Interim Action Feasibility Study Report
Hidden Lane Landfill Superfund Site
Sterling, Virginia

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Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	Micrograms per liter
°	Degree(s)
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response and Liability Act
COC	Contaminant of concern
DCE	Dichloroethene
DNAPL	Dense non-aqueous phase liquid
EA	EA Engineering, Science, and Technology, Inc., PBC
EPC	Exposure point concentration
ERA	Ecological Risk Assessment
FS	Feasibility study
ft	Foot or Feet
GRA	General response action
HHRA	Human health risk assessment
HLLF	Hidden Lane Landfill
LEL	Lower explosive limit
LUC	Land use control
MCL	Maximum contaminant level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operations and maintenance
PCE	Tetrachloroethene
POETS	Point-of-Entry Treatment System
PRG	Preliminary remediation goal
RAO	Remedial action objective
RI	Remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act

TBC	To Be Considered
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
UV	Ultraviolet
VaDOT	Virginia Department of Transportation
VDEQ	Virginia Department of Environmental Quality
VDH	Virginia Department of Health
VI	Vapor intrusion
VOC	Volatile organic compound

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EXECUTIVE SUMMARY

The purpose of this Interim Action Feasibility Study (FS) is to develop and evaluate remedial alternatives for addressing current potential human health risks associated with exposure to trichloroethene (TCE) contaminated groundwater in the vicinity of the Hidden Lane Landfill (HLLF) Superfund Site that has been affected by past activities related to the landfill. Following this Interim Action FS, U.S. Environmental Protection Agency (USEPA) Region 3 will select the preferred interim action remedial alternative for addressing human health risks in an Interim Record of Decision (ROD). Groundwater remediation will be addressed in a future FS and ROD.

HLLF is located on approximately 30 acres in Sterling, Loudoun County, Virginia, and is privately owned. The landfill was active from 1971 to 1984, and currently consists of a soil mound covered with a 2-foot (ft) clay cover and vegetation. HLLF is situated in a residential area, and in 2005 TCE was detected in residential wells in the adjacent Broad Run Farms community. Point-of-Entry Treatment Systems (POETS) were installed in affected residences, and the site was listed on the USEPA National Priorities list on 19 March 2008.

A Remedial Investigation (RI) Report completed in 2015 concluded TCE in groundwater is the primary contaminant of concern at HLLF. The dissolved-phase TCE plume, emanating from the landfill, extends approximately 2,500 ft downgradient (to the Potomac River). The highest concentrations of TCE in groundwater were found toward the southern portion of the landfill and at depths ranging from approximately 200 ft below ground surface (bgs) to 460 ft bgs. No evidence was found of contaminated groundwater adversely impacting surface water or sediment quality in nearby water bodies. The human health risk assessment conducted as part of the RI identified potential concerns for human health exposure to groundwater containing TCE.

The three remedial alternatives evaluated in the FS are as follows:

- Alternative 1 – No Action
- Alternative 2 – Continued Maintenance of POETS with Land Use Controls
- Alternative 3 – Extension of the Public Water Supply with Land Use Controls.

In accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the “No Action” alternative is developed to provide a baseline against which the other remedial alternatives are to be compared.

Alternative 2 includes (1) maintenance of POETS in homes where TCE concentrations greater than the USEPA maximum contaminant level have been reported or may potentially be reported in samples from the potable water supply well, and (2) land use controls to prevent use of contaminated groundwater.

Alternative 3 includes (1) connection of occupied structures within the area of impacted groundwater to the public drinking water supply, and (2) land use controls to prevent groundwater use.

These alternatives were examined for adherence to nine criteria specified in the NCP. Based on this evaluation, Alternative 3 is implementable, offers a high degree of public protectiveness, is the most effective and permanent alternative, is preferred by the State, and is believed to be preferred by a majority of impacted residents as well as local officials.

1. INTRODUCTION

This Feasibility Study (FS) has been prepared for an Interim Action targeting current potential human health risks at Hidden Lane Landfill (HLLF) Superfund Site (Figure 1-1). The FS activities were conducted under U.S. Environmental Protection Agency (USEPA) Remedial Action Contract No. EP-S3-07-07: Work Assignment WA013RICO03MN.

This Interim Action FS has been conducted by EA Engineering, Science, and Technology, Inc., PBC (EA) for USEPA Region 3 in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300) establishes the framework for FSs.

1.1 PURPOSE AND REPORT ORGANIZATION

The purpose of this Interim Action FS is to develop and evaluate remedial alternatives for addressing current potential human health risks associated with exposure to trichloroethene (TCE) contaminated groundwater in the vicinity of HLLF that has been affected by past activities related to the landfill. This FS is based on the findings of the human health risk assessment (HHRA) conducted as part of the HLLF Remedial Investigation (RI) (EA 2015).

Potential risks associated with groundwater exposure via residential potable water supply wells are the focus of this Interim Action FS. Following this Interim Action FS, the USEPA Region 3 will select the preferred interim action remedial alternative for addressing human health risks in an Interim Record of Decision (ROD). Groundwater remediation will be addressed in a future FS and ROD.

During the RI, site geology and hydrology were characterized and areas with contaminants of concern (COCs) were identified. This information is used in this Interim Action FS to develop remedial action objectives (RAOs) and to screen remedial technologies to identify technologies and process options that warrant further consideration based on their applicability to site-specific conditions. Technologies that are retained through the screening are further developed into remedial alternatives. Remedial alternatives described in this report are developed and screened based on federal, state, and local applicable or relevant and appropriate requirements (ARARs), To Be Considered (TBC) regulatory guidelines, and the findings of previous investigations.

This report is divided into the following chapters:

- ***Chapter 1, Introduction***—Outlines the purpose and organization of the report; presents background information and physical characteristics of the site; and summarizes the nature and extent of contamination, potential contaminant fate and transport, and the results of the baseline risk assessments (the HHRA and the ecological risk assessment [ERA]).

- ***Chapter 2, Identification and Screening of Technologies*****—**Provides an overview of the FS evaluation process; defines the RAOs; identifies COCs and the chemical-, location-, and action-specific ARARs; develops Preliminary Remediation Goals (PRGs); and identifies General Response Actions (GRAs) for the media of concern (groundwater).

- ***Chapter 3, Development of Remedial Action Alternatives and Evaluation Criteria***—Identifies and screens/evaluates applicable technologies based on the site-specific conditions and the COCs identified.

- ***Chapter 4, Detailed Analysis of Interim Action Alternatives***—Presents a detailed comparative analysis of individual alternatives and, based on the assessment, provides a recommendation and justification for the preferred alternative.

- ***Chapter 5, Conclusions and Recommendation***—Summarizes the preferred alternative.

- ***Chapter 6, References***—Includes references used in preparation of this FS.

1.2 BACKGROUND INFORMATION

1.2.1 Site Description

HLLF is privately owned and is located approximately ¾ mile north of Route 7 near the intersection of Route 28 in Sterling, Loudoun County, Virginia (Figure 1-1). The landfill is no longer active and consists of a covered/capped soil mound with vegetative cover. The landfill is approximately 50 feet (ft) high, 400 ft wide, and 2,000 ft long (Figure 1-2).

HLLF is situated in a residential area. The Countryside subdivision is a high-density residential community located to the east and south of the site (Figure 1-2). The Countryside residential area is serviced by public water and sewer connections, and most homes have basements or crawl spaces. The sanitary sewer easement transects the HLLF property (north of the landfill) and runs perpendicular to the landfill. The Broad Run Farms community is a less dense residential community located to the west and northwest of HLLF. These homes are connected to the public sewer; however, they receive their potable water from individual water supply wells. In addition, most homes in Broad Run Farms have basements or crawl spaces. Additional residential homes of Broad Run Farms are located approximately 1,500 ft northwest of the landfill on Youngs Cliff Road.

The floodplain of the Potomac River, which consists of undeveloped wooded land, lies directly north of the site and is approximately 2,000 ft in width from the river's edge.

1.2.2 Site History and Use

HLLF was originally part of 147.18 acres of undeveloped wooded land owned by private citizens. In 1967, the owners submitted a request to Loudoun County asking that the land be rezoned to allow residential development of the property. Loudoun County denied the request.

In 1971 the owners requested permission from the Loudoun County Zoning Administrator to fill their land to bring it above flood level. Loudoun County Zoning informed the owners that Ordinance Section 9-8.1 did not prohibit a landowner from lawfully filling or otherwise improving their land. However, at no time did the owners inform the Zoning Administrator that they intended to fill their land with refuse (Tetra Tech EM Incorporated 2007).

In early 1971, the owners began filling a portion of HLLF with construction debris, tree stumps, scrap material, tires, automobile and truck bodies, metal, and wood. The landfill continued to operate as an unlined, unpermitted landfill from 1971 to 1981, and occupied approximately 30 of the 147.18 acres. In November 1973, the Bureau of Solid Waste and Vector Control conducted an inspection and noted evidence that garbage and hazardous materials were being brought onto the landfill for disposal. In April 1977, an inspection at the landfill revealed a large amount of trash from the Reston area including domestic refuse and containers originating from the United States Geologic Survey National Center containing liquid chemicals; the containers were marked "toxic and poison" (Tetra Tech EM Incorporated 2007).

In 1981, the owners sold the portion of the land operating as a landfill to the Furnace Associates, and retained ownership of the undeveloped land (Virginia Department of Health [VDH] 1985). From 1981 until its court-ordered closure in 1984, the landfill operated under Virginia Solid Waste Permit No. 356, which authorized the landfill to receive non-industrial, non-hazardous, construction and demolition debris consisting of rubble, bricks, concrete, and lumber.

In 1977, 1983, and 1986 fires broke out on the landfill. The fire in 1983 started in January and reportedly lasted until April 1983 (Loudoun Independent Newspaper 2009).

In mid-1984, a nearby resident alleged that sometime after 1980 the landfill had received potentially hazardous waste consisting of 55-gallon drums of paint pigment, oil, and creosote-like material. However, when the VDH Bureau of Solid Waste conducted a site inspection on 13 October 1984, they found no visible evidence of the disposal of hazardous wastes (VDH 1985). At this time, the landfill was undergoing close-out procedures. By November 1984, approximately 75 percent of the landfill had been covered with a 2-ft clay cover that was intended to be impermeable. The VDH Site Inspection Report noted that the cover "appeared to be well constructed with no erosion or leachate problems" (VDH 1985). The landfill restoration (clay cover and vegetation) was completed in 1986 (Loudoun Independent Newspaper 2009). In the mid-1990s, sink holes were observed on the landfill (Commonwealth of Virginia 1996), and additional material, consisting primarily of soil, stone, and concrete rubble, was deposited on portions of the landfill in an effort by the landowner to fill the sink holes and conduct post-closure maintenance (Commonwealth of Virginia 1997, Loudoun County 1997).

In 1986 methane gas was reported in the Countryside subdivision, which is located to the east of the landfill. Fourteen landfill gas monitoring wells were installed between the landfill and the Countryside subdivision in September 1988. Results from these monitoring wells confirmed that methane gas was being generated by the landfill and was migrating toward the homes in the Countryside subdivision (EA 2015). In November 1988, the former operator of the landfill installed a series of ventilation wells on the east side of the landfill property. In January 1998, a concentration of methane at 15 percent of the lower explosive limit (LEL) of 5 percent methane by volume was recorded inside the home and in the backyard of a Countryside resident. However, in April 1998, methane gas readings in excess of the regulatory level were found beyond the landfill property boundary in only 1 of the 14 landfill gas monitoring wells. Eight landfill gas wells were installed on the west side of the landfill (Board Run Farm subdivision) in December 2008. Positive detections of methane, between 0.3 and 1.7 percent by volume, were reported in two landfill gas wells in December 2011 and in one landfill gas well collected on the east side of the landfill in June 2012. Methane was not observed in the landfill gas wells on the west side of the landfill. The RI Report concluded that the potential risk of adverse generation and migration of methane gas from the landfill to adjacent properties is minimal, and that methane gas generation and migration is not a concern at the landfill (EA 2015).

USEPA conducted a Preliminary Assessment of the landfill in 1988-1989. TCE contamination was detected in two private wells in the Broad Run Farms community, west of the landfill. No TCE was detected in the three downgradient landfill monitoring wells, landfill seeps, soils, or surface water. Based on the information available at the time and the limited scientific understanding of bedrock aquifers, the TCE in private wells was not related to HLLF. No further action under CERCLA was recommended.

In March 2005, 67 residential wells in the Broad Run Farms neighborhood were sampled for TCE by the Loudoun County Health Department. Following that effort, the Virginia Department of Environmental Quality (VDEQ) installed 22 Point-of-Entry Treatment Systems (POETS) in affected residences to intercept the TCE before it entered the house plumbing.

USEPA reopened its evaluation of HLLF in October 2005, and a site assessment was completed in 2007. This resulted in HLLF being proposed to USEPA's National Priorities List of contaminated sites on 19 September 2007. HLLF was listed on the National Priorities List on 19 March 2008. In May 2008, responsibility for the investigation and remediation of HLLF was transferred from the VADEQ to the USEPA. Between 2005 and 2017, under direction of the USEPA, POETS were installed at additional residential homes in Broad Run Farms with TCE detections in their potable water supply wells at concentrations above the maximum contaminant level (MCL) of 5 micrograms per liter (µg/L), for a total of 36 homes with POETS.

RI activities conducted under the direction of USEPA began in early 2009. The investigation included sampling and analysis of groundwater, surface water, and sediment, as well as landfill gases associated with the landfill. The potential for migration of site-related vapors into private homes was also evaluated.

1.2.3 Nature and Extent of Contamination

The RI results indicated that the volatile organic compound (VOC) TCE is the primary COC. No other compounds were consistently detected at concentrations above the USEPA MCL. The dissolved-phase TCE plume, emanating from the landfill, extends approximately 2,500 ft downgradient (to the Potomac River). The highest concentrations of TCE in groundwater were found toward the southern portion of the landfill, and TCE concentrations followed a south to north concentration gradient. With respect to the vertical extent of TCE contamination, the highest concentrations of TCE were found at depths ranging from approximately 200 ft below ground surface (bgs) to 460 ft bgs. The RI concluded that there is no evidence that contaminated groundwater is adversely impacting surface water or sediment quality in nearby water bodies.

During the RI, some non-volatile organics were found at concentrations above comparison criteria; however, these concentrations were isolated and there was no pattern suggesting overall contamination of area groundwater. Metals were also present at concentrations above some comparison criteria. However, available soil data do not indicate sources of metals that could lead to groundwater contamination. Elevated metals concentrations are therefore believed to be due to localized natural conditions in the aquifer.

1.2.4 Contaminant Fate and Transport

Based on the RI findings, TCE was likely released into soil below the landfill and then leached from soil into groundwater. RI data suggest that the approximate release volume was in the range of 2.7-67.9 gallons. Because the landfill is not lined, TCE likely migrated from the landfill down into the fractures of the Balls Bluff Siltstone to depths of approximately 460 ft bgs. TCE that migrated into the underlying fractured bedrock has dissolved over time into groundwater, creating a dissolved-phase plume. It can be inferred from the relatively low concentration of TCE observed in groundwater that a dense non-aqueous phase liquid (DNAPL) source, which would have consisted of pure undissolved TCE product, appears to no longer exist; either the DNAPL source dissipated over time or TCE was not released from the landfill as DNAPL (e.g., dissolved in leachate). Observed TCE concentrations in the fractured bedrock source area are indicative of a TCE source that is sorbed within specific bedrock fractures, and the concentrations are at least one order of magnitude lower than would be expected if TCE DNAPL was nearby.

Based on its physical properties and the available migration pathways, TCE is expected to persist in the groundwater; although the TCE concentrations are generally low, the observed concentrations represent potential concerns for human health exposure to groundwater. Contaminant migration from HLLF into groundwater (in the dissolved phase) appears to be controlled by geologic features such as fractures and bedding planes as well as historical pumping from the nearby residences (in Broad Run Farms). Transport of TCE in groundwater appears to have significant horizontal and vertical components with localized pathways controlled by fracture flow.

Groundwater flow in the bedrock underlying HLLF (i.e., bedrock of the Culpeper Group) is largely regulated by secondary porosity, which is composed of open fractures and joints. These openings form the more permeable pathway for groundwater to flow. The degree of fracture and joint development is controlled by the thickness and brittleness of the sedimentary rock units (Trapp and Horn 1997). This means that secondary fracture porosity and permeability is more developed in the thinner, more rigid siltstone and sandstone units of the bedrock than in the more malleable shale units. The siltstone, sandstone, and conglomerate units may also contain some degree of primary porosity or intergranular pore space. Intergranular porosity tends to be more important to groundwater storage than to groundwater flow. This is due to the relatively low permeability associated with the primary porosity. Based on poor sorting and cementation of the strata, primary porosity in the bedrock underlying HLLF is negligible while secondary porosity in the form of bedding plane parallel fractures and high-angle joint set fractures is widespread (Nelms and Richardson 1990).

High-angle joint sets in the bedrock have formed perpendicular to bedding plane partings, and are the most numerous type of fracture. The length of the vertical joints tends to be limited and confined to the more brittle sedimentary units. Joints are important to the vertical movement of groundwater; however, the restricted aerial and vertical extent of these joints limits their importance when considering more regional groundwater flow.

More significant to the regional flow network are bedding plane parallel fractures. These fractures develop along zones of weakness that occur at the contacts between differing rock types. Bedding plane fractures may be continuous over large areas and are significant in number in the vicinity of HLLF. It is because of their consistent orientation, significant number, and wide-scale distribution that the bedding plane fractures greatly influence the groundwater flow system over large lateral areas at the site.

Large-scale vertical faults/fractures that extend to significant depth and affect broad sections of rock strata may also be present near HLLF. These large-scale fractures are the least widespread of the fracture types. Wells drilled through these fractures may have anomalously high yields, because the fractures connect with many bedding plane fractures and joints. Large-scale vertical faults/fractures may be expressed at the surface by linear topographic features (i.e., faults). They may also be expressed as linear stream segments, where they act as a major groundwater discharge pathway.

The aquifer within the Balls Bluff Siltstone is predominately regulated by secondary porosity due to pore-space compaction and concentration in combination with extensive fracturing (Trapp and Horn 1997). The fractures are the product of tectonic stress-induced faulting as well as depositional and exfoliation related events. Syn-depositional fractures include desiccation fractures or “mud cracks” associated with the drying of sediment in shallow, intermittent bodies of water prior to lithification (Ryan et al. 2006). These fractures have formed perpendicular to the bedding surface. Exfoliation-related fractures result from the isostatic effects of post-lithification uplift and erosion. The reduction in confining stress on the bedrock from the erosion of the overlying strata has resulted in fractures that are predominantly parallel to bedding planes and cross-bedded surfaces. The combination of fault-related fractures, as well as bed-parallel, bed-normal, and bed-oblique fractures has resulted in complex “brick work” fracture networks within the Balls Bluff Siltstone (Ryan et al. 2006). Bedrock in the study area is typically west-dipping between 5 degrees (°) and 60°, steepening to the west. Along the east side of the basin, the strata generally dip gently westward; however, the dip becomes progressively steeper to the west-northwest in proximity to the major border fault fronting the Blue Ridge (Lee 1979).

Based on the monitoring well and residential water supply well data, the TCE plume appears to be in a steady-state condition (i.e., the footprint of the plume has changed little over time).

Vertical flow paths with downward gradients along fractures intersect the zone of highest concentrations detected at HLLF, while upward gradients are more prevalent in wells located near the Potomac River. The westward dip direction of prevailing fractures as well as artificial gradients induced by residential pumping to the west appear to have pulled the plume slightly westward immediately adjacent to HLLF. Subsequently, the northward strike of predominant fractures as well as the natural flow of groundwater toward the Potomac River appears to have directed the plume from the residential area west of HLLF to the north, where groundwater discharges to the Potomac River.

The RI found no evidence that TCE has migrated into media other than groundwater within the overburden soil and fractured bedrock. This was confirmed by a vapor intrusion (VI) study conducted in 2015 (discussed in Section 1.2.6) and by seep water, surface water, and sediment sampling conducted as part of the RI (EA 2015).

Chlorinated organic compounds, such as TCE, can be degraded in groundwater by chemical and biological processes. These processes include reductive dechlorination, which occurs under anoxic conditions and produces daughter products including cis-1,2-dichloroethene (DCE) and vinyl chloride. Due to the potential for TCE to degrade in the groundwater, these TCE degradation products are considered secondary COCs for HLLF.

1.2.5 Baseline Risk Assessment

1.2.5.1 Human Health Risk Assessment Conclusions

The HHRA evaluated residential exposure to groundwater, surface water, sediment, and landfill seep water. Groundwater data were from monitoring wells and from untreated residential potable well water. Data were divided into two exposure areas for evaluation: one near the landfill and the other near the Potomac River. The results of the HHRA indicated that there are no human health concerns from exposure to surface water, sediment, and landfill seep water in the vicinity of the landfill, regardless of exposure area evaluated. Groundwater was identified as the only media of concern for human health.

Carcinogenic risk results associated with residential exposure to untreated groundwater were within the USEPA acceptable risk range of $1x10^{-6}$ to $1x10^{-4}$ in both exposure areas. In the exposure area near the landfill, carcinogenic risks for TCE in untreated groundwater were $7x10^{-5}$. In the exposure area near the Potomac River, carcinogenic risks for TCE in untreated groundwater were $3x10^{-5}$. Arsenic and TCE were the primary contributors to carcinogenic risks for both exposure areas. However, carcinogenic risks for arsenic were the same within both exposure areas. This suggests that arsenic levels in groundwater are generally consistent from the landfill to the Potomac River. Elevated arsenic concentrations were also randomly distributed across the study area. Arsenic levels are therefore attributed to naturally occurring levels rather than site-related sources.

In the exposure area near the landfill, exceedance of non-carcinogenic thresholds was due to TCE, cobalt, and manganese. In the exposure area near the Potomac River, exceedance of non-carcinogenic thresholds was due to TCE only. While cobalt and manganese were identified as posing potential non-carcinogenic risks to receptors in the exposure area near the landfill, the HHRA identified uncertainties with the oral reference doses for both metals. The uncertainties result in an overestimation of the potential for risks from cobalt and manganese. Furthermore, due to the randomness of detections above screening levels, it is USEPA's and VDEQ's conclusion that the elevated levels of metals are due to background conditions and are not site related. Therefore, the HHRA reached a final conclusion that potential concerns for human health exposure to groundwater near HLLF is due to TCE.

1.2.5.2 Ecological Risk Assessment Conclusions

The ERA evaluated data generated from surface water and sediment samples collected from ponds and drainages in the vicinity of the landfill and from the Potomac River. Soil and groundwater evaluations were included as Appendixes to the ERA. The results of the ERA and the associated appendixes indicated that analyte concentrations in sediment, surface water, soil, and groundwater are unlikely to pose risks to ecological receptors. No analytes in any media were identified as COCs for ecological receptors.

1.2.6 Vapor Intrusion Evaluation

A VI study was conducted at residential buildings adjacent to the site in 2015. The objective of the VI study was to characterize the presence of VOC contamination (primarily TCE) at and around the site and to determine if VI may be occurring. Sub-slab soil gas sampling, indoor air monitoring, and indoor air sampling were conducted at residential units.

Neither TCE nor its breakdown products were detected in any of the 11 sub-slab soil gas samples, the 8 crawl space or first floor air samples, or 2 outdoor ambient air samples. Tetrachloroethene (PCE) was detected at low concentrations in each of these media; however, PCE is not a site-related contaminant and was not detected in groundwater. Neither TCE nor PCE was detected in indoor air during a survey using real-time air monitoring. Based on the results of the investigation, VI from contamination associated with HLLF is not a concern.

2. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The purpose of this chapter is to assemble pertinent information that will be used in the screening, development, and evaluation of remedial alternatives for groundwater contamination and source area containment at HLLF. Specific goals of this chapter are:

- Define the RAOs; identify the contaminants of interest and associated federal, state or commonwealth, and local ARARs; and develop remediation goals (Section 2.1)

- Identify GRAs for the media of concern (groundwater) (Section 2.2)

- Identify and screen technology types and process options (Section 2.3).

This information will be used by the decision-makers in development of the ROD for HLLF.

2.1 REMEDIAL ACTION OBJECTIVES

To develop remedial alternatives to address contaminated groundwater, RAOs are first developed that will prevent or eliminate complete exposure pathways where concentrations have resulted in unacceptable risks.

The following RAO has been developed for the interim action to address immediate human health risks associated with the groundwater contamination at HLLF:

- Prevent potential human residential exposure to contaminated groundwater as a drinking water source until concentrations of COCs are below the PRGs.

2.1.1 Contaminants of Interest

As per the HHRA, the primary COC in groundwater at HLLF is TCE. TCE degradation products cis-1,2-DCE and vinyl chloride are considered secondary COCs at HLLF.

2.1.2 Applicable or Relevant and Appropriate Requirements

Various regulations were identified and evaluated for the site. Regulations and requirements typically fall into three categories: action-specific, chemical-specific, and location-specific. Each of these categories is described below.

- Action-specific requirements are technology- or activity-based limitations. These requirements set controls or restrictions on the design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants. Typical examples include National Pollutant Discharge Elimination System requirements or Clean Air Act requirements, or requirements for operating a remediation system on a site.

- Chemical-specific requirements are health- or risk-based numerical values or methodologies limiting the amount of contaminant that may be discharged to, or allowed to remain in, environmental media. These include, for example, MCLs promulgated under the Safe Drinking Water Act and cleanup levels in Hazardous Substance Cleanup Act regulations.

- Location-specific requirements address physical features of a specific site where a remedial action will be carried out. For example, the Fish and Wildlife Coordination Act stipulates specific requirements for the protection of fish and wildlife from the control or structural modifications of a natural stream.

The following groups of applicable requirements were considered:

- Commonwealth of Virginia requirements
- Federal requirements.

Action-specific, chemical-specific, and location-specific requirements are included in Tables 2-1 and 2-2.

2.1.3 Development of Preliminary Remedial Goals

USEPA MCLs are the primary chemical-specific ARARs for groundwater at HLLF (Table 2-1). As indicated in Table 2-2, the Virginia MCLs are currently the same as the USEPA MCLs for the site COCs. Therefore, the MCLs for TCE and its daughter products (Table 2-3) are selected as the PRGs for groundwater at HLLF. Additionally, USEPA will periodically assess the human health risks associated with groundwater exposure to ensure the risks remain in the acceptable risk range.

2.2 GENERAL RESPONSE ACTIONS

GRAs are broad categories of actions that are identified as potential options for achieving the RAO. The GRAs were selected based on the media of concern (groundwater) at the site and the chemical properties of TCE, the primary COC. The four GRAs identified for the interim action, to address the potential human health risks associated with contaminated groundwater at the site, (in no particular order of preference) are as follows:

- No Action
- Institutional Controls
- Treatment of Groundwater Prior to Residential Use
- Provision of Alternative Water Supply.

2.2.1 No Action

The NCP requires consideration of a "No Action" response. No Action serves as a baseline against which the performance of other remedial alternatives can be compared. This response assumes no active remedial measures are implemented, although any processes that naturally attenuate the contamination would continue under this GRA.

2.2.2 Institutional Controls

This GRA would reduce exposure to contaminated groundwater through the use of institutional actions such as land use controls (LUCs). Technologies under this GRA can be used in combination with other actions or can be used alone in cases where such controls are sufficient to protect human health and possibly also the environment. In addition, this GRA may be implemented as the only action in circumstances where active response actions such as treatment or removal of the contaminated media are not feasible. CERCLA 5-year reviews would be required to evaluate and document compliance with the RAOs and assess protectiveness of the restrictions as long as potential risks remain above acceptable levels.

2.2.3 Treatment of Groundwater Prior to Residential Use

Under this GRA, a treatment technology would likely be applied to remove the targeted constituents from the groundwater after it is pumped from the aquifer via residential wells, before the water is used as tapwater. Thus, technologies under this GRA can minimize exposure to contaminants in groundwater. The POETS currently in place in the Broad Run Farms community are an example of a technology under this GRA.

2.2.4 Provision of Alternative Water Supply

Under this GRA, residences within the impacted area would be provided with water from an alternative source, rather than the local groundwater, to be used as tapwater. This GRA could thus eliminate residential use of groundwater as tapwater. Connection to the local public water supply is an example of a technology under this GRA.

2.3 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESSS OPTIONS

This section identifies and screens specific groundwater technologies and process options for the GRAs identified in Section 2.2. In this section, technologies and process options are screened based on effectiveness, implementability, and cost. Table 2-4 summarizes the representative groundwater technologies and process options identified for each GRA and indicates the technologies and process options that were retained for further consideration in development of remedial alternatives.

2.3.1 No Action

There are no technologies or process options associated with this response action. This option has been summarized as a basis for comparison with the other remedial alternatives.

This option includes neither LUCs nor efforts to contain, remove, treat, or dispose of potentially impacted groundwater at the site, or to address human health concerns related to exposure to impacted groundwater. While natural attenuation of the COCs may continue under a No Action remedy, the design/evaluation and monitoring to assure and verify natural attenuation requires its consideration as a separate option. Implementation of a No Action alternative would require a review at least every 5 years to ensure protection of human health and the environment.

Effectiveness—No Action is not an effective alternative because it would not prevent or minimize human exposure. No actions would be taken to prevent or minimize potential human exposure to groundwater. No action would be taken to prevent or minimize further migration of COCs, whether or not future migration is limited due to site characteristics and the potential for natural attenuation.

Implementability—No Action is technically implementable. Administrative implementation of this option would be difficult due to required regulatory agency approval and potentially unfavorable public opinion.

Cost—No capital or annual operation and maintenance (O&M) costs are associated with the No Action option. The only costs are in conducting the remedial action reviews every 5 years, or as required.

The NCP requires retaining the No Action alternative for comparative purposes.

2.3.2 Land Use Controls

LUCs are an applicable technology option for the Institutional Controls GRA at HLLF. LUCs are used to limit the potential for exposure to COCs, primarily through restrictions on land use or access. The most likely process option for LUCs at HLLF would be restrictions to limit future use of groundwater as drinking water in areas around the landfill where groundwater is impacted by landfill COCs.

Effectiveness—LUCs would not be effective as a standalone technology because they would not address risks to residents that currently obtain their tapwater from contaminated groundwater wells. However, in combination with a technology to treat or supply alternative drinking water, LUCs that limit groundwater use would be effective for further reducing the potential for exposure to COCs in groundwater. Therefore, if well publicized and enforced, LUCs would address the RAO for preventing potential human residential exposure to groundwater with COC concentrations exceeding PRGs.

Implementability—The implementation of groundwater use restrictions primarily involves the legal recording of restrictions for private use of water supply wells for potable agricultural or other means. Implementation of use restrictions can be difficult to monitor and enforce.

Cost—Costs for implementing LUCs are expected to be low. Recurring costs are associated with outreach and enforcement, and conducting periodic remedial action reviews as required.

This option will be retained for further consideration and would be combined with other technologies that will be retained.

2.3.3 Potable Water Supply Well Head/Residential Treatment

This technology is a groundwater treatment option that includes the use of residential treatment systems to remediate groundwater before it reaches human receptors. Residential treatment is used to limit human exposure to COCs by remediating groundwater at the exposure points. The POETS currently in place at residences in the Broad Run Farms community are examples of this technology.

Effectiveness—Residential treatment systems are currently in place and are effective in the short-term for reducing the potential for exposure to COCs. Thus, this option would address the RAO for preventing potential human residential exposure to groundwater with COC concentrations exceeding PRGs. However, monitoring and maintenance are required to maintain the effectiveness of the treatment systems.

Implementability—Residential treatment systems are implementable and are currently in place as a protective measure for those residents impacted by the contaminated groundwater from HLLF. The residential treatment systems may need to be maintained for 30 years or more, until COC concentrations are consistently below the PRGs.

Cost—Capital costs for implementing residential treatment utilizing the POETS currently in place is low, as minimal additional capital costs would be incurred. However, the O&M costs associated with this option are expected to be high due to the need for regular monitoring and maintenance over multiple decades. Therefore, overall costs associated with this alternative are expected to be high.

This option will be retained for further consideration.

2.3.4 Extension of the Public Water Supply

Extension of the public water supply to impacted residences is an example of a technology under the Provision of Alternative Water Supply GRA. As described in Section 1.2.1, residences in the Broad Run Farms community, to the west of HLLF, are connected to public sewer but receive potable water from individual water supply wells. The Countryside area, to the east of HLLF, is serviced by public water, as are buildings along Leesburg Pike, to the south. This option would eliminate exposure to contaminated groundwater by connecting households in the Broad Run Farms Community that are potentially exposed to landfill COCs in groundwater to the public water supply. This option would likely target residences where the residential potable water supply wells have been determined to be contaminated, and which currently have POETS in place, and residences with potable water supply wells identified as having the potential for future impacts.

Effectiveness—Extension of the public water supply would be effective for reducing the potential for residential exposure to COCs in groundwater, and thus addressing the RAO for preventing potential human residential exposure to groundwater with COC concentrations exceeding PRGs. This option would be more effective and permanent than the POETS currently in place, as this option would not require regular monitoring and maintenance of the residents' tapwater to ensure that COC concentrations are below acceptable limits.

Implementability—Connection of local residences impacted by the groundwater contamination at HLLF to the public water supply is implementable. However, this process may meet resistance from residents who prefer to stay on their private water supply wells.

Cost—Costs for extending the public water supply to impacted residences are expected to be moderate. There are no annual O&M costs associated with this option. The only recurring costs are in conducting periodic remedial action reviews as required.

This option will be retained for further consideration.

3. DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES AND EVALUATION CRITERIA

Remedial action alternatives were developed from the technologies retained during screening (Section 2.3) to address the RAO (Section 2.1), as illustrated on Figure 3-1 and described below. Remedial alternatives are inclusive of all elements associated with remedial design, construction and startup, and O&M.

Three alternatives were developed for the interim action to address current potential risks to human health and meet the RAO described in Section 2.1:

- Alternative 1 – No Action
- Alternative 2 – Continued Maintenance of POETS with LUCs
- Alternative 3 – Extension of the Public Water Supply with LUCs.

A detailed analysis of these remedial alternatives with respect to the NCP evaluation criteria (Section 3.1) is presented in Section 4.

3.1 EVALUATION CRITERIA

Pursuant to USEPA guidance, remedial alternatives were examined for adherence to nine criteria, as specified in the NCP. These criteria are:

1. Overall Protection of Human Health and the Environment
2. Compliance with ARARs
3. Long-Term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, and Volume through Treatment
5. Short-Term Effectiveness
6. Implementability
7. Cost
8. Commonwealth Acceptance
9. Community Acceptance.

In order to facilitate a detailed evaluation of remedial alternatives in this FS, the following rationale was applied to the nine criteria:

1. Overall Protection of Human Health and the Environment

   — Ability of the alternative, as a whole, to achieve and maintain protection of human health and the environment.

2. Compliance with ARARs

   — Compliance with chemical-, action-, and location-specific ARARs, as well as other TBC guidance.

3. Long-Term Effectiveness and Permanence

   - Magnitude of residual risk
   - Adequacy and reliability of controls.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

   - Treatment processes used and materials treated
   - Amount of hazardous materials destroyed or treated
   - Degree of expected reductions in toxicity, mobility, and volume
   - Degree to which treatment is irreversible
   - Type and quantity of residuals remaining after treatment.

5. Short-Term Effectiveness

   - Protection of community and workers during remedial actions
   - Environmental impacts
   - Time until remedial action objectives are achieved.

6. Implementability

   - Ability to construct and operate the technology
   - Availability and reliability of prospective technologies
   - Ease of undertaking additional remedial actions, if necessary
   - Ability to monitor effectiveness of remedy
   - Ability to obtain approvals from other agencies and coordination with those agencies
   - Availability of equipment and specialists and offsite treatment, storage, and disposal services.

7. Cost[1]

   - Capital costs
   - O&M costs
   - 30-year present worth costs (utilizing discount rate of 3.2 percent)
   - As requested by USEPA, costs for administrative activities including remedial design, LUCs, restoration advisory board meetings, and 5-year reviews are not included in the cost estimates presented in this Interim FS.

1. Costs developed in this FS are based on 2012 dollars.

8. Commonwealth Acceptance

   — Evaluation of Virginia Commonwealth agencies' preferences and concerns regarding the alternatives.

9. Community Acceptance

   — Evaluation of the local community's preferences and concerns regarding the alternatives.

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4. DETAILED ANALYSIS OF INTERIM ACTION ALTERNATIVES

This section presents a detailed analysis of the interim action remedial alternatives with respect to the NCP evaluation criteria (Section 3.1). The remedial alternatives are compared relative to each other with respect to the NCP evaluation criteria in Section 4.4.

4.1 ALTERNATIVE 1 – NO ACTION

4.1.1 Description

Pursuant to Section 300.430(e)(3)(ii)(6) of the revised NCP, the "No Action" alternative is developed to provide a baseline against which the other remedial alternatives are to be compared. The No Action alternative includes no removal actions or institutional controls. No further groundwater monitoring would be conducted.

Estimated Capital Cost:	$0
Estimated O&M Cost	$0
Estimated Total Present Worth Cost:	$0
Estimated Construction Timeframe:	Immediate
Estimated Time to Achieve RAOs:	Will not achieve RAOs.

4.1.2 Evaluation

Overall Protection of Public Health and Welfare of the Environment**—**The ERA did not identify risks to ecological receptors (see Section 1.2.5); therefore, environmental protection is already achieved. The No Action alternative for addressing human health risks does not contain provisions to prevent future human exposures, and would not be protective of human health.

Compliance with ARARs—ARARs are not applicable to No Action alternatives.

Long-Term Effectiveness and Permanence—The No Action alternative for addressing human health risks would not be effective in the long term because no remedial components or institutional controls would be enacted to prevent or minimize human exposure to elevated COC concentrations in groundwater.

Reduction of Contaminant Toxicity, Mobility, and Volume through Treatment—Remedies to address human health risks should decrease public exposure to toxicity in the site groundwater. No treatment or other controls are specified under the No Action alternative to reduce the toxicity, mobility, and volume of COCs in groundwater. Local residents would be exposed to COCs in groundwater used as drinking water, and their associated toxicity.

Short-Term Effectiveness—The No Action alternative would not create short-term risks via its implementation, but also would not include any provisions to decrease human health risks in the short term.

Implementability—Because no actions would be performed, the No Action alternative would be readily implementable in a technical sense. This alternative also would not interfere with potential future remedial actions. However, administratively, this alternative may not receive regulatory or public approval because potential human health risks would not be addressed.

Cost—The No Action alternative has no capital costs and no long-term costs; per regulatory guidance, costs for the No Action alternative are $0. A summary of estimated costs for 5-year reviews for the No Action alternative is provided in Table 4-1.

Commonwealth Acceptance—A No Action remedy would not be acceptable to VDEQ because it does not address the potential human health concerns associated with exposure to TCE in groundwater.

Community Acceptance—A No Action remedy is not expected to be acceptable to the community as it would not protect residents from current potential risks to human health.

4.2 ALTERNATIVE 2 – CONTINUED MAINTENANCE OF POINT-OF-ENTRY TREATMENT SYSTEMS WITH LAND USE CONTROLS

This alternative includes: (1) Maintenance of the POETS that are in place in homes where TCE concentrations greater than the MCL have been reported in the water samples collected from their potable water supply well, and (2) LUCs to prevent groundwater use. The 5-year reviews would be conducted because COCs would remain onsite at concentrations that exceed PRGs.

Estimated Capital Cost:	$99,203
Estimated O&M Cost	$9,996,692
Estimated Total Present Worth Cost:	$10,095,896
Estimated Construction Timeframe:	Not Applicable
Estimated Time to Achieve RAOs:	RAO for human health is met by POETS currently in place.

4.2.1 Description

Alternative 2 would address the RAOs through the following remedial components:

- Maintenance of the POETS that are in place in homes in the Broad Run Farms community (west of HLLF) that had concentrations of TCE in potable well water that were greater than the MCL or that may potentially become impacted with TCE concentrations greater than the MCL. These POETSs would be maintained until COC concentrations decreased to below PRGs.

- Implementation of LUCs to prevent contaminated groundwater use or access

- Five-year reviews.

4.2.1.1 Point-of-Entry Treatment Systems

As discussed in Section 1.2.2, POETS were installed by the VDEQ at 30 residential homes in Broad Run Farms, located west, southwest, and north-northwest of the landfill (see Figure 4-1), between 2005 and 2008. The systems were installed due to the presence of TCE in their potable water supply wells at concentrations greater than the MCL. Since the USEPA took over responsibility for HLLF in 2008, POETS have been installed at six additional residences for a total of 36 systems.

The POETS consist of an ultraviolet (UV) unit that disinfects the water, a pre-filter cartridge that removes sediment in the water, and two liquid granular activated carbon filters that remove the COC (i.e., TCE) from the water. The following O&M activities are completed on a regular basis for the POETS:

- Periodic carbon filter unit(s) replacement
- Annual replacement of UV bulb
- Pre-filter cartridge replacements on as needed basis
- Non-routine maintenance and repairs to the individual treatment units
- Quarterly monitoring.

Water samples are also collected from the residences with POETS as part of a quarterly monitoring program. The monitoring program consists of the collection of water samples to monitor concentrations of VOCs, in particular TCE, and the effectiveness of the treatment systems. Samples collected for the monitoring program are analyzed for VOCs. Three samples are collected from each residence with POETS during each monitoring event, as follows:

- Pre-treatment (raw)
- Between carbon units (mid)
- Post-treatment (tap).

Under Alternative 2, monitoring and maintenance of the existing POETS would continue until the TCE concentrations in pre-treatment samples are less than the PRGs. USEPA would continue to evaluate the potential need to sample the potable well water at additional homes and the potential need for additional homes to receive POETS until TCE concentrations throughout the residential area are less than the PRGs.

4.2.1.2 Land Use Controls

Deed restrictions would prevent human receptors from contacting or incidentally ingesting contaminated groundwater by creating administrative barriers for groundwater use. With respect to future development of vacant parcels over the TCE plume, the issue will be compliance with deed requirements to prohibit drilling of any type of well for potable or agricultural uses until groundwater is restored to drinking water standards.

4.2.1.3 Periodic Reviews

The periodic reviews would be conducted to confirm that concentrations of COCs are not increasing. The reviews would focus on the data from the long-term monitoring program, as well as the future site use. The site review would evaluate the site status to determine whether continued monitoring or additional action is necessary.

4.2.2 Evaluation

Overall Protection of Human Health and the Environment**—**Alternative 2 would protect human health by limiting the use of untreated groundwater. The POETS would continue to prevent human consumption and use of impacted groundwater without treatment to remove COCs. LUCs would ensure that untreated groundwater at the site is not used.

The ERA did not identify risks to ecological receptors (see Section 1.2.5); therefore, environmental protection is already achieved.

Compliance with ARARs—The POETS would decrease COC concentrations in residents' drinking water to meet PRGs, and the POETS would be maintained until COC concentrations in the residents' potable well water are less than the PRGs. The LUCs would further prevent contact with groundwater containing COCs in excess of PRGs. Achievement of chemical-specific ARARs in groundwater within the aquifer will be addressed in a future FS for groundwater remediation.

Long-Term Effectiveness and Permanence**—**The POETS and LUCs would be effective for protecting human health for as long as the systems are maintained. However, these process options are not permanent solutions, as they require maintenance and enforcement.

Reduction of Toxicity, Mobility, or Volume through Treatment**—**Remedies to address human health risks should decrease public exposure to toxicity in the site groundwater. The POETS would decrease the toxicity of the groundwater from residential potable water supply wells, prior to its use as drinking water. However, Alternative 2 would not affect the toxicity, mobility, or volume of COCs within the groundwater aquifer; these will be addressed in a future FS for groundwater remediation.

Short-Term Effectiveness**—**Minimal human health concerns are associated with maintenance of the POETS or implementation of LUCs. POETS are already in-place; therefore, the RAO for protection of human health has already been met in the short term.

Implementability**—**Alternative 2 is implementable. POETS are already installed and undergoing regular maintenance, and installation of additional POETS would be implementable. LUCs to limit groundwater use are also expected to be implementable.

Cost**—**Estimated capital and O&M costs associated with Alternative 2 are presented in Table 4-2. Costs for this alternative are primarily associated with deed restrictions on properties, installation of new POETS, maintenance of the POETS, and a contingency fee. The estimated 30-year present worth cost is $10,095,896.

Commonwealth Acceptance**—**VDEQ has indicated that when compared with other alternatives, long-term O&M of POETS by the Commonwealth is not an acceptable remedy due to many factors, including but not limited to, concerns related to cost, maintenance, access, and protectiveness. Therefore, Alternative 2 is not expected to be acceptable to the Commonwealth.

Community Acceptance**—**This alternative may be acceptable to the community, which includes residents living in homes where POETS are currently installed and maintained. Some local residents present at a public meeting in June 2017 expressed support for this alternative. However, a larger number of the residents present expressed interest in a more permanent source of groundwater that is not impacted.

4.3 ALTERNATIVE 3 – EXTENSION OF THE PUBLIC WATER SUPPLY WITH LAND USE CONTROLS

This alternative includes: (1) Connection of occupied structures within the area of impacted groundwater to the public drinking water supply, and (2) LUCs to prevent groundwater use. The 5-year reviews would be conducted because COCs would remain onsite at concentrations that exceed PRGs.

Estimated Capital Cost:	$6,743,450
Estimated O&M Cost	$0
Estimated Total Present Worth Cost:	$6,743,450
Estimated Construction Timeframe:	2 years (includes design)
Estimated Time to Achieve RAOs:	RAO would be met by POETS until construction and then upon connection to public water supply.

4.3.1 Description

Alternative 3 would address the RAOs through the following remedial components:

- Connection of occupied structures in the area where TCE concentrations are greater than the MCL to the public drinking water supply.

- Implementation of LUCs to prohibit groundwater use or access

- Five-year reviews.

4.3.1.1 Extension of the Public Water Supply

As stated in Section 1.2.1, homes in the Broad Run Farms Community, located west and northwest of HLLF, are connected to the public sewer but not public water. Although these homes are within the service area of the Loudoun Water public utility's central system, the homes receive their potable water from individual water supply wells, some of which are impacted by TCE from HLLF.

Under Alternative 3, water supply lines would be extended into the Broad Run Farms Community from an existing water main on McPherson Circle to the east (in the Countryside community) and Broad Run Drive to the south, near Leesburg Pike (Route 7) (Figure 4-1). Homes with detections of TCE concentrations above the MCL in their water supply wells or whose wells could potentially be impacted by TCE above the MCL would be connected to the public water supply, with residents' approval. It is anticipated that this would include homes along Persimmon Lane, Redrose Drive, Tranquil Court, White Oak Drive, Hidden Acres Way, Mallard Street, and Youngs Cliff Road, requiring approximately 4 miles of water supply line. While final alignment of the water line will be determined during a future design phase, the conceptual alignment provided by Loudoun Water and shown on Figure 4-1 includes looped water mains (avoiding dead-ends that may be associated with water quality issues), consistent with best practices. Each residence would receive its own service-line connection from the supply line to the home. New easements for the water lines would likely be required from the property landowners, and new rights-of-way may need to be established, as the existing Virginia Department of Transportation (VaDOT) right-of-way may not be sufficient for both water and sanitary sewer lines with the required 10-ft horizontal separation. The extension of the mains would be conducted in accordance with the Loudoun Water Engineering Design Manual (Loudoun Water 2016). Design and construction of the required infrastructure would be coordinated with Loudoun Water, Loudoun County, VaDOT, and all associated permits would be obtained.

After construction is complete, the connections would be inspected by Loudoun Water, which would also oversee testing and an as-built survey of the new lines. Once the connections have been verified, the residential potable water supply wells would be abandoned in accordance with applicable requirements, and LUCs would limit future use of groundwater (see below). Some residential potable water supply wells could possibly be repurposed as monitoring wells, as part of the USEPA's on-going investigations, in place of abandonment. Property owners would be responsible for the cost of the water supply provided by Loudoun Water once the connections are complete.

Following the connection of the public water supply to the residential homes with TCE impacted potable water supply wells (within the dissolved TCE groundwater plume), maintenance of the existing POETS by USEPA would end. Limited monitoring of residential potable water supply wells outside the dissolved TCE groundwater plume within the Broad Run Farms community may be conducted. If additional residential potable water supply wells are found to be impacted by TCE in the future, these additional homes may be connected to the water supply.

4.3.1.2 Land Use Controls

Deed restrictions would prevent human receptors from contacting or incidentally ingesting contaminated groundwater by creating administrative barriers for groundwater use. With respect to future development of vacant parcels over the plume, the issue will be compliance with deed requirements to prohibit drilling of any type of well for potable or agricultural uses until groundwater is restored to drinking water standards.

4.3.1.3 Periodic Reviews

The periodic reviews would be conducted to confirm that concentrations of COCs are not increasing. The reviews would focus on the data from the long-term monitoring program, as well as the future site use. The site review would evaluate the site status to determine whether continued monitoring or additional action is necessary.

4.3.2 Evaluation

Overall Protection of Human Health and the Environment**—**Alternative 3 would protect human health by eliminating the need to use groundwater from residential potable water supply wells in the impacted area as a drinking water source. In combination with extension of the public drinking water system, LUCs would ensure that untreated groundwater at the site is not used.

The ERA did not identify risks to ecological receptors (see Section 1.2.5); therefore, environmental protection is already achieved.

Compliance with ARARs—The public water supply would provide a source of drinking water that meets applicable ARARs, including MCLs. LUCs would further prevent contact with groundwater containing COCs in excess of PRGs. Achievement of chemical-specific ARARs in groundwater within the aquifer will be addressed in a future FS for groundwater remediation.

Long-Term Effectiveness and Permanence**—**Extension of the public water supply and LUCs would be effective for protecting human health. A public water supply is a long-term or permanent alternative water source, whereas LUCs would require public outreach and enforcement until ARARs are met in groundwater.

Reduction of Toxicity, Mobility, or Volume through Treatment**—**Remedies to address human health risks should decrease public exposure to toxicity in the site groundwater. Extension to a public water supply would eliminate the need for groundwater treatment to lower the toxicity of the local groundwater prior to use. Alternative 3 would not affect the toxicity, mobility, or volume of COCs within the groundwater; these will be addressed in a future FS for groundwater remediation.

Short-Term Effectiveness**—**Some short-term human health concerns may be associated with installation of water supply lines to provide public water. These concerns would be addressed through safe work practices. Extension of the public water supply could be completed within 2 years. With POETS already in-place, the RAO for protection of human health has already been met in the short term.

***Implementability*—**Alternative 3 is implementable. Other buildings in the area are already connected to public water, and this alternative would require installation of approximately 4 miles of new water lines. LUCs to limit groundwater use are also expected to be implementable.

***Cost*—**Estimated capital and O&M costs associated with Alternative 3 are presented in Table 4-3. Costs for this alternative are primarily associated with the deed restrictions on properties, design, installation and connection of the public water supply lines, potable water supply well abandonment, and contingency fee. The estimated 30-year present worth cost is $6,743,450.

***Commonwealth Acceptance*—**VDEQ has indicated a preference for a remedy that includes a water line because, when compared to other alternatives, a water line will require significantly less O&M at a lower cost, with minimal access needs, and will provide a greater degree of protectiveness. Therefore, Alternative 3 is anticipated to be acceptable to the Commonwealth.

***Community Acceptance*—**The majority of affected local residents present at a public meeting in June 2017 indicated their support for an extension of the public water supply to their homes. However, some residents have expressed resistance, indicating that they prefer to continue to obtain their water from their potable water supply wells rather than the public water supply. This concern could be addressed by allowing these residents to continue to use their potable water supply well after the public water supply has been extended to their homes. The resident would incur all future costs for O&M of their existing POETS.

4.4 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the final step of the analysis of alternatives to address current human health risks associated with groundwater exposure at HLLF. Here, the alternatives, which were evaluated individually against the criteria described in Section 3.1, are compared to each other for their relative effectiveness for each of those criteria. The comparison of alternatives is intended to identify the advantages and disadvantages of each alternative relative to the others, based upon nine criteria, so that the key decision-making trade-offs can be identified. Table 4-4 summarizes this comparative analysis.

4.4.1 Overall Protection of Human Health and the Environment

Alternative 1 – No Action would not be protective of human health because it does not address exposure to groundwater with COCs exceeding PRGs. Therefore, Alternative 1 will not be considered further in this analysis since it fails the first threshold criterion.

Alternatives 2 and 3 would protect human health by preventing use of untreated site groundwater. Under Alternative 2, the POETS would remove COCs prior to groundwater use as drinking water. Under Alternative 3, extension of the public water supply would provide an extra degree of protectiveness by eliminating the need to use contaminated site groundwater as a drinking water source. Both of these alternatives would use LUCs to further prevent the use of untreated site groundwater. No risks to the environment have been identified at the site.

4.4.2 Compliance with ARARs

Alternatives 2 and 3 would provide drinking water that is in compliance with chemical-specific ARARs. Achievement of chemical-specific ARARs in groundwater within the aquifer will be addressed in a future FS for groundwater remediation.

4.4.3 Long-Term Effectiveness and Permanence

Alternatives 2 and 3 would be effective for protecting human health in the long term. Alternative 2 would require maintenance of the POETS, whereas the public water supply under Alternative 3 would be relatively permanent. Both of these alternatives would require public outreach and enforcement to ensure that the LUCs remain effective.

4.4.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives 2 and 3 would decrease public exposure to toxicity in the site groundwater. Alternative 2 would decrease the toxicity of the groundwater from residential potable water supply wells prior to use, whereas Alternative 3 would eliminate the need for the use of site groundwater. Neither of these alternatives would affect the toxicity, mobility, or volume of COCs within the groundwater; these will be addressed in a future FS for groundwater remediation.

4.4.5 Short-Term Effectiveness

Alternative 2 would be somewhat more effective in the short-term than Alternative 3 for protecting the community and site workers. Alternative 3 would require subsurface work to install public water lines, while Alternative 2 would not require construction activities. The POETS already in place would continue operation during construction activities required under Alternative 3; however, a minor, short-term decrease in water quality could be associated with the switch from the treated potable water to public water under Alternative 3.

4.4.6 Implementability

Both Alternatives 2 and 3 would be implementable. Alternative 2 is more readily implementable in the short term because the POETS are already in place. Alternative 3 requires more surface disturbance, but installation of public water supply lines is implementable. Whereas the POETS would require regular maintenance until groundwater COC concentrations fall below PRGs, minimal maintenance would be required under Alternative 3, once the connection to public water has been completed.

4.4.7 Cost

The following statement of cost estimates is based upon a preliminary review of the anticipated requirements for each alternative. The costs cited in this section are based upon approximate design specifications, monitoring costs, and vendor quotes, where possible. These preliminary cost estimates are anticipated to be from within -30 percent to +50 percent of the actual costs for completing the remedial actions. Therefore, these costs are primarily used as an order of magnitude comparison. Additionally, as indicated in Section 3.1, costs for administrative activities including remedial design, LUCs, restoration advisory board meetings, and 5-year reviews are not included in the cost estimates presented in this Interim FS.

In summary, total costs (as adjusted for present worth over the specified time periods) are:

- *Alternative 1* – No Action: $0
- *Alternative 2* – Continued Maintenance of POETS with LUCs: $10,095,896
- *Alternative 3* – Extension of the Public Water Supply with LUCs: $6,743,450.

4.4.8 Commonwealth Acceptance

VDEQ is expected to prefer Alternative 3 because it includes extension of the public water supply to residences impacted by HLLF-related COCs in groundwater, it will require significantly less O&M at a lower cost, with minimal access needs, and it will provide a greater degree of protectiveness. Alternative 2 is likely unacceptable due to its reliance on maintenance of the POETS, which the Commonwealth has determined to be less effective than Alternative 3.

4.4.9 Community Acceptance

Residents in the Broad Run Farms community adjacent to HLLF currently use groundwater as drinking water. POETS have been installed on residential potable water supply wells impacted by HLLF-related COCs. Alternatives 2 and 3 are potentially acceptable to the residents, as either would limit exposure to COCs in groundwater. The majority of local residents present at a public meeting in June 2017 expressed a preference for public water rather than POETS. However, some residents expressed a preference for POETS, stating that they do not wish to be connected to the public water supply.

5. CONCLUSIONS AND RECOMENDATION

This Interim Action FS addresses current human health risks associated with groundwater exposure at HLLF in Sterling, Virginia. Based on the evaluation presented in this Interim Action FS, Alternative 3 is recommended to address current human health risks at HLLF:

- *Alternative 3* – Extension of the Public Water Supply with LUCs.

The description, evaluation, and justification for these alternatives are presented in Chapter 4. This alternative offers a high degree of public protectiveness.

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Figures

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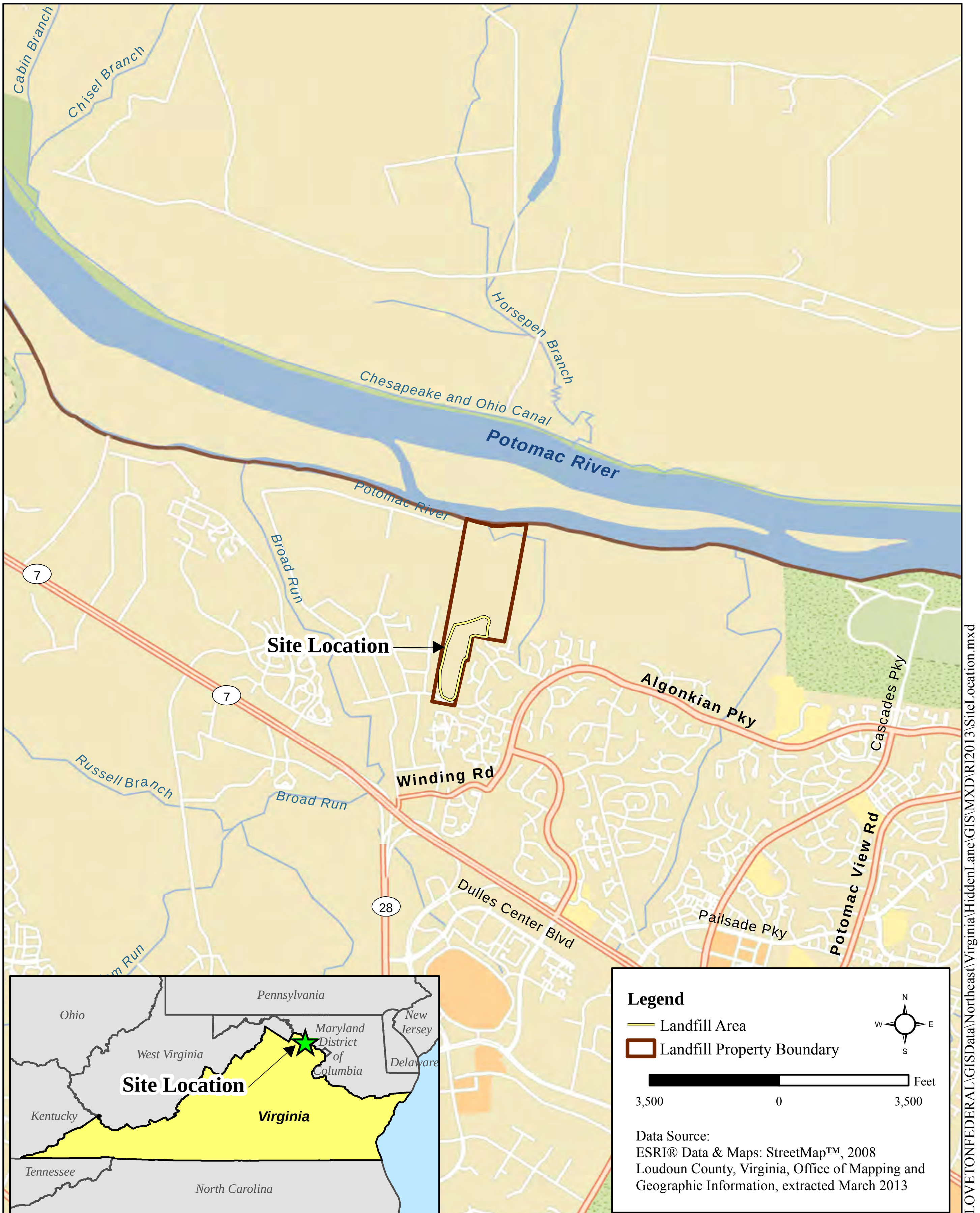
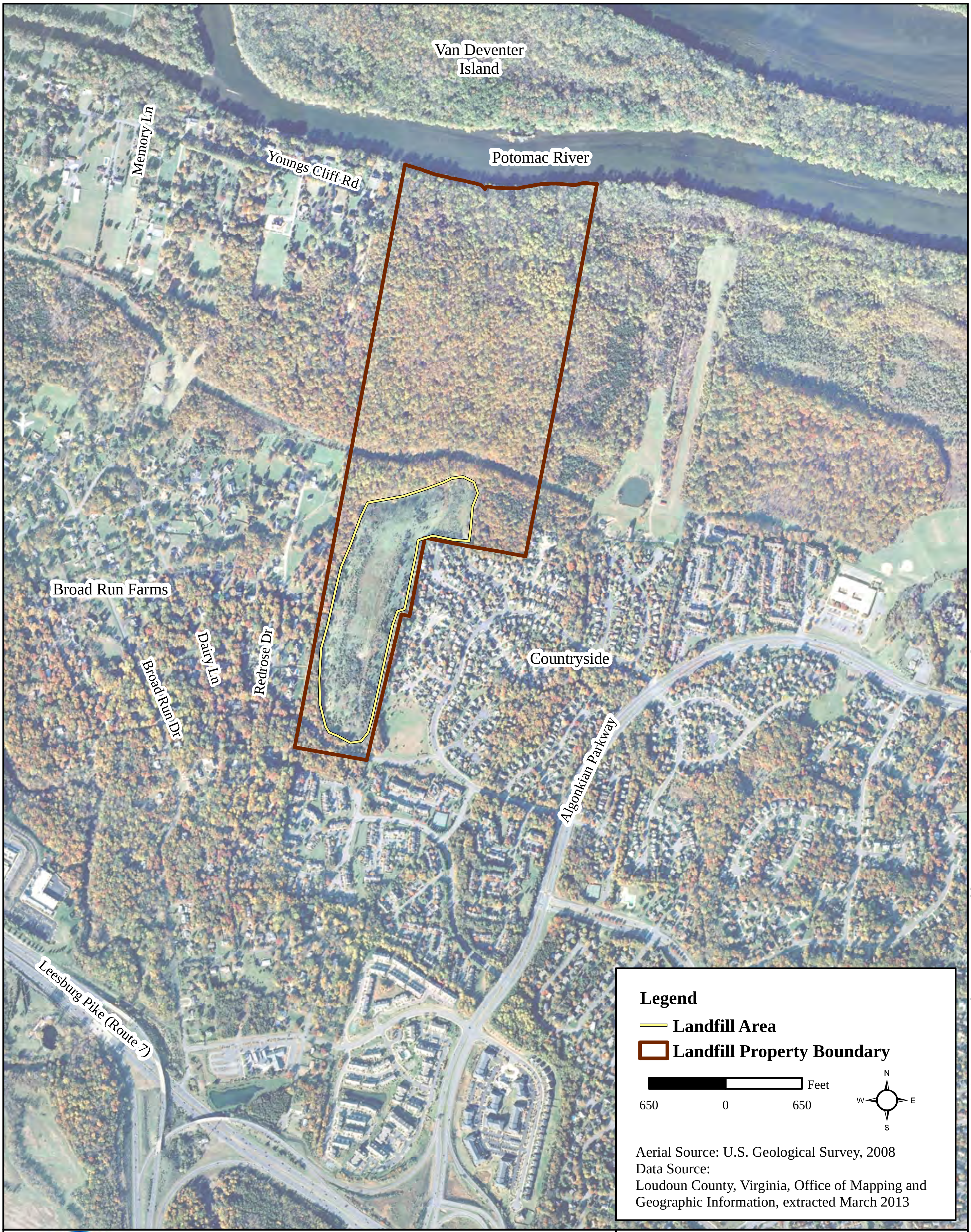


U.S. Environmental Protection Agency
Hidden Lane Landfill Site
Loudoun County
Sterling, VA

FIGURE 1-1
SITE LOCATION MAP



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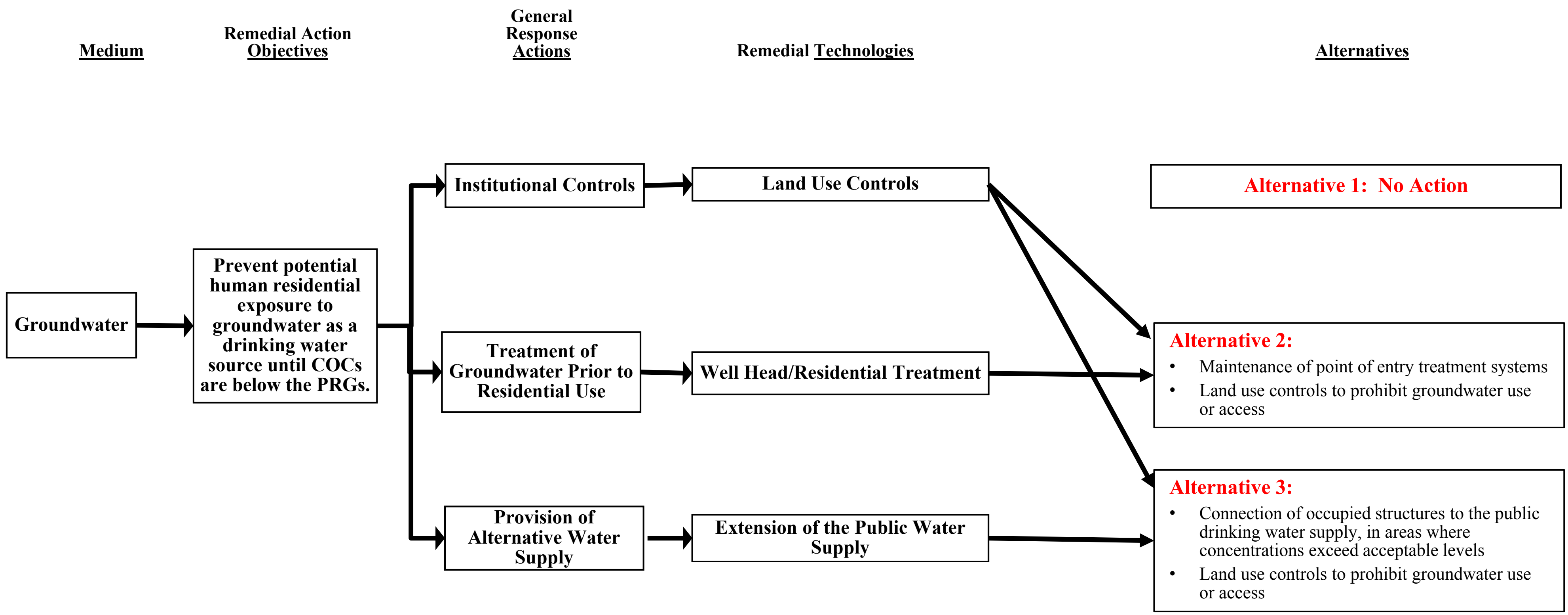
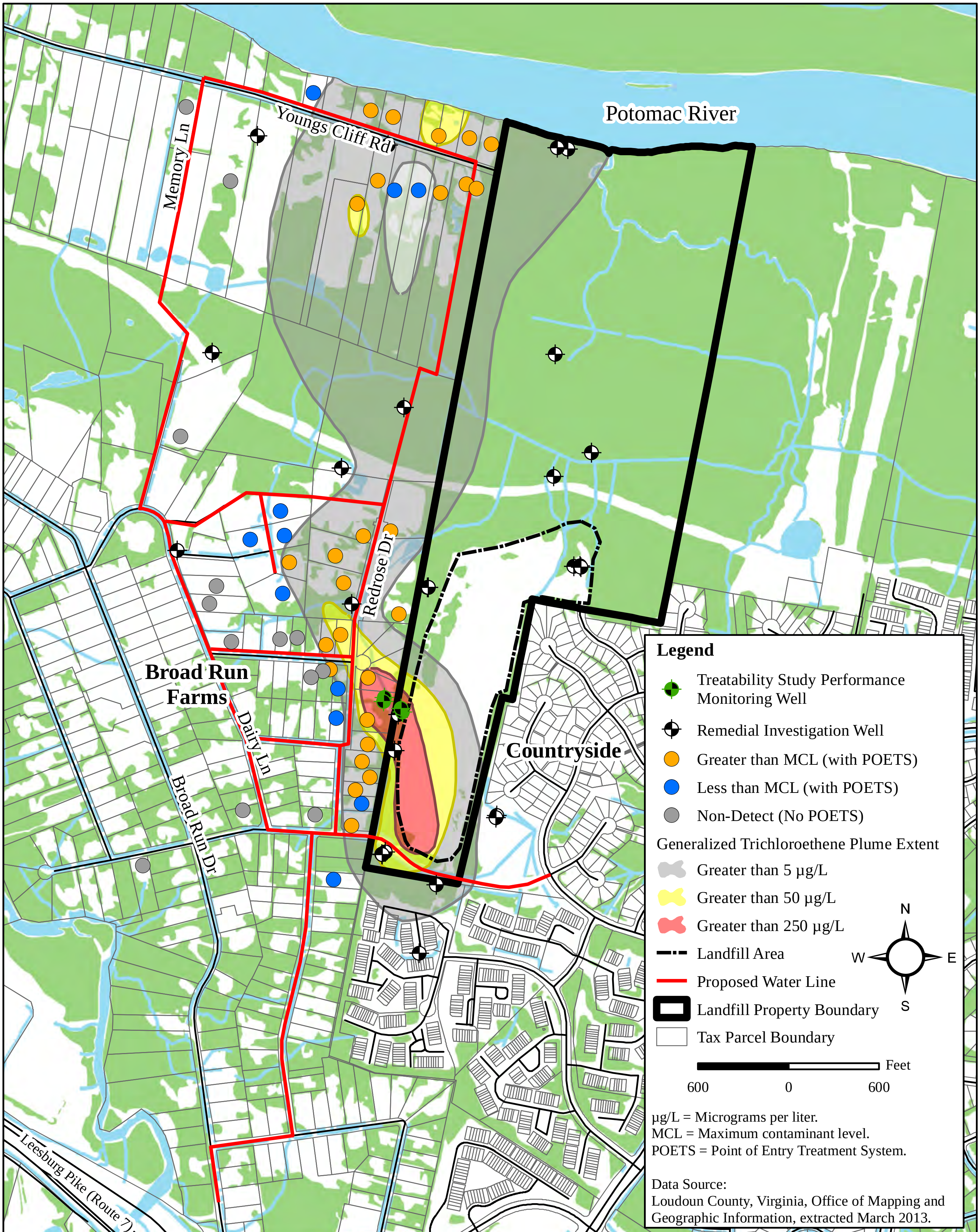
U.S. Environmental Protection Agency
Hidden Lane Landfill Site
Loudoun County
Sterling, VA

FIGURE 1-2
SITE MAP

Figure 3-1 Remedial Alternative Development





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Loudoun County
Sterling, VA

FIGURE 4-1
PROPOSED WATER LINE AND GENERALIZED TRICHLOROETHENE PLUME EXTENT

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Tables

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Table 2-1 List of Potential Federal Regulations

Potential ARARs/TBCs	Citation or Reference	Requirements	Applicability	Comments and Analysis
FEDERAL CHEMICAL-SPECIFIC REGULATIONS				
National Primary Drinking Water Standards	40 CFR Sections 141.50 and 141.61	Establishes health-based standards (i.e., Maximum Contaminant Levels) for public drinking water.	Applicable	Applicable for contaminants that impact groundwater.
FEDERAL LOCATION-SPECIFIC REGULATIONS				
None	None	None	None	None
FEDERAL ACTION-SPECIFIC REGULATIONS				
Clean Air Act				
NAAQS	40 CFR Part 50	Establishes primary and secondary NAAQS for ambient air quality to protect public health and welfare; for sulfur dioxide, nitrogen oxide, carbon monoxide, ozone, lead, and particulate matter.	Applicable	Applicable to activities that have the potential to impact ambient air quality.
Standards of Performance for New Stationary Sources	40 CFR 60	Establishes emission standards for pollutants from new or modified stationary (facility) sources.	Applicable	Potentially applicable to activities that have the potential to impact ambient air quality.
RCRA (42 U.S. Code 6901)				
Standards for Waste Generators and Transporters	40 CFR Parts 262 and 263	Applicable to generators and transporters of hazardous waste. Requires that transporters be licensed hazardous waste haulers.	Applicable	Applicable to alternatives that involve offsite transport and disposal of hazardous wastes, if waste is temporarily stored onsite.
Containers	40 CFR 264.171 through 264.178	Regulations cited under 40 CFR 264.171 to 264.178 (Subpart I) concerning permanent onsite storage of hazardous wastes or temporary storage phases used during various cleanup actions such as removal or incineration.	Applicable	Applicable to alternatives that require use of temporary containers to hold hazardous wastes, if used.

Potential ARARs/TBCs	**Citation or Reference**	**Requirements**	**Applicability**	**Comments and Analysis**
NOTES: ARAR = Applicable or relevant and appropriate requirement. CFR = Code of Federal Regulations. NAAQS = National Ambient Air Quality Standards. RCRA = Resource Conservation and Recovery Act of 1976. TBC = To be considered.				

Table 2-2 List of Potential State Regulations

Potential ARARs/TBCs	Citation or Reference	Requirements	Applicability	Comments and Analysis
STATE CHEMICAL-SPECIFIC REGULATIONS				
Virginia Waterworks Regulation	12 VAC 5-590-440, Tables 2.2 and 2.3	Establishes MCLs for drinking water, surface water criteria, and best available technology for treatment of drinking water.	Applicable	The Virginia MCLs are currently the same as the federal MCLs for the site chemicals of concern.
STATE LOCATION-SPECIFIC REGULATIONS				
None	None	None	None	None
STATE ACTION-SPECIFIC REGULATIONS				
Regulations Governing the Construction and Use of Wells	12 VAC - 590-840B	Contains requirements governing the location, design, installation, use disinfection, modification, repair, and abandonment of all wells and associated pumping equipment.	Applicable	Any well installation or abandonment implemented as part of the remedy will be done in accordance with the substantive requirements of the well regulations.
Virginia Ambient Air Quality Standards: Control of Particulate Matter	9 VAC 5-30-60	These regulations establish standards for particulate matter in ambient air.	Applicable	The substantive requirements of these regulations will be attained during construction activities. No permits are required.
Virginia Regulations: New and Modified Stationary Sources: Visible and Fugitive Dust Emissions	9 VAC 5-50-20; 60 to 120	These regulations establish standards for visible and fugitive dust stationary sources.	Applicable	The substantive requirements of these regulations will be attained during emissions from new/modified construction activities. No permits are required.

NOTES: ARAR = Applicable or relevant and appropriate requirement.
MCL = Maximum contaminant level.
TBC = To be considered.
VAC = Virginia Administrative Code.

Table 2-3 Preliminary Remediation Goals for Groundwater

Chemical of Concern	Preliminary Remediation Goal / Maximum Contaminant Level (µg/L) [(a)]
Trichloroethene	5
Cis-1,2-Dichloroethene	70
Vinyl Chloride	2

(a) Maximum contaminant levels are from Primary Drinking Water Regulations, EPA-816-F-09-0004, May 2009. Available at: http://water.epa.gov/drink/contaminants/index.cfm.

NOTES: µg/L = Micrograms per liter.

Table 2-4 Remedial Technology Screening for Interim Action

General Response Action	Remedial Technology/ Process Option	Technology Description	Effectiveness		Implementability		Cost [(a)]		Status
No Action	No Action	None	No actions would be taken to minimize human exposure, address COCs in groundwater, or monitor progress toward meeting Remedial action objectives.	**W**	Easily implemented. However, may be difficult to obtain approval from regulators and public.	**W**	Low	**B**	Not Applicable
Institutional Controls	Land Use Controls	Restrictions to limit use of groundwater around Landfill	Effective in minimizing further exposure to COCs in groundwater via drinking water, if well publicized and enforced.	**B**	May meet some resistance from residents desiring to use groundwater.	**A**	Low	**B**	Retained
Treatment of Groundwater Prior to Residential Use	Well Head/Residential Treatment	Localized carbon treatment systems	Effectively reduces current risks to human health; however, does not diminish overall clean-up timeline.	**A**	Treatment systems are currently in place; option would be easily implemented.	**B**	High	**W**	Retained
Provision of Alternative Water Supply	Extension of the Public Water Supply	Extension of existing public water supply to serve residents in impacted area	Effective in preventing further exposure to COCs in groundwater via drinking water.	**B**	May meet some resistance from residents.	**A**	Moderate	**A**	Retained

(a) Costs represent rough estimates for comparison, from case studies of similar sites, and are expected to vary widely depending on specific design and other related parameters.

NOTES:
A = Average.
B = Better.
COC = Contaminant of concern.
W = Worse.

Table 4-1 Estimated Cost of Alternative 1—No Action

Item No.	Cost Categories and Items	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS				
1	**No Action**			
	Not applicable			$0
	Line Item Total			$0
			Total	**$0**

Table 4-2 Estimated Cost of Alternative 2—Continued Maintenance of Point-of-Entry Treatment Systems with LUCs

Item No.	Cost Categories and Items	Units	Unit Cost	Quantity (#)	Total Cost
A. CAPITAL COSTS					
1	**Installation New Treatment Systems**[1]				
1.1	Installation of New Treatment Systems	Each	$6,614	10	$66,136
1.2	Management and Site Services	20% of costs		20%	$13,227.10
				Subtotal:	$79,362.60
				ALL ITEMS SUBTOTAL:	$79,362.60
				Contingency (25%)	$19,840.65
				Total Capital Costs:	**$99,203.25**
B. O&M COSTS					
2	**Maintenance of POETS**				
2.1	Replacement of GAC Filter	Each	$699	40	$27,940
2.2	UV Light Replacement	Each	$308	40	$12,320
2.3	Emergency Calls	Each	$308	15	$4,620
2.4	Management and Coordination	10% of cost		10%	$4,488.00
				Subtotal	$49,368.00
3	**Monitoring of POETS**				
3.1	Quarterly Sampling of POETs, including sample collection, submission to the laboratory, and analysis	Event	$69,225	120	$8,307,030.00
3.2	Data Validation and Management and Preparation/Submission of Residential Letters	Event	$14,463	120	$1,735,575.60
3.3	Emergency Sampling/Resampling	Per year	$34,197	30	$1,025,902.50
				Subtotal	$11,068,508.10
				Total O&M Costs:	**$11,117,876.10**

C. 30-YEAR PRESENT VALUE[2]

O&M Costs	$9,996,692

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$99,203
O&M Costs	$9,996,692
30-Year Total Present Worth Costs	**$10,095,896**

Notes:

1. Currently 36 residences have POETs. It is assumed that an additional 10 would be added over the next 30 years.
2. Present Value = (O&M) x (P/F), Real Discount Rate 0.7% for 30 years.
3. As per the EPA, costs for Administrative Land Use Controls, Restoration Advisory Board Meetings, and Five-Year Reviews are not included.

Table 4-3 Estimated Cost of Alternative 3—Connection to the Public Water Supply with LUCs

Item No.	Cost Categories and Items	Unit Cost	Quantity	Units	Total Cost
A. CAPITAL COSTS					
101	**SITE WORK**				
1.1	Mobilization and Demobilization	$53,300.00	1	LS	$53,300
1.2	Construction Stakeout	$24,800.00	1	LS	$24,800
1.3	Clearing and Grubbing	$4,300.00	10	AC	$41,660
1.4	Maintenance of Traffic	$1,000.00	168.8	LS	$168,800
1.5	Restoration of Paved Surfaces	$84.00	586	SY	$49,240
1.6	Restoration of Unpaved Surfaces	$69.00	422	MSF	$29,120
1.7	Test Pitting & Utility Investigation	$192.00	25	EA	$4,800
1.7	Management and Site Services	20% of costs	20%		$63,684
	Subtotal				**$435,404**
102	**EROSION AND SEDIMENT CONTROL**				
2.1	Stabilized Construction Entrance	$39.50	31	SY	$1,250
2.2	Silt Fence	$5.88	1000	LF	$5,880
2.3	Management and Site Services	20% of costs	20%		$1,426
	Subtotal				**$7,130**
103	**WATER DISTRIBUTION PIPING**				
	103A : Pipe Installation				
3A.1	12" DIP Water Pipe	$120.00	5,550	LF	$666,000
3A.2	8" DIP Water Pipe	$75.00	15,550	LF	$1,166,250
3A.3	Utility Trenching, Backfill, & Compaction	$28.17	21,100	LF	$594,390
3A.4	Bedding	$41.50	781	LCY	$32,440
3A.5	Sawcutting	$9.80	234	SY	$2,300
3A.6	Dewatering	$1,025.00	169	Days	$173,020
3B.3	Management and Site Services	20% of costs	20%		$526,880
	Subtotal				**$3,161,280**
	103B : Isolation Valves				
3B.1	8" Gate Valve	$2,725.00	10	EA	$27,250
3B.2	12" Gate Valve	$6,200.00	4	EA	$24,800
3B.3	Management and Site Services	20% of costs	20%		$10,410
	Subtotal				**$62,460**
	103C : Fittings				
3C.1	8" Fittings	$23,130.00	1	LS	$23,130
3C.2	12" Fittings	$34,475.00	1	LS	$34,475
3C.3	Management and Site Services	20% of costs	20%		$11,521
	Subtotal				**$69,126**
	103D: Waterline Connections				
3D.1	Piping Tie-ins	$2,500.00	2	EA	$5,000
3D.2	Residential Tie-ins	$4,000.00	75	EA	$300,000
3D.3	Management and Site Services	20% of costs	20%		$61,000
	Subtotal				**$366,000**
	103E: Waterline Abandonment				
3E.1	Abandon in Place Existing Waterlines/Wells	$4,400.00	75	EA	$330,000
3E.2	Management and Site Services	20% of costs	20%		$66,000
	Subtotal				**$396,000**
	103F : Waterline Disinfection & Testing				
3F.1	Hydrostatic Testing	$37,452.50	1	LS	$37,460
3F.2	Chlorination/Disinfection	$24,792.50	1	LS	$24,800
3F.3	Management and Site Services	20% of costs	20%		$12,452
	Subtotal				**$74,712**

Table 4-3 Estimated Cost of Alternative 3—Connection to the Public Water Supply with LUCs

Item No.	Cost Categories and Items	Unit Cost	Quantity	Units	Total Cost
	103G: Miscellaneous Concrete				
3G.1	Thrust Blocks on 8" 90 degree bends	$102.00	6	EA	$620
3G.2	Thrust Blocks on 12" 90 degree bends	$202.00	2	EA	$410
3G.3	Management and Site Services	20% of costs	20%		$206
	Subtotal				**$1,236**
	103H: Appurtenances				
3H.1	Sampling Station	$1,255.00	2	EA	$2,510
3H.2	Hydrants	$9,600.00	70	EA	$672,000
3H.3	Management and Site Services	20% of costs	20%		$134,902
	Subtotal				**$809,412**
	Line Item Total				**$4,940,226**
104	**AS-BUILT DRAWINGS**				
4.1	Preparation & Submission of As-Built Drawings	$10,000.00	1	LS	$10,000
4.2	Management and Site Services	20% of costs	20%		$2,000
	Subtotal				**$12,000**
	ALL LINE ITEMS SUBTOTAL:				**$5,394,760**
	Contingency (25%)				$1,348,690
	Total Capital Costs:				**$6,743,450**

C. 30-YEAR PRESENT VALUE [5]

O&M Costs	$0

D. COST SUMMARY

Cost Element	Cost ($)
Capital Costs	$6,743,450
O&M Costs	$0
30-Year Total Present Worth Costs	**$6,743,450**

Notes:

1. All items are assumed to include the necessary labor, material, and equipment to furnish and install the item listed unless otherwise noted.
2. This cost estimate does not include environmental permitting costs unless otherwise noted.
3. This cost estimate does not include costs for construction or contract management.
4. Subcontracting markup is applied to construction activities.
5. Present Value = (O&M) x (P/F), Real Discount Rate 0.7% for 30 years.
6. As per the EPA, costs for the design, Operations and Maintenance, and Administrative Land Use Controls are not included.

Table 4-4 Comparative Analysis Summary of Alternatives for Interim Action

Alternative 1 No Action		Alternative 2 Continued Maintenance of Point-of-Entry Treatment Systems with LUCs		Alternative 3 Connection to the Public Water Supply with LUCs	
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT					
Does not provide protection.	N	Protects human health by treating site groundwater prior to use as drinking water and through restrictions on groundwater use.	Y	Protects human health by replacing use of site groundwater as drinking water and through restrictions on groundwater use.	Y
COMPLIANCE WITH ARARs					
Does not comply with ARARs.	N	Provides drinking water that is in compliance with chemical-specific ARARs.	Y	Provides drinking water that is in compliance with chemical-specific ARARs.	Y
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Not effective for achieving remedial action objectives.	W	Effective for protecting human health in the long term, but requires maintenance of the POETS.	A	Effective for protecting human health in the long term. Permanent; no maintenance required.	B
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME					
Not applicable.	W	Decreases the toxicity of the groundwater in residential wells prior to use. Does not affect the toxicity, mobility, or volume of COCs within the groundwater.	A	Decreases public exposure to toxicity by replacing the use of site groundwater. Does not affect the toxicity, mobility, or volume of COCs within the groundwater.	A
SHORT-TERM EFFECTIVENESS					
No additional impacts beyond those already present at the site.	A	No human health concerns; treatment systems are already in place. Remedial action objective for protection of human health has been met in the short term.	B	Short-term human health concerns during installation of new water supply lines. Treatment systems would remain in place to achieve remedial action objective for protection of human health in the short term.	A
IMPLEMENTABILITY					
Technically implementable but not administratively.	W	Highly implementable in the short term; treatment systems are in place. Long-term, regular maintenance is required.	B	Implementable; does not require long-term maintenance.	B
COST [(a)]					
Capital – $0 O&M – $0 Total – $0		Capital – $99,203 O&M – $9,996,692 Total – $10,095,896		Capital – $6,743,450 O&M – $0 Total – $6,743,450	
STATE ACCEPTANCE					
Not acceptable	W	Not preferred by Virginia Department of Environmental Quality due to long-term maintenance requirements.	W	Preferred by Virginia Department of Environmental Quality, as well as Loudoun County.	B

Alternative 1 No Action		**Alternative 2 Continued Maintenance of Point-of-Entry Treatment Systems with LUCs**		**Alternative 3 Connection to the Public Water Supply with LUCs**	
COMMUNITY ACCEPTANCE					
Not acceptable	**W**	Acceptable, but only preferred by a minority of residents, based on June 2017 public meeting.	**A**	Preferred by a majority of residents, based on June 2017 public meeting.	**A**

(a) Net present value costs are based on a 0.7 percent discount rate. Administrative costs are not included.

NOTES:
- **A** = Average.
- **B** = Better.
- ARAR = Applicable or relevant or appropriate requirement.
- COC = Contaminant of concern.
- LUC = Land use control.
- **N** = No (for threshold criteria)
- O&M = Operation and maintenance.
- POETS = Point-of-entry treatment system.
- **Y** = Yes (for threshold criteria)
- **W** = Worse.