phase concentration (Equation E.6). For the site-specific case, based on the site data, identification of properties of more than one soil layer in the vadose zone may be required. If this is the case, then include the separate contributions from each of the soil layers.

D_{cap}^{eff} is the effective diffusion coefficient through the capillary fringe; calculate it using Equation E.13, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on the semi-empirical model presented by Millington and Quirk.

Equation E.13 - Effective Diffusion Coefficient in the Capillary Fringe

$$D_{\text{cap}}^{\text{eff}} = D^{\text{air}}\,\frac{\Theta_{\text{acap}}^{3.33}}{\Theta_T^2} + D^{\text{wat}}\,\frac{1}{H}\,\frac{\Theta_{\text{wcap}}^{3.33}}{\Theta_T^2}$$

Calculate the effective diffusion coefficient through foundation cracks (D_{crack}^{eff}) using Equation E.13.

E.8.6 Input Parameters

See the Default Parameters Section of this Appendix for the input parameter values used in Equations E.11, E.12, and E.13. The parameters L_{GW} and h_v are unique to these equations and can be found in Equations E.14 and E.15, respectively.

Equation E.14 - Depth to Top of Groundwater from the Bottom of Basement or Foundation

$$L_{\mathrm{GW}} = \text{(Depth to top of groundwater) - (Depth to bottom of basement)}$$

Equation E.15 - Thickness of Vadose Zone below Basement or Foundation

$$h_v = \mathrm{L_{GW}} \text{-} \mathrm{h_{cap}x}$$

When calculating the VF_{wesp}, use the following default input parameter values and modify them only with prior approval from BUSTR:

- Aerial fraction of cracks in foundation/walls (η);
- COC-specific input parameter values (H, D^{air}, D^{wat});
- Volumetric air content in foundation/wall cracks (Θ_{acrack}); and
- Volumetric water content in foundation/wall cracks (Θ_{wcrack}).

See Section E.3 for input parameter values for some common COCs. Contact BUSTR if any COC-specific input parameter values are not in this Appendix.

Input Parameters That Might Be Site-Specific

There are four groups of site-specific input parameters that may be modified when calculating the VF_{wesp} during Tier 2:

1. Physical Dimensions of the Building

The length, width, and height of the building must be accurately estimated because the model used to calculate indoor air concentration assumes that concentrations of COCs are evenly mixed throughout the building. Never assume the height of the building to be more than one story or 8 ft. (243.84 cm). If there is no basement for the building, then assume that the basement height is zero. Additionally, the enclosed space foundation/wall thickness (L_{crack}) may also be modified based on the actual thickness of the basement floor or building slab (if no basement exists). Modifications to the physical dimensions of the building may require a re-calculation of the volume/infiltration area ratio (L_B) and/or institutional controls (i.e., Environmental Covenant) to ensure that this building configuration is maintained and protective of future land use.

2. Depth to Groundwater

The depth to the top of the groundwater (DTW) and the thickness of the capillary fringe (h_{cap}) are the only physical dimensions required for the volatilization factor. Calculate the depth to top of groundwater from bottom of basement (L_{GW}) based on the DTW from the ground surface. Calculate the thickness of the vadose zone (h_v) based on the thickness of the capillary fringe (h_{cap}). If the depth of the bottom of the basement is below the DTW, then use a value of 30.48 cm for L.

3. Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the bottom of the basement may be used if sufficient data is collected to demonstrate that these values represent the soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (F_{oc});
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_T);
- Volumetric water content in the capillary fringe (Θ_{wcap}); and
- Volumetric air content in the capillary fringe (Θ_{acap}).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

E.9 Soil to Groundwater Leaching Pathway

Where a soil source exists above groundwater, COCs adsorbed to soil can dissolve in infiltrating water, migrate to groundwater, and mix with groundwater. There are two potential pathways that must be evaluated.

- Soil leaching to drinking water pathway ALs are calculated using the drinking water action levels (MCLs) as the target concentrations for the COCs in groundwater. When there are no BUSTR established drinking water ALs exist, the GUPUS, or USEPA Region 9 preliminary remediation goals (PRGs), may be used.
- When groundwater is not drinking water, the calculated groundwater to indoor air pathway Als or SSTLs are the target concentration for COCs in groundwater.

Tier 1 ALs assume a horizontal dilution factor of 10 for a well located 30 ft. from the center of the source area. The Tier 2 model, however, does not include this dilution factor and assumes the well is located directly in the center of the source area. Therefore, COC concentrations must be modeled to a site-specific point of exposure. If the Tier 2 concentration is less than the Tier 1 concentration, the Tier 1 concentration can be used.

E.9.1 Assumptions

Assume the corresponding source soil thickness for each soil type:

- Class 1 soil: 6 ft. (182.88 cm);
- Class 2 soil: 4 ft. (121.92 cm); or
- Class 3 soil: 2 ft. (60.96 cm).

Assume the corresponding depth to groundwater according to the groundwater category:

- <15 ft.: 14 ft. (426.72 cm);
- 15 to 30 ft.: 15 ft. (457.20 cm);

- 31 to 50 ft.: 31 ft. (944.88 cm); or
- >50 ft.: 50 ft. (1524.0 cm).

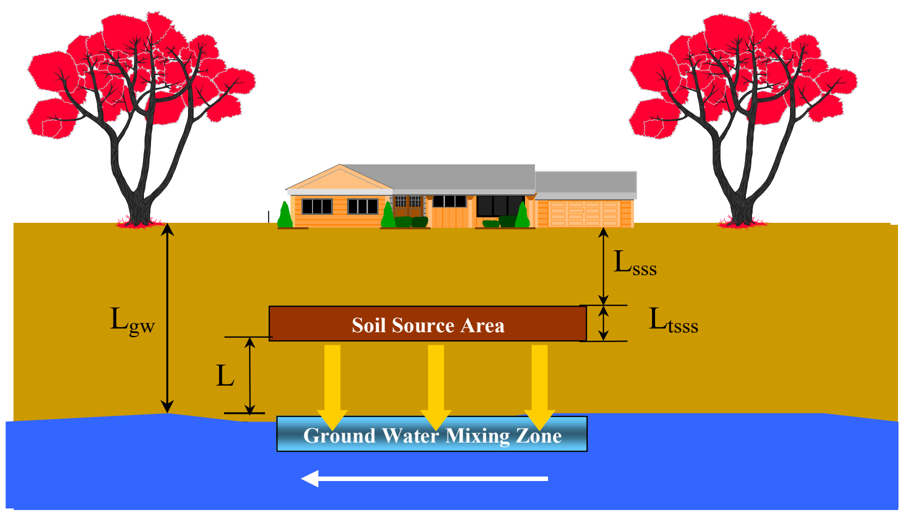
The distance between the bottom of the source area and the top of the groundwater is calculated using Equation E.16.

Equation E.16 - The Distance between the Bottom of the Soil Source and the Top of the Groundwater

$$L = L_{gw} - L_{sss} - L_{tsss}$$

L_{gw} is the depth to groundwater, L_{sss} is the depth to the top of the soil source area, and L_{tsss} is the thickness of the soil source area. Where L is less than 1 ft. (30.48 cm), L is set equal to 1 ft. (30.48 cm.) (Figure E.3).

Figure E.3 - Soil Leaching to Groundwater Assumptions



E.9.2 Algorithms

The first step in calculating the SSTL for soil leaching COCs to groundwater is to calculate the soil leaching to groundwater SSTL without degradation. As demonstrated in Equation E.17, below, do this by dividing the applicable action level (MCL for drinking water) or SSTL (groundwater to indoor air) by a soil to groundwater leaching factor.

Equation E.17 - Soil to Groundwater SSTL without Degradation

$$\mathrm{SSTL}_{\mathrm{no\ deg}} = \frac{\mathrm{AL}_W}{\mathrm{LF}_{\mathrm{SW}}}$$

AL_w is the action level/SSTL for a COC in water, and LF_{sw} is the soil to groundwater leaching factor. Specifically, this leaching factor includes both partitioning and mixing; calculate it using

Equation E.18, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation E.18 - Soil to Groundwater Leaching Factor

$$\mathrm{L}F_{SW} = \frac{\rho_s}{[\Theta_{ws} + K_s\rho_s + H\Theta_{as}]\left[1 + \frac{U_{gw}\delta_{gw}}{\mathrm{I+W}}\right]} \times 10^0 \frac{cm^3 - kg}{m^3 - g}$$

When using the above formula to calculate a Tier 1 action level, a factor of 10 should be added. During Tier 2 SSTL calculations, the factor of 10 is not included because the well is assumed to be directly in the souce.

Determine the degradation of COCs by calculating the time for water to infiltrate through soil from the bottom of the soil source area to the top of the groundwater. Then apply that travel time to a first order degradation rate. This process, based on the Green-Ampt model, assumes that infiltration is responsible for the mobilization of hydrocarbons in the vadose zone.

Determine the time needed for the infiltrating water to move from the location of the highest concentration of a COC to the groundwater with Equation E.19.

Equation E.19 - Time for Infiltrating Water to Move from the Source to the Water Table

$$\mathrm{t} = \left(\frac{\Theta_{\mathrm{as}}}{K_u}\right) \mathrm{x} \left[\mathrm{L} - (\mathrm{h} - \Psi) \mathrm{x} \left(\ln \left(\frac{\mathrm{h} + \mathrm{L} - \Psi}{(\mathrm{h} - \Psi)}\right)\right)\right] \mathrm{x} \frac{1 \quad \mathrm{day}}{86400 \quad \mathrm{seconds}}$$

Calculate the seepage velocity of the groundwater using Equation E.20.

Equation E.20 - Vertical Seepage Velocity of Water

$$V_{\mathrm{w}} = \frac{L}{t}$$

Use Equation E.21 to calculate the travel velocity of the COCs in the soil.

Equation E.21 - COCs Velocity

$$\mathrm{V_C} = \frac{V_w}{\left[1 + \left(\frac{(P_s)K_d}{\Theta_t}\right)\right]}$$

Calculate the partitioning coefficient between soil pore water and the soil using Equation E.22.

Equation E.22 - Partitioning Coefficient between Soil Pore Water and Soil

$$K_d = K_{OC} \mathrm{\ x\ } F_{OC}$$

For determining the time required for the COCs to reach the groundwater, use Equation E.23.

Equation E.23 - Travel Time for COCs to Reach Water Table

$$t_c = \frac{L}{V_c}$$

Calculate the ratio of the final COC concentration in the soil pore relative to the original concentration using Equation E.24.

Equation E.24 - Ratio of Final COCs Concentration in Soil Pore to Original Concentration

$$\frac{C_f}{C_w} = e^{(-kt_c)}$$

Then calculate the SSTL for soil leaching to groundwater using Equation E.25.

Equation E.25 - SSTL for Soil Leaching to Groundwater

$$\text{SSTL} = \frac{\text{SSTL}_{\text{no deg}}}{\frac{C_f}{C_w}}$$

E.9.3 Input Parameters

L is the depth to groundwater from the bottom of the source. Section E.3 contains the remaining input parameters for Equations E.17 – E.25.

The following default input parameters must be used and may be modified only with prior approval from BUSTR:

- The COC-specific input parameter values (H, K_{oc}); and
- Groundwater mixing zone thickness (δ_{gw}).

Input Parameters That Might Be Site-Specific

The following two groups of site-specific input parameters in equations used for developing SSTLs may be modified:

1. Physical Dimensions of the Subsurface Source Area

These parameters include the width of the source area parallel to the groundwater flow direction (W) and the depth to groundwater from the bottom of the source area (L).

2. Site-specific Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone may be used if sufficient data is collected to demonstrate that these values represent soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon; (Foc),
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_T);
- Groundwater Darcy velocity (U_{gw});
- Infiltration rate (I);
- Saturated hydraulic conductivity of vadose zone (K_s);
- Unsaturated hydraulic conductivity of vadose zone (K_u); and
- Wetting front suction head (Ψ).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

E.10 Outdoor Air Inhalation Pathway

In situations where the indoor air exposure pathway has been eliminated, the outdoor air exposure from subsurface soil or groundwater must be evaluated. The direct contact with soil pathway addresses outdoor inhalation of volatiles and particulates from surface soil. The points of exposure are:

- Surface soil is considered 0 to 10 ft. for the residential scenario;
- 0 to 2 ft. for the non-residential scenario: or
- Assume that excavation workers are exposed to the area of highest soil contamination to a default depth of 10 ft.

Calculate an outdoor air concentration that is protective of the receptor for each COC. This outdoor air concentration is the acceptable COC concentration for a receptor outside of a home or other building. Evaluate this pathway for adult and child residential receptors, adult non-residential receptors, and adult excavation worker receptors.

E.10.1 Assumptions

Residential Land Use

Calculate the residential outdoor air concentrations for carcinogenic COC's with a combined adult and child exposure that averaged life spans. This assumption suggests that a resident spends some of that time as a child and the remainder as an adult. The combined approach results in more conservative ALs/SSTLs as opposed to evaluating adults or children individually.

Calculate the residential outdoor air concentrations for non-carcinogenic COC's with only the child's exposure. These assumptions were made for the non-carcinogen case because during the child's exposure, the body weight values are low and the inhalation rates are equal to the adult values, resulting in more conservative ALs/SSTLs.

Non-Residential Land Use

Calculate the non-residential and excavation worker outdoor air concentrations for both carcinogenic and non-carcinogenic COC's for the adult worker. Although residents may be exposed at non-residential properties, their exposures are assumed to be infrequent and of short duration. Adult workers are the maximally exposed receptor group, resulting in more conservative ALs/SSTLs.

E.10.2 Algorithms

Calculate the SSTLs for vapor to outdoor air with Equations E.1, E.2, and E.3 in the Indoor Air Inhalation Section.

E.10.3 Input Parameters

See the input parameters found in Section E.3.

E.11 Subsurface Soil to Outdoor Air Pathway

Where a contaminant source area exists below an outdoor area, COCs adsorbed to soil can volatilize into the soil pore spaces, travel through the soil, and mix with the ambient air. Evaluate this pathway for adult and child residential receptors, adult non-residential receptors, and adult excavation worker receptors.

E.11.1 Algorithms

Calculate the $SSTL_{soil\text{-}air}$ values for vapor to outdoor air from soil sources by using Equation E.26, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation E.26 - Vapor to Outdoor Air from a Soil Source

$$SSTL_{soil\text{-}air} = \frac{SSTL_{air}}{VF} \times 10^{-3} \frac{mg}{ug}$$

E.11.2 Input Parameters

$SSTL_{air}$ is the SSTL for outdoor air inhalation for a COC. (Equations E.1, E.2, and E.3)

VF (also referenced as $VF_{samb)}$ is the volatilization factor for a COC in subsurface soil migrating to outdoor air (Equation E.27).

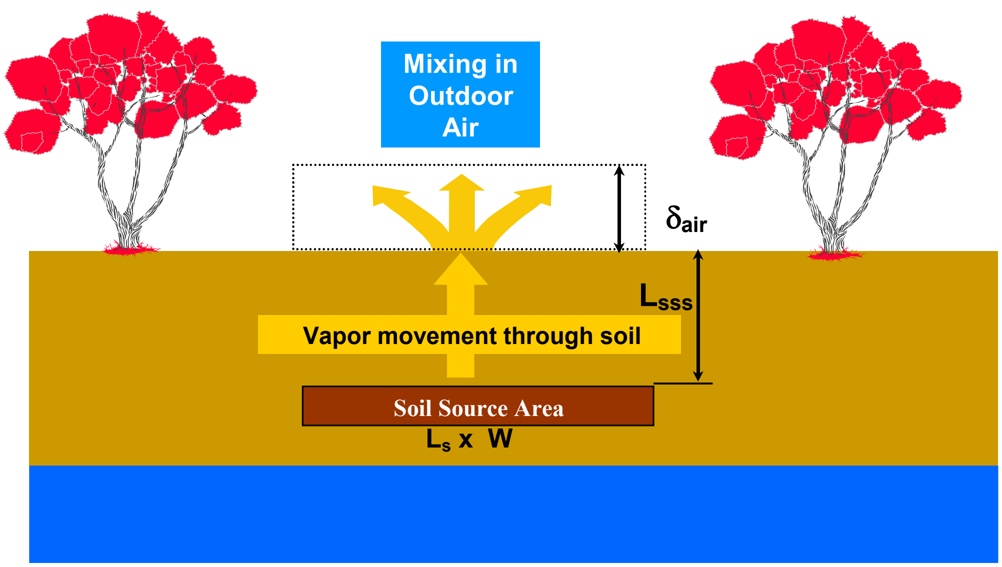
E.11.3 Volatilization Factor for a COC in Subsurface Soil to Outdoor Air (VF_{samb})

The VF for COCs in subsurface soil to outdoor air relates the COC concentration in soil vapor to its concentration in soil, and accounts for diffusion through the soil and mixing with ambient air.

E.11.4 Assumptions

Assume that the receptor is located directly over the soil source area. Vapors are assumed to migrate through the soil and mix with ambient air. Mixing in ambient air occurs in a box with dimensions defined as the length of the source L_{Source} (L_s) area perpendicular to wind direction by the width of source W_{Source} (W) area parallel to wind direction by the height of the mixing zone Delta Air (δ_{air}) (Figure E.4).

Figure E.4 - Soil to Outdoor Air Dimensions



E.11.5 Algorithms

Calculate the volatilization factor (VF_{samb}) for COCs in subsurface soil to outdoor air using Equation E.27, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model presented by Johnson, Hertz, and Byers.

Equation E.27 - Volatilization Factor for COCs in Subsurface Soil to Outdoor Air

$$VF_{samb} = \frac{H\rho_s}{[\theta_{ws}+k_s\rho_s+H\theta_{as}]\left(1+\frac{U_{air}\delta_{air}L_s}{D_s^{eff}W}\right)} \times 10^3 \frac{cm^3-kg}{m^3-g}$$

E.11.6 Input Parameters

Calculating the volatilization factor requires the calculation of an effective diffusion coefficient for the vapor phase chemical in soil (D_s^{eff}). To do this, use Equation E.6.

When calculating the VF_{samb}, use the following default input parameters and modify the values for these parameters with prior approval from BUSTR:

- The COC-specific input parameter values (H, K_{oc}, etc.); and
- The ambient air mixing zone height (δ_{air}).

See Section E.3 for specific input parameter values for COCs. If COC-specific input parameter value is not provided, then use another publicly available reference.

Input Parameters That Might Be Site-Specific

The following three groups of site-specific input parameters when calculating the VF_{samb} for purposes of developing the $SSTL_{soil-air}$ may be modified:

1. Physical Dimensions for the Subsurface Source Area

Two physical dimensions are required for this VF_{samb}: the depth to the top of the subsurface source area (Lsss) and the width of the source area parallel to the wind direction (W_{Source}). If site-specific input parameter values are not determined for these dimensions, use the values in Section E.3, Default Parameters. The required dimensions are shown in Figure E.4.

2. Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the ground surface may be used if sufficient data is collected to demonstrate that these values represent soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Soil bulk density (ρ_s);
- Fraction organic carbon (F_{oc});
- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as}); and
- Total soil porosity in the vadose zone (Θ_t).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_t, any changes to one of these values must be reflected by changes in the other two values. If site-specific characteristics for subsurface soil for the site are not determined use the values presented in Section E.3.

3. Wind Speed above Ground Surface in Ambient Mixing Zone

Use the wind speed (U_{air}) above the ground surface (i.e., in the ambient mixing zone) to determine site-specific information for the site and the surrounding area. If a site-specific U_{air} is not determined, then use a wind speed of 225 cm/sec.

E.12 Groundwater to Outdoor Air Pathway

Where a groundwater source area exists below an open area, COCs can volatilize into the soil pore spaces, travel through the soil, and mix with the ambient air. Evaluate this pathway when the groundwater to indoor air pathway has been eliminated.

E.12.1 Algorithms

Calculate the $SSTL_{water\text{-}air}$ for vapor to outdoor air from a groundwater source using Equation E.28, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*.

Equation E.28 - Groundwater Vapors to Outdoor Air

$$SSTL_{water\text{ - }air} = \frac{SSTL_{air}}{VF} \text{ x } 10^{-3}\ \frac{mg}{ug}$$

E.12.2 Input Parameters

$SSTL_{air}$ is the SSTL for outdoor air inhalation for a COC (Figures E.1, E.2, and E.3).

VF (also referenced as VF_{wamb}) is the volatilization factor for a COC in groundwater migrating to outdoor air (Equation E.29).

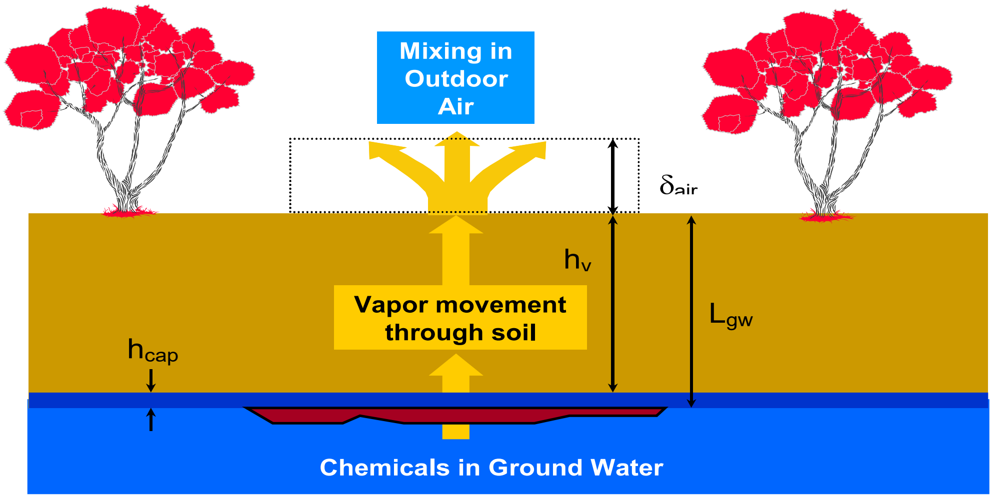
E.12.3 Volatilization Factor for a COC in Groundwater to Outdoor Air

The VF_{wamb} for COCs in groundwater to outdoor air relates the COC concentration in groundwater to its concentration in soil vapor; this VF describes diffusion through the soil and mixing with ambient air.

E.12.4 Assumptions

Assume that the receptor is located directly over the groundwater source area. Also assume that vapors migrate through the soil and mix with ambient air. Mixing in ambient air occurs in a box with dimensions defined as the length of the source area perpendicular to wind direction (L_s) by the width of source (W) area parallel to groundwater flow direction by the height of the mixing zone (δ_{air}) (Figure E.5).

Figure E.5 - Groundwater to Outdoor Air Dimensions



E.12.5 Algorithms

Calculate the VF_{wamb} for COCs in groundwater to outdoor air using Equation E.29, which is found in the *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*. This equation is based on a model presented in the *Superfund Exposure Assessment Manual*.

Equation E.29 - Volatilization Factor for COCs in Groundwater to Outdoor Air

$$VF_{wamb} = \frac{H}{1+\left[\frac{U_{air}\delta_{air}L_{GW}}{W D_{ws}^{eff}}\right]} \text{ x } 10^3 \frac{L}{m^3}$$

E.12.6 Input Parameters

Calculating the VF_{wamb} requires the calculation of an effective diffusion coefficient for the vapor phase chemical from the groundwater surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}). This calculation requires an effective diffusion coefficient for the vapor phase chemical in soil (D_{s}^{eff}) and the effective diffusion coefficient through the capillary fringe (D_{cap}^{eff}), which is derived as follows:

- The effective diffusion coefficient in soil (D_{s}^{eff}) uses Equation 6;
- The effective diffusion coefficient through the capillary fringe (D_{cap}^{eff}) uses Equation E.13; and
- The effective diffusion coefficient for the vapor phase chemicals from the groundwater surface through the capillary fringe and through the vadose zone soil (D_{ws}^{eff}) uses Equation E.12, *with* the exception that the term h_v is the thickness of the vadose zone from ground surface, instead of from the bottom of the basement.

Use the following default input parameters when calculating the VF_{wamb}:

- The COC-specific input parameter values (H, D^{air}, D^{wat}); and
- The ambient air mixing zone height (δ_{air}).

See Section E.3 for COC-specific input parameter values. Contact BUSTR if a COC-specific input parameter value is not provided.

Input Parameters That Might Be Site-Specific

The following three groups of site-specific input parameters when calculating the VF_{wamb} may be modified:

1. Physical Dimensions of the Subsurface Source Area

Use only the depth to the top of the groundwater source area (L_{gw}), the thickness of the capillary fringe (h_{cap}), and the width of the source area (W) parallel to the groundwater flow direction to calculate VF_{wamb}. Calculate the thickness of the vadose zone below the ground surface (h_v) by subtracting the thickness of the capillary fringe. If site-specific input parameter values are not determined, then use the values in Section E.3.

2. Characteristics of the Subsurface Soil

Site-specific characteristics of the subsurface soil in the vadose zone between the top of the source area and the ground surface may be used if sufficient data is collected to demonstrate that these values represent soil within this zone. The following site-specific subsurface soil characteristics may be modified:

- Volumetric water content in the vadose zone (Θ_{ws});
- Volumetric air content in the vadose zone (Θ_{as});
- Total soil porosity in the vadose zone (Θ_t);
- Volumetric water content in the capillary fringe (Θ_{wcap}); and
- Volumetric air content in the capillary fringe (Θ_{acap}).

Since the sum of the Θ_{ws} and the Θ_{as} must equal the Θ_T and the sum of the Θ_{wcap} and the Θ_{acap} must equal the Θ_T, any changes to one of these values must be reflected by changes in the other two values.

3. Wind Speed above Ground Surface in Ambient Mixing Zone

Use the wind speed (U_{air}) above the ground surface (i.e., in the ambient mixing zone) to determine site-specific information for the site and the surrounding area. If a site-specific U_{air} is not determined, then use a wind speed of 225 cm/sec.

E.13 TPH Action Levels

The TPH ALs apply to all BUSTR sites during the Tier 1 and Tier 2 Evaluations. The TPH ALs are applicable to all scenarios and **cannot be re-calculated based on land use, receptor, site-**

specific data, or other factors. Additional evaluation of TPH may be conducted in Tier 3 (Section 3.12 and Appendix G).

At BUSTR sites the proper soil classification and petroleum distillate fraction must be identified to determine the applicable TPH AL for the release.

E.14 Fate and Transport in Groundwater

When considering a migration of COCs in the groundwater, use fate and transport modeling to calculate COC concentrations at various distances from the source. During a Tier 2 Evaluation, the BUSTR-Screen model (based on the transport equation developed by P. A. Domenico) must be used.

E.14.1 Assumptions

The BUSTR-Screen model is based on the following assumptions:

- One-dimensional groundwater flow along the centerline of the plume;
- Steady state source concentration;
- Finite or infinite mass of source;
- First-order decay;
- Uniform and constant aquifer properties; and
- Three-dimensional dispersion within the plume.

E.14.2 Algorithms

Equations E.30 and E.31 define the maximum COC concentration allowable in the groundwater at the source area ($SSTL_{source\_area}$) for meeting the AL or SSTL at the point of exposure.

Equation E.30 - Maximum Concentration at Source Area to Meet SSTL or Action Level at the Point of Exposure

$$SSTL_{source\_area} = \frac{ALpoe}{DAFgw}$$

The *ALpoe* is the action level or SSTL applied at the point of exposure.

The *DAFgw* is the dilution attenuation factor calculated by the Domenico solution.

Equation E.31 - Dilution Attenuation Factor

$$DAFgw = EXP\left\{\frac{sPod}{2 \times Ldisp}\left[1 - \sqrt{1 + \left(\frac{4 \times deg\,r\,ade_{lo} \times Ldisp \times Rf}{Vseep}\right)}\right]\right\} \times ERF\left[\frac{GWSource}{4 \times \sqrt{Tdisp \times sPod}}\right] \times ERF\left[\frac{GDSource}{2 \times \sqrt{Vdisp \times sPod}}\right]$$

Calculate the retardation factor (Rf) with Equation E.32.

Equation E.32 - Retardation Factor

$$Rf = 1 + \frac{Rhobsat \times FOCgw \times Koc}{PorSat}$$

Use the Equation E.33 to derive the seepage velocity (V_{seep}).

Equation E.33 - Seepage Velocity

$$VSeep = \frac{Kssat \times Igrad}{PorSat}$$

E.14.3 Input Parameters

Table E.7 includes the input parameters for Equations E.30 through E.33:

Table E.7 - Input Parameters

Variable	Description	Units	Value
Koc	Organic carbon partitioning factor	L/kg	Chemical of concern specific
Rhobsat	Soil bulk density in saturated zone	kg/L	Site-specific
Porsat	Total soil porosity in the saturated zone	cm^3/cm^3	Site-specific
$F_{oc}sat$	Fraction organic carbon in saturated zone	g-oc/g soil	Site-specific
GWSource	Width of source area parallel to groundwater flow direction	ft.	Site-specific
GDSource	Depth of source area parallel to groundwater flow direction	ft.	Site-specific
Ldisp	Longitudinal dispersivity	ft.	$Ldisp = 0.1 \times sPod$
Tdisp	Transverse dispersivity	ft.	$Tdisp = 0.33 \times Ldisp$
Vdisp	Vertical dispersivity	ft.	$Vdisp = 0.05 \times Ldisp$
SPod	Saturated zone distance from source area to point of exposure	ft.	Site-specific
Vseep	Seepage velocity (Equation 33)	ft./yr.	Site-specific
Degrade_lo	Degradation rate at low end of range	1/yr.	Chemical of concern specific
Igrad	Groundwater gradient	ft./ft.	Site-specific
Kssat	Saturated hydraulic conductivity of saturated zone	ft./yr.	Site-specific

NOTE: Some variable names, symbols, and units of measurement listed above are not consistent with Appendix G, however, the equations produce identical results. Appendix G describes the procedures for conducting groundwater fate and transport modeling during Tier 2 Evaluations.

E.15 References

American Society for Testing and Materials (ASTM). *Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites,* ASTM Designation E: 1739-95, ASTM, Conshohocken, PA.

Charbeneau, R.J., 2000. *Groundwater Hydraulics and Pollutant Transport*, Prentice Hall, Upper Saddle River, NJ.

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Appendix F: BUSTR-Screen Groundwater Model

F.1 Introduction

BUSTR-Screen is a groundwater fate and transport model combining a user interface with BIOSCREEN, a Microsoft® Excel based modeling program created by the USEPA (Newell, McLeod and Gonzales, 1996 and 1997). The purpose of the BUSTR-Screen interface to the BIOSCREEN model is to simplify the presentation of input parameters and output results for BUSTR corrective action sites.

BIOSCREEN and BUSTR-Screen are Microsoft® Excel based modeling programs based on Domenico fate and transport equations. The equations and calculations used in the BUSTR-Screen model are identical to those used in the BIOSCREEN model, version 1.4. Both models predict the amount of natural attenuation of dissolved hydrocarbons in confined or unconfined aquifers. The models are designed to predict only horizontal flow with a constant seepage velocity.

BUSTR requires that BUSTR-Screen be used if groundwater fate and transport modeling is performed during the Tier 2 Evaluation process. Other groundwater models are not allowed during the Tier 2 process.

The following information outlines how to use the BUSTR-Screen model for BUSTR corrective action sites. BUSTR-Screen can be downloaded through the BUSTR resource website at https://com.ohio.gov/divisions-and-programs/state-fire-marshal/underground-storage-tanks-bustr/corrective-action-clean-up.

F.2 Approach

BUSTR Tier 2 corrective actions described in OAC 1301:7-9-13, effective September 1, 2022, allows for the use of fate and transport modeling to predict COC concentrations at an assumed POE. Groundwater fate and transport modeling may be necessary to predict whether future concentrations of COCs meet ALs or SSTLs at a POE. POD located between the source area and POE is then used as a monitoring point to validate the model predictions.

The BUSTR-Screen model is used in a two-phased approach during Tier 2 evaluations, as follows:

In the first phase performed as part of the Tier 2 Evaluation report, either BUSTR default values or site-specific data are used to predict chemical concentrations at the POD and POE. Field data are then compared to the predicted values. Do not adjust the BUSTR-Screen model to fit the observed field data curve in this first phase of a Tier 2 Evaluation. If the field data exceeds the predicted values, a RAP, IRA, or second phase of Tier 2 modeling may be conducted. If the field data does not exceed the predicted values, and sufficient time has elapsed to demonstrate the COCs have not reached the POD, then a monitoring plan should be submitted to validate the model (in some cases, historical data may be sufficient).

In the second phase of Tier 2 modeling (often referred to as the Calibration Phase), the BUSTR-Screen model can be calibrated to fit the actual field data curve by calculating a site-specific biodegradation rate and/or by adjusting the hydraulic conductivity value (Section F.6). This second phase of modeling must first be proposed to BUSTR within the Tier 2 Evaluation report. BUSTR must approve the plan to calibrate the model before this second phase of modeling is performed.

More complex numerical models or other analytical fate and transport models may be used in a Tier 3 Evaluation with prior BUSTR approval. The Tier 3 Evaluation Plan must include a demonstration of why the proposed model is appropriate for the site conditions. Refer to Section 3.13 for additional details.

F.2.1 Limitations

There are some limitations to the use of the BUSTR-Screen Model at BUSTR-regulated sites. The limitations include, but are not limited to, the following:

- The model should not be used to model vertical flow; it is appropriate for simple horizontal flow only;
- The model should not be used with increasing or fluctuating groundwater COC concentrations, and the plume should be stable to decreasing in size and concentration;
- The model is not appropriate for areas with complicated hydrology, under conditions where flow boundaries exist, or where groundwater flow is influenced by pumping wells (intermittent or constant);
- The model is not appropriate for conditions where groundwater velocity changes significantly over the modeled area, where groundwater flow direction is not well defined, or in geologic formations where chemical diffusion is the prime mechanism of transport (heavy clays, etc.);
- The model was developed for aquifers in granular porous media (e.g., sand and gravel), and is not applicable to karst bedrock aquifers. To model contaminant transport in bedrock aquifers, either site-specific data or "gravel" default data (Table F.1) must be used during the first phase of modeling; and
- The model may be used to develop soil and groundwater remediation SSTLs. However, after contamination is remediated to SSTL concentrations, additional groundwater sampling is required to ensure that subsequent leaching will not cause COC concentrations to exceed SSTLs at the POE.

F.2.2 Modeling with Free Product

When free product is present, a Tier 2 Evaluation report which evaluates all pathways must be submitted within 18 months of the Tier 1 Investigation approval date. However, pathways affected by the presence of free product (i.e., groundwater pathways such as groundwater ingestion, groundwater to indoor air and soil leaching to drinking water) will not be evaluated/approved by BUSTR until free product has been recovered to the maximum extent practicable. The Tier 2 Evaluation report must identify which pathways are affected by the presence of free product.

As part of the free product recovery activities, BUSTR may require that monitoring wells without free product be sampled to evaluate groundwater contaminant levels during free product recovery activities. These sampling events may be used as part of the BUSTR-Screen modeling requirements.

After free product is recovered to the maximum extent practicable, BUSTR will complete its review of pathways that have been affected by the presence of free product. In addition, BUSTR may require additional groundwater monitoring events to verify groundwater contaminant levels in the locations where free product is present.

Following termination of the free product recovery activities, all remaining pathways (i.e., groundwater pathways such as groundwater ingestion, groundwater to indoor air, and soil leaching to drinking water) must be re-evaluated and a Tier 2 Evaluation Addendum submitted.

If free product is present when the Tier 2 Evaluation is submitted the following items must be described and evaluated in an appendix of the Tier 2 Evaluation Form:

- Locations of free product and potential receptors (ingestion and indoor air);
- Distances from the source area to the potential receptors;
- Site map showing the monitoring wells where free product will be recovered and the monitoring wells where groundwater samples will be collected for lab analyses;
- Site and surrounding area conditions (e.g., locations of free product, DWSPA, nearby potable wells, residential dwellings, preferential pathways, etc.);
- Availability of a municipal water source and other information from the Tier 1 Drinking Water Determination; and
- The frequency and duration of the groundwater monitoring, sampling, analysis, and reporting program.

F.2.3 Default vs. Site-Specific Parameter Values

For different soil types, use the default soil parameter values provided in the BUSTR-Screen model (Table F.1). For different chemicals of concern, use the chemical-specific default values presented in Table F.2. Do not use the default soil parameter values from the BUSTR Technical Guidance Manual (September 2022) as they are intended for vadose zone soils. The default values in Table F.1 are intended only for the BUSTR-Screen model and may not be appropriate for other models. BUSTR recommends collecting site-specific soil and groundwater data when using BUSTR-Screen to determine clean-up goals for soil and/or groundwater contamination, as using the BUSTR default values may predict overly conservative clean-up goals and result in escalated expenses of remediation.

All site-specific values used in BUSTR-Screen must be from the aquifer matrix being modeled. Accurate values for the BUSTR-Screen input parameters are required. Generating accurate parameter values for modeling may require gathering data from the site in a manner not stated in the OAC or the BUSTR Technical Guidance Manual (such as from fully penetrating wells and sampling of the aquifer matrix).

Table F.1 - Saturated Zone Soil Types and Default Values

Saturated Zone Soil Type	Soil Classification Symbol	Horizontal Hydraulic Conductivity (cm/sec)	Porosity (cm^3/cm^3)	Fraction of Organic Carbon in Saturated Zone (g/g)	Bulk Density (kg/L)
Clay	MH, CH, OH	1 x 10e-5	0.20	0.001	1.8
Silt	ML, CL, OL	1 x 10e-3	0.30	0.001	1.7
Silty Sand	SM, SC	1 x 10e-1	0.30	0.001	1.6
Clean Sand	SW, SP	1	0.30	0.001	1.5
Gravel	GW, GP, GM, GC	10	0.35	0.001	1.4

Note - BUSTR default values shall be used when site-specific values are unknown.

Table F.2 - Chemical-Specific Default Values

Chemical of Concern	Partition Coefficient (L/kg)	Phase 1 Modeling – Default Solute Half-Life (years)
Benzene	146	1.97
Toluene	234	0.07
Ethylbenzene	446	0.62
Xylenes	383	0.99
Methyl tertiary-butyl ether (MTBE)	11.6	1,000*
Naphthalene	1,540	0.70
1,2,4 -Trimethylbenzene	614	0.15
1,2 – Dibromoethane (EDB)	39.6	0.32
1,2 – Dichloroethane (EDC)	39.6	0.99

For chemicals of concern not listed in the above table, please refer to Table E.5.2.

*During Phase 1 Modeling, a solute half-life of 1,000 years must be used for MTBE to simulate “no degradation”. Site-specific values may be used during Phase 2 Modeling.

F.3 Data Input Worksheets

The purpose of the BUSTR-Screen interface to the BIOSCREEN model is to simplify the presentation of input parameters and output results for BUSTR corrective action sites. To meet this objective, BUSTR has provided two data entry worksheets, identified as the “BUSTR” worksheet and the “Variable” worksheet tabs in Excel (Figures F.1 and F.2). Note that these two worksheets are substantially similar to the data input worksheets on all other BUSTR Spreadsheets used for calculating SSTLs. **All data must be entered into these two worksheets.** Please note that BUSTR-Screen does not allow data entry on the former BIOSCREEN worksheets labeled “Input”, “Centerline Output”, or “Plume Output”. If data is inadvertently entered on these three sheets, the model will not run correctly; thus, forcing the user to start over with a new, unaltered copy of BUSTR-Screen.

Before entering data onto the data entry worksheets, the Tier 1 and Tier 2 investigation information should be reviewed to ensure an adequate understanding of the hydrogeologic characteristics of the site and surrounding properties. This review should include soil boring logs, geologic cross-sections, location of migration pathways, potentiometric surface maps, location of hydraulic flow boundaries, seasonal fluctuations of the groundwater table, etc. The following should be completed before the start of modeling:

- The plume is stable to decreasing in size and concentration;
- The source area monitoring well is identified for each COC;
- The plume is delineated in all directions;
- An appropriate POD downgradient from the source well that has detectable concentrations of the COC is present; and
- Determine if additional groundwater sampling data will be required to validate the model.

Data input begins by selecting the appropriate COC from the drop-down list located on the “BUSTR” worksheet of BUSTR-Screen (Figure F.1). If the COC is not listed, select “Other”, and fill in the chemical name, Koc, and half-life values to the right. Values for these parameters may be found in BUSTR's Technical Guidance Manual (Appendix E). Next, select the saturated zone soil type. Soil types correspond to USCS Soil Classifications identified in Table 3.2. After selecting the chemical and the soil classification, BUSTR-Screen automatically generates default values for the appropriate chemical and soil parameters and inserts those default values on the "Variable" worksheet. These default values may be replaced with site-specific values if site-specific values have been determined. When site-specific values are used, a reference must be provided listing the appropriate report and the specific page, table or figure number. Additional documentation such as geotechnical laboratory results and slug test data should also be included with the report. A discussion of Chemical & Physical Properties, Soil Parameters, and Site-specific Parameters is presented in sections F.3.1, F.3.2, and F.3.3, respectively.

Figure F.1 - "BUSTR" Worksheet from BUSTR-Screen

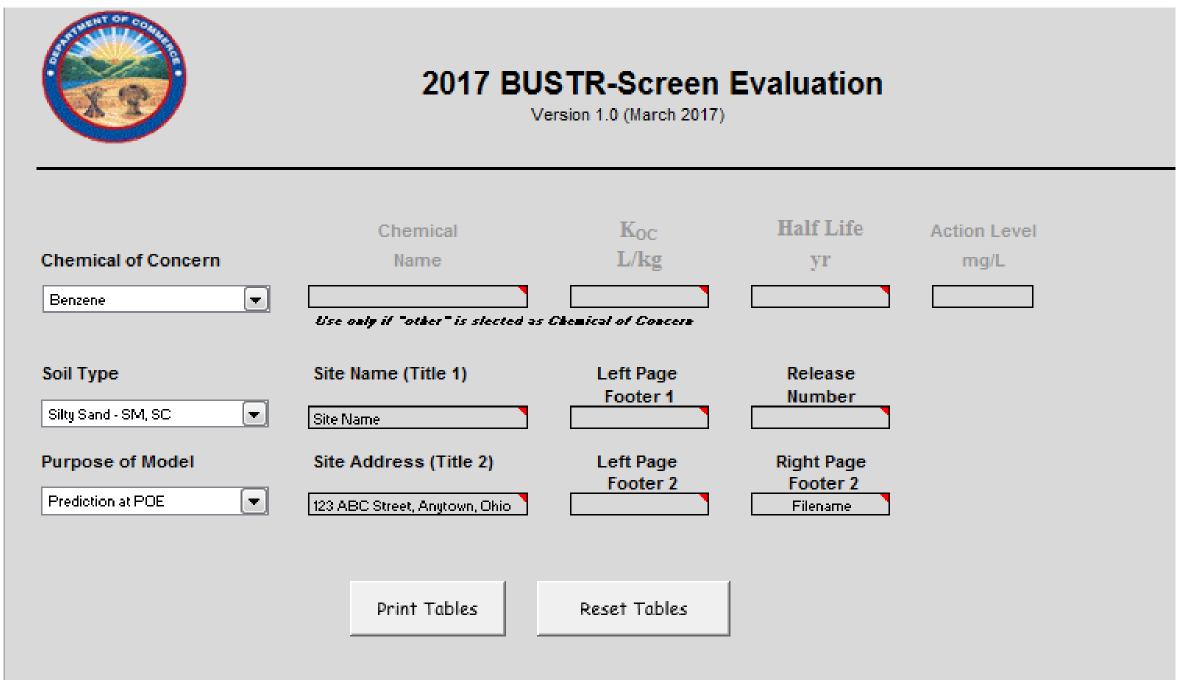

Figure F.2 - "Variable" *Worksheet* from BUSTR-Screen

Prediction at POE
Summary of Input Parameters
(Benzene / Silty Sand - SM, SC)

Description	Source / Default	Symbol	Value	Units	Reference[1]
Chemical and Physical Properties for Benzene					
Partion Coefficient	Default	K_{oc}	146	L/kg	
Solute Half-Life	Default	t-half	0.227	year	
Groundwater Action Level	Default	AL	0.005	mg/L	
Soil Parameters for Silty Sand - SM, SC					
Hydraulic Conductivity	Site Specific / 1.00E-01	K	1.20E-02	cm/sec	Enter Reference
Porosity	Default	n	0.3	unitless	
Fraction of Organic Carbon	Site Specific / 0.001	foc	0.005	unitless	Enter Reference
Soil Bulk Density	Default	rho	1.6	kg/L	
Site Specific Parameters					
Hydraulic Gradient	Site Specific	i	0.02	unitless	Enter Reference
Estimated Plume Length	Site Specific	Lp	100	feet	Enter Reference
Retardation Factor	Default	R	4.9	unitless	
Modeled Area Length	Site Specific	-	300	feet	Enter Reference
Modeled Area Width (must exceed total plume width)	Site Specific	-	60	feet	Enter Reference
Simulation Time	Model Specific	-	200	year	Enter Reference
Source Thickness in Saturated Zone	Default	-	10	feet	
Source Center: Width	Site Specific	-	10	feet	Enter Reference
Source Center: Concentration	Site Specific	-	2.5	mg/L	Enter Reference
Source Middle: Width	Site Specific	-	10	feet	Enter Reference
Source Middle: Concentration	Site Specific	-	0.5	mg/L	Enter Reference
Source Outer: Width	Site Specific	-	10	feet	Enter Reference
Source Outer: Concentration	Site Specific	-	0.1	mg/L	Enter Reference
Soluble Mass	Default	-	Infinite	kg	
Field Data for Comparison					
Concentration at 0 feet from source	Site Specific	-	2.5	mg/L	Enter Reference
Concentration at 30 feet from source	Site Specific	-		mg/L	
Concentration at 60 feet from source	Site Specific	-	0.4	mg/L	Enter Reference
Concentration at 90 feet from source	Site Specific	-		mg/L	
Concentration at 120 feet from source	Site Specific	-	0.12	mg/L	Enter Reference
Concentration at 150 feet from source	Site Specific	-		mg/L	
Concentration at 180 feet from source	Site Specific	-		mg/L	
Concentration at 210 feet from source	Site Specific	-		mg/L	
Concentration at 240 feet from source	Site Specific	-		mg/L	
Concentration at 270 feet from source	Site Specific	-		mg/L	
Concentration at 300 feet from source	Site Specific	-		mg/L	

[1]When referencing field data, refer to the appropriate report and page where this information was previously presented to BUSTR.

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F.3.1 Chemical & Physical Properties

Partition Coefficient (Koc): This is the organic carbon-to-water (i.e., soil-to-water) partition coefficient. Large values indicate a high affinity for the contaminant to adhere to the organic carbon fraction of the soil. Use the default value listed in Table F.2.

Solute Half-life (t-half): The solute half-life is the time that it takes a petroleum chemical dissolved in the plume to biologically decay to one-half of its original concentration. During the **first phase** of BUSTR-Screen modeling, BUSTR requires use of the default values presented on Table F.2. Refer to Appendix E to obtain default values for other COCs not listed on Table F.2. During the **first phase** of modeling, the most conservative value (i.e., the largest t-half value) must be selected. During the **second phase** of modeling, BUSTR allows the use of site-specific solute half-lives. Section F.6 provides additional information regarding site-specific half-lives.

Groundwater Action Level (AL): This is the maximum contaminant level in a drinking water ingestion exposure scenario (e.g., an unrestricted potable use standard established by the Ohio EPA). For most BUSTR sites the Tier 1 Action Levels (developed under a residential receptor and groundwater is drinking water scenario) are appropriate.

F.3.2 Soil Parameters

Hydraulic Conductivity (K): This is the horizontal hydraulic conductivity of the saturated zone. Slug tests or pump tests are conducted at the site to determine the site-specific hydraulic conductivity. When slug tests or pump tests are performed to estimate horizontal hydraulic conductivity, BUSTR recommends performing at least three tests at different wells in the source area or near the plume's centerline. The highest hydraulic conductivity value must be used in the BUSTR-Screen model during the first phase of modeling. During the second phase of modeling, BUSTR allows the value for hydraulic conductivity to be varied in order to calibrate the model. When using the default values listed in Table F.1, the value corresponding to the most permeable type of soil in the saturated zone should be used, even if that type of soil is not the most predominant at the site.

The potentiometric surface map and geologic cross-sections should be used to select the monitoring wells used for testing. The selected wells must be in areas that are representative of the aquifer containing the contaminant plume, and the more permeable zones of the aquifer. The selected wells should not be influenced by anomalies (e.g., former tank cavities). Also, note the following:

- If the contaminant plume is in a bedrock aquifer, modeling with "gravel" default data (Table F.1) must be used or pump tests can be performed (slug test results cannot be used). Pump tests within an extensive network of groundwater monitoring wells will be necessary. Contact the BUSTR coordinator prior to the implementation of pump tests.
- Use at least one laboratory test (e.g., American Society for Testing and Materials (ASTM) D2487, ASTM D422) of the most permeable portion of the saturated zone when determining the USCS Soil Classification type of the aquifer matrix.
- Results from a vertical hydraulic conductivity test (ASTM D5084) or the vertical hydraulic conductivity data presented in Appendix E may not be used with the BUSTR-Screen model.

Porosity (n): This is a ratio of the void space to the bulk volume of the aquifer matrix. Site-specific values may be determined using USEPA-approved laboratory methods for total porosity or calculations derived from geotechnical data (e.g., United States Army Corps of Engineers EM-1110-2-1906). For BUSTR modeling purposes, BUSTR will consider total porosity equal to effective porosity (no adjustment is necessary to convert total porosity to effective porosity). Samples used to obtain site-specific values must be collected from the aquifer matrix. Alternatively, the default values listed in Table F.1 may be used. The porosity values listed in Appendix E or values obtained from unsaturated zone soil samples may not be used.

Fraction of Organic Carbon (Foc): This value is the fraction of the aquifer soil matrix that is composed of naturally occurring organic carbon in uncontaminated areas. The Foc value is obtained through laboratory analysis of soil from within the aquifer matrix. Samples should be collected from borings located in uncontaminated areas that are downgradient of the source area and are within the migration pathway of the contaminant plume. Alternatively, the BUSTR default value of 0.001 should be used (ASTM 1995). Normally, two or three soil samples should be analyzed, and the average value should be used in BUSTR-Screen. The BUSTR default values listed in Appendix E are for vadose zone soils and may not be used in the BUSTR-Screen model. BUSTR recommends the Walkley-Black laboratory method to determine the fraction of organic carbon because most soils in the aquifer matrix contain less than 1% organic carbon. If a percentage of **organic matter** is obtained through laboratory analysis (such as ASTM-D2974), the **organic matter** value must be multiplied by a conversion factor of 0.58 to estimate a value for **organic carbon**.

Soil Bulk Density (ρ): This value is the bulk density of soil within the aquifer matrix and may be different than bulk densities obtained from above the saturated zone. Obtain soil bulk density from geotechnical analysis of soil within the aquifer matrix or by using the BUSTR default value (Table F.1) based on the most permeable soil type encountered within the saturated zone. If a site-specific value is used in the model, samples from the aquifer matrix in the assumed migration pathway must be used.

F.3.3 Site-Specific Parameters

BUSTR has not determined default values for many of the site-specific parameters listed below (source thickness and soluble mass are the exceptions). Therefore, site-specific values must be developed by the BUSTR-Screen user, and the values developed must then be entered on the "Variable" worksheet.

Hydraulic Gradient (i): Hydraulic gradient is the slope of the potentiometric surface. Calculate the hydraulic gradient by constructing potentiometric surface maps using static water level data from groundwater monitoring wells. Hydraulic gradients should be calculated for several sampling events (typically four quarters) due to the possibility of fluctuating groundwater flow. The USEPA's hydraulic flow calculator may be used to estimate hydraulic gradients (https://www3.epa.gov/ceampubl/learn2model/part-two/onsite/index.html).

Estimated Plume Length (Lp): The distance used for the plume length (Lp) is the downgradient distance from the source area (i.e., area of highest concentration) to the point where the groundwater concentration equals the BUSTR action level for the groundwater ingestion pathway (e.g., 0.005 mg/L for benzene). Estimate Lp from field data and justify the result. Refer to Figure F.3 for an example illustration.

Retardation Factor (R): The retardation factor is the ratio of the groundwater seepage velocity to the rate that organic chemicals migrate in the groundwater. BUSTR-Screen calculates the retardation factor automatically using the values provided for soil bulk density, partition coefficient and fraction of organic carbon. BUSTR allows the use of retardation factors for all COCs, including MTBE.

Modeled Area Length: Normally, this value is the distance from the source area to the POE. However, BUSTR may require that shorter distances be modeled if modeling to the POD. Note that BUSTR-Screen uses the value entered as the modeled area length (e.g., 300 ft.), and automatically calculates 10 evenly spaced downgradient distances from the source area, and then inserts those 10 values in the "Field Data for Comparison" section of the BUSTR-Screen "Variable" worksheet. These calculated distances are also automatically added to "Section 7 – Field Data for Comparison" on the "Input" worksheet and the "Centerline Output" worksheet.

Modeled Area Width: This value must equal or exceed the width of the contaminant plume. Generally, allowing a modeled area width that is twice as wide as the plume width is acceptable.

Simulation Time: If the soluble mass parameter of the BUSTR-Screen model is entered as "infinite", increase the simulation time until the contaminant concentration at the point of exposure reaches steady state conditions. If the soluble mass parameter is entered as a finite value, adjust the simulation time so that the COC concentration at the POE is equal to its maximum value. Time steps may be viewed and printed from the "Centerline Output" worksheet by depressing the "Calculate Animation" button.

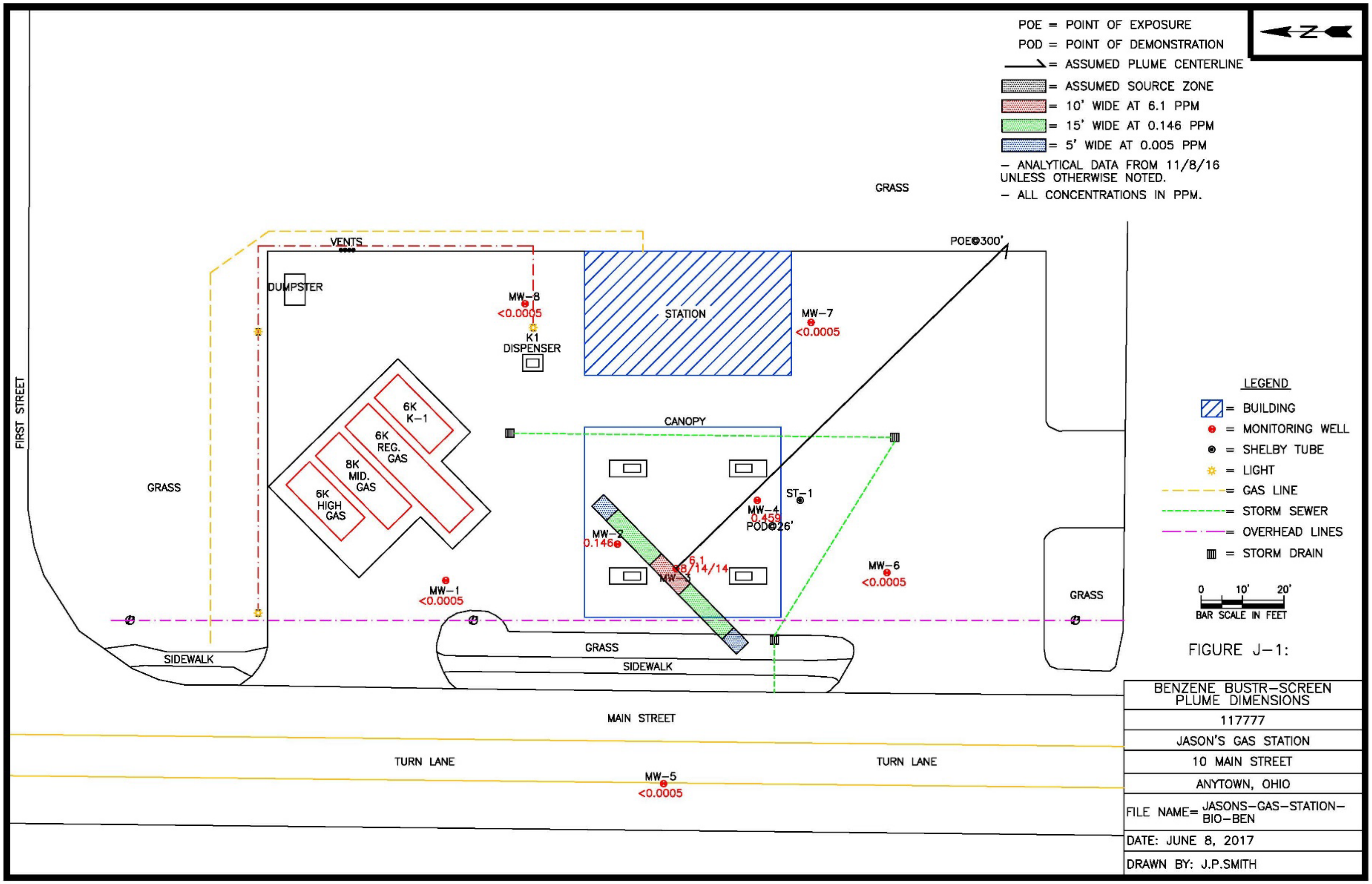
BUSTR considers steady state conditions as the maximum distance the plume will travel before reaching equilibrium (i.e., the leading edge of the plume is no longer increasing in concentration downgradient of the source area). To determine if the dissolved plume has reached steady state conditions, the simulation time must be increased until the leading edge of the plume reaches its maximum concentration and distance from the source area.

Source Thickness in Saturated Zone: This value is the depth of contamination in the saturated zone within the source area. Use either site-specific data or the BUSTR default value of 10 ft. Site-specific data is gathered by obtaining samples from wells within the source area that are screened at different depths (i.e., nested wells or other approved techniques) or by determining the amount of water table fluctuation (i.e., the smear zone). For most petroleum release sites, a value of 10 ft. is sufficiently accurate. If dense chemicals (e.g., chlorinated compounds) are present or if significant precipitation infiltration causes COCs to be forced downward into the aquifer, then the 10 ft. thickness may not be appropriate and site-specific data should be used.

Source Zones (width and concentration): The source zones and the associated widths are graphically presented in "Section 6 – Source Data" on the "Input" worksheet of BUSTR-Screen. The source zones are identified as "Center", "Middle", and "Outer". Enter a minimum of two source zone widths with their respective COC concentrations. Use the highest COC concentrations and their associated zone widths for the center zone and the middle zone. If the source is wide and sufficient data exists, also input a COC concentration and width for the outer zone. These concentrations and their associated width distances represent the source zone perpendicular to the centerline of the plume and groundwater flow direction. Adequate characterization of the source area may require the installation of additional soil borings and monitoring wells perpendicular to the plume centerline for input into BUSTR-Screen. Additional information concerning the insertion of source zone concentrations is available in the BIOSCREEN User's Manual (Newell, McLeod and Gonzales, 1996 and 1997).

Source Half-life (Soluble Mass): The soluble mass is the quantity of the COC available to mix with groundwater moving through the aquifer matrix. For BUSTR Tier 2 modeling purposes, an infinite soluble mass in the source area should normally be used. However, a finite soluble mass may be used under certain circumstances. For example, if a known quantity of petroleum product was released from the UST system, or if the quantity of total soluble mass can be accurately estimated, then a finite soluble mass may be used. The value calculated for finite soluble mass must include all soluble components of the petroleum product. Generally, calculating a value for finite soluble mass will require a significant number of soil samples (vadose zone and saturated zone) and groundwater samples, to accurately characterize the distribution of petroleum hydrocarbon constituents at the site and to estimate the total mass of soluble petroleum hydrocarbon.

Figure F.3 - BUSTR-Screen Plume Dimensions



Seepage Velocity: Seepage velocity is defined as "actual interstitial groundwater velocity, equaling Darcy velocity divided by effective porosity". Seepage velocity is calculated automatically by BUSTR-Screen by multiplying the hydraulic conductivity by the hydraulic gradient and dividing by effective porosity. In BUSTR-Screen, seepage velocity is measured in feet per year (ft./yr.) with typical values ranging from 0.5 ft./yr. to 200 ft./yr. BUSTR recommends that actual site data be used for hydraulic conductivity and porosity to develop a more accurate SSTL. Additional information concerning the seepage velocity is available in the BIOSCREEN User's Manual (Newell, McLeod and Gonzales, 1996 and 1997).

Seepage velocity is **critical** for determining how long sampling is required at the POD to determine if the COC concentrations predicted with BUSTR-Screen are approximately equal to the actual field concentrations at the POD. As such, BUSTR-Screen predicts the future migration of the source area contamination to the POD and subsequently to the POE, and the seepage velocity determines how fast the source concentration migrates from the source area.

For example, if the seepage velocity of the saturated zone is 10 ft./yr. and the source zone monitoring well is located 20 feet from the POD, then at least two years of sampling must be conducted at the POD following the date the source concentration value was collected at the source monitoring well. This allows enough time to elapse for the source area to migrate to the POD to validate BUSTR Screen predictions. See Section F.4 for further details.

F.3.4 Field Data for Comparison

Site-specific data must be collected in the source area and along the plume centerline, and the concentrations must then be entered on the "Variable" worksheet.

Enter the values of concentration using site-specific data from monitoring wells to compare the field data to the values predicted by BUSTR-Screen. In most cases, downgradient detections of COCs in the POD monitoring wells are required for BUSTR-Screen to accurately model the plume. Obtain the COC concentration data from monitoring wells within the source area and from wells located near the centerline of the plume. The concentrations entered must be from the same sampling event and from sampling points that show stable to decreasing COC concentrations over time. Also, recall that the distances from the source were calculated by BUSTR-Screen based on the value entered for modeled area length. Thus, the actual locations of the monitoring wells may not exactly match the distances from the source as listed on the "Variable" worksheet.

Example F.1 - POD Comparison Table

Chemical of Concern	Point of Demonstration (POD)	POD Prediction Date	Predicted POD Concentration	Actual Date of POD Sampling	Actual POD Concentration	Predicted POE Concentration
Benzene	MW-2	July 2022	0.025 mg/l	7/1/2022	0.016 mg/l	0.004 mg/l

Increasing or unstable COC concentrations are indications that the BUSTR-Screen model is not appropriate for the site. Due to the temporal variability of COC concentrations at petroleum release sites, **a graph of "concentrations vs. time" must be provided for all wells in the source area and for wells along the plume centerline**. These graphs should provide evidence that the COC concentrations are decreasing or stable, and that the values predicted by BUSTR-Screen are conservative when compared to actual site data. In situations where it may be unclear if the plume is increasing or unstable contact BUSTR staff prior to starting modeling in BUSTR-Screen.

During the first phase of modeling in a Tier 2 Evaluation, do not adjust the COC concentrations predicted by BUSTR-Screen to fit the observed field data curve. Calibration of the BUSTR-Screen model to actual site data is only allowed in the second phase of modeling during a Tier 2 Evaluation (Section F.6).

The following are common errors BUSTR has observed during the first phase of modeling:

- The current or historical COC concentration(s) is not used. Do not perform COC averaging for individual monitoring wells.
- The default or most conservative hydraulic conductivity (i.e., the fastest hydraulic conductivity) is not used. Do not calibrate the model with adjusted hydraulic conductivity, seepage velocity or COC half-life in the first phase of modeling.
- Monitoring is not performed in the downgradient direction. Regardless of which direction the POE was determined in, BUSTR-Screen monitoring must be performed from the source area in a downgradient direction parallel with groundwater flow.
- Appropriate PODs are not selected. Detections of COCs in downgradient POD monitoring wells are required for BUSTR-Screen to model correctly.
- The correct POE has not been selected. If potable wells are located within 300 feet of the site, the POE is the property line nearest to the source area regardless of groundwater flow direction.
- A complete 300 ft. door-to-door water well survey was not conducted, or an adequate response rate (75%) was not achieved. A complete door-to-door water well survey is required to justify a 300' POE.

F.4 Model Validation

For BUSTR-Screen modeling performed during a Tier 2 Evaluation at BUSTR sites, model validation refers to how the predicted COC values compare to the actual field data. Model validation may only be conducted if modeling demonstrates that the POE will not be impacted above ALs.

Monitoring actual contaminant concentrations at the site is required to validate the predictions made by the BUSTR-Screen model. The sampling point(s) used to validate the model is defined as the POD. The location of the POD is described in OAC 1301:7-9-13 (O)(2), effective September 1, 2022. The POD must be located on the contaminant plume centerline (i.e., the line connecting the source area with the POE). The model should predict a detectable concentration of the COC at the POD (if the model predicts a value of zero, that point should not be used for the POD). Also, the monitoring well located at the POD should have a detectable concentration of the COC to verify that the POD evaluation point is in the contaminant migration pathway. Refer to Figure F.3 for an example of a correctly configured BUSTR-Screen site model illustrating the locations and concentrations of COC at the POD.

The POD is then monitored to evaluate the model predictions. In some cases, it may be necessary to install more than one POD monitoring well. The time required for groundwater monitoring depends on the length of time, which is primarily determined by seepage velocity and other factors (e.g., retardation), that the model predicts will transpire until the concentration at the POD reaches the predicted value. If BUSTR-Screen predicts that it takes a certain number of years for contamination to move from the source area to the POD, the POD must be monitored for that number of years to validate the model assumptions. For example, if the BUSTR-Screen model predicts a benzene concentration of 0.02 mg/L at the POD in 2 years, the POD must be monitored for 2 years. After 2 years of monitoring, if the benzene concentration at the POD exceeds the predicted value of 0.02 mg/L, the model predictions are not valid. Phase 2 modeling may be appropriate.

OAC 1301:7-9-13 (O)(1), effective September 1, 2022, requires that a monitoring plan (to verify the fate and transport model assumptions and predictions) be submitted for approval by BUSTR, and that the plan includes the anticipated length and frequency of the monitoring activities (Section 3.15). The length and frequency of groundwater monitoring must be selected based on the COC concentrations, groundwater seepage velocity, location of the POD, and other site-specific factors. BUSTR may approve quarterly, bi-annual, or annual monitoring, depending on the nature and migration of the contaminant plume, and on the locations of the POD and POE. If bi-annual or annual monitoring is approved, samples must be collected at approximately the same time each year to account for fluctuations within the aquifer. All validation monitoring plans must be pre-approved by BUSTR.

In certain cases, historical data may be used to validate the BUSTR-Screen model predictions. For example, if 5 years of groundwater monitoring has already been performed at the source area and POD locations, then BUSTR may allow the use of the existing data to validate the BUSTR-Screen predictions. To do this, the initial sampling events are used to predict the concentrations in subsequent years. However, historical data cannot be used to validate the model if an active remediation system was in operation during the historical period. BUSTR will consider the use of historical data to validate modeling on a case-by-case basis.

The following are common errors BUSTR observed during the first phase of modeling:

- An insufficient site map is supplied with the report. The site maps should include the POE, the POD used to validate the model assumptions, the model predicted concentration at the POD compared to actual concentrations present at the POD, and the plume centerline and source area monitoring wells used as input values into the BUSTR-Screen model.
- The saturated hydraulic conductivity (vertical hydraulic conductivity) value was mistakenly used in the model. The hydraulic conductivity value used in BUSTR-Screen must be obtained from slug tests.

If dissolved-phase COCs above ALs have migrated off-site and the POE associated with the groundwater ingestion pathway is the nearest property boundary to the site, the impacted area(s) must be addressed by an interim response action and/or a remedial action plan.

F.5 Data Presentation & Information Submitted to BUSTR

Generally, all BUSTR-Screen modeling work will be submitted with the Tier 2 Evaluation report (or as a separate report if model calibration work has also been performed). Summarize the BUSTR-Screen modeling work with the following information:

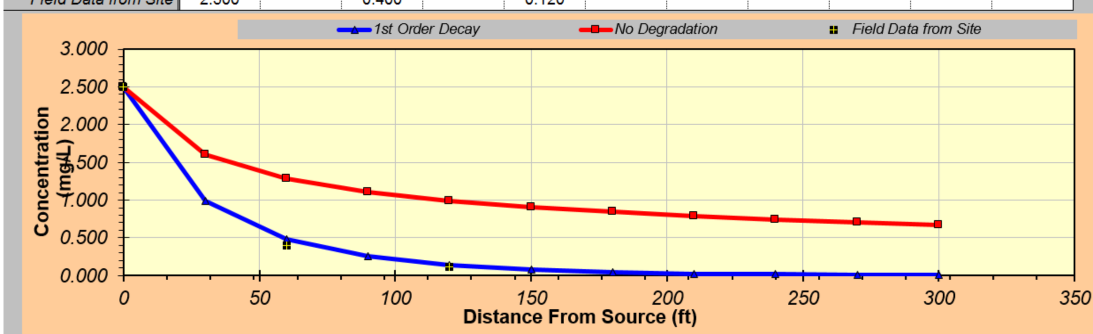
- Printouts of all the BUSTR-Screen worksheets used in the modeling effort. This must include the “BUSTR”, “Variable”, “Input”, “Centerline Output” (Figure F.4) and “Plume Output” worksheets for all COCs being evaluated;

- Site maps showing the source area, plume length, plume width, groundwater flow direction, monitoring well locations, potentiometric surface, centerline from the source area to the POD and to the POE (see example presented as Figure F.3), and other pertinent features. Geologic cross-sections should also be submitted;
- Summary of findings, conclusions, and recommendations;
- Discussion of final model outputs;
- Determination of the time (years) to reach "steady state";
- Sources of error and uncertainty, including a qualitative sensitivity analysis;
- Tables of all data used in verifying the model including any calculations, laboratory results, geotechnical data, etc.; and
- Graphics of "concentration vs. time" for all monitoring wells in the source area and along the plume centerline

Figure F.4 - "Plume *Centerline*" Worksheet from BUSTR-Screen

Dissolved Benzene Concentration Along Plume Centerline (mg/L at Z=0)
Silty Sand - SM, SC
Distance from Source (ft)

TYPE OF MODEL	0	30	60	90	120	150	180	210	240	270	300
No Degradation	2.500	1.607	1.284	1.109	0.993	0.908	0.842	0.789	0.745	0.707	0.675
1st Order Decay	2.500	0.988	0.486	0.258	0.142	0.080	0.046	0.026	0.015	0.009	0.005
Field Data from Site	2.500		0.400		0.120						



Calculate Animation

Time: 200 Years

Site Name
123 ABC Street, Anytown, Ohio

Prediction at POE

F.6 Model Calibration during the Second Phase of Modeling

BUSTR only allows the BUSTR-Screen model to be calibrated during the second phase of the Tier 2 modeling effort. Model calibration should only be performed if the work completed in the first phase of modeling indicates that the COC concentration at the POE will exceed the drinking water standard. This second phase of modeling must first be proposed to BUSTR as part of the Tier 2 Evaluation report. BUSTR must approve the plan to calibrate the model before this second phase of modeling is performed. During this second phase, the hydraulic conductivity parameter (K) and/or the solute half-life (t-half) can be manipulated in an attempt to calibrate the model so that the COC concentrations predicted by the model approximate the actual field concentrations at the source and POD wells.

The Calibration Plan must include, but is not limited to the following:

- A detailed description of the proposed activity;
- Identification of monitoring wells to be used for calibration;
- Description of data sets used for half-life (t-half) and/or COC degradation rate (k) calculations;
- Description of data sets used for hydraulic conductivity (K) calculations;
- Monitoring plan activities (Section 3.14);
- Estimated time of completion; and
- Completion report contents.

F.6.1 Calibration using Hydraulic Conductivity Estimates

The **hydraulic conductivity** (K) value may be manipulated during calibration based on the slug test or pump test data collected at the site. Slug or pump tests should be performed on at least three different wells located in the source area and along (or near) the plume centerline and must be representative of the aquifer matrix associated with the contaminant plume. To determine the allowable values for hydraulic conductivity (K) that may be used during model calibration, two ranges must be determined:

- Use the results from the slug or pump tests and determine the range of (K) values bounded by the maximum and minimum values of (K);
- Calculate the geometric mean of (K) using the results of the slug or pump tests; and
- Determine a range of (K) values bounded by the limits of the mean plus or minus one order of magnitude.

The allowable values of (K) that may be used to calibrate BUSTR-Screen are all values included in both hydraulic conductivity ranges (i.e., the values common to both ranges). Example F.2 provides an example of the hydraulic conductivity evaluation described above.

A worksheet tab is included with the BUSTR-Screen spreadsheet to assist in calibration using hydraulic conductivity values during the calibration process. The spreadsheet tab is titled “K Value Calculator”. The hydraulic conductivity (K) values should be reported in both cm/sec and log K.

Example F.2 - Hydraulic Conductivity Evaluation

	Hydraulic Conductivity (K) (cm/sec)	**Hydraulic Conductivity (Log K)**
SLUG TEST DATA		
MW-1	1.11×10^{-4}	- 3.95
MW-2	1.81×10^{-4}	- 3.74
MW-3	4.69×10^{-4}	- 3.33
MW-4	2.05×10^{-3}	- 2.69
CALCULATIONS and COMPARISON OF RANGES		
Maximum	2.05×10^{-3}	- 2.69
Minimum	1.11×10^{-4}	- 3.95
Geometric Mean	3.73×10^{-4}	Not Applicable
Arithmetic Mean	Not Applicable	- 3.43
Mean plus 1 Order of Magnitude	3.73×10^{-3}	- 2.43
Mean minus 1 Order of Magnitude	3.73×10^{-5}	- 4.43
ALLOWABLE SITE-SPECIFIC RANGE	1.11×10^{-4} to 2.05×10^{-3}	-3.95 to -2.69

In this example, the allowable values of hydraulic conductivity for calibrating the BUSTR-Screen model range between 1.11×10^{-4} cm/sec and 2.05×10^{-3} cm/sec because this is the range of values intersected by the two hydraulic conductivity ranges described in Section F.6.1.

F.6.2 Calibration using Solute Half-life Estimates

The **solute half-life** (t-half) value may be manipulated during calibration based on site-specific data. BUSTR's approach is based on information presented in:

- "Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites (ASTM, 1998 et seq.)
- "Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies (USEPA, 2002) (EPA/540/S-02/500)

The following three steps outline the procedures for calculating a solute half-life (t-half):

Step 1:

BUSTR requires a graphic plot of **concentration-vs.-distance** for all chemicals that exceed action level concentrations to demonstrate that the plume is stable to decreasing. At least three monitoring wells must be included in the concentration-vs.-distance approach, with one of the wells located in the source area and at least two wells located along the centerline of the COC plume. Several plots should be prepared, and they should include the concentration-vs.-distance data for at least three different sampling events that represent several years of plume evolution.

Step 2:

The solute half-life (t-half) must be estimated based on the **concentration-vs.-time** approach described in the two documents referenced above. The concentration-vs.-time regression analysis is based on the first-order decay equation $\{C_{(t)} = C_i\ e^{-(kt)}\}$ and is used to estimate the solute degradation rate (k). When calculating the value of a solute's half-life (t-half), only use a natural log (ln), not a base 10 log (log) when deriving half-life. Half-lives derived using a base 10 log will not be accepted as valid by BUSTR. The concentration-vs.-time regression analysis must be based on the following:

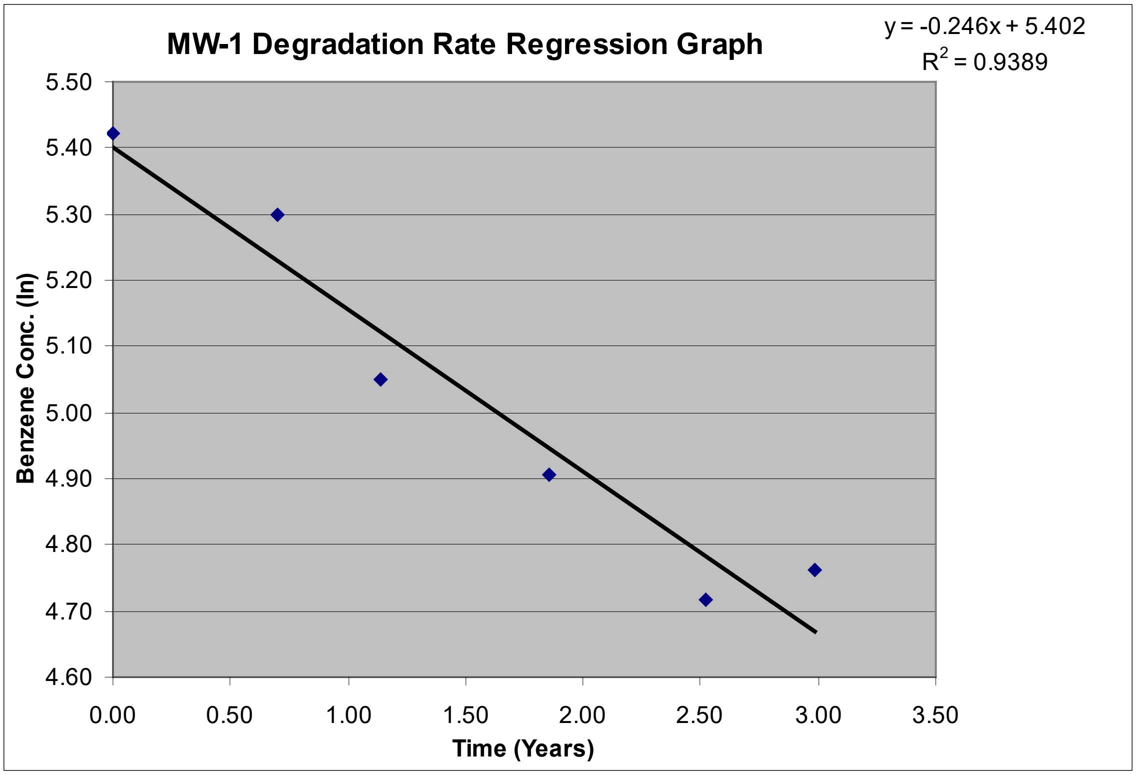
- At least three monitoring wells must be evaluated;
- All monitoring wells must be located near the centerline of the COC plume, but the wells cannot be located in the source area;
- At least six sampling dates must be used, covering a span of at least three years;
- The evaluations and calculations described above should be performed with an understanding that seasonal variability, changing groundwater flow directions, changing hydraulic gradients, soil heterogeneity, and other issues may impact the results of the fate and transport model;
- Although not required, the concentration-vs.-time regression calculations may include a "goodness of fit" statistical calculation using the coefficient of determination (R^2); and
- Although not required, a quantitative sensitivity analysis may be performed using the BUSTR-Screen model for the hydraulic conductivity and solute degradation rate parameters. BUSTR recommends using the two-tailed 80% confidence intervals for these two parameters.

Example F.3 is an example of how to calculate the degradation rate for a specific well (MW-1) using Microsoft® Excel.

Example F.3 - Degradation Rate Regression Analysis

MW-1			
Sampling Date	**Years**	**Benzene Concentration (µg/L)**	**Benzene Concentration Natural Log (ln)**
2/18/2008	0.00	226	5.42
11/1/2008	0.70	200	5.30
4/8/2009	1.14	156	5.05
12/25/2009	1.85	135	4.91
8/26/2010	2.52	112	4.72
2/11/2011	2.98	117	4.76

The site-specific COC concentrations must be converted to natural log (ln) in the concentration vs. time regression analysis. Do not use base 10 log. In addition, it is important to use years for the rate of regression analysis (not days or months) because the input value used for BUSTR Screen has units based in years.



If the slope determined from the concentration vs. time regression analysis is positive, the plume is not considered stable to decreasing and a site-specific half-life for use in the fate and transport model is not appropriate.

Step 3:

The regression analyses described in Step 2 above will provide estimates of the solute degradation rate (k) for each monitoring well. In the example above, the slope of the degradation line equals 0.246 for MW-1. Those values must be converted to estimates of the solute half-life (t-half) using the following equation: **(t-half) = 0.693 / (k)**. Convert all values of (k) to (t-half) and determine the range of (t-half) values bounded by the maximum and minimum values of (t-half). The allowable values of (t-half) that may be used to calibrate BUSTR-Screen are all values within the range. Example F.4 provides an example of the solute degradation date range calculation.

Example F.4 - Solute Degradation Rate Evaluation

	Benzene Degradation Rate *(k) (per year)	**Benzene Half-life (t-half) (years)**
SITE-SPECIFIC VALUES		
MW-1	0.246	2.8
MW-2	0.347	2.0
MW-3	0.408	1.7
MW-4	0.495	1.4
ALLOWABLE SITE-SPECIFIC RANGES	0.246 to 0.495	1.4 to 2.8

* Based on concentration-vs.-time regression analyses, performed in step 2 above.

F.6.3 Reporting of Model Calibration Activities

Prepare a summary report describing the activities performed to calibrate the BUSTR-Screen model. The report should include the following items:

- All pertinent information listed in Section F.5;
- A summary of the data and calculations performed in conjunction with Section F.6.1;
- A summary of the data, calculations and graphic plots developed in conjunction with Section F.6.2; and
- A Monitoring Plan, prepared in accordance with Section 3.15 to verify the fate and transport assumptions and predictions of the calibration procedures.

F.7 References

American Society for Testing and Materials (ASTM), 1995 et seq., *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*, ASTM E1739-95, Philadelphia, PA.

American Society for Testing and Materials (ASTM), 1998 et seq., *Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites*, ASTM E1943-98, Philadelphia, PA.

Newell, C.J., R.K. McLeod and J.R. Gonzales, 1996. *BIOSCREEN Natural Attenuation Decision Support System*, User's Manual Version 1.3, National Risk Management Research Laboratory, Office of Research and Development, USEPA, Cincinnati, OH.

Newell, C.J., R.K. McLeod and J.R. Gonzales, 1997. *BIOSCREEN Natural Attenuation Decision Support System*, Version 1.4, July 1997, Version 1.4 Revisions. National Risk Management Research Laboratory, Office of Research and Development, USEPA, Cincinnati, OH.

USEPA, 2002. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* by Newell, C.J., H.S. Rifai, J.T. Wilson, J.A. Conner, J.A. Aziz, and M.P. Suarez. (EPA/540/S-02/500, November 2002.)

Appendix G: TPH Evaluation in Tier 3

Unlike the COC ALs listed in Chapter 3 (Tables 3.3 through 3.7 and in Table 3.9) which were developed based on risk-based criteria, the TPH action levels listed in Table 3.8 are based on the physical properties of petroleum and the impacted soil. When TPH is detected above ALs, BUSTR requires soil removal and other remediation techniques be evaluated. After demonstrating that soil removal and other remediation techniques are not viable options, a site-specific evaluation of TPH (e.g., risk calculation) may be proposed in a Tier 3 Evaluation Plan. Environmental covenants to manage TPH may be considered only after soil excavation, soil remediation, and/or risk analysis of TPH has been conducted.

To evaluate TPH contamination that cannot be addressed through remediation, a Tier 3 Evaluation may be used to calculate the potential risk associated with TPH. TPH contamination represents a complex mixture of chemicals rather than a single chemical, making assessing the risk associated with soil impacted by TPH difficult.

BUSTR has identified the following options to address TPH contamination that cannot be remediated.

G.1 Tier 3 Evaluation Plan

A Tier 3 Evaluation Plan must identify the source area for TPH (i.e., areas where TPH exceeds the ALs) and propose an investigation to re-sample each location exhibiting elevated concentrations of TPH. The plan must be submitted to BUSTR for approval. In addition to the requirements of OAC 1301:7-9-13 (M), the plan must identify and include the following:

- A map that identifies the location, dimensions, and depth of the TPH “source area”;
- Soil boring logs for data points within the TPH source area;
- A cross-section through the source area;
- The existing TPH data to be evaluated during the Tier 3; and
- A determination for whether additional soil samples will be collected and analyzed to provide an adequate number of samples from the “source area”.

G.2 Surrogate VOC/SVOC Analysis

Choosing this option will require the collection of additional soil samples from the source area, to identify the concentrations of the individual chemicals associated with TPH. Risk-based ALs (or SSTLs) for the detected surrogate chemicals can then be developed.

Soil must be re-sampled where the highest TPH-impacted soil intervals were detected using BUSTR-approved methods. Samples should be field-screened and selected for lab analysis according to the highest PID readings. Regardless of field screenings, a sample from the interval that previously contained TPH exceeding ALs must be analyzed.

Samples must be analyzed by the following methods based on the analytical group. **The full scan of each method is required.** This method may not be appropriate for TPH in Analytical Group 5. Please contact BUSTR prior to preparing a work plan.

Table G.1 - Accepted Sample Analysis Method

Analytical Group	Accepted Analysis Method
Group 1	EPA Method 8260
Group 2	EPA Method 8260 and 8270
Group 3	EPA Method 8270
Group 4	EPA Method 8260 and 8270
Group 5	Contact BUSTR

To generate SSTLs for specific pathways, BUSTR spreadsheets should be used to calculate risk-based ALs (or SSTLs) for the detected chemicals. BUSTR spreadsheets already contain toxicity and chemical specific data for many VOCs and SVOCs. If any of the detected chemicals are not already included in the drop-down menus of BUSTR's spreadsheets, chemical specific data must be obtained according to Section 3.9.3. If the data is not available on the BUSTR spreadsheets or in the CIDARS database, the specific COC does not need further evaluation. Consult Section 3.10.3 on how to calculate SSTLs for COCs not on the BUSTR spreadsheet dropdowns.

SSTLs must be developed for all complete soil exposure pathways (i.e., soil to indoor air, soil to outdoor air and direct contact) for all detected compounds where toxicity data is available. If more than one carcinogen or one non-carcinogen is detected, a Multiple Chemical Adjustment (Section 3.10.4) must be performed for each indoor air, outdoor air, and direct contact pathway. Initially, the Multiple Chemical Adjustment should be performed using the maximum concentration of each COC regardless of location for each pathway.

If the initial Multiple Chemical Adjustment exceeds the allowable risk, then a second phase of evaluation may be applied at each boring location (e.g., five boring locations would require five risk calculations for the indoor air pathway). This should be discussed with the site coordinator and a work plan would be required for approval prior to application.

SSTLs must also be developed for the soil-to-drinking water leaching pathway for all detected compounds where toxicity data is available. Individual COCs should be evaluated using the BUSTR soil-to-drinking water leaching spreadsheet in a similar fashion as the Tier 2 process. The Multiple Chemical Adjustment does not need to be performed for the soil leaching pathway; however, each COC should be evaluated individually as in the Tier 2 process. For example, the factor of 10 must be applied to the spreadsheet number if the Tier 1 groundwater ingestion AL is used. If the groundwater ingestion AL input in the SSTL spreadsheet has been changed by back calculating using BUSTR-Screen, the factor of 10 does not apply. If a detected compound exceeds the soil-to-drinking water leaching pathway, then further evaluation is required. Groundwater samples may be needed to determine current groundwater concentrations and to conduct BUSTR-Screen modeling and back calculation of the soil-to-drinking water leaching pathway. Copies of all models and spreadsheets must be included in the report, regardless of the final output.

A Tier 3 Evaluation Plan must be submitted identifying the source area for TPH (i.e., areas where TPH exceeds the ALs) and proposing an investigation to re-sample each location exhibiting elevated concentrations of TPH.

G.2 Statistical Analysis

G.2.1 Introduction

The purpose of this section is to describe the requirements for calculating a 95% Upper Confidence Limit (UCL) for TPH under BUSTR's 2022 corrective action rule (OAC 1301:7-9-13). This statistical method cannot be used if the VOC/SVOC Surrogate Method described above was previously evaluated and exceeded the allowable risk. In addition, BUSTR does not allow a 95% UCL calculation to be used for any individual chemical of concern in soil or groundwater, it can only be used for TPH.

Before calculating a 95% UCL for TPH, BUSTR requires that soil removal and other remediation technologies be evaluated. Only after determining that soil removal and other technologies are not viable will BUSTR consider a request to perform a Tier 3 Evaluation using a 95% UCL calculation.

A Tier 3 Evaluation Plan must be submitted to BUSTR for approval. In addition to the requirements of OAC 1301:7-9-13 (M), the plan must identify and include the following:

- A map that identifies the location, dimensions and depth of the TPH "source area";
- Soil boring logs for data points within the TPH source area;
- A cross-section through the source area;
- The existing TPH data to be used in the UCL calculation; and
- A determination if additional soil samples are needed to provide an adequate number of samples from the "source area".

G.2.2 Basic Sampling Requirements

A complete characterization of the "source area" must be performed. Only data from the "source area" may be used in the statistical calculations because the calculations assume that all the TPH data were collected from the same statistical population. This is the most important aspect of developing a statistically valid dataset. In most cases, a complete characterization of the source area will require the installation of additional soil borings. Without a valid dataset, the subsequent statistical calculations will not yield adequate approximations for any of the resulting statistical parameters (mean, median, standard deviation, UCL, etc.).

Therefore, the basic sample and dataset requirements are as follows:

- Use only TPH data from a "source area";
- Use a minimum of 12 samples;
- Use a maximum of 15% non-detect lab results because, by definition, the "source area" must contain the highest TPH values. For example, if 12 samples are used, then only 1 of those TPH values can be a non-detectable value. Also, limiting the dataset to less than 15% non-detects enhances the possibility that the dataset will approach a normal (Gaussian) distribution; and
- For the non-detectable concentration, use the detection limit as the TPH concentration in the subsequent UCL calculations.

G.2.3 Data Entry and Statistical Results

Use USEPA's *ProUCL* (version 5.1.0.0, *et seq*.) statistical program to perform the statistical analyses (available at: https://www.epa.gov/land-research/proucl-software). This helps provide consistency between all the Tier 3 TPH Evaluation Plans and allows BUSTR's staff to easily review the submitted information.

Step-by-step instructions are as follows:

- Open the *ProUCL* program as described on USEPA's website and download the program to your computer;
- Open the file folder and then open the "ProUCL application file (approx. 1,240 KB);
- On your worksheet, enter the TPH (source area) concentrations into the first column, and label the column heading "Concentrations" by right clicking on the column header and selecting "Header Name". In the second column, enter the sample identification names for each of the TPH samples and label the header "Sample Location". The consultant must submit the t worksheet page to BUSTR;
- Along the Toolbar at the top of your screen, open the following tabs and submit copies of the pages listed below (approximately 7-8);
    - Graphs (toolbar tab) – "Histogram" page
    - Statistical Tests (toolbar tab) – "Outlier" page
    - Goodness-of-Fit (Statistical Tests tab) –Normal, Gamma and Lognormal graph pages
    - UCLs/EPCs (toolbar tab) – "All" pages
- Please select the correct data set when opening the above tabs. This is accomplished by clicking on the "Concentrations" variable and transferring it over to the "Selected" box in the "Selected Variables" window before clicking "OK".

G.2.4 Evaluating the Results

The "UCL" toolbar page (listed above) will be the primary document used to determine whether one of the statistical distributions adequately represents the TPH dataset and to determine the estimated 95% UCL value.

This page presents the relevant statistics for three distributions (normal distribution, lognormal distribution, and Gamma distribution).

For these three distributions, the page states whether the data appear (or does not appear) to fit a normal, lognormal or Gamma distribution at the 5% significance level. BUSTR will not allow any of the non-parametric statistics to be used as an estimate of the 95% UCL value.

Near the bottom of the "UCL" page(s), *ProUCL* identifies which of the three distributions may potentially be used for the UCL calculation and identifies the 95% UCL value for the TPH dataset. **The 95% UCL value will be used instead of the on-site maximum and compared to the TPH AL.**

If the *ProUCL* pages indicate that the TPH data do not appear to fit one of the three distributions listed above or if there are other problems with the dataset (as explained in the *ProUCL* documents), then additional source area TPH data may need to be collected.

The information from the Graphs, Outlier Tests, and Goodness of Fit toolbar tabs will also be used by BUSTR to help evaluate the “UCL” toolbar statistical summary info.