Exponent®

Environmental Group

Draft Final

Feasibility Study

Heglar Kronquist Landfill
Mead, Washington

Prepared for

DCO Management, LLC
Baton Rouge, Louisiana

Exponent®

Draft Final

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This feasibility study has been prepared solely for the use of DCO Management, LLC, for submittal to the Washington State Department of Ecology in accordance with Agreed Order No. 6557.

Acronyms and Abbreviations

ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
DCO Management	DCO Management, LLC
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
gpm	gallons per minute
Gemini	Gemini Management, Inc.
HDPE	high-density polyethylene
MTCA	Model Toxics Control Act
NPDES	National Pollutant Discharge Elimination System
RI	remedial investigation
RO	reverse osmosis
STA	Small Tract Agricultural
the Site	Heglar Kronquist Landfill
WAC	Washington Administrative Code
WMI	Waste Management Inc.

1 Introduction

DCO Management, LLC (DCO Management) is submitting this feasibility study (FS) report for the Heglar Kronquist Landfill (the Site) located near Mead, Washington (Figure 1). This FS was conducted to evaluate remedial alternatives and recommend a cleanup action. This document has been prepared pursuant to *Agreed Order No. 6557* executed on March 30, 2009, with the Washington State Department of Ecology (Ecology) (Ecology 2009), Washington Administrative Code (WAC) 173-340-350, and the *Final Remedial Investigation/Feasibility Study Work Plan* dated September 18, 2009 (ARCADIS 2009).

1.1 Purpose and Organization

The purpose of the FS is to develop and evaluate cleanup action alternatives to enable a cleanup action to be selected for the Site. If concentrations of hazardous substances do not exceed the cleanup level at a standard point of compliance, no further action is necessary.

This FS report is organized into the following sections:

- **Section 1–Introduction.** This section provides an introduction to the FS report, including the purpose of the study and the report organization.
- **Section 2–MTCA Cleanup Standards and Remedial Action Goals.** This section presents the Model Toxics Control Act (MTCA) cleanup standards and remedial action goals based on results of the remedial investigation (RI) report (Exponent 2011).
- **Section 3–Identification and Initial Screening of Technologies and Process Options.** Technologies and process options are identified and screened in this section.
- **Section 4–Development of Proposed Remedial Alternatives.** Proposed remedial alternatives are developed and described in this section. This section also includes a preliminary evaluation of implementability, cost effectiveness,

and long-term effectiveness in protecting human health and the environment of each alternative.

- **Section 5–Detailed Evaluation of Remedial Action Alternatives with Respect to MTCA Criteria.** Proposed remedial alternatives are evaluated against the MTCA criteria.
- **Section 6–Recommended Remedial Action Alternative.** Based on the detailed evaluation presented in Section 5, one of the remedial alternatives is recommended.

1.2 Background Information

1.2.1 Site Description

The Heglar Kronquist Landfill is situated in a rural area near the intersection of E Heglar and E Kronquist Roads approximately 10 miles northeast of downtown Spokane, Washington (Figure 1). Although the Site is defined as the Heglar Kronquist Landfill, the area of impact is defined beyond property boundaries, as appropriate, in accordance with Ecology's cleanup rule (WAC 173-340). A legal description for the property was provided in the RI report. The Site is located on Parcel No. 46032.9022 and is classified "Resource Lands" and zoned Small Tract Agricultural (STA). According to the Spokane County Zoning Code, Resource Lands Chapter 14.616:

> "The Small Tract Agricultural zone establishes small tract agricultural areas devoted primarily to berry, dairy, fruit, grain, vegetable, Christmas trees, and forage crop production. Direct marketing of agricultural products to the public and associated seasonal festivities are permitted. Residential density is 1 unit per 10 acres and residential uses should normally be associated with farming operations."

The Site is situated at an elevation of approximately 2,200 ft. Adjacent properties are also zoned STA. Kaiser (now DCO Management) acquired the noncontiguous property south of the Site (Parcel No. 46033.9047) in June 1997.

The Site is situated in a complex hydrogeologic area, mapped as landslide material on the Washington State Geologic Map. The Site is located within the Deadman Creek drainage about 1 mile southeast of Deadman Creek in Ecology Water Resource Investigation Area 55. The Heglar Kronquist progress report prepared by Sweet, Edwards & Associates, Inc. on May 23, 1980, indicates that the landfill is situated on a landslide block (Figure 2, Schematic Geologic Section in Sweet Edwards [1980]).

The highlands east of the landfill are capped with fine-grained loess deposits of the Palouse Formation which, based on well logs, consists mostly of clay. The loess is underlain by basalts of the Columbia River Group. Beneath the basalt is the Latah Formation which is composed of siltstone, shale, and some sandstone. These formations are exposed in the slope east of the landfill.

The groundwater flow regime at the Site is complex, in part because of the landslide, as well as the secondary porosity created by joints and fractures, which likely occurred both before and during the landslide.

1.2.2 Site History

In April 1963, a former Site owner entered into an agreement with Spokane County allowing the county "the right to remove earth, gravel, or rock material from within the boundaries" of the Site for a 10-year period (Spokane County 1963). Under this agreement, a small county gravel pit/quarry was operated on the property until it was closed in 1969. In 1969, a private contractor (Gemini Management, Inc. [Gemini]) consulted with Spokane County and the Water Pollution Control Commission (predecessor to Ecology) to evaluate the suitability of several locations in the Spokane area for the final disposal of secondary aluminum slag (dross). On August 12, 1969, the county visited the Heglar Kronquist pit with Gemini and concurred with the suitability of the abandoned pit for dross disposal. Spokane County issued a letter of understanding to Gemini dated August 25, 1969, noting that disposal of aluminum slag residue in the Heglar Kronquist pit as proposed did not require a license from the county (Spokane County 1969a). On September 5, 1969, Spokane County sent a second letter to Gemini confirming the suitability of the Heglar Kronquist pit for dross disposal, provided that two conditions were met

(Spokane County 1969b). The first condition was to control runoff during the course of the work to prevent water from entering the pit area. The second condition was to cover the filled area with a suitable layer of impervious material to "seal off the entrance of surface water" upon completion of the work.

From 1969 to 1974, Gemini disposed of approximately 55,000 cubic yards of aluminum (black) dross into the 4-acre quarry. The black dross originated from white dross recycling processes at Kaiser's Trentwood Plant in the Spokane Valley. The estimated extent of dross fill reported by others is shown on Figure 2. During this time, the Spokane County Utilities Department received one report on September 21, 1972, indicating that a neighbor had dumped refuse into the pit (SCUD 1972). There is no evidence in the project documents that anything other than black dross was placed into the pit with this one exception. Black dross disposal ceased in 1974 when elevated levels of chloride and sodium were detected in one shallow water supply well and a spring near the Site. Several investigations and remedial actions were completed following cessation of disposal activities as described in the RI report.

According to Kaiser records, the black dross in the landfill is composed of the following:

- 39 percent sodium chloride
- 35 percent aluminum oxide
- 19 percent potassium chloride
- 4 percent free aluminum
- 2 percent cryolite (aluminum sodium fluoride)
- 1 percent carbides and nitrides.

White dross is a by-product of molten aluminum processes and is formed on the surface of the molten metal. Aluminum is recovered from white dross in furnaces and salts are added to optimize recovery. "Black dross" or "salt cake" is produced during secondary aluminum recovery/recycling of white dross. Black dross contains a lower concentration of metals than white dross, but a much higher concentration of salts.

The principal indicator of dross impact in groundwater and surface water is chloride. Although nitrate is a constituent related to dross, it is not a good indicator of groundwater impacts due to other sources of nitrate in the area. Water contact with black dross under some circumstances is known to produce hydrogen, methane, acetylene, and ammonia gases. Air quality inside the landfill and in ambient air was evaluated as part of the RI as discussed in Section 1.2.4.3.

1.2.3 Quarterly Groundwater Monitoring Results

Six monitor wells were installed during Phase II of the RI in September 2010. Baseline sampling was conducted in September and October 2010 and these results were presented in the final RI report (Exponent 2011). Since the RI, quarterly sampling events have been conducted in January and April 2011. Results from these sampling events are generally consistent with the RI, except for the water quality at two wells closest to the landfill. Chloride concentrations in groundwater at MW-1 and MW-4 increased significantly in April 2011. Increases were also observed for other Site-related constituents (calcium, magnesium, nitrate, potassium, and sodium). Ammonia increased at MW-4; however, ammonia has not been detected at any other monitor well, the U.S. Environmental Protection Agency (EPA) has not published toxicity values for exposure to ammonia in drinking water, and a MTCA groundwater cleanup standard is not available for ammonia.

A review of water level elevations and U.S. Weather Service rainfall data from Spokane, Washington, indicates that infiltration and recharge was approximately 40 percent above normal from November 2010 to April 2011. At the same time, soil temperature data from the U.S. Weather Service for the nearest site (Lind, Washington) showed soil temperatures frequently above freezing which would allow most of the rainfall and snow melt to infiltrate the cap.

In January 2011, high turbidity (sediment) resulted in elevated metals in the sample collected from MW-2 (primarily aluminum, iron, and manganese). The sample was filtered at the laboratory and reanalyzed. As expected, metals results for this reanalysis were significantly lower. The sample collected from MW-4 was also reanalyzed due to elevated chloride in January 2011, however the reanalysis results were comparable to the initial results and this increase is attributable to increased infiltration and recharge as discussed above. Initial and reanalysis results are provided in Appendix A.

Data for both the January and April 2011 events confirm the results of the RI, including the groundwater flow geometry as shown on Figure 3 and described as follows:

- Flow from the landfill area northwestward toward MW-1
- Flow around the north end of the fine-grained zone and then southward through the MW-3 area toward MW-2, with ultimate discharge through Springs SW-2 and/or SW-3
- A flow segment between the landfill and the BH-10 and MW-4 area.

Nitrate, chloride, and sodium data for April 2011 are shown for MW-1 through MW-6 on Figures 4 through 7. Because the chloride concentrations in groundwater increased in January and April 2011, the area of groundwater impact above standards has expanded beyond that depicted in the RI and includes both MW-1 and MW-4 as shown on Figure 5.

Figure 3 shows water level elevations for April 2011. A water level elevation map for January 2011 was presented in the RI report; however, analytical data for the January 2011 event were not available at the time the report was published. A summary of field and analytical results, and laboratory reports and data validation summaries for the January and April 2011 events are provided in Appendix A.

1.2.4 Nature and Extent of Contamination

The nature and extent of contamination at the Site was determined in the RI, and a brief summary is presented below. RI sample locations are shown on Figures 2 and 7.

1.2.4.1 Dross

Black dross is landfilled at the Site and is a source material for potential groundwater and air contaminants. Historical data suggests that black dross is present in the landfill to a depth of 50 ft. During the RI in May 2010, dross was encountered in boreholes D-1, D-3, and D-4 below the cap material to depths ranging from 5 to 43 ft. Boring D-2, located near the southeast portion of the landfill, did not encounter dross. The dross encountered in the RI borings was dry with the exception of dross at location Boring D-1, where some moisture was encountered at levels below saturation. Groundwater was not encountered in any dross borehole.

All samples were analyzed for major anions and cations and a focused list of dross-related constituents. The following indicator constituents were detected in the dross: chloride, potassium, sodium, magnesium, calcium, and nitrate. The following constituents were also detected: ammonia (reported as nitrogen), fluoride, nitrite, total nitrogen, total Kjeldahl nitrogen, orthophosphate, sulfate, aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, thallium, vanadium, and zinc. Trace levels of cyanide and polychlorinated biphenyls were reported in one dross sample at concentrations near the detection limits. Volatile organic compounds, semivolatile organic compounds (with the exception of a trace reported level of bis[2-ethylhexyl]phthalate), total petroleum hydrocarbon, mercury, and selenium were not detected in the dross.

Although MTCA cleanup levels are not applicable to this material/medium (dross), screening was completed during the RI for comparison purposes only and RI dross results did not exceed the conservative Method B standard formula values for direct contact with soil. Some constituents (primarily chloride, potassium, sodium, and to a lesser extent calcium and magnesium) in the dross are leachable when dross comes into contact with water (moisture), and groundwater has been affected in the area as a result of this leaching. The elevated nitrate observed in area groundwater is attributable to local agriculture and/or cattle activity and, near the landfill, to some dross leaching.

The RI included an evaluation of similar dross sites in Washington and Ecology’s publications regarding the designation of black dross. This evaluation included one site where dross from several aluminum companies, including Kaiser, was placed. Following testing and evaluation, dross at these sites was determined to be non-hazardous by or with concurrence from Ecology. Based on these case studies, it is apparent that the black dross landfilled at the Heglar Kronquist Landfill is neither a dangerous waste nor a hazardous waste.

1.2.4.2 Groundwater and Surface Water

The groundwater impacts caused by the landfill are localized, extending southwest to an area near MW-2a which was dry and not completed as a monitor well, and southeast to the area of MW-4. As described in the Section 1.2.3, impacted groundwater is also present along the nearby unnamed drainage to the west, resulting from springs and subsurface discharge. It is apparent that the impacted groundwater does not extend to the north much past MW-1, as boring, spring, and well data show low chlorides in the area of SW-4, BH-13, 4ada, and beyond. Flow is restricted in this area by the granites. Figures 4 through 6 shows the approximate extent of the impacted groundwater and the smaller area of cleanup level or advisory exceedances.

1.2.4.3 Air

Extensive air sampling was conducted as part of the RI. Air was evaluated in a dross borehole installed through the landfill, in multiple gas vents, and also ambient air on the landfill cover and at the boundaries. As expected, the primary air contaminant detected closest to the source in the dross borehole is ammonia, which is formed when nitrides in the dross react with water. Carbon monoxide and methane were also measured inside the landfill during screening but neither constituent was measured in ambient air during health and safety monitoring. Carbon monoxide was not detected by the analytical laboratory in any of the air samples. Methane was detected by the analytical laboratory in ambient air at a low percentage indicative of unimpacted air (0.0002 percent). Methane may form when carbides in the dross react with water.

No constituents were detected in ambient air above published health-based standards and no additional assessment was recommended in the RI. Chloroethane and chloromethane were reported in multiple gas vent samples; however, neither constituent was detected in ambient air. Some constituents likely present in polyvinyl chloride sealants and adhesives that may have been used in constructing the venting system may be slowly off-gassing at low concentrations (e.g., acetone and tetrahydrofuran). A few common laboratory contaminants were also reported in air samples such as acetone and methylene chloride.

MTCA was updated in 2011. This update included newly published MTCA Method B and C air cleanup levels for ammonia. Ammonia was not detected above these newly published values, although the lower, newly published Method B and C standards for air are below the sample detection limits shown in the RI. For ammonia in air, the detection limits are based on the sampling time and rate, which were set to avoid over-saturation of the sampling media. Ammonia was monitored on the surface of the landfill for health and safety reasons during air sampling and dross sampling. Although field meter detection limits also exceed the new standards, ammonia was not detected in ambient air during the health and safety monitoring on the landfill cover. During dross boring, ammonia was detected in the immediate vicinity of the open hole, however, air monitoring was also conducted a short distance away, and ammonia was not detected. Therefore, due to dispersion, it is unlikely that ambient air concentrations exceed these newly published standards.

1.2.5 Baseline Risk Assessment

An ecological survey and screening was completed during the RI. Based on the results of the ecological survey and data screening, nitrite and elevated levels of chloride and nitrates in groundwater in the project area and in surface water in the spring/holding pond and drainage areas do not pose an unacceptable risk to livestock, aquatic species, or crop species.

A baseline human health risk assessment and MTCA cleanup level analysis was completed during the RI. The following cleanup level categories were identified for the protection of human health:

- Dross: not applicable
- Groundwater: Method B cleanup levels
- Surface water: Method B cleanup levels

- Air: Method B cleanup levels for ambient air on the boundary of the landfill; Method C cleanup levels for ambient air on the landfill.

Method C cleanup levels may be considered for groundwater and surface water if compliance with Method B is impossible or may cause greater environmental harm.

Nitrate is the only constituent related to landfill impacts that was detected in groundwater and surface water above health-based standards during the RI. Some nitrate is attributable to area-wide sources such as fertilizers and cattle activity. Nitrate in surface water is not expected to be a human health concern because the primary standard is based on protection of drinking water and only incidental ingestion of surface water is anticipated. Also, elevated nitrate in the drainage is not expected to result in groundwater impacts above the standard as shown by low nitrate concentrations in alluvial groundwater samples collected in the vicinity of the drainage.

Although impacted groundwater was evaluated based on protection of human health for drinking water, there is no current exposure to impacted groundwater as a drinking water source above primary health-based standards. In addition, land and water use are not expected to change in the future based on the evaluation conducted during the RI. No private wells screened in groundwater impacted by the Site above primary health-based standards were identified during the RI. In addition, there is a restriction on installing new water wells within 1,000 ft of the landfill property boundary (WAC 173-160-171), although this prohibition includes provisions for granting a variance if a demonstration can be made that construction and operation of the well will not result in risks to human health or the environment. As stated in WAC 173-160-171(3)(b)(vi), "the minimum set-back distance for water wells other than for public water supply" is:

> One thousand feet from the boundary of a permitted or previously permitted (under chapter173-304, 173-306, 173-351, or 173-350 WAC) solid waste landfill as defined by the permit; or one thousand feet from the property boundary of other solid waste landfills. Except, a variance may be granted if documentation is provided that demonstrates the construction and operation of the well adjacent to the landfill will not further degrade the environment and will not cause a public health risk.

Ambient air concentrations do not exceed available health-based standards.

1.3 Identification of Areas and Volumes to be Remediated

The RI identified one area of groundwater and groundwater discharging to springs (surface water) which requires remedial action assessment. MTCA cleanup standards for nitrate for ingestion of groundwater by residents are exceeded in this area. However, there is no current use of this nitrate-impacted groundwater and future use is not anticipated based on the prohibition in WAC 173-160-171 to install new water wells, other than for public water supply, within 1,000 ft of the landfill property boundary. In addition, chloride exceeds a secondary aesthetic-based standard and sodium in groundwater exceeds the upper limit of an EPA drinking water advisory based on taste thresholds.

This impacted groundwater and surface water area is carried forward into this FS. This area was estimated using a sample-by-sample comparison to the MTCA cleanup standards, including the secondary standard and the EPA advisory (potential applicable or relevant and appropriate requirements [ARARs]). RI sample locations for all media are shown on Figures 2 and 7. The area of impacted groundwater that exceeds the human health-based MTCA cleanup standard for nitrate, adjusted to account for area-wide background, is shown on Figure 4. The area of impacted groundwater that exceeds the secondary aesthetic standard for chloride is shown on Figure 5. The area of impacted groundwater that exceeds the upper limit of EPA's advisory for sodium based on a taste threshold is shown on Figure 6. These areas were considered in this FS and comprise a total area of approximately 36 acres.

Removal of the landfilled dross at the Site is also evaluated in this FS as an alternative to restore water quality. Constituent concentrations in the dross do not exceed MTCA cleanup standards for residential exposure to soil, although these are not applicable standards for the waste. As discussed in Section 1.2.2, the volume of aluminum black dross landfilled at the Site is estimated to be 55,000 cubic yards. The estimated extent of the landfilled dross is shown on Figure 2.

2 MTCA Cleanup Standards and Remedial Action Goals

Groundwater and surface water have been affected by the Site. A summary of MTCA cleanup standards and associated remedial action goals for these media are provided in the following sections. Although the RI demonstrated that ambient air has not been affected by the Site, cleanup standards for air are also discussed.

2.1 MTCA Cleanup Standards

MTCA cleanup standards are composed of points of compliance and MTCA cleanup levels. Based on information developed in the RI, cleanup standards have been selected as described in the following sections.

2.1.1 Points of Compliance

Groundwater and surface water have been affected by the Site. For groundwater, the standard point of compliance is selected throughout the Site (WAC 173-340-720(8)(c)). For surface water, the point of compliance is the point or points at which hazardous substances are released to surface waters of the state (WAC 173-340-730(6)(a) and (b)). The point of compliance for ambient air is throughout ambient air at the Site.

2.1.2 MTCA Cleanup Levels

MTCA cleanup levels are established as described in WAC 173-340-700. Based on the RI, Method B is selected for groundwater and surface water and is the universal method for determining cleanup levels for all media at all sites. Under the Method B framework, cleanup levels are established using ARARs, risk equations, and other MTCA requirements in WAC 173-340-720 through 760. As discussed in Sections 4 and 5, cleanup actions retained and evaluated in this FS are expected to comply with MTCA Method B groundwater and surface water cleanup levels, and therefore conditional Method C cleanup levels are not needed.

Method B cleanup levels are appropriate and were selected for ambient air on the boundary of the landfill. Method C industrial cleanup levels are appropriate and were selected for ambient air on the landfill. Site-related constituents were not detected in ambient air during the RI.

2.1.2.1 Groundwater

A detailed list of MTCA Method B groundwater cleanup levels is provided in the RI (Exponent 2011). Groundwater cleanup levels and advisories for indicator chemicals are summarized in the following table.

Cleanup levels for indicator chemicals in groundwater

Chloride	250 mg/L
Nitrate	14.4 mg/L
Sodium	60 mg/L

Note: mg/L - milligram per liter

The nitrate groundwater cleanup level has been adjusted to 14.4 mg/L, to account for the area-wide background level determined during the RI. The sodium groundwater cleanup level is selected as the upper limit of EPA's advisory based on taste.

2.1.2.2 Surface Water

A detailed list of MTCA Method B surface water cleanup levels is provided in the RI (Exponent 2011). Surface water cleanup levels for indicator chemicals are summarized in the following table.

Cleanup levels for indicator chemicals in surface water

Chloride	250 mg/L
Nitrate	14.4 mg/L

Note: mg/L - milligram per liter

The ecological assessment conducted as part of the RI showed that chloride concentrations measured in exceedance of the surface water standard of 230 mg/L do not result in unacceptable exposure to ecological receptors at and in the vicinity of the Site. This standard is based in part, on a sensitive aquatic species of algae *Spirogyra setiformis*, which exhibited adverse effects at 71 mg/L chloride (U.S. EPA 1988); adverse chronic effects observed in aquatic invertebrates and fish occurred at chloride concentrations above 250 mg/L. However, it was determined in the RI that given the significant algal biomass observed onsite, it is unlikely that spring and surface water chloride levels are adversely impacting algal growth. Therefore, the surface water standard has been set at the groundwater standard for protection of groundwater surrounding the drainage.

The nitrate groundwater cleanup level of 14.4 mg/L, adjusted to account for area-wide background, is selected as the surface water cleanup level. The RI demonstrated that nitrate levels above this concentration are not harmful to ecological receptors that may be exposed to the surface water. In addition, the surface water drainage is created by a groundwater discharge and is influenced by groundwater in the area. Therefore, the cleanup standard for nitrate in surface water is set at the groundwater cleanup standard for protection of groundwater surrounding the drainage.

2.1.2.3 Air

A complete list of MTCA Method B and C air cleanup levels is provided in the RI (Exponent 2011). No exceedances of these cleanup levels were noted in the RI for ambient air, therefore, cleanup levels are not summarized in this section and remedial action goals are not developed for this medium. A discussion of newly published MTCA air cleanup levels for ammonia and sample detection limits is provided in Section 1.2.4.3.

2.2 Remedial Action Goals

CERCLA guidance (U.S. EPA 1988) and draft revisions to the MTCA (WAC 173-340-350; Ecology September 9, 2009) include development of remedial action objectives or goals in a FS. In accordance with WAC 173-340-360, remedial actions must comply with MTCA cleanup standards, which are protective of human health and the environment. The remedial action goals are used to achieve the risk standards for impacted groundwater and surface water (groundwater discharging from springs).

Based on the results of the RI and the associated quarterly groundwater monitoring in 2010 and 2011, remedial action goals (listed below) have been developed for groundwater and surface water in the area of impact. These Site-specific remedial action goals provide the foundation for developing and evaluating remedial actions for the Site.

Remedial action goals for groundwater, Heglar Kronquist Landfill

	Remedial Action Goals	Cleanup Levels for Indicator Chemicals
Health-Based		
	Prevent exposure to nitrate in groundwater above the acceptable health-based level, which has been adjusted to the area-wide background level, via the ingestion pathway for current and future residents. Groundwater with nitrate concentrations exceeding this level is present as shown on Figure 4. This area includes groundwater in the vicinity of the drainage from the springs.	Nitrate: 14.4 mg/L
Health Advisory and Aesthetics		
	Prevent exposure to chloride in groundwater, which does not pose a hazard, but may result in aesthetic issues (e.g., a salty taste) via the ingestion pathway for current and future residents.	Chloride: 250 mg/L Sodium: 60 mg/L
	Prevent exposure to sodium in groundwater, which may pose a hazard for sodium-sensitive receptors via the ingestion pathway for current and future residents. Toxicity values and an associated risk-based concentration have not been published. Therefore, the upper limit of the qualitative range published in an EPA advisory based on taste thresholds is used for this remedial action goal.	
	Groundwater with chloride and sodium concentrations exceeding these levels is present as shown on Figures 5 and 6, respectively. For chloride, this area includes groundwater in the vicinity of the drainage from the springs.	

Note: mg/L - milligram per liter

TDS and specific conductivity are not listed, although exceedances of secondary cleanup standards were noted in the RI, since neither has been selected as an indicator chemical for the Site.

Remedial action goals for surface water, Heglar Kronquist Landfill

Medium	Remedial Action Goals	Cleanup Levels for Indicator Chemicals
Health-Based		
	Prevent exposure to nitrate in surface water above the acceptable health-based level, which has been adjusted to the area-wide background level for groundwater, via the ingestion pathway for current and future residents. Surface water with nitrate concentrations exceeding this level is present as shown on Figure 4.	Nitrate: 14.4 mg/L
Health Advisory and Aesthetics		
	Prevent chloride in surface water above the secondary, aesthetic-based standard for groundwater, for protection of groundwater surrounding the drainage. Surface water with chloride concentrations exceeding these levels is present as shown on Figures 5. This area includes groundwater discharged to springs as surface water.	Chloride: 250 mg/L Sodium: N/A

Note: mg/L - milligram per liter

The acceptable level for nitrate has been adjusted to be equivalent to the area-wide background level of 14.4 mg/L that was determined in the RI. Remedial alternatives presented in this FS are designed to achieve the primary health-based standard (adjusted to the background level) for nitrate, and the secondary standard and advisory taste threshold levels for chloride and sodium as goals.

Although water quality standards and an advisory level are exceeded in groundwater and surface water off the property, no current adverse risk was identified for human health or the environment in the RI. In addition, land and water use are not expected to change in the future based on the evaluation conducted during the RI. This is attributable to Site-specific exposure scenarios, including the existing regulatory prohibition against installing water wells within 1,000 feet of the property boundary of the landfill. Therefore, although adverse risks have not been identified, remedial action goals have been established to address cleanup standard exceedances. Nitrate is the only constituent above health-based MTCA standards. Goals have also been established for chloride and sodium, although these are based on aesthetics (e.g., taste). It is expected that remediation of nitrate will result in remediation of both chloride and sodium.

A secondary maximum contaminant level is published for chloride based on aesthetics. Published EPA standards are not available for sodium. Rather, EPA has published a recommended level for sodium-sensitive individuals and a recommended range for most individuals in an advisory titled *Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis of Sodium* dated February 2003 (U.S. EPA 2003). This sodium advisory "provides guidance on concentrations at which problems with taste would likely occur" and also evaluates sodium sensitivity. The advisory is not health-based; toxicity values are not available to quantify health risks for this essential nutrient, which is physiologically important and "needed to maintain body fluid volume and blood pressure." Rather, published dietary goals and other data are evaluated. A 2,400 mg/L daily dietary goal has been published for sodium by several government and health agencies. The EPA advisory for the taste threshold for most individuals (a range unlikely to be perceived as salty) is 30−60 mg/L, which is only 2.5−5.0 percent of this dietary goal based on an intake of 2 L/day. This range, which is based on aesthetic effects, is very conservative because "most individuals will not be able to detect the presence of sodium in this concentration range."

According to the advisory, "about 3% of the population is on sodium-restricted diets, which sometimes require sodium intakes of less than 500 mg (~1/4 teaspoon) per day." This restricted intake level of 500 mg/day, is the estimated minimum daily requirement for sodium for healthy adults and children. However, this is a very low intake; "therapeutic sodium-restricted diets can range from below 1,000 to 3,000 mg/day."

In the advisory, EPA provides a guidance or recommended level of 20 mg/L for sodium in drinking water based on the lowest intake evaluated for sodium-sensitive individuals of 500 mg/day. This low concentration is only 8 percent of this conservative intake and EPA states that the 20 mg/L recommended level "should not be extrapolated to the entire population." The advisory notes that the health effect of primary concern for long-term lower level exposures (not lethal high doses) is hypertension. The advisory also notes that there are inconsistencies and uncertainties in the study data that do not allow definite conclusions on the benefits of a reduced sodium intake. The advisory states that "drinking water does not play a significant role in sodium exposure for most individuals," and that factors including exercise and lower alcohol consumption may play a significant role in reducing blood pressure and the risk for cardiovascular disease. The main source of sodium in diet is table salt with 99 percent of daily salt intake from food, and only 1 percent from drinking water (University of Massachusetts and U.S. EPA 2007).

3 Identification and Initial Screening of Technologies and Process Options

In accordance with WAC 173-340-350(8)(b)(i) and (ii), an initial screening of technologies and process options was completed. The following types of alternatives and process options were eliminated from further analysis in the initial screening:

- Those that clearly do not meet the requirements in WAC 173-340-360, including alternatives and process options with disproportionate costs
- Alternatives and process options that are not technically possible.

The remaining alternatives and process options were retained for further evaluation. The initial screening of these alternatives is summarized below and in Table 1.

3.1 No Action

Under a no action alternative, the Site remains as-is with no additional remediation, institutional or engineering controls, or monitoring. As noted in the background section, this Site was previously closed with a two-layer cap. If this alternative is selected, repair of the existing cover and gas vents would not be completed. This alternative is implementable, but may not meet the remedial action goal for effective long-term protection of human health. Although there is no current unacceptable exposure and future land and water use and exposure are not expected to change, some action is deemed necessary to ensure long-term effectiveness. This alternative is not carried through for a more detailed evaluation because it fails to meet MTCA threshold requirements, including compliance with cleanup standards and compliance monitoring.

3.2 Institutional Controls

Institutional controls are legal and/or administrative tools to prevent unacceptable exposures to contamination left in place at the completion of remedial actions, such as preventing certain uses of a property, and maintenance of barriers, such as capping. If the waste is not removed, institutional controls may facilitate long-term protection of human health and the environment. Institutional controls are implementable and may be effective as an element of a remedial action. Institutional controls are retained for further analysis.

3.3 Engineering Controls

Engineering controls are physical measures that are designed to prevent or minimize exposure to residual contamination remaining on the Site, such as enhancement of capping on the property. If the waste is not removed, engineering controls can be effective tools for ensuring the long-term protection of human health and the environment. Engineering controls are implementable and are retained for further analysis if the waste is not removed.

3.4 Waste Removal

Waste removal would ensure the long-term protection of human health and the environment in the project area because the landfilled dross would be removed. Waste removal would need to be combined with disposal as described below. This alternative is retained for further analysis as a permanent alternative (WAC 173-340-200) that serves as a baseline against which other alternatives are evaluated, to determine whether the cleanup action selected is permanent to the maximum extent practicable.

3.5 Disposal

Offsite disposal, if feasible, would be conducted in conjunction with waste removal. This technology is considered to be effective in protecting human health and the environment in the project area for the long term. During the RI, a request was made of Waste Management Inc. (WMI) to accept and dispose of dross cuttings in its local non-hazardous or hazardous landfills. WMI would not accept the waste at any of its landfills. Similar requests were not made of local municipal waste landfills because disposal of dross with wet municipal waste may result in gas emissions and odors.

In May 2011, WMI indicated that it may lift its ban and allow black dross disposal on a case-by-case basis, but a final decision has not been made to accept black dross from the Site. WMI has concerns based on dross handling at other landfills such as the Countywide Landfill in Ohio. These concerns may prevent issuance of a final approval to accept the waste. Final approval may be issued following review of data, including additional information that may be required by WMI. Although black dross is not hazardous, WMI is considering disposal in its hazardous waste landfill to ensure that the dross is kept dry. Although the implementability of disposal is not fully known, disposal is retained for further analysis to evaluate permanence.

Recycling is not considered because there is very little recoverable aluminum in black dross, which is characterized by high salt content and low metals. Also, the amount of recoverable aluminum in black dross decreases as it ages (breaks down) in the landfill, and the black dross has been landfilled at the Site for more than 35 years. The facility that processed the RI drill cuttings (Aleris Recycling, Inc. in Post Falls, Idaho) estimated that the black dross cuttings generated from the landfill during the RI in 2010 had very low recoverable aluminum. Given this low recoverable aluminum, recycling is not economically feasible.

3.6 Treatment

Waste treatment is not feasible for the black dross landfilled at the Site. A treatment technology does not exist to effectively treat the waste *in situ*. Reportedly, the dross was landfilled in large blocks. Some of these blocks may be intact, and others may have deteriorated. The waste was landfilled above the water table and the majority is presumed to be unreacted. *In situ* treatment would require deactivation of the dross and would result in generation of toxic gases. Also, it is not possible to deactivate the entire volume of waste. Even if the outside surface could be deactivated *in situ*, unreacted surfaces would be exposed as the waste deteriorated over time. Waste removal is evaluated in place of *ex situ* treatment.

Water treatment was also evaluated for this FS. At this time, the most effective and proven technologies for treatment of nitrate, sodium, and chloride are reverse osmosis (RO) and distillation. RO is a membrane process that removes contaminants by reversing the natural process of osmosis. Pressure is applied to force the impacted water (concentrated solution) through a semi-permeable membrane allowing purified (treated) water to diffuse through the membrane. The rejected contaminants are removed from the untreated side of the membrane as a concentrated waste stream, which is typically discharged to a sewer or septic system. A variety of RO membranes are available with differing rejection (removal) efficiencies. Many household RO systems have a recovery rate of approximately 20–30 percent (e.g., 20–30 gallons of purified water generated for every 100 gallons of water treated) and generate between 10 and 35 gallons of purified water per day. Many industrial systems have a recovery rate of approximately 25–75 percent. The effectiveness of an RO system depends on several factors, including adequacy of operation and maintenance, the membrane type selected, and feed water quality. Elevated iron and manganese in feed water, both of which occur naturally in Site area groundwater, may negatively affect RO treatment efficiency.

Distillation is another treatment option for water contaminated with nitrate and salts. In this process, impacted water is boiled and purified steam is condensed back to a liquid with the impurities left behind. This distilled water may be stored in a tank for subsequent use. Removal efficiencies are very high for distillation with almost all minerals removed, which may result in treated water with a “flat” taste. While distillation produces purified water it also produces a waste product of concentrated salts. This concentrated stream must be discharged or disposed.

Although these water treatment technologies have been identified for Site contaminants, it would be difficult and costly to implement either of these technologies to treat groundwater or surface water at the springs on a continuous, large scale. Operation and maintenance would be intensive. RO and distillation are typically used to treat only water that is used for drinking and cooking rather than the entire water supply, because of low recovery rates and concentrated waste streams that would need to be managed. Sewer connections are not present in the area and discharge of concentrated salt wastes to private septic systems will likely adversely affect local water quality. In addition, full scale treatment by RO or distillation would require groundwater capture and reinjection of treated water (pump and treat), which may not be feasible, is very costly, and does not provide source control.

Groundwater treatment by RO or distillation is not retained for further evaluation because it is not deemed effective for the Site. The groundwater regime is complex with fractured flow through the basalt rubble zone that moves northwestward and southward from the landfill. This complex, fractured basalt system precludes efficient and complete capture of impacted groundwater. It would be difficult to locate the fractures intercepting impacted groundwater, and even if these fractures could be located, recovery would need to be conducted in three areas to capture impacted groundwater flow northwest, southwesterly, and southeast of the landfill. The chaotic geometry of the basalt rubble in the slide block and the resultant flow path complexity would make complete capture difficult. Recovery would also be complicated with significant variation in recovery rates, with the highest flows during periods of highest precipitation and as the fractures dewater, and lower flows during other times of the year.

The flow rate of the spring was not measured during the RI, however, observations indicate that the flow rate is at least 2–5 gallons per minute (gpm) or more at the impacted spring (SW-3), and varies seasonally. In addition, historical data show that the adjacent spring (SW-2) has been impacted at times. Using a conservatively low minimum flow rate of 2 gpm, over one million gallons of spring water would be generated per year. Based on hydraulic data collected during the RI, groundwater wells would likely need to produce at least 10 gpm to afford any kind of reasonable capture. A minimum of three recovery wells would need to be installed to capture the plume from the landfill. Therefore, a minimum of 30 gpm or almost 16 million gallons of water per year would be recovered requiring treatment. As an example, a general approach and select average costs of a groundwater recovery with RO treatment is discussed below using an assumed groundwater recovery rate of 30 gpm.

Groundwater recovery and RO treatment would require a manufactured RO system with pretreatment, heat-traced surge and storage tanks for recovered groundwater and reject water storage, a heated equipment shed for the RO system, piping and instrumentation, and electricity (connection to City power). The capital costs for this recovery and treatment system are estimated to be more than $200,000, with actual costs dependent on system elements and other factors, such as the size of the surge and storage tanks.

For optimal treatment, input water must be free of sediment and particulates, and fed at a consistent flow rate with high pressure and a temperature of approximately 75 degrees F. To remove all particulates, dissolved constituents that easily precipitate when oxidized, such as iron and manganese, must also be removed to prevent fouling of the RO systems. With these ideal operating parameters, an approximate reject stream of at least 30 percent is expected. Variation from these conditions will result in higher rejection rates. Variations due to field conditions are expected for full-scale treatment and would likely result in a higher reject stream of approximately 40– 60 percent. Assuming a groundwater recovery rate of 30 gpm and 40 percent rejection, this is equivalent to a daily reject volume of approximately 17,000 gallons, and an annual reject volume of over 6 million gallons. This reject stream will need to be containerized and disposed of off-Site. At an assumed average cost of 30 cents per gallon, transport and disposal would be almost 2 million dollars per year and would require removal using four to six tank trucks per day, depending on access, weight limits, road conditions, disposal volume and other factors. During winter months, local roads become impassable, therefore, a large storage tank (e.g., 200,000 gallons or more) would be needed to store reject water that cannot be hauled. The cost of a large reject storage tank will likely be approximately $250,000, and has not been added to the capital project cost discussed above.

Labor costs have not been evaluated for groundwater recovery, treatment and disposal. Significant labor costs would be required to install the systems, provide engineering oversight, and conduct daily operation and maintenance activities, such as reject water removal. In addition, annual operation and maintenance expense costs have not been estimated such as membrane filter replacement and pump repair and replacement.

The conservatively low volume estimates and associated select cost estimates discussed above demonstrate that surface water or groundwater recovery and treatment is cost prohibitive, that groundwater recovery may not be effective due to capture issues in a fractured zone. Either would generate very large volumes of water with high capital costs and excessive operation and maintenance, and disposal costs. For the groundwater treatment example described above, annual disposal cost of reject water alone would be almost 2 million dollars.

Currently, there is no adverse exposure to impacted water and there is a use restriction prohibiting installation of new water wells within 1,000 ft of the landfill property boundary. In addition, land and water use are not expected to change in the future based on the evaluation conducted during the RI.

Dispersion and dilution will occur as an element of other alternatives considered below to attenuate residual impacts to levels below cleanup standards following implementation of the remedy. Dispersion and dilution are retained for further analysis.

3.7 Groundwater Barrier Technology

Subsurface barriers may be installed at some sites to prevent groundwater from infiltrating source areas. Barriers may also be constructed to contain impacted groundwater for subsequent collection and treatment. Groundwater barrier technologies are deemed ineffective for the landfill Site because the RI and historic information demonstrate that groundwater impacts are attributable to surface water infiltration through the cap rather than groundwater infiltration through the landfill. A surface water barrier (i.e., capping) is included in the engineering controls described above.

3.8 Evaluation and Selection of Representative Technologies

Based on the initial screening, the following representative technologies are retained for further analysis:

- Institutional controls
- Engineering controls (cap enhancement)
- Waste removal
- Offsite disposal
- Dispersion and dilution.

4 Development of Proposed Remedial Alternatives

Based on the initial screening of technologies and process options, two remedial alternatives have been developed for more detailed analysis in accordance with MTCA criteria:

- Alternative 1–Waste Removal, Offsite Disposal, Dispersion/Dilution, and Compliance Monitoring
- Alternative 2– Cap Enhancement, Institutional Controls, Dispersion/Dilution, and Compliance Monitoring.

A brief description of each alternative is provided in this section followed by a preliminary evaluation of implementability, cost effectiveness, and effectiveness in meeting the remedial action goals of protecting human health and the environment in the long term. A detailed evaluation of each alternative against MTCA criteria is provided in Section 5. This includes compliance with ARARs (i.e., local, state, and federal laws).

4.1 Alternative 1–Waste Removal, Offsite Disposal, Dispersion/Dilution, and Compliance Monitoring

Alternative 1 includes removal, by excavation, of the existing cap and approximately 55,000 cubic yards of black dross landfilled within the approximate 2.5-acre former quarry. To ensure that all landfilled waste is removed, the pit would be over-excavated. For costing purposes, approximately 20 percent has been added to account for this over-excavation. Following removal, the waste would be disposed at an offsite, permitted landfill. WMI placed a ban on disposal of black dross at all of its landfill locations, including the locations closest to the project site, over 1 year ago. In recent discussions, WMI has decided to accept black dross waste at its hazardous waste landfill in Arlington, Oregon. Due to issues with landfilling black dross at other sites, including the Countywide Landfill described below, WMI has recently decided that it may approve black dross disposal on a case-by-case basis in its hazardous waste landfill at a disposal cost of $52 per ton. However, as discussed below, based on professional judgment the $52 per ton cost is not feasible. Although the black dross has not been characterized as hazardous, WMI believes that it is more protective to manage it in the hazardous waste landfill in Arlington, Oregon. The RI results indicate that a majority of the black dross in the Heglar Kronquist landfill is dry and is, therefore, unreacted. Therefore, it is likely that WMI would require deactivation and solidification prior to landfilling such that the $52 per ton disposal cost is not feasible. This additional treatment results in a significantly higher disposal cost of $129 per ton, and will generate additional waste streams (e.g., gases and liquids). Groundwater quality would be restored to levels below MTCA cleanup standards in approximately 2–5 years through dispersion and dilution following dross removal.

4.1.1 Preliminary Evaluation of Alternative 1

Alternative 1 may be implementable because the local landfill (WMI) has recently decided to lift the complete ban on accepting black dross waste on a case-by-case basis. However, this determination is uncertain and the landfill could reinstate the ban or decide that it will not accept the waste upon final review and decision making. In addition, the cost of Alternative 1 is disproportionately high compared with potential additional protectiveness achieved compared with the other alternatives. The cost for Alternative 1 is estimated to be $20,064,000 as shown in Appendix B, Table B-1. As discussed in Section 5, the protectiveness of Alternative 1 is expected to be lower than leaving the waste in place because of short-term exposure to gases during removal and handling, and the potential for worsened long-term exposure at a new landfill location if the waste is not completely deactivated. Other important short-term issues include noise from the removal activities, and disturbances to local roadways (e.g., E Heglar and E Kronquist Roads), including dust/dirt and possible roadway accidents. Alternative 1 is expected to be effective in remediating the Site in the long term. Despite the uncertainties with implementability, Alternative 1 is retained to evaluate permanence.

4.2 Alternative 2–Cap Enhancement, Institutional Controls, Dispersion/Dilution, and Compliance Monitoring

Alternative 2 includes implementation and maintenance of engineering and institutional controls. A review of the cap and Site conditions indicates that even if the cap was constructed as intended in the mid-1980s, improvements would have been necessary to address burrowing, desiccation of the clay layer from insufficient hydration (low rainfall), and drainage from the hillside to the east onto and through the cap. Alternative 2 includes maintenance to rework drainages and the existing cover, where present, with added cap layers to improve reliability of the cap in the long term. In Alternative 2, the existing cap would be enhanced and the vent system would be repaired, if the damaged vents could be located and repairs could be made without intrusive work on the cover or venting system. The existing venting system with the damaged vents is operating well as shown by the ambient air results from the RI. Therefore, repairs would not be worthwhile if these necessitated disturbance of the landfill cover and venting system.

Landfilling ceased in approximately 1974, prior to the 1985 promulgation of WAC 173-304, *Minimum Functional Standards for Solid Waste Handling*. In addition, Ecology (known as Washington Pollution Control Commission at that time) and the Spokane Health Department reviewed the proposed landfilling in 1969 and determined that no license or permit was needed. Therefore, based on this regulatory assessment and because cap maintenance is proposed in this alternative, compliance with WAC 173-304 is not required. Rather, this work would be designed and completed in substantive compliance with the overall purpose of WAC 173-304 "to protect public health, to prevent land, air and water pollution, and conserve the state's natural, economic, and energy resources."

The existing cap was constructed on the landfill in approximately 1984 and was reportedly composed of a passive gas venting system buried in 1 ft of gravel, and covered with 2 ft of compacted clay and 2 ft of top soil vegetated with native grasses. A drainage layer was not planned or installed above the compacted clay. During an evaluation of the cap in July 1994, seven test pits were excavated to evaluate the cover, and an average clay thickness of 1.7 ft and an average topsoil thickness of 1.5 ft were encountered (Appendix C). However, during the RI in May 2010, four boreholes were installed through the landfill in the eastern area and this reported cover composition system was not encountered.

A Site visit was conducted in May 2011 when grasses were only a few inches tall allowing for a thorough inspection of the cover. Numerous burrow holes were discovered across the landfill, primarily in the eastern area. The rodent burrowing activity has significantly disturbed the top soil layer, likely allowing infiltration through the cap. A review of local weather data shows that the project area does not receive enough rainfall to keep the clay hydrated, and it may have cracked in some areas allowing infiltration through this less permeable zone.

Cap enhancement in Alternative 2 will include placement of a less permeable layer that is not prone to damage by weather (high-density polyethylene [HDPE]), and placement of a drainage layer that will act as a biological barrier and promote runoff. The restored cap is expected to reduce infiltration through the cap by approximately 90–99 percent. These added layers will result in an enhanced cap that exceeds the closure requirements in Chapter 173-304 WAC, which requires a minimum 2-ft thick cap.

4.2.1 Cap Enhancement

In Alternative 2, minor regrading of the existing cap would be conducted to ensure proper drainage and to prepare the surface for placement of additional cap material. A conceptual design approach is presented in this section, which may be modified during the final engineering design of this alternative. During this phase approximately 10 pine trees located along the southern boundary of the landfill would be removed to ensure that the root systems do not disturb the landfill in the future. The soil pile present on the eastern end of the landfill would be used to fill small depressions and approximately 3,500 cubic yards of reduced permeability (non-expansive) fill would be brought onsite to grade the remainder of the cap. A review of historic aerial photos indicates that the soil pile and an adjacent pile of pea gravel are likely residual materials from the cap repair completed in 2004 following vandalism.

The landfill surface would be graded to result in a minimum 4 percent grade on the surface from a natural crown in the eastern area of the landfill. The existing ditches and swales would be moved away from the landfill on the east and north sides to allow placement of the liner anchor on the landfill side of the ditches and swales. This grading and relocation of the ditches and swales will eliminate the current drainage across the southeast corner of the landfill shown in the topographic survey provided in Appendix D. Surface water in this area would be re-routed to prevent this drainage from traversing the landfill cover prior to discharge to the ditch along the north side of E Kronquist Road.

Following grading and preparation work, a geosynthetic liner system would be placed over the prepared surface followed by a drainage layer. The multi-layer liner system and gravel are designed to provide a barrier to surface water infiltration and rodent burrowing as described below. These layers would be covered in approximately 18 in. of top soil. The finished cover would be vegetated with natural grasses. This cover system is described below.

The geosynthetic liner system will extend 5–10 ft beyond the previously identified dross fill boundary on the north, east, and south edges of the landfill, where possible, depending on slope. On the west edge of the landfill, the geosynthetic liner and drain system will extend 50–75 ft beyond the previously identified dross fill boundary to accommodate drainage and infiltration beyond the dross fill. The liner system would likely include a geonet covered in a nonwoven geotextile (a geocomposite), covered with a 60-mil HDPE liner.

A drainage layer would be placed over the HDPE liner layer. This layer will also serve to retard rodent activity and disturbance of the cap in the future. During site reconnaissance in May 2011, numerous burrow holes were discovered across the landfill soil cap indicating significant rodent burrowing activity. The drainage layer would likely include a second geocomposite layer placed over the HDPE liner to aid in proper drainage and protect the liner from damage. This geocomposite may consist of a geonet covered in a 16-ounce per square yard layer of nonwoven geotextile. Although the geocomposite is "rodent resistant," a 6-in. layer of 3/4-in. minus crushed gravel would be added in between the geocomposite and the top soil to better protect against the high level of rodent activity that is expected to occur in the top soil layer. The 16-ounce per square yard geotextile would protect the HDPE liner against damage from the crushed gravel.

The drainage layer would be overlain with approximately 18 in. of soil. The soil would be seeded with native grasses to provide a vegetated cover. The top soil layer provides a surface for minor, light vehicle traffic and soil for vegetation. The vegetative cover would be placed to reduce erosion of top soil. Alternatively, a synthetic turf may be used to cover the landfill.

Currently, the slope on the majority of the cover is between 2 and 33 percent. A few areas along the eastern boundary have slopes less than 2 percent and slopes greater than 33 percent. Alternative 2 will result in a crown at the eastern end of the landfill (following natural topography) with slopes ranging from 4 to 33 percent, with the exception of the southern landfill edge along E Kronquist Road, where slopes would exceed 33 percent. Current landfill cover slopes and elevations are shown on Figures 8 through 10. The proposed remedial alternative, including conceptual details and final elevations are provided on Figures 11 through 16. A cross section showing the conceptual cap design is provided on Figure 12.

The Site is situated adjacent to a steep slope on the east and has a steep slope on the south above E Kronquist Road, which requires careful precipitation run-on control and cap anchoring. On the north side is a drainage swale in close proximity to the edge of the fill area. Surface run-on from the east could infiltrate the cap on the east and also, possibly, on the north side. To provide protection of the cap and minimize infiltration of surface run-on, a 2-ft square anchor trench is proposed as shown in Figures 11 and 13 through 15. Because the normal extension of the drain layers and the topsoil would impact (extend into and beyond) the existing drainage onto the Site from the east at both the east and north sides, a surface drain layer is proposed as indicated in Figures 11 and 13. The liner system would be wrapped into the anchor trench to act as a barrier to upslope surface water and groundwater drainage on the east and north sides. The anchor trench will also prevent the liner from lifting during installation and will compress liner layers to prevent separation.

Modifications would be made to the drainage ways at the east and north ends of the landfill to better collect surface drainage and prevent flow under the cap. Water would be collected in a fabric-wrapped slotted drain pipe buried in gravel with minor discharge in the east area of the landfill to the ditch along E Kronquist Road and the majority of discharge to existing drainage ways to the north-northwest. These modifications will replace the existing swales in these areas. Cap enhancement activities at the southeastern corner of the landfill extend slightly beyond the eastern property boundary. This work is contingent upon execution of an access agreement with the property owner.

On the south side, the anchor trench includes a 3-ft rock toe anchor or buttress to prevent failure of the cap and erosion along the steep southern edge of the cap. This anchor will allow surface water run-off to flow through the rock and infiltrate through the existing soil between the anchor and the ditch or migrate to the ditch along E Kronquist Road, which occurs with the current cap.

The landfill generally slopes to the west, and the majority of infiltrated precipitation will follow the drain layers to the relatively flat infiltration/drain area at the toe of the slope at the west end of the landfill. To protect the integrity of the soil cover, the drain layer and soil cover have been extended beyond the liner as shown on Figure 11.

4.2.2 Gas Vent System Repair

In addition to cap maintenance, the gas vent system may be repaired. Although design documents indicate the vent pipes are made of Schedule 40 steel, a closer inspection indicates that the pipes may have been fabricated using an aluminum alloy. A fallen pipe was observed in the east area of the landfill and it was lighter than would be expected for steel. Two vents have been removed from the system and their locations have not been observed. Another vent has been cut off near the ground surface. The passive venting system is functioning well without these vents being intact as evidenced by air data, and observation of the landfill surface which does not indicate that gases are accumulating and breaking through the cover. Also, the affected gas vent laterals have at least one functional vent. Given this, an attempt would be made to locate and repair the gas vents; however, if these vents cannot be located and/or easily repaired, this element of the alternative would not be completed.

During preparation work, an attempt to determine the location of the two broken vents would be made using both a locating device and local excavation. If necessary, a vacuum truck or similar equipment may be used to remove sediment that may have accumulated in the lines. This sediment may be added to the landfill surface prior to grading and placement of the cover materials. Three new vent pipes may be fabricated and installed on the landfill. The remaining portion of the existing vent pipes would be exposed to the depth necessary to install a flexible connection and a new vent pipe. The area around the stand pipe would be backfilled with 3/4-in. minus crushed gravel up to the multilayer liner system.

4.2.3 Institutional Controls

Institutional controls would be implemented as an element of Alternative 2. These controls would include inspection and maintenance of the cap system, fencing, signage, and use restrictions for the property as required by MTCA. A prohibition on groundwater use will not need to be placed because this prohibition is published in WAC 173-160-171 with a minimum setback distance for installing new water wells, other than for public water supply, of 1,000 ft from the landfill property boundary. Indicator constituents were not measured above cleanup standards in groundwater outside of the 1,000 ft radius from the Site that would require institutional controls. A description of the landfill and prohibitions on disturbing the landfill system would be added as a restriction on the property deed. Maintenance and monitoring requirements, including inspections, would be documented in a plan.

In accordance with WAC 173-340-440(8)(a), institutional controls would be described in a restrictive covenant on the property. The covenant would be executed by DCO Management and recorded with the register of deeds for Spokane County. The restrictive covenant would run with the land, and be binding on DCO Management's successors and assigns. Elements of the landfill would be inspected and maintained on a routine basis, including the cap, gas vent system, drainage ditches, locking fence, and signage. The estimated cost of this alternative assumes annual inspections and minor repairs for 20 years, which is the post-closure timeframe defined in WAC 173-304 and is used as an ARAR.

4.2.4 Monitoring

Compliance monitoring would be conducted as an element of Alternative 2 as required in WAC 173-340-410. Groundwater and surface water monitoring would be conducted until water quality standards are met at the points of compliance described in Section 2.1.1. Sampling frequency and duration would be dependent upon results, with an anticipated monitoring duration of 5 years, with quarterly monitoring the first 2 years, semi-annual monitoring in years 3 and 4, and annual monitoring event in year 5.

In addition, ammonia monitoring in select gas vents would be conducted one time, 2 years following the cap work during dry weather conditions (likely mid-summer). The monitoring would be conducted in the 3 gas vents with the highest ammonia concentration measured during the RI to evaluate air within the venting system following cap enhancement.

4.2.5 Preliminary Evaluation of Alternative 2

In Alternative 2, engineering and institutional controls are combined into a remedial action that is implementable, and effective in protecting human health and the environment. The cap enhancement, vent repair, monitoring, and related activities can be completed during the spring and summer months. Alternative 2 is expected to be effective in protecting human health and the environment. Current water use and prohibitions against future water use were deemed protective in the RI. Alternative 2 provides the added protection of enhancing the cap to eliminate areas of current infiltration/breakthrough and provides assurance of long-term protection through monitoring until cleanup levels are attained, ongoing inspections, and maintenance. Alternative 2 can be accomplished for an estimated cost of $1,787,000 as shown in Appendix B, Table B-2. This cost estimate includes 5 years of monitoring and 20 years of maintenance.

5 Detailed Evaluation of Remedial Action Alternatives with Respect to MTCA Criteria

MTCA criteria for cleanup actions (WAC 173-340-360) include threshold requirements and other requirements. The cleanup action shall meet the following threshold requirements:

- Protect human health and the environment
- Comply with cleanup standards (WAC 173-340-700 through -760)
- Comply with applicable state and federal laws (WAC 173-340-710)
- Provide for compliance monitoring (WAC 173-340-410 and WAC 173-340-720 through -760).

In addition, cleanup actions shall meet the following other requirements:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns (WAC 173-340-600).

ARARs are discussed in this section and are summarized in Table 2 for each alternative. The overall evaluation of Alternatives 1 and 2 against these MTCA cleanup action criteria is presented below and is summarized in Table 3.

5.1 Individual Analysis of Alternatives

Individual analyses of Alternatives 1 and 2 are presented in the following sections. Each MTCA requirement, or balancing factor, is rated using the following qualitative scale:

- Unacceptable/1
- Poor/2

- Fair/3
- Moderate/4
- Good/5.

These ratings are also summarized in Table 3, along with a total qualitative score for each alternative.

A disproportionate cost analysis is required by MTCA as an element of cleanup action selection to ensure that preference is given to permanent solutions to the maximum extent practicable. A disproportionate cost evaluation was completed using a semi-quantitative cost evaluation test to compare costs and benefits as summarized in the following sections and in Table 4.

5.1.1 Alternative 1–Waste Removal, Offsite Disposal, Dispersion/Dilution, and Compliance Monitoring

As discussed in the initial screening in Section 4, Alternative 1 is considered to be effective in the long term in protecting human health and the environment and is rated "good/5." It is uncertain if a commercial landfill would accept the waste, therefore, implementability is rated "poor/2." As shown in Table 4, the high cost of Alternative 1 is disproportionate to any added protectiveness. Therefore, cost-effectiveness is rated "poor/2."

Removal of black dross from the pit is a permanent alternative that will eliminate exposure in the long term, assuming all dross can be recovered, however, it has been determined that this is not practicable as discussed below. Therefore, permanence is rated "moderate/4." However, some short-term exposure will occur during the long removal project due to releases of ammonia and other gases. This exposure cannot be completely controlled and the magnitude of exposure will depend on the volume and frequency of rainfall during the time the pit is open with exposed dross, and the effectiveness of engineering controls used during the removal. In addition, salts would be released to the groundwater system during removal.

It is likely that some moist dross would be encountered during removal. Transportation of wet dross is prohibited by the Department of Transportation and EPA. If any wet dross is removed it will need to be dried onsite prior to transport, which will also result in short-term gas generation with potential exposure to residents in the area. Approximately 1,860 dump truck loads of black dross and 448 dump truck loads of over-excavated soil would be removed during this project (assuming 34 yards per load), which would likely be completed over one or more years. For costing purposes it is assumed that removal would be completed between April 1 and September 30 of 1 year with approximately 15 loads per day during a 6-day work week. This duration may be expanded to 2 years depending on weather conditions (projected spring rainfall) and engineering measures. Therefore, although Alternative 1 provides good protection of human health and the environment in the project area in the long term, exposure of nearby residents and workers to gases generated during dross removal is expected in the shorter term. Exposure potential also exists during and following transportation, and, if the waste is not completely deactivated, following dross landfilling at the permitted landfill. Municipal solid waste landfills in the United States have experienced significant issues with dross that has been mixed and landfilled with other municipal wastes. Reactions with water and other wastes can result in heat and generation of toxic gases including ammonia. Heat and gas generation have been issues at the Countywide Landfill in East Sparta, Ohio, where more than 600,000 tons of dross were landfilled in the 1990s.

The aluminum black dross at the Heglar Kronquist landfill is not mixed with other waste, and gases are controlled with the passive venting system installed in approximately 1984. It was determined during the RI that minor infiltration through the cap results in some impact to water quality, but no adverse risk was identified for human health or the environment in the RI. Waste removal, transport, and landfilling at another location results in a higher potential risk to human health and the environment compared with leaving the waste in place in the Heglar Kronquist landfill.

In this more detailed evaluation, consideration of these short-term risks, and also the long-term protectiveness for the Site of removing the landfilled dross results in an overall rating of “moderate/4” for protection of human health and the environment.

This alternative is compliant with the cleanup standards, and this requirement is rated “good/5.” Groundwater and surface water quality is expected to recover within 2−5 years following initiation of the removal project by contaminant reduction through dispersion and dilution. The calculation of restoration time frames is described in Section 5.1.2 for Alternative 2. Restoration may be more rapid for Alternative 1 because the dross (source) will be removed. This alternative may be completed in a manner that complies with applicable state and federal laws, although there would likely be short-term gas generation (e.g., ammonia). Therefore, this requirement is rated "moderate/4." Specific ARARs that are or may be applicable to Alternative 1 are summarized in Table 2. Local ARARs include Spokane County ordinances for grading, noise disturbances, health and sanitation, public right-of-way, and motor vehicles. State ARARs include the MTCA Cleanup Regulation (WAC 173-340), Regulation and Licensing of Well Contractors and Operators (WAC 173-162), State Environmental Policy Act (WAC 197-11, WAC 173-802), and Water Quality Standards for Surface Waters (WAC 173-201A). Federal ARARs include the National Primary Drinking Water Regulations (40 CFR 141), Federal Water Pollution Control Act (aka Clean Water Act) (33 USC 1251 et. Seq.), and the National Toxics Rule (40 CFR 131).

Compliance monitoring could be conducted until water quality recovers, although current impacts do not pose adverse risk based on the exposure pathways. Therefore, compliance monitoring is rated "good/5," whether it is needed or deemed unnecessary. The restoration timeframe is uncertain due to variations in groundwater flushing and the time frame to obtain approvals and permits. The time frame is expected to be very short, likely about 2– 5 years, which results in a rating of "good/5." In addition to offering a permanent solution, Alternative 1 considers public concern and the public's request that the waste be removed from the Site; however, moving the waste to a new location may result in public concerns due to short-term risks such as gas generation. Also, significant noise and disturbances on local roadways (e.g., dirt and traffic disturbances) would occur during the long removal project. There may also be public concern regarding the new landfill location similar to Countywide Landfill in Ohio. Overall, consideration of public concerns is rated "moderate/4." Engineering and institutional controls would not be necessary if the waste is removed from the pit. This detailed evaluation results in a total qualitative score of 40 for Alternative 1.

As discussed earlier, Alternative 1 may not be implementable because local disposal facilities may not ultimately accept dross because of issues at other municipal waste landfills. Similar issues may be encountered at a hazardous waste landfill, depending on landfilling and maintenance procedures and whether or not the waste is fully deactivated. Although the dross is not hazardous, landfills have had issues with heat and gas generation from mixing this waste with other municipal wastes. Short-term exposure and uncertainties with implementation result in a lower score for this alternative. In addition, the cost of this alternative is disproportionate to the protectiveness as discussed below. As demonstrated in the RI, impacts to water quality do not result in adverse risks for human health or the environment.

A disproportionate cost evaluation test is summarized in Table 4. For Alternative 1, overall protectiveness of human health and the environment is rated “moderate/4,” based on the degree to which existing risks will be reduced, the time required to reduce risks and attain cleanup standards, on-site and off-site risks resulting from implementing this alternative, and improvement of the overall environmental quality. Although cleanup standards are expected to be attained in a short time (2–5 years), implementation of this alternative is expected to result in significant short-term implementation risks as described above.

Permanence is evaluated as “the degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.” Permanence for Alternative 1 is rated “good/5.” By removing the dross, this alternative permanently reduces or eliminates the contaminants and the source of releases. Although, 55,000 cubic yards of dross waste would be generated and, as described above, waste characteristics result in handling and disposal issues.

Cost is rated “poor/2,” due to the high cost of this alternative. Long-term effectiveness is rated “good/5”. If the alternative can be implemented, it is expected to be effective in the long-term. In addition, restoration of water quality is expected to occur in a short time (2−5 years). Management of short-term risks during implementation is rated “fair/3,” based on the issues discussed above including gas generation and transportation issues. Technical and administrative implementability is rated "poor/2," given the uncertainties in dross disposal described above, and, also in consideration of the complexity and long duration of the removal action. Consideration of public concerns is rated "moderate/4" as discussed above.

Costs for Alternative 1 were determined to be disproportionate to the benefits achieved as shown in Table 4. Permanence ranks slightly higher for Alternative 1, however, this is out of balance with the high cost, poor technical and administrative implementability based on the uncertainty in dross disposal, and short-term implementation risks such as gas generation and transportation issues.

5.1.2 Alternative 2–Cap Enhancement, Institutional Controls, Dispersion/Dilution, and Compliance Monitoring

The cap, and possibly the passive venting system, would be enhanced in Alternative 2. As discussed in the RI report, the cap does not currently appear to be complete. In particular, a clay layer was not observed during the RI boring program on the landfill, although others have reported clay thicknesses up to 2 ft, and clay with this approximate thickness was encountered during a cap evaluation in 1994.

Rainfall and evaporation data were evaluated for the Spokane area to determine an estimated infiltration rate of surface water through the existing cap. This evaluation indicates that approximately 12 in. of water may infiltrate the cap per year. The evaluation completed in support of this FS indicates that cap enhancement composed of filling depressions, grading, placing a geosynthetic liner system and a drainage system, and covering with top soil and vegetation will reduce infiltration and promote better drainage. This cap enhancement work, along with other elements of the remedy, is expected to meet the remedial action goals developed in Section 2. This alternative assumes that the cover can be regraded without disturbing the venting system and that vent repairs, if completed, would be limited to replacing the three damaged vents observed during the RI. One vent has been cut off near (slightly above) ground surface and two other vents are missing with the locations unknown. However, air data gathered during the RI and observations of the cover indicate that the venting system is functioning properly (e.g., no blisters on the surface or noticeable gases on the landfill cover).

Beginning with the Spring 2011 sampling event, chlorides in three monitor wells increased at MW-1, MW-3, and MW-4. The likely explanation for this increase is an influx of recharge caused by unusually high fall and winter precipitation. Using the "arrival" times of these increases, a maximum groundwater velocity of 1–6 ft per day was calculated. This velocity, though high, is expected because much of the flow is fracture controlled. It is generally assumed for aquifers in clastic formations, that the majority of cleanup will occur after three to five pore volumes are flushed. Cleanup in fractured reservoirs is quicker than for clastic reservoirs because porosities are lower and velocities are higher. Using a conservative velocity of 3 ft/day, the groundwater between the landfill and springs SW-2/SW-3 would turn over about five times in 5 years. Therefore, once the cap would be constructed, which will reduce surface infiltration, the majority of the cleanup should occur within the first 2−5 years.

In addition to cap enhancement, institutional controls would be implemented to ensure protection of human health and the environment. Institutional controls are legal or administrative tools to prevent unacceptable exposures to contamination left in place at the completion of remedial actions, such as preventing certain uses of a property. Engineering controls are physical measures that are designed to prevent or minimize exposure to residual contamination remaining onsite. In addition to maintenance of capping on the landfill and the venting system, the fencing would be maintained to prevent entry by unauthorized people onto the landfill site.

As discussed in the initial screening in Section 4, Alternative 2 is considered to be effective in meeting remedial action goals and protecting human health and the environment in the long term. Therefore, long-term effectiveness is rated "good/5." Alternative 2 is easily implemented and this factor is rated "good/5." Alternative 2 is also deemed cost-effective with a rating of "good/5."

Protection of human health and the environment, considering short and long-term risks, is rated "good/5." Short-term risks are not expected, no adverse risks were identified for the Site in the

RI, and this alternative increases protectiveness by enhancing the cover and providing long-term maintenance. This alternative is expected to be compliant with the cleanup standards at the points of compliance. Groundwater and surface water quality is expected to improve very quickly following cap enhancement and groundwater is expected to meet cleanup levels at the points of compliance. This MTCA requirement is rated “moderate/4.” Water quality impacts are expected to be reduced to levels below cleanup standards within 2−5 years of cap enhancement at the points of compliance by contaminant reduction through dispersion/dilution.

This alternative can be completed in a manner that complies with applicable state and federal laws, and this requirement is rated “good/5.” Although the landfill predates WAC 173-304 and a permit was not required prior to construction, this alternative is generally compliant with pertinent requirements of WAC 173-304. Specific ARARs that are or may be applicable to Alternative 2 are summarized in Table 2. Local ARARs include Spokane County ordinances for grading, noise disturbances, public right-of-way, and motor vehicles. State ARARs include the MTCA Cleanup Regulation (WAC 173-340), Regulation and Licensing of Well Contractors and Operators (WAC 173-162), State Environmental Policy Act (WAC 197-11, WAC 173-802), and Water Quality Standards for Surface Waters (WAC 173-201A). Federal ARARs include the National Primary Drinking Water Regulations (40 CFR 141), Federal Water Pollution Control Act (aka Clean Water Act) (33 USC 1251 et. Seq.), and the National Toxics Rule (40 CFR 131).

This alternative provides for compliance monitoring at the spring until constituents are reduced to concentrations that are below applicable cleanup standards. Therefore compliance monitoring is rated “good/5.” Although compliance monitoring is required by MTCA until cleanup levels are achieved, there is no current exposure above health-based risk levels. In addition, land and water use are not expected to change in the future based on the evaluation conducted during the RI. Permanence is rated “moderate/4,” which is lower that Alternative 1 for waste removal and offsite disposal. The restoration timeframe is uncertain due to variations in groundwater flushing. The time frame is estimated to be within 2−5 years, and this requirement is rated “good/5.” Alternative 2 considers public concerns by improving landfill conditions and developing and implementing a maintenance program to ensure the continued protection of human health and the environment. This MTCA requirement is rated "moderate/4," because although it addresses the public's concern regarding protection of human health and the environment, some nearby residents have stated that they will continue to be concerned as long as the landfill remains. Institutional controls would be implemented as part of this alternative. This detailed evaluation results in a total qualitative score of 47 for Alternative 2.

A disproportionate cost evaluation test is summarized in Table 4. The test criteria are described in Section 5.1.1. For Alternative 2, overall protectiveness of human health and the environment is rated "good/5." Restoration is expected to occur within 2−5 years without implementation risks. In addition, current use does not result in unacceptable risks and land and water use and exposures are not expected to change in the future.

Permanence is evaluated as "the degree to which the alternative permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated." Permanence for Alternative 2 is rated "moderate/4." Dross would not be removed, however, the cap would be enhanced to prevent infiltration and contaminant releases.

Cost is rated "good/5." Long-term effectiveness is rated "good/5". This alternative is expected to be effective in the long-term with restoration of water quality expected to occur in a relatively short time (2−5 years). Management of short-term risks during implementation is rated "good/5," since no implementation risks are expected. This alternative is easily implemented, therefore, technical and administrative implementability is rated "good/5." Consideration of public concerns is rated "moderate/4" as discussed above.

Based on this evaluation, costs for Alternative 2 were determined to be proportionate to the benefits achieved as shown in Table 4.

6 Recommended Remedial Action Alternative

The remedial action alternatives for the Site were evaluated as discussed above. This evaluation is also summarized in Table 3, including a semi-quantitative evaluation that was completed by ranking the balancing factors required by MTCA and scoring each alternative. Based on this evaluation, Alternative 2–Cap Enhancement, Institutional Controls, Dispersion/Dilution, and Compliance Monitoring, is recommended as the remedial action for the Site.

Alternative 2 provides an implementable means to ensure both short- and long-term protection of human health and the environment. Alternative 2 will almost eliminate infiltration through the cap, which is expected to result in compliance with cleanup standards at the point of compliance at the spring within 2−5 years. The progress of the remedial action in complying with cleanup standards will be evaluated through compliance monitoring as required by MTCA. Alternative 2 will be completed in accordance with applicable state and federal laws as discussed below. Although removal of the landfill is a more permanent solution, it is not considered to be practicable as demonstrated in the evaluations provided in Sections 4 and 5.

Alternative 2 provides a reasonable restoration timeframe. Groundwater quality improvements are expected to be observed within 2−5 years following cap enhancement. Alternative 2 is responsive to the public's concern to protect human health and the environment. Although some nearby residents expressed a strong desire that the landfill be removed, this evaluation shows that rather than eliminating risk, short-term risks would be generated during dross removal, handling, and transport. In addition, risk may be moved to an alternate landfill location if the waste is not fully deactivated. So, additional protection would not be realized in a removal action and costs are disproportionately higher (approximately $20,064,000) as demonstrated in Table 4.

Although not part of this remedial alternative, Ecology will consider requests for variances to allow installation of water wells within 1,000 ft of the landfill property boundary (e.g., for all zones except the basalt rubble zone where groundwater is impacted as shown on Figures 4 through 6).

6.1.1 MTCA Expectations for Cleanup Actions

In addition to the threshold and other MTCA requirements, MTCA includes several additional expectations for cleanup actions including the following:

- Emphasis on treatment technologies
- Minimize long-term management
- Use of engineering controls where treatment is impracticable
- Minimize potential for migration
- Consolidate hazardous substances to degree possible
- Natural attenuation in compliance with WAC 173-340-370(7), as appropriate
- Cleanup action will not result in significantly greater overall threat to human health and the environment
- For facilities adjacent to surface water, prevent/ minimize releases via groundwater discharge in excess of cleanup levels by taking active measures.

As discussed in this FS, treatment was evaluated and was determined not to be practicable for the dross or groundwater. Alternative 2 has been designed in a manner that minimizes long-term management of the landfill. Annual inspections and minor, occasional maintenance (e.g., mowing the cover to reduce rodent activity) will be necessary following enhancement work. The potential for migration will be minimized by eliminating almost all infiltration through the cap, which was demonstrated to be the source of groundwater and surface water impacts in the RI, with follow-up compliance monitoring. Black dross will remain consolidated in the landfill for this alternative. Alternative 2 does not rely on dispersion and dilution, although following the cap work these processes will act to reduce contaminant concentrations to levels below cleanup standards. Alternative 2 offers greater protection to human health and the environment compared with the current condition and this action will not result in a significantly greater threat to human health and the environment. Short-term exposures will not occur as a result of remedy implementation and long-term exposure will be significantly reduced by preventing infiltration of surface water through the cap. Groundwater and surface water quality will be improved and it is expected that MTCA cleanup standards will be attained at the points of compliance described in Section 2.1.1. The Site is not adjacent to surface water, however, the cleanup action will prevent/minimize releases via groundwater discharge in excess of cleanup levels.

6.1.2 Residual Risk Assessment

As demonstrated by the RI, the Site as-is does not present a human health or ecological risk for current exposures. In addition, the land and water use is not expected to change in the future based on the evaluation conducted during the RI. However, maintenance is necessary to ensure this protection in the long term, such as preventing access to the landfill site and preventing future damage to the cover from trees, plants, and burrowing rodents with subsequent increased infiltration. Alternative 2 provides for routine maintenance of the landfill to ensure long-term protection. Residual risks following implementation of this remedial action are expected to be stable or improved, with no adverse risk to human health or the environment.

6.1.3 Regulatory Requirements

An ARARs analysis was completed and presented in the RI (Exponent 2011) and ARARs have been evaluated in this study as described above and summarized in Table 2. As discussed previously, WAC 173-304, *Minimum Functional Standards for Solid Waste Handling*, was promulgated after construction of the Heglar Kronquist Landfill and no permit was required by state and local agencies at that time. Therefore, although the remedial alternative was developed to be in substantive compliance with WAC 173-304, cap enhancement is not required to meet these standards.

The remedial action will be conducted in compliance with MTCA, WAC 173-340, and other state ARARs including Regulation and Licensing of Well Contractors and Operators (WAC 173-162), State Environmental Policy Act (WAC 197-11, WAC 173-802), and Water Quality Standards for Surface Waters (WAC 173-201A). In addition, a Spokane County grading permit will be necessary for the earthwork and a Spokane County right-of-way permit may be needed for work conducted near E Kronquist Road on the south side of the landfill. Work must also be conducted in accordance with the Spokane County noise disturbance and motor vehicles ordinances. A National Pollutant Discharge Elimination System (NPDES) permit will not be required because the proposed design diverts collected, unimpacted run-on to the existing drainage ways along the north side of the landfill.

The remedial action will also be conducted in compliance with federal ARARs, including the National Primary Drinking Water Regulations (40 CFR 141), Federal Water Pollution Control Act (aka Clean Water Act) (33 USC 1251 et. Seq.), and the National Toxics Rule (40 CFR 131).

6.1.4 Point of Compliance Monitoring

In accordance with MTCA, the standard point of compliance for groundwater is throughout the Site from the uppermost level of the saturated zone to the lowest depth potentially affected by the Site. Groundwater quality will be monitored at the existing monitor well network MW-1 through MW-6. The point of compliance for surface water is the point or points at which substances are released to surface waters of the state. Surface water quality will be monitored at Springs SW-2 and SW-3, and in the drainage from the springs at SW-5. Monitor wells MW-2 through MW-4, and surface water sampling locations SW-2, SW-3, and SW-5, are located on private property not owned by DCO Management. Therefore, point of compliance monitoring at these locations is contingent on execution of access agreements with property owners.

These point of compliance groundwater and surface water monitoring locations are shown on Figure 17. As discussed in Section 4.3.4, monitoring would be conducted over 5 years, with quarterly monitoring the first 2 years, semi-annual monitoring in years 3 and 4, and annual monitoring in year 5.

The following parameters will be included in the compliance monitoring program:

- **Field Measurements**
  - Depth to water
  - pH

  - Specific conductivity
  - Temperature
  - Turbidity
- **Analytical Laboratory Parameters**
  - Chloride
  - Nitrate as nitrogen
  - Sodium.

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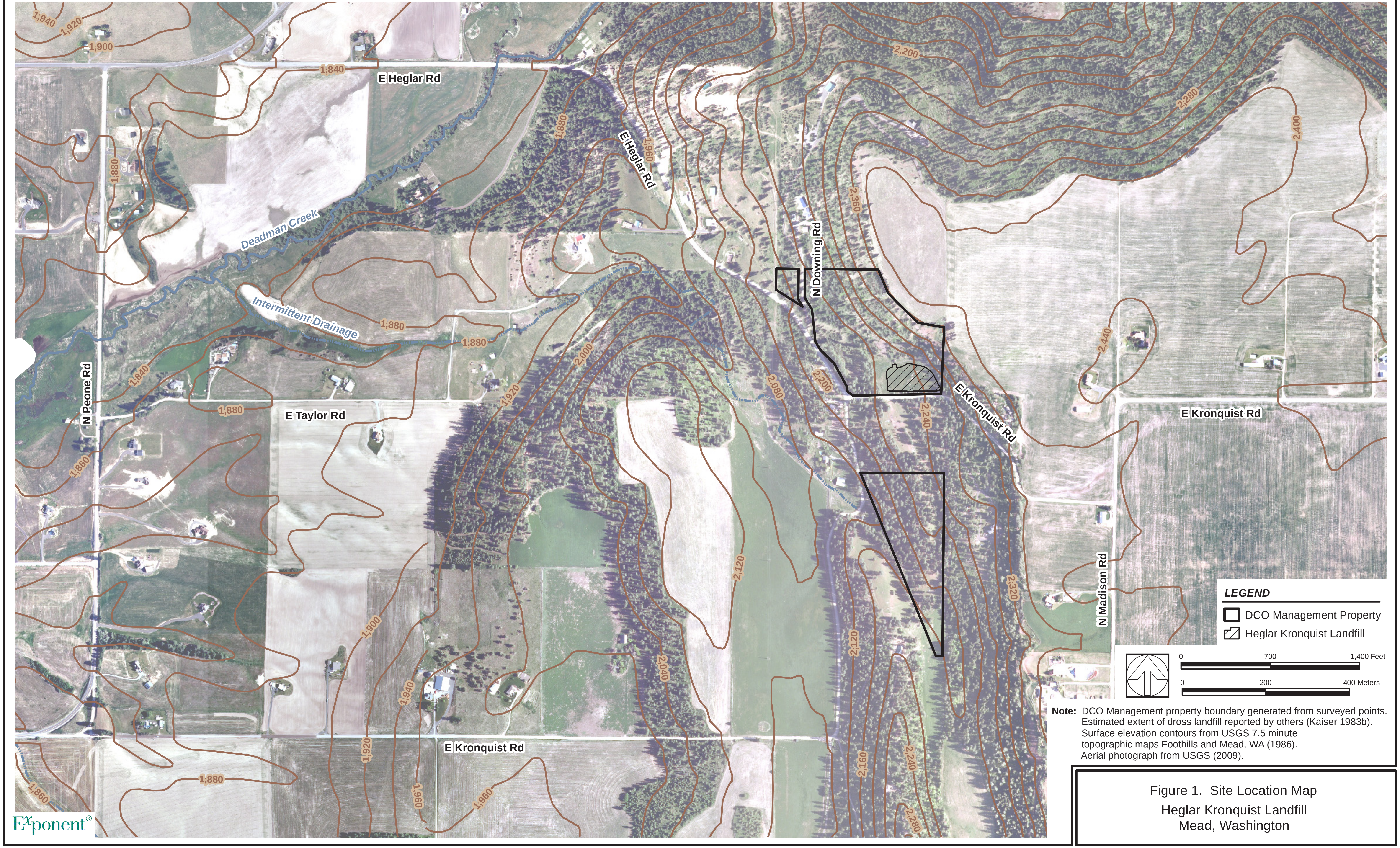
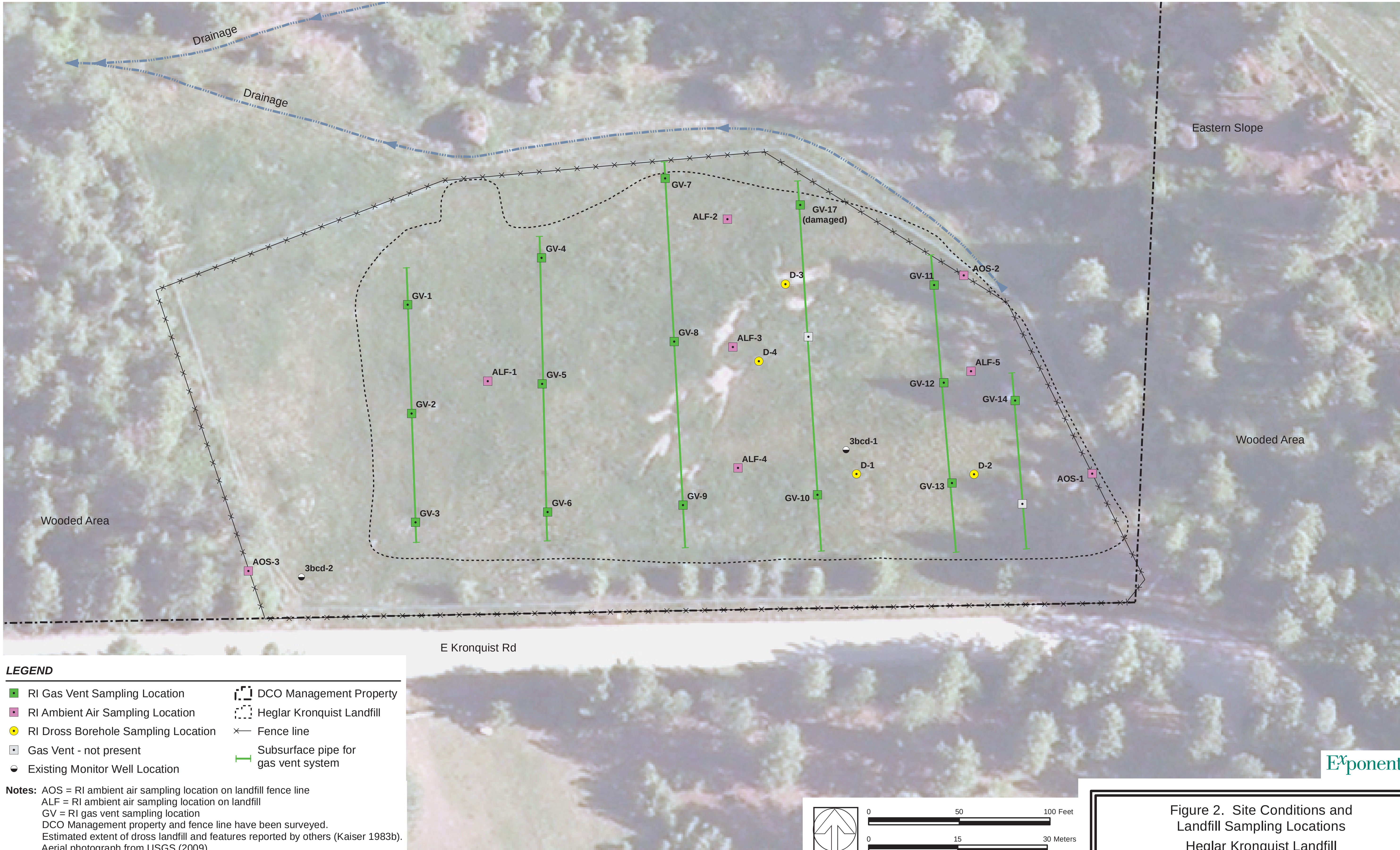
Figures



Note: DCO Management property boundary generated from surveyed points. Estimated extent of dross landfill reported by others (Kaiser 1983b). Surface elevation contours from USGS 7.5 minute topographic maps Foothills and Mead, WA (1986). Aerial photograph from USGS (2009).

Figure 1. Site Location Map
Heglar Kronquist Landfill
Mead, Washington



Notes: AOS = RI ambient air sampling location on landfill fence line
ALF = RI ambient air sampling location on landfill
GV = RI gas vent sampling location
DCO Management property and fence line have been surveyed.
Estimated extent of dross landfill and features reported by others (Kaiser 1983b).
Aerial photograph from USGS (2009).

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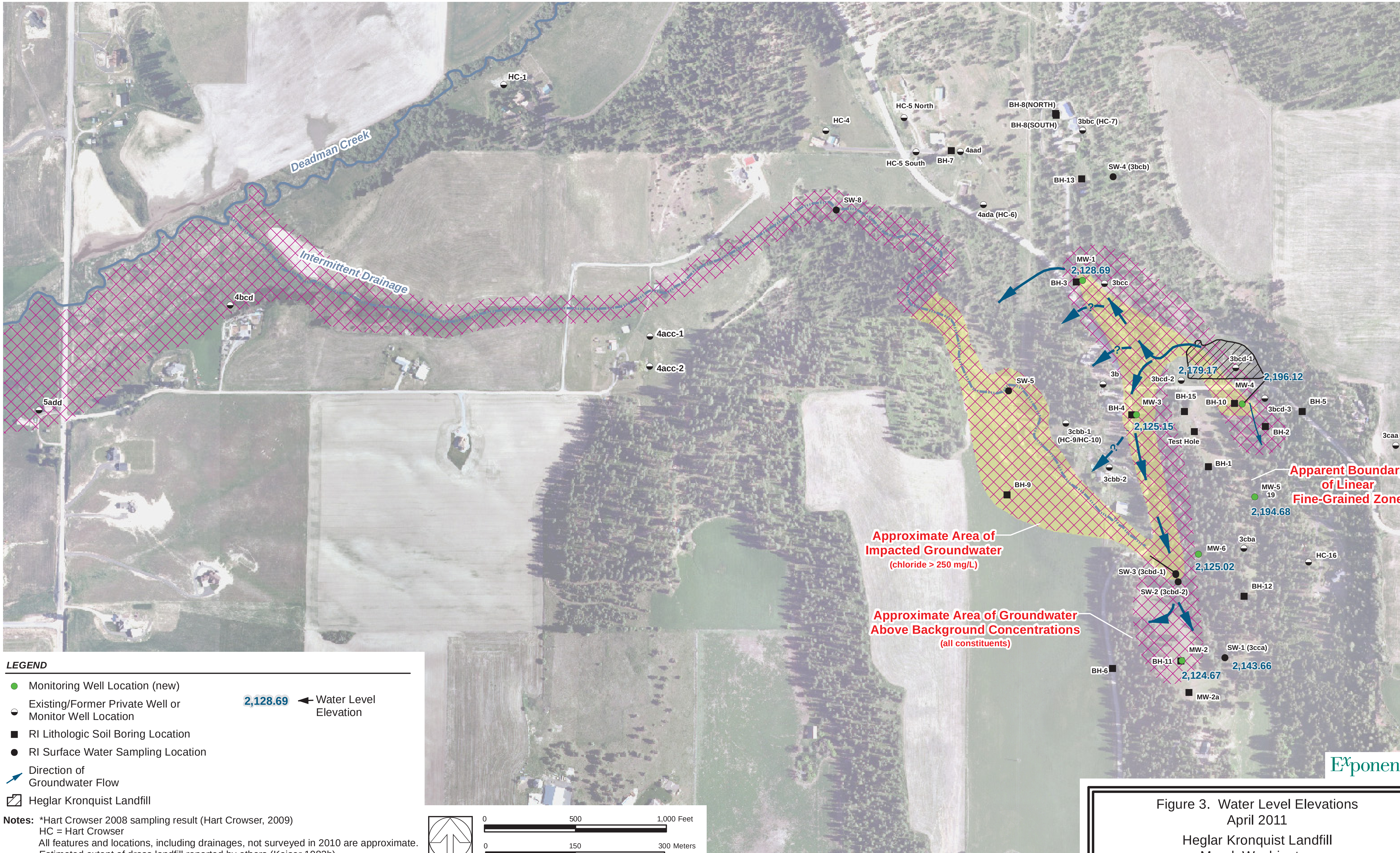
Figure 2. Site Conditions and Landfill Sampling Locations
Heglar Kronquist Landfill
Mead, Washington



LEGEND

- Monitoring Well Location (new)
- Existing/Former Private Well or Monitor Well Location
- RI Lithologic Soil Boring Location
- RI Surface Water Sampling Location
- Direction of Groundwater Flow
- Heglar Kronquist Landfill
- 2,128.69 ◄ Water Level Elevation

Notes: *Hart Crowser 2008 sampling result (Hart Crowser, 2009)
HC = Hart Crowser
All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).

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Figure 3. Water Level Elevations
April 2011
Heglar Kronquist Landfill
Mead, Washington

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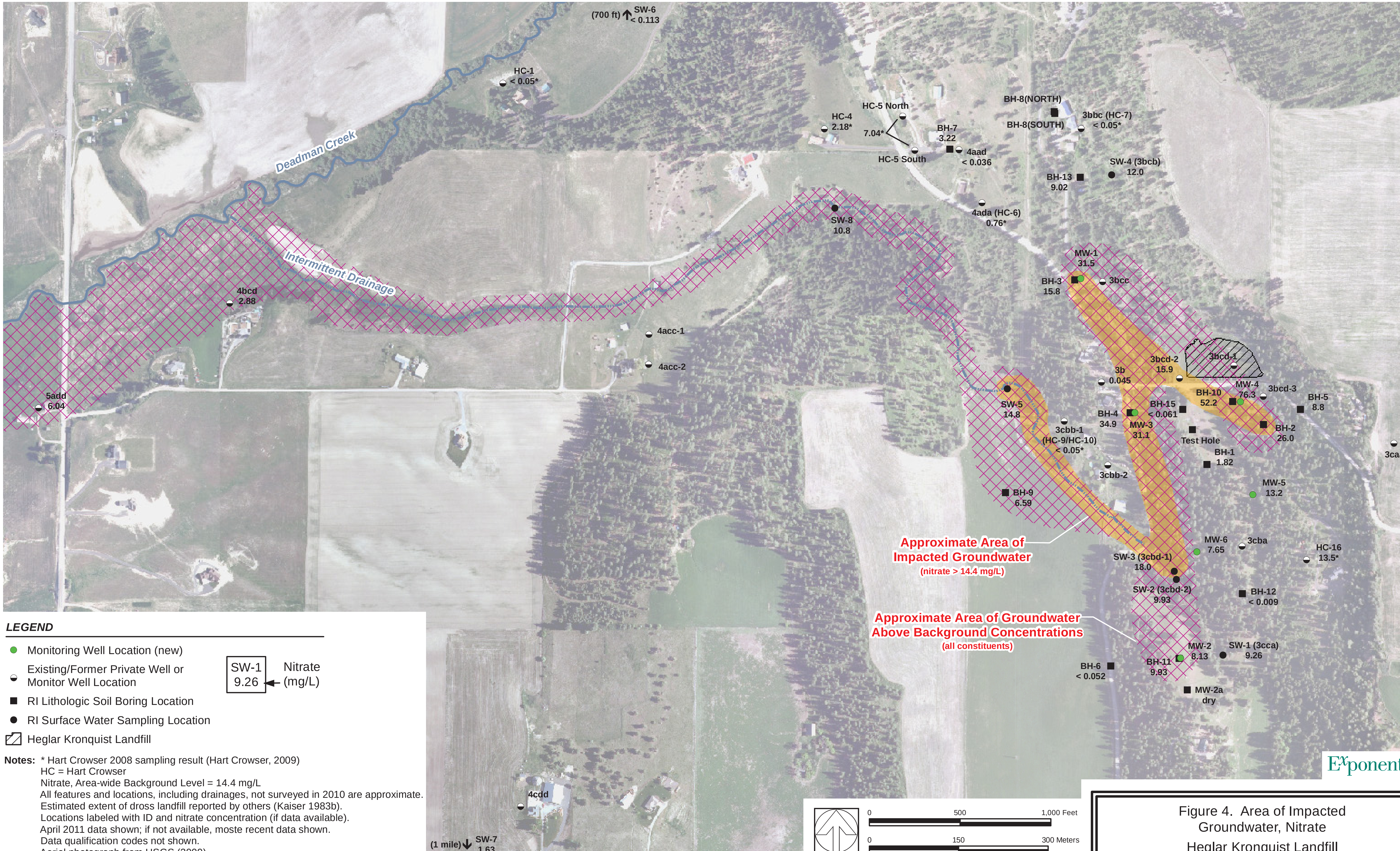


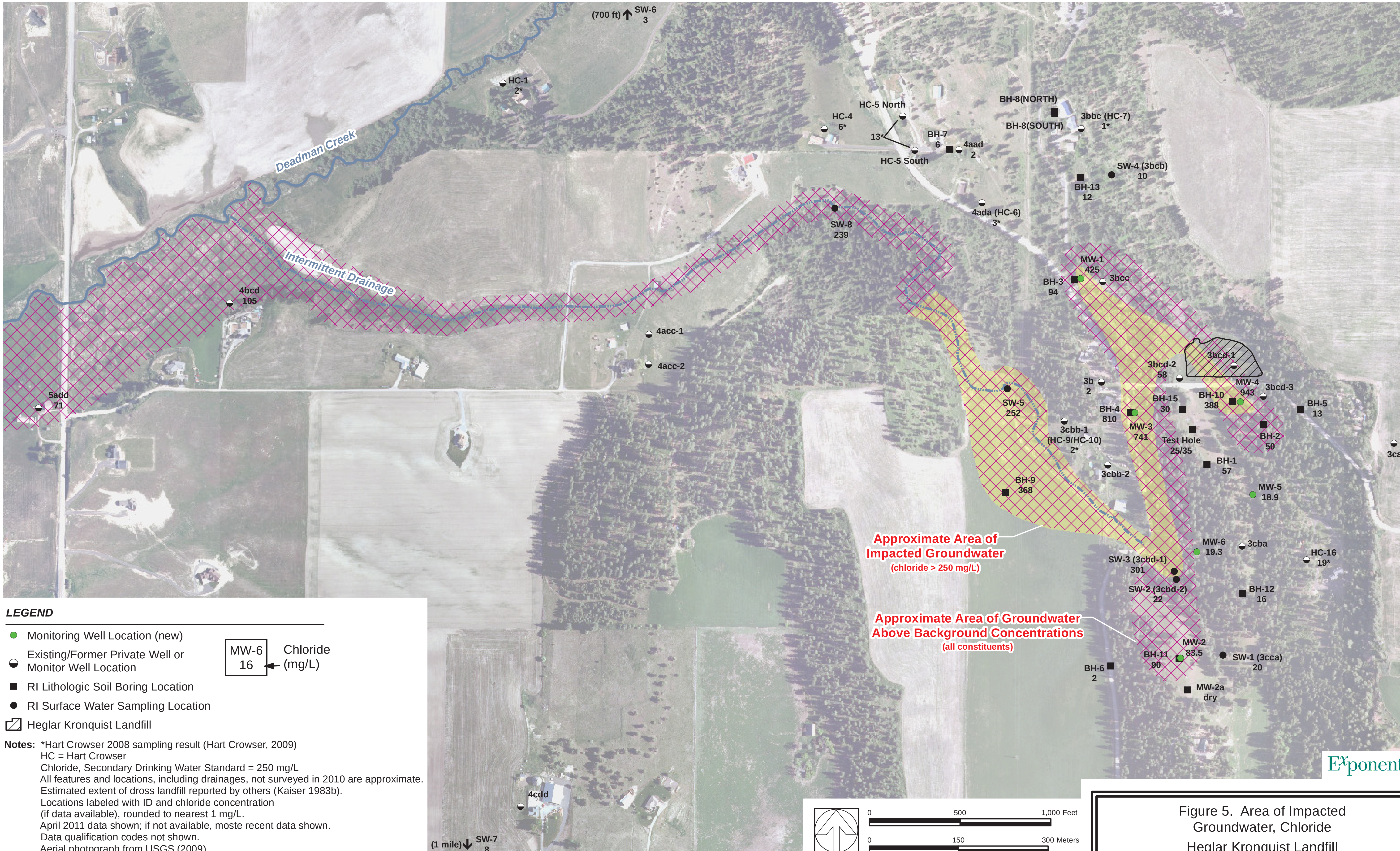
LEGEND

- Monitoring Well Location (new)
- Existing/Former Private Well or Monitor Well Location
- RI Lithologic Soil Boring Location
- RI Surface Water Sampling Location
- Heglar Kronquist Landfill

SW-1 9.26 ← Nitrate (mg/L)

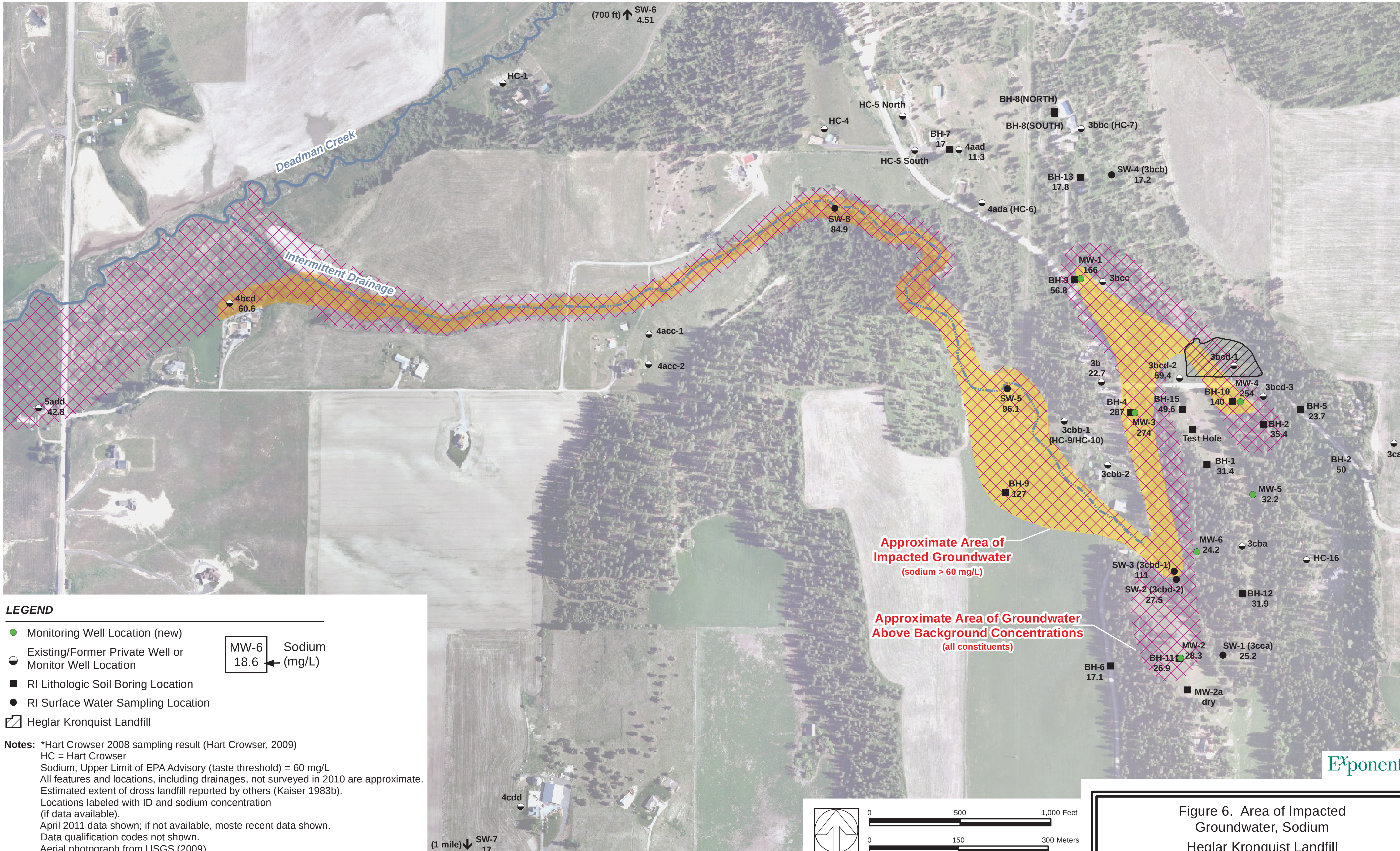
Notes: * Hart Crowser 2008 sampling result (Hart Crowser, 2009)
HC = Hart Crowser
Nitrate, Area-wide Background Level = 14.4 mg/L
All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).
Locations labeled with ID and nitrate concentration (if data available).
April 2011 data shown; if not available, moste recent data shown.
Data qualification codes not shown.
Aerial photograph from USGS (2009).

Figure 4. Area of Impacted Groundwater, Nitrate
Heglar Kronquist Landfill
Mead, Washington



Notes: *Hart Crowser 2008 sampling result (Hart Crowser, 2009)
HC = Hart Crowser
Chloride, Secondary Drinking Water Standard = 250 mg/L
All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).
Locations labeled with ID and chloride concentration (if data available), rounded to nearest 1 mg/L.
April 2011 data shown; if not available, moste recent data shown.
Data qualification codes not shown.
Aerial photograph from USGS (2009).

Figure 5. Area of Impacted Groundwater, Chloride
Heglar Kronquist Landfill
Mead, Washington



LEGEND

- Monitoring Well Location (new)
- Existing/Former Private Well or Monitor Well Location
- RI Lithologic Soil Boring Location
- RI Surface Water Sampling Location
- Heglar Kronquist Landfill

MW-6 18.6 ← Sodium (mg/L)

Notes: *Hart Crowser 2008 sampling result (Hart Crowser, 2009)
HC = Hart Crowser
Sodium, Upper Limit of EPA Advisory (taste threshold) = 60 mg/L
All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).
Locations labeled with ID and sodium concentration
(if data available).
April 2011 data shown; if not available, moste recent data shown.
Data qualification codes not shown.
Aerial photograph from USGS (2009).

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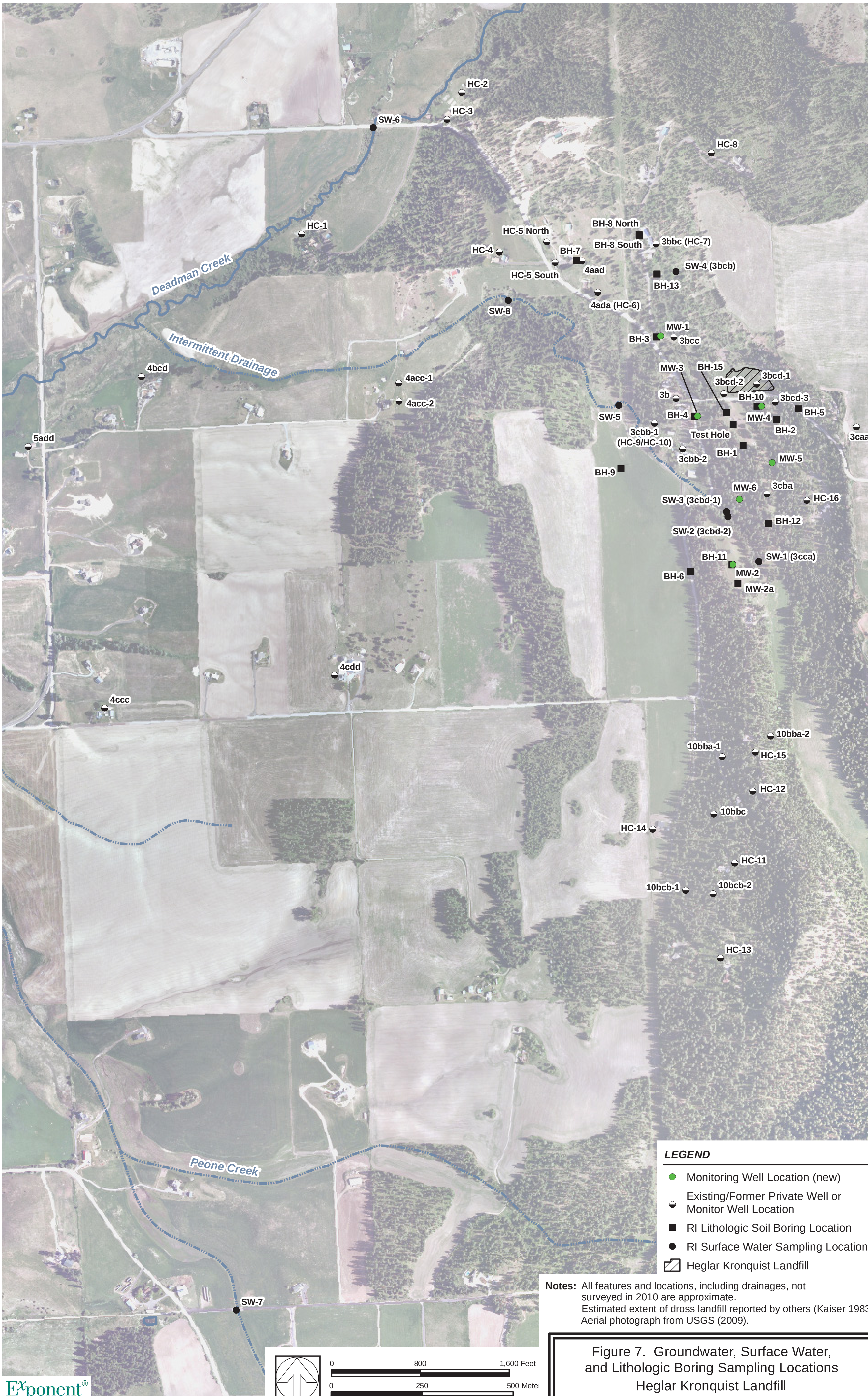
Figure 6. Area of Impacted Groundwater, Sodium
Heglar Kronquist Landfill
Mead, Washington



Notes: All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).
Aerial photograph from USGS (2009).

Figure 7. Groundwater, Surface Water, and Lithologic Boring Sampling Locations
Heglar Kronquist Landfill
Mead, Washington

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Figure 8. Percent Rise of Slope
Exisiting Conditions in May 2011
Heglar Kronquist Landfill
Mead, Washington

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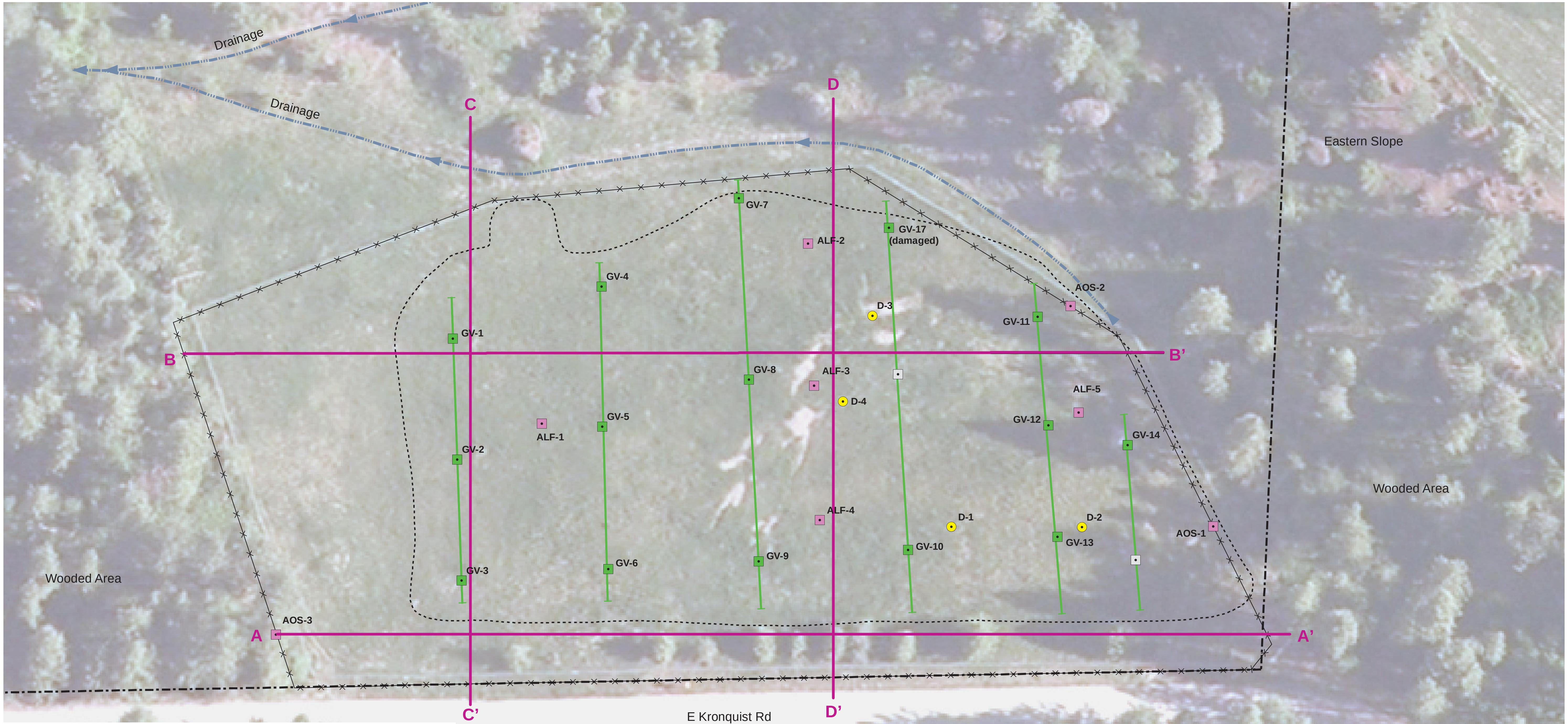

LEGEND

- RI Gas Vent Sampling Location
- RI Ambient Air Sampling Location
- RI Dross Borehole Sampling Location
- Gas Vent - not present
- DCO Management Property
- Heglar Kronquist Landfill
- Fence line
- Subsurface pipe for gas vent system

Notes: AOS = RI ambient air sampling location on landfill fence line
ALF = RI ambient air sampling location on landfill
GV = RI gas vent sampling location
DCO Management property and fence line have been surveyed.
Estimated extent of dross landfill and features reported by others (Kaiser 1983b).
Aerial photograph from USGS (2009).

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0 50 100 Feet
0 15 30 Meters

Figure 9. Landfill Elevation Profile Locations

Heglar Kronquist Landfill
Mead, Washington

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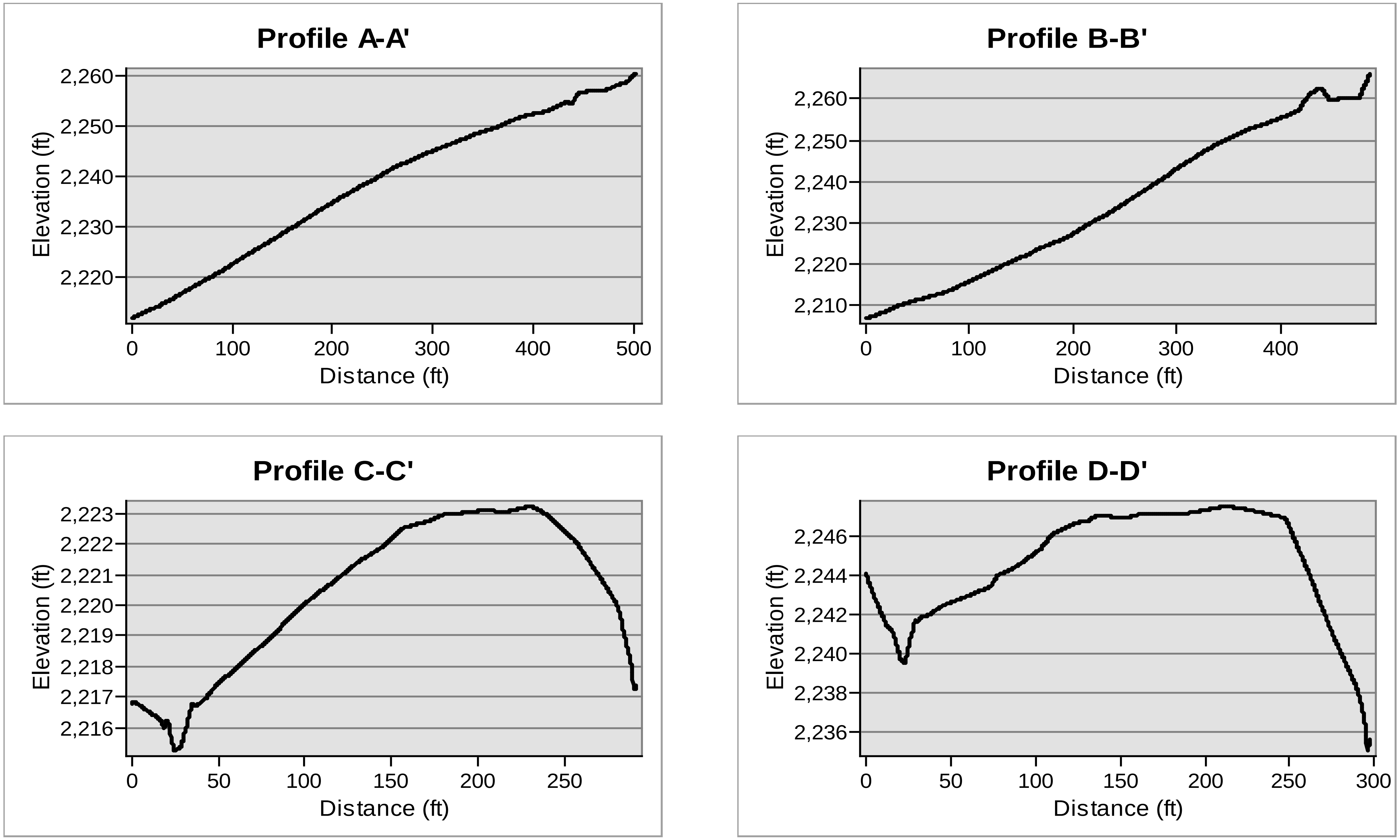
Figure 10. Landfill Elevation Profiles, Existing Conditions in May 2011



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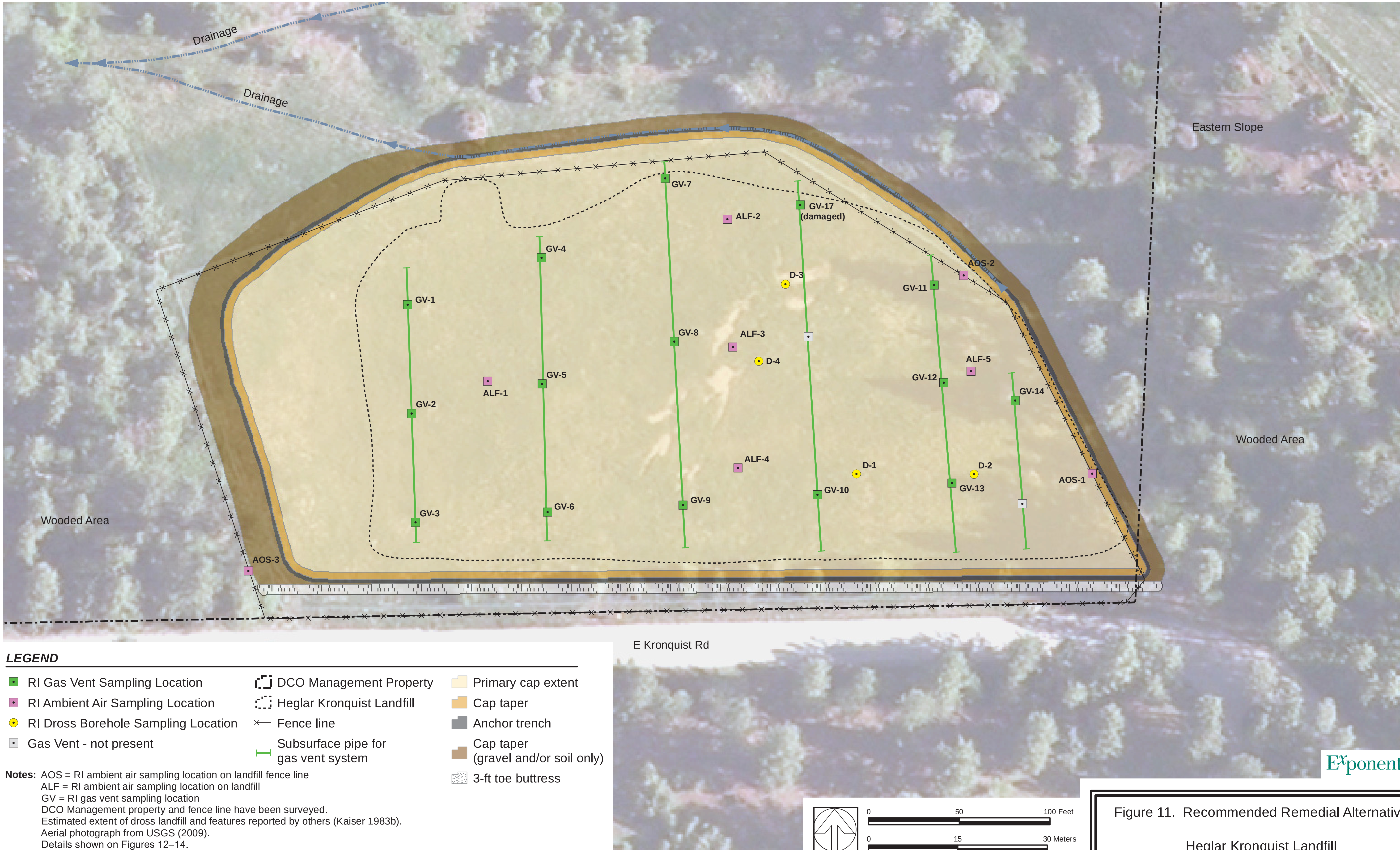


LEGEND

- RI Gas Vent Sampling Location
- RI Ambient Air Sampling Location
- RI Dross Borehole Sampling Location
- Gas Vent - not present
- DCO Management Property
- Heglar Kronquist Landfill
- Fence line
- Subsurface pipe for gas vent system
- Primary cap extent
- Cap taper
- Anchor trench
- Cap taper (gravel and/or soil only)
- 3-ft toe buttress

Notes: AOS = RI ambient air sampling location on landfill fence line
ALF = RI ambient air sampling location on landfill
GV = RI gas vent sampling location
DCO Management property and fence line have been surveyed.
Estimated extent of dross landfill and features reported by others (Kaiser 1983b).
Aerial photograph from USGS (2009).
Details shown on Figures 12–14.

Figure 11. Recommended Remedial Alternative

Heglar Kronquist Landfill
Mead, Washington

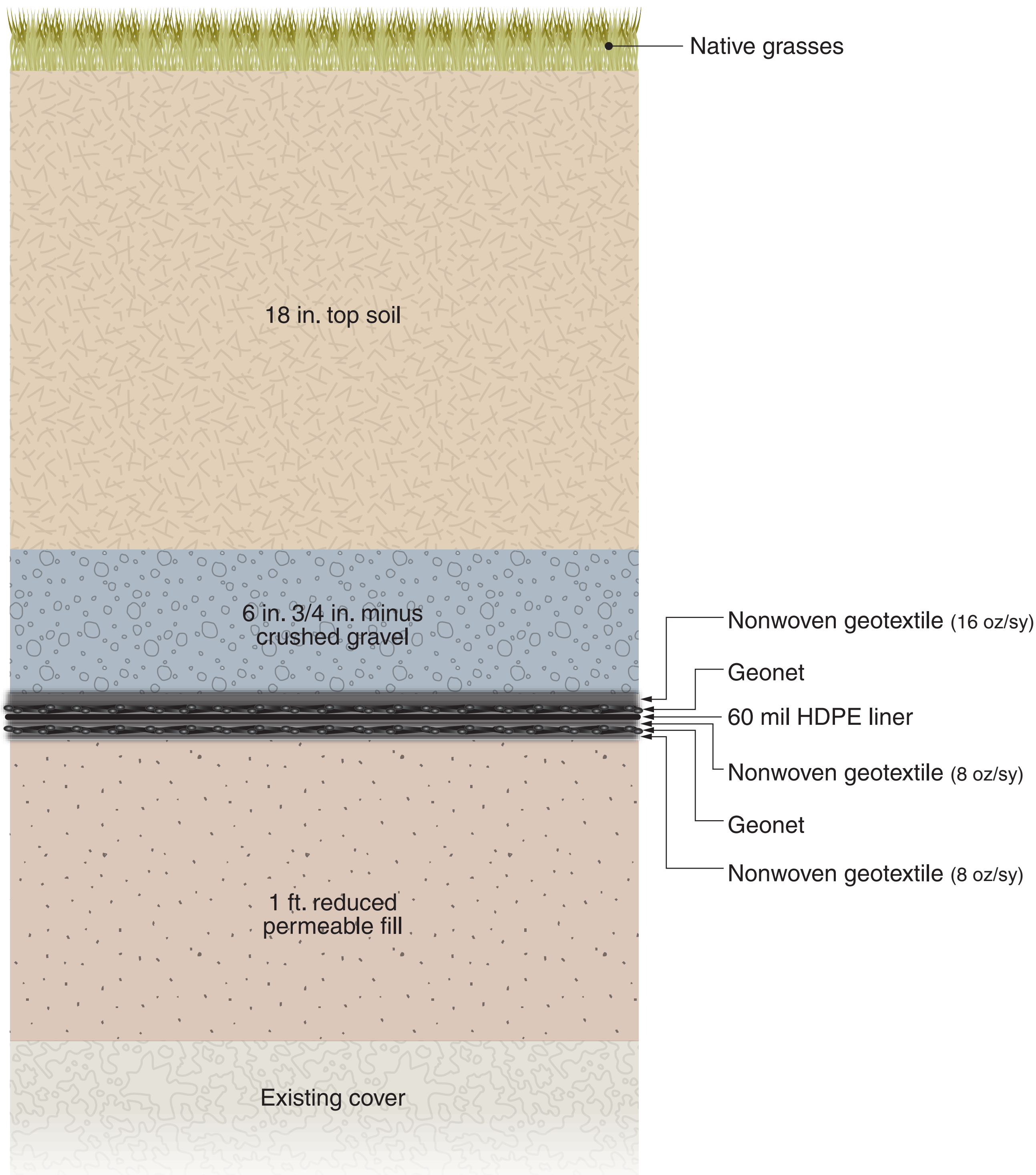
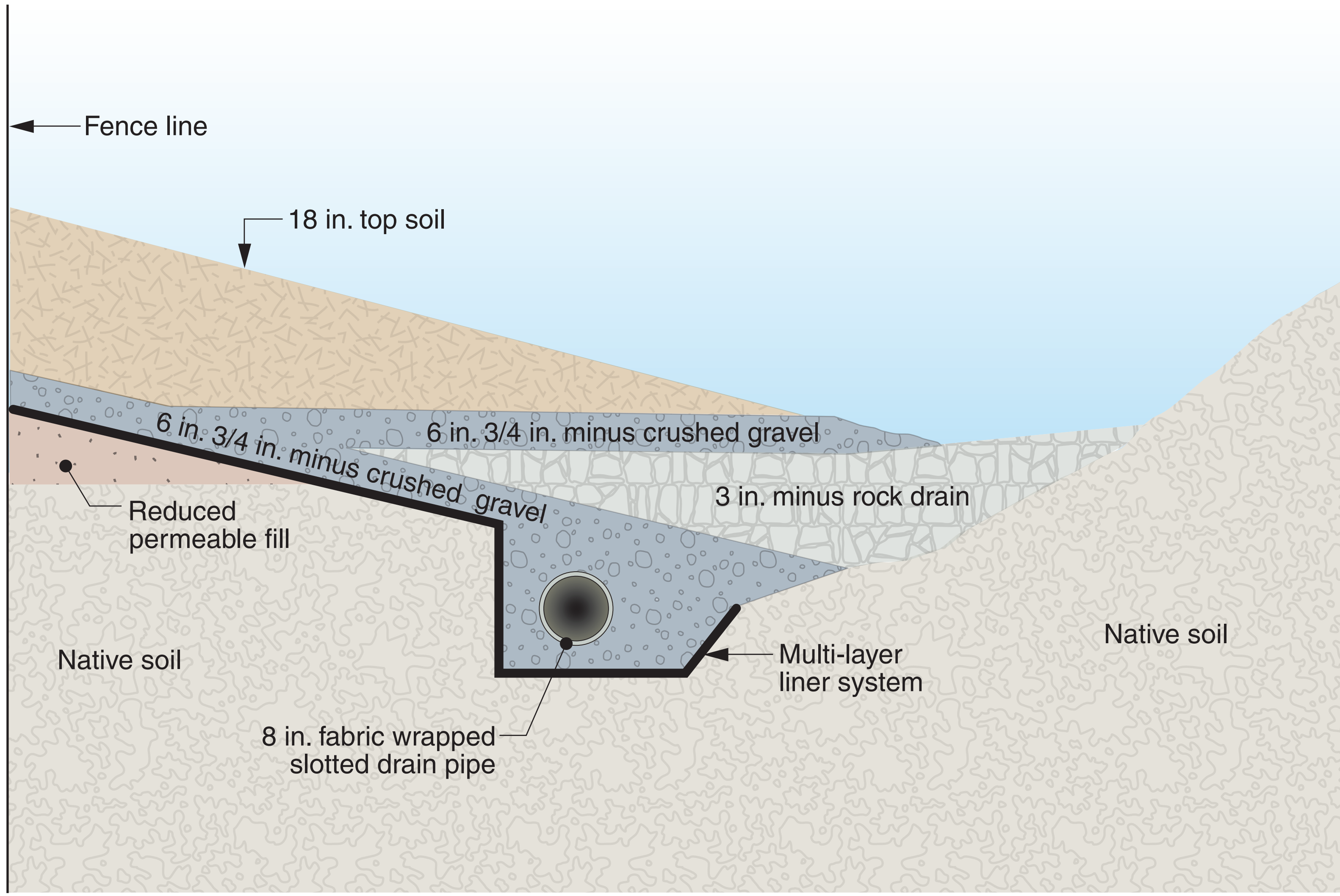
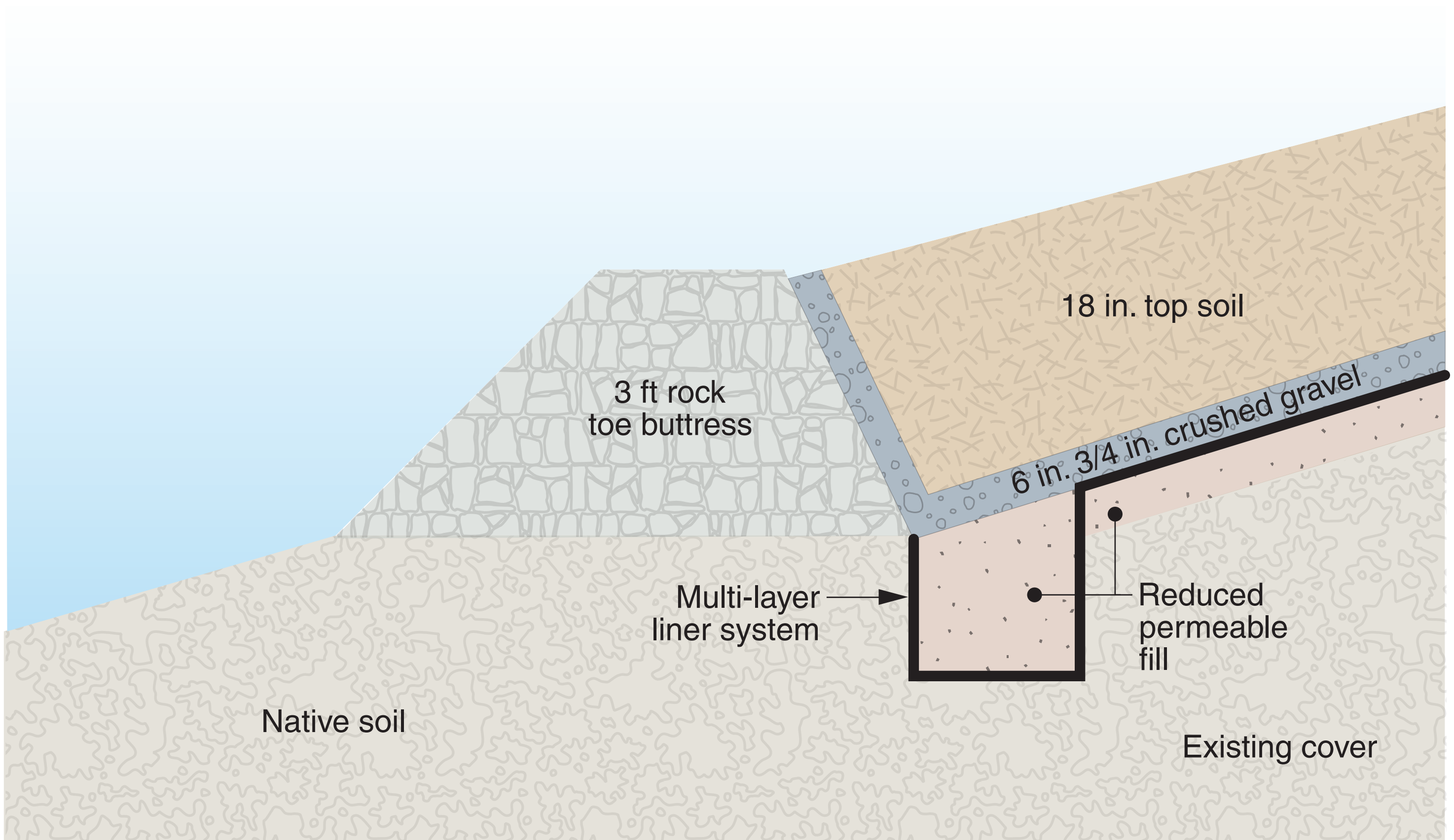


Figure 12. Cross Section of Proposed Cap Design
Heglar Kronquist Landfill
Mead, Washington



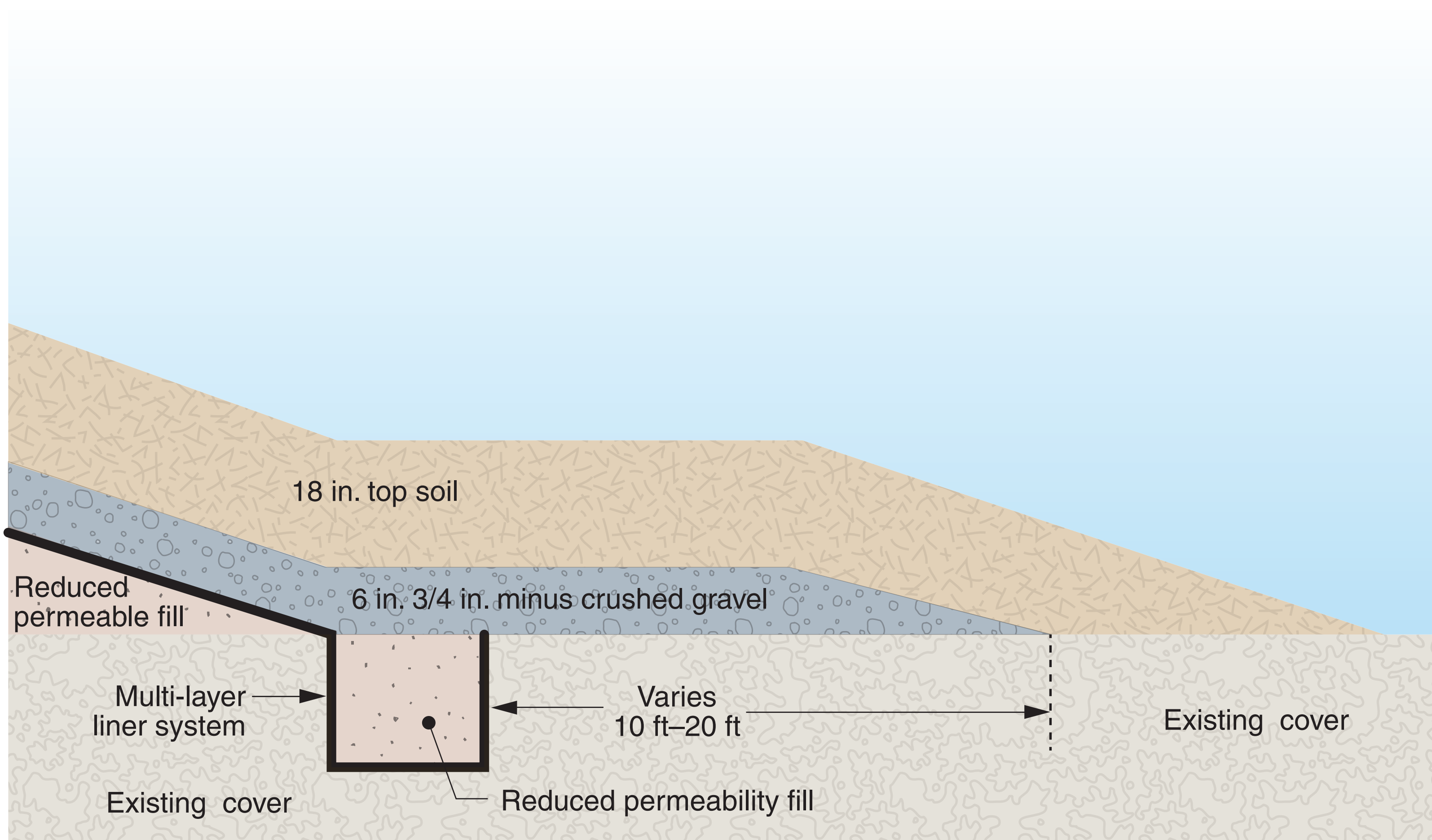
Not to scale.
Profile looking north; north side similar.

Figure 13. East Side Drain
Heglar Kronquist Landfill
Mead, Washington



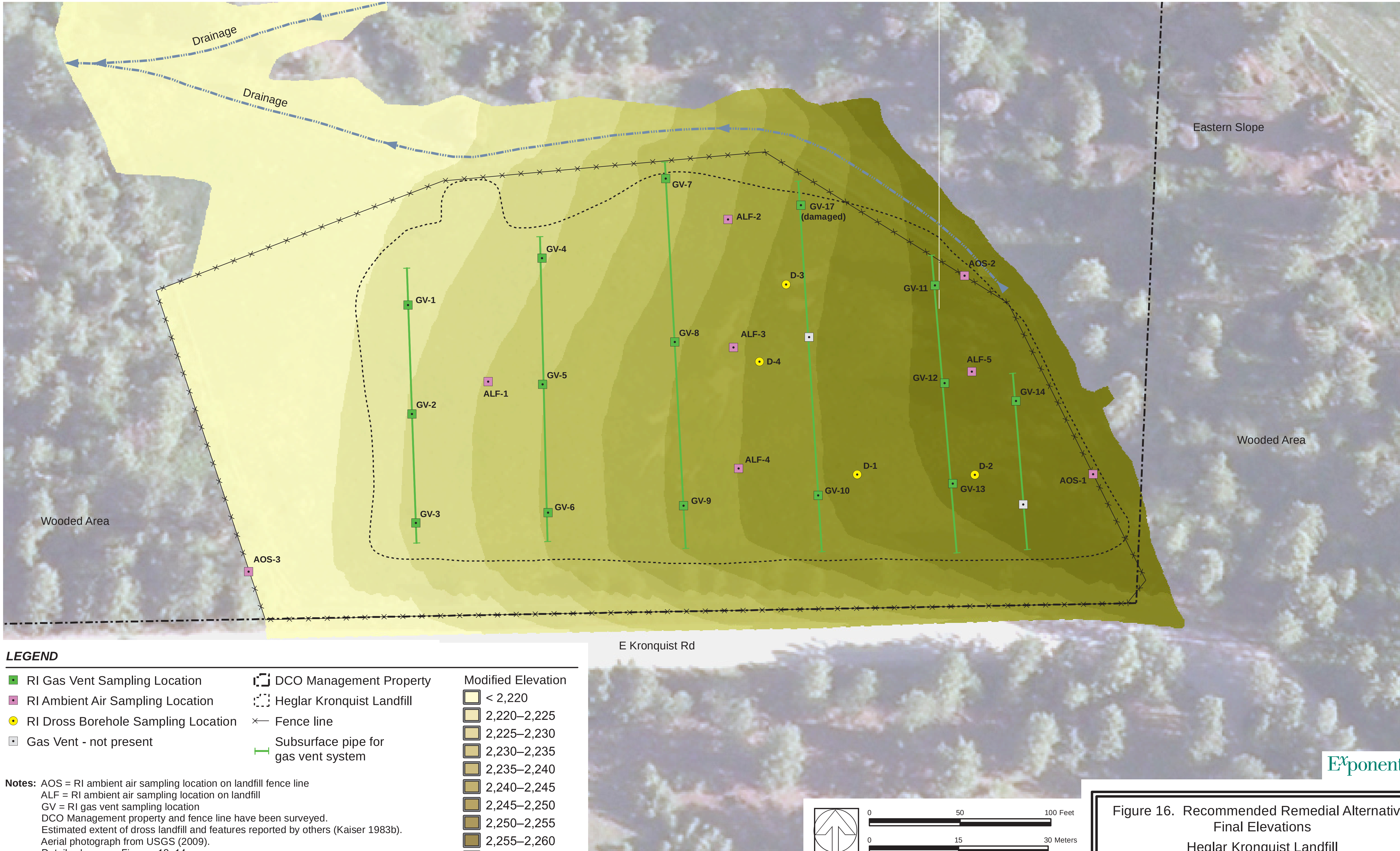
Not to scale.
Profile looking west.

Figure 14. Recommended Remedial Alternative, South Side Drain
Heglar Kronquist Landfill
Mead, Washington



Not to scale.
Profile looking south.

Figure 15. Recommended Remedial Alternative, West Side Cover Anchor
Heglar Kronquist Landfill
Mead, Washington



LEGEND

- RI Gas Vent Sampling Location
- RI Ambient Air Sampling Location
- RI Dross Borehole Sampling Location
- Gas Vent - not present
- DCO Management Property
- Heglar Kronquist Landfill
- Fence line
- Subsurface pipe for gas vent system

Modified Elevation

- < 2,220
- 2,220–2,225
- 2,225–2,230
- 2,230–2,235
- 2,235–2,240
- 2,240–2,245
- 2,245–2,250
- 2,250–2,255
- 2,255–2,260
- > 2,260

Notes: AOS = RI ambient air sampling location on landfill fence line
ALF = RI ambient air sampling location on landfill
GV = RI gas vent sampling location
DCO Management property and fence line have been surveyed.
Estimated extent of dross landfill and features reported by others (Kaiser 1983b).
Aerial photograph from USGS (2009).
Details shown on Figures 12–14.

Figure 16. Recommended Remedial Alternative, Final Elevations

Heglar Kronquist Landfill
Mead, Washington

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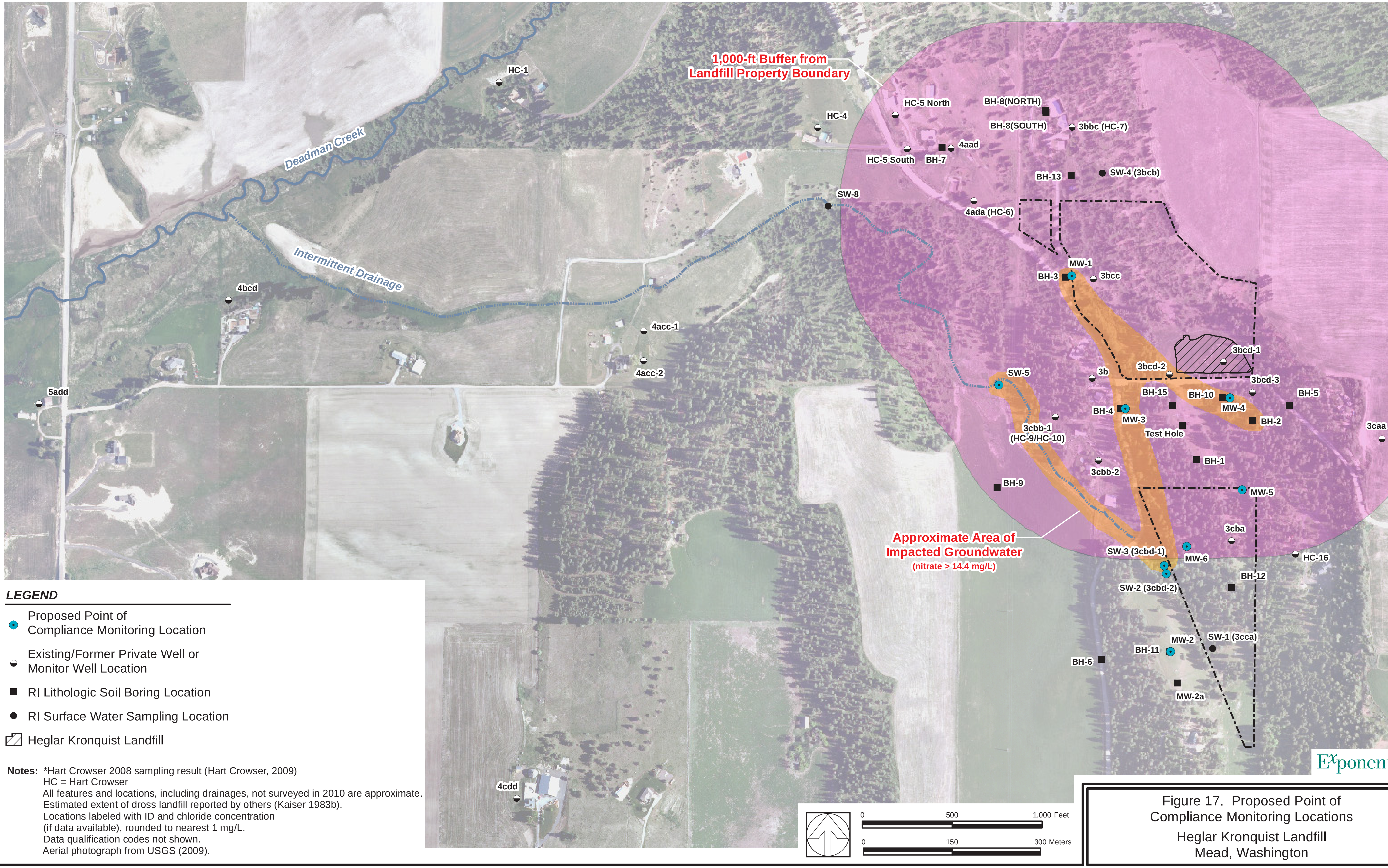

Notes: *Hart Crowser 2008 sampling result (Hart Crowser, 2009)
HC = Hart Crowser
All features and locations, including drainages, not surveyed in 2010 are approximate.
Estimated extent of dross landfill reported by others (Kaiser 1983b).
Locations labeled with ID and chloride concentration
(if data available), rounded to nearest 1 mg/L.
Data qualification codes not shown.
Aerial photograph from USGS (2009).

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Figure 17. Proposed Point of Compliance Monitoring Locations
Heglar Kronquist Landfill
Mead, Washington

Tables

Table 1. Initial technology and process screening—Heglar Kronquist Landfill, Mead, Washington

General Response Actions	Remedial Technology	Process Options	Description	Screening Comments
No Action	None	Not applicable	No action	Does not meet MTCA threshold requirements, including compliance with cleanup standards and compliance monitoring. Not retained for further evaluation.
Institutional Controls	Access restrictions	Deed restriction	Prohibition on installing new wells exists for all properties within 1,000 ft of the landfill boundary to prevent exposure. Include information regarding landfill and property use restrictions.	Potentially applicable.
		Maintenance of fencing and signage	Maintain existing fencing and signage to preclude entry by unauthorized personnel.	Potentially applicable.
	Site maintenance and monitoring	OMM Plan	Establish routine site operation, maintenance, and monitoring procedures and requirements in a plan.	Potentially applicable.
Engineering Controls	Cap enhancement	Multiple	Enhance cap using amended clay or geosynthetics and a drainage layer, include maintenance of gas vent system and surrounding drainages.	Potentially applicable.
	Groundwater flow barriers	Multiple	Installation of a barrier to prevent groundwater contact with landfilled waste.	Not effective. Impacts from surface water infiltration through the cap.
Waste Removal	Waste removal	Excavation	Remove black dross from landfill by excavation.	Potentially applicable. Feasibility is uncertain. Retained as a baseline to evaluate permanence and in consideration of public concerns.
Offsite Disposal or Recyling	Disposal	Offsite disposal in permitted landfill	Dispose of black dross in an offsite permitted landfill.	Potentially applicable if combined with waste removal.
	Recycle	Offsite recycling	Recycle black dross at an offsite recycler.	Not implementable. Very little recoverable aluminum in the black dross.
Waste Treatment	*In situ* waste treatment	Multiple	Treat waste *in situ*.	Not feasible to effectively treat waste *in situ*.
Groundwater Treatment	groundwater treatment	Pump and Treat Reverse Osmosis Distillation	Capture and treat impacted groundwater.	Not feasible to effectively capture and treat inorganic constituents in a fractured bedrock system.

Note: [shaded] - not retained for future analysis

Table 2. Summary of ARARS, Heglar Kronquist Site, Mead, Washington

ARARs	Alternative 1 – Waste Removal, Offsite Disposal, Dispersion/ Dilution, and Compliance Monitoring	Alternative 2 –Cap Enhancement, Institutional Controls, Dispersion/ Dilution, and Compliance Monitoring	Comments
Local Laws			
SCC Title 3, Section 3.10.020 Grading	X	X	Grading activities must comply with this ordinance.
SCC Title 6, Chapter 6.12 Noise Disturbances	Possible	Possible	Work activities must comply with this ordinance. May be needed, depending on work activities, work area and distance to residential properties.
SCC Title 8 Health and Sanitation	X	Not applicable	Waste disposal must comply with this ordinance.
SCC Title 9, Chapter 9.40 Encroachments and Work Within Public Right-of-Way	Possible	Possible	May be needed, depending on location of the work area.
SCC Title 46 Motor Vehicles	X	X	Use of motor vehicles, such as size, weight, and load, must comply with this ordinance.
State Laws			
WAC 173-340 MTCA – Cleanup Regulation	X	X	The remedial action will be conducted under MTCA. Therefore, all remedial alternatives must comply with MTCA.
WAC 173-162 Regulation and Licensing of Well Contractors and Operators	X	X	As part of Alternatives 1 and 2, two monitor wells on the landfill will be decommissioned in accordance with WAC 173-162. If the monitor well network is decommissioned in the future, this decommissioning must also be in compliance with WAC 173-162.
WAC 173-303 Dangerous Waste Regulations	Not applicable	Not applicable	Black dross is not a dangerous waste, therefore, this ARAR is not applicable.
WAC 173–304 Minimum Functional Standards for Solid Waste Handling	Not applicable	Not applicable	The landfill was operated and closed prior 1985, when the standards in WAC 173-304 were promulgated. Therefore, compliance with WAC 173-304 is not required. Rather, this work would be designed and completed in substantive compliance with the overall purpose of WAC 173-304 "to protect public health, to prevent land, air and water pollution, and conserve the state's natural, economic, and energy resources."
WAC 173-350 Solid Waste Handling Standards	X	Not applicable	As noted above, substantive compliance with the overall purpose of WAC 173-304 is applicable, however, compliance with WAC 173-304 and WAC 173-350, both promulgated after the landfill was operated and closed, are not applicable. Solid waste handling standards apply to disposal of dross for Alternative 1.

Table 2. Summary of ARARS, Heglar Kronquist Site, Mead, Washington

ARARs	Alternative 1 – Waste Removal, Offsite Disposal, Dispersion/ Dilution, and Compliance Monitoring	Alternative 2 –Cap Enhancement, Institutional Controls, Dispersion/ Dilution, and Compliance Monitoring	Comments
State Laws (cont.)			
WAC 197-11, WAC 173-802 State Environmental Policy Act (SEPA)	X	X	A SEPA review is required for all proposals with probable significant adverse impacts on the quality of the environment. Ecology will conduct a SEPA review during the RI/FS process.
WAC 173-201A Water Quality Standards for Surface Waters	X	X	MTCA requires that cleanup actions comply with applicable standards.
Federal Laws			
40 CFR 141 National Primary Drinking Water Regulations	X	X	MTCA requires that cleanup actions comply with applicable standards.
40 CFR 260-268 Resource Conservation and Recovery Act	Not applicable	Not applicable	Black dross is not a hazardous waste, therefore, this ARAR is not applicable.
33 USC 1251 et. Seq. Federal Water Pollution Control Act (aka Clean Water Act)	X	X	MTCA requires that cleanup actions comply with applicable standards.
40 CFR 131 National Toxics Rule	X	X	MTCA requires that cleanup actions comply with applicable standards.

Note:

ARAR - applicable or relevant and appropriate requirement
CFR - Code of Federal Regulations
MTCA - Model Toxics Control Act
SEPA - State Environmental Policy Act
SCC - Spokane County Code
WA - Washington Administrative Code

Table 3. MTCA remedial alternative screening—Heglar Kronquist Landfill, Mead, Washington

		MTCA Initial Screening			MTCA Requirements									
					Threshold Requirements				Other MTCA Requirements					
Remedial Alternative	Description	Effective?	Implementable?	Cost Effective?	Protection of Human Health and the Environment	Compliance with Cleanup Standards	Compliance with State and Federal Laws	Provision for Compliance Monitoring	Use of Permanent Solutions to Maximum Extent Practicable	Reasonable Restoration Time Frame	Consideration of Public Concerns	Balancing Factors, Total Score[a]	Recommended Remedial Alternative	Comments
Alternative 1 Waste Removal, Offsite Disposal, Dispersion/Dilution, and Compliance Monitoring	Excavation and offsite disposal of 55,000 cubic yards of black dross at a permitted landfill. Reduction of contaminant concentrations through dispersion/dilution. Compliance Monitoring.	Good / 5	Poor / 2	Poor / 2	Moderate / 4	Good / 5	Moderate / 4	Good / 5	Moderate / 4	Good / 5	Moderate / 4	**40**		This alternative is not acceptable because costs are disproportionate to the level of protectiveness. In addition, significant uncertainties exist regarding the ability to dispose of dross in local landfills. This alternative was carried through as a baseline for evaluating permanence.
Alternative 2 Cap Enhancement, Institutional Controls, Dispersion/ Dilution, and Compliance Monitoring	Enhance cap by filling depressions and grading to minimize infiltration. Install geosynthetic and drainage layers. Possible repair of damaged gas vents. Long-term inspection and maintenance. Compliance monitoring. Reduction of contaminant concentrations through dispersion/dilution. File a deed restriction (covenant).	Good / 5	Good / 5	Good / 5	Good / 5	Moderate / 4	Good / 5	Good / 5	Moderate / 4	Good / 5	Moderate / 4	**47**	√	This alternative is effective in meeting remedial action goals.

[a] Remedial Alternative Ratings / Scores:

Good	5
Moderate	4
Fair	3
Poor	2
Unacceptabl	1

Table 4. Disproportionate cost screening—Heglar Kronquist Landfill, Mead, Washington

Remedial Alternative	Description	Disproportionate Cost Test Evaluation Criteria: Protectiveness	Permanence	Cost	Long-Term Effectiveness	Management of Short-Term Risks	Technical and Administrative Implementability	Consideration of Public Concerns	Disproportionate Test Criteria, Total Score[a]	Disproportionate Test Criteria without Cost, Score[a]	Recommended Remedial Alternative	Comments
Alternative 1 Waste Removal, Offsite Disposal, Dispersion/Dilution, and Compliance Monitoring	Excavation and offsite disposal of 55,000 cubic yards of black dross at a permitted landfill. Reduction of contaminant concentrations through dispersion/dilution. Compliance Monitoring.	Moderate / 4	Good / 5	Poor / 2	Good / 5	Fair / 3	Poor / 2	Moderate / 4	**25**	**23**		For this baseline alternative, costs are disproportionate to benefits. In fact, benefits acheived in this alternative score lower than benefits achieved in Alternative 2 and costs are substantially higher. Therefore, the incremental cost of of this alternative over that of Alternative 2 exceeds the degree of benefits achieved.
Alternative 2 Cap Enhancement, Institutional Controls, Dispersion/ Dilution, and Compliance Monitoring	Enhance cap by filling depressions and grading to minimize infiltration. Install geosynthetic and drainage layers. Possible repair of damaged gas vents. Long-term inspection and maintenance. Performance and compliance monitoring. Reduction of contaminant concentrations through dispersion/dilution. File a deed restriction (covenant).	Good / 5	Moderate / 4	Good / 5	Good / 5	Good / 5	Good / 5	Moderate / 4	**33**	**28**	√	This alternative uses permanent solutions to the maximum extent practicable. The cost of this alternative is proportionate to the degree of benefits achieved.

[a] Remedial Alternative Ratings / Scores:

Good	5
Moderate	4
Fair	3
Poor	2
Unacceptable	1