Feasibility Study

Marshall Landfill
Spokane County, Washington

for
Washington State Department of Ecology

May 31, 2018

GeoEngineers
Earth Science + Technology

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File No. 0504-104-00

May 31, 2018

Prepared for:

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ABBREVIATIONS AND ACRONYMS

ARAR – Applicable or Relevant and Appropriate Requirements

CAP – Cleanup Action Plan

COC – contaminants of concern

COPEC – contaminant of potential environmental concern

CSM – Conceptual Site Model

CUL – cleanup level

DCA – Disproportionate Cost Analysis

DNR – Department of Natural Resources

Ecology – Washington State Department of Ecology

FS – Feasibility Study

GeoEngineers – GeoEngineers, Inc.

LEL – Lower Explosive Limit

MCPA – 2-methyl-4 chorophenoxyacetic acid

MCPP - Mecroprop

MSW – municipal solid waste

MTCA – Model Toxics Control Act

PGG – Pacific Groundwater Group

RAO – Remedial Action Objective

RI – Remedial Investigation

SCHD – Spokane County Health District

SL – screening level

TEE – Terrestrial Ecological Evaluation

VOCs – volatile organic compounds

WAC – Washington Administrative Code

EXECUTIVE SUMMARY

This report presents the Feasibility Study (FS) conducted for the Marshall Landfill site in Spokane County, Washington (herein referred to as the "Site"). The Site is situated northwest of Cheney-Spokane Road about one mile southwest of the town of Marshall, Washington and seven miles southwest of Spokane, Washington. The Site is located within portions of Section 21 and 28 of Township 24 North, Range 42 East, approximately shown in the Vicinity Map, Figure 1. The Site is bounded on the east by South Cheney-Spokane Road, on the south by a former landfill property owned by Spokane County, and on the west and north by privately-owned undeveloped land. The general Site layout is presented in the Site Plan and Monitoring Well Map, Figure 2.

The FS was conducted to develop, evaluate and select cleanup action alternatives to address contamination identified in the Remedial Investigation (RI) Report dated May 22, 2018. GeoEngineers prepared this FS in compliance with the RI/FS Work Plan approved by the Washington State Department of Ecology (Ecology) for the site and in general accordance with the requirements defined by the Model Toxics Control Act (MTCA), as described in Washington Administrative Code [WAC] 173-340-350. Ecology will select a cleanup action and prepare a cleanup action plan (CAP) for the Site.

The Site consists of four primary historic land use areas, including:

- The approximate 25-acre Main Landfill;
- The Five-Acre Landfill;
- A gravel pit; and
- The Former Spokane County Landfill (an off-site property that was not characterized during GeoEngineers' Remedial Investigation (GeoEngineers 2018), which is located adjacent to the southern boundary of the Main Landfill, and was operated by Spokane County as a daily-burn landfill from the 1950s until 1970).

For the purposes of this FS, the Former Spokane County Landfill is not addressed, primarily because access to the county landfill was not permitted during the RI and therefore, the extent and type of contamination (if any) in not known.

The Main and Five-Acre Landfills received waste during portions of the period from 1970 through 1990. Neither the Main Landfill nor the Five-Acre Landfill is equipped with a bottom liner. The Main Landfill and Five-Acre Landfill were closed under Permit No. SCHD SW-MARSH-001. The Main Landfill was reportedly covered with a layer of fine to medium sand. A passive landfill gas venting system and a compacted-clay cap was installed in 1990 at the Five-Acre Landfill; however, the as-built condition of the clay cap is not well documented.

Site contamination greater than cleanup levels (CULs) generally is limited to landfill gases (volatile organic compounds [VOCs] and methane). RI soil results indicate that soil at the landfills does not pose a significant risk to human health or the environment. However, observations of the clay cap over the Five-Acre Landfill indicated that the cap is not intact over the entire area of the landfill and some waste was exposed. Contaminants were detected in groundwater at concentrations exceeding MTCA CULs; however, the detections, locations, and frequency were not indicative of a plume and appeared to be isolated anomalies.

Because of the intermittent and isolated nature of the observed groundwater contamination, groundwater remediation is not considered practical or feasible. Surface water is not considered to contain contaminants of concern.

Based on the initial screening, seven remedial alternatives were developed during the FS. The remedial alternatives included complete removal of municipal waste and potential contaminated material for off-site disposal, various alternatives utilizing capping the municipal waste and potential contaminated material with a soil cover system or a soil and geosynthetic layer system, and institutional controls. Of the developed alternatives, Alternative 3 is the preferred alternative. Alternative 3 generally consists of the following activities:

- Regrade the Main Landfill buttress berm to no steeper than a stable 2.1H:1V slope and construct a gravity block retaining wall as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way).
- Construct a fence around the Main and Five-Acre Landfills.
- Cover both the Main and Five-Acre Landfill, and the area between with a soil cap, to include about 2 feet of low-permeability soil covered with about 6 inches of topsoil, then hydroseeded.
- Install a passive landfill gas collection and venting system.
- Conduct long-term groundwater monitoring and cap maintenance.
- Place a deed restriction (environmental covenant) on the property.

This alternative achieves MTCA criteria, is protective of human health and the environment, and provides a reasonable cost compared to alternatives that ranked higher. Comparison of the remedial alternatives and ranking of each alternative are shown in Evaluation of Cleanup Action Alternatives, Table 5 and Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives, Table 6. A restrictive covenant will be placed on the deed for the property and long-term compliance monitoring will be implemented. The cost for Alternative 3 is about $5,340,000.

This alternative would result in long-term groundwater monitoring and cap inspection because contamination remains on site. For cost comparative purposes, groundwater monitoring will be conducted quarterly for 5 years and annually for 20 years.

1.0 INTRODUCTION

This report presents the Feasibility Study (FS) conducted for the Marshall Landfill site in Spokane County, Washington (herein referred to as the "Site"). This FS was conducted to develop and evaluate cleanup alternatives to address contamination identified during GeoEngineers' Remedial Investigation (RI) (GeoEngineers 2018). The Site is situated northwest of Cheney-Spokane Road about 1 mile southwest of the town of Marshall, Washington and 7 miles southwest of Spokane, Washington. The Site is located within portions of Section 21 and 28 of Township 24 North, Range 42 East, approximately shown in the Vicinity Map, Figure 1. The Site is bounded on the east by South Cheney-Spokane Road, on the south by a former landfill property owned by Spokane County, and on the west and north by privately-owned vacant land. The general Site layout is presented in the Site Plan and Monitoring Well Map, Figure 2.

2.0 SITE BACKGROUND

2.1. Site Description

Four primary historic land use areas within the Site and surrounding area, including two waste disposal areas, are delineated in Figure 2 and listed below:

- <u>The Main Landfill:</u> This approximate 25-acre waste disposal area is located within the south-central portion of the Site. Sand and gravel removed from the Main Landfill were replaced with waste during the period from 1970 through 1990. The landfilled waste thickness was estimated at 100 feet in the Main Landfill (Fetrow Engineering, Inc. [Fetrow] 1991).
- <u>The Five-Acre Landfill:</u> This approximate 5-acre waste disposal area is located within the northwest portion of the Site. Waste was disposed within the Five-Acre Landfill during the period from 1980 through 1984. The landfilled waste thickness was estimated at 45 feet in the Five-Acre Landfill (Fetrow 1991).
- <u>The Gravel Pit:</u> This area north of the Main Landfill and east of the Five-Acre Landfill currently is operated as a gravel pit by Action Materials.
- <u>The Former Spokane County Landfill</u>: This property is located adjacent to the southern boundary of the Main Landfill and was operated by Spokane County as a daily-burn landfill from the 1950s until 1970. This landfill has no bottom liner (Fetrow 1991).

The Former Spokane County Landfill technically is part of the Site, as interpreted through definition and practice in the Model Toxics Control Act (MTCA). However, permission to access the property during the RI was not granted; therefore, the extent, type, media, and magnitude of contamination on this property, if any, is not well understood. Although the Former Spokane County Landfill technically is considered part of the Site, it is not addressed in the alternatives within this FS because of the lack of information. Several remedial alternatives listed in the FS might be applicable to the Former Spokane County Landfill.

Neither the Main Landfill nor the Five-Acre Landfill is equipped with a bottom liner. As the Main Landfill and Five-Acre Landfills were filled, daily cover material consisting of 6 to 12 inches of sand was placed on the solid waste (Fetrow 1991). As a result, both Site landfills consist of alternating layers of waste material and sand of variable thickness.

Disposal operations ceased on-Site in 1990. At that time, the Main Landfill and Five-Acre Landfill were closed under Permit No. SCHD SW-MARSH-001 (Fetrow 1991). The Main Landfill was reportedly covered with a layer of fine to medium sand. A passive landfill gas venting system and a compacted-clay cap was installed in 1990 at the Five-Acre Landfill; however, the as-built condition of the clay cap is not well documented. Observations of the clay cap over the Five-Acre Landfill prior to the RI indicated the cap was not intact over the entire area of the landfill and some waste was exposed.

The southern and southeastern boundaries of the Main Landfill were buttressed with what appears to be a berm constructed of sandy materials from the adjacent gravel pit. The buttress berm reportedly was constructed to add additional capacity to the Main Landfill. The design parameters and as-built constructed condition of the buttress berm are not well documented.

2.2. Historical Operations and Site Use

GeoEngineers performed a review of Washington State Department of Natural Resources (DNR) aerial photographs for the period from 1968 through 2011 as a basis for identifying the growth of disturbed land within the Site (that could be indicative of waste disposal and/or gravel mining) over time. Our observations are summarized in Historic Limits of Disturbed Land Use, Figure 3, and summarized below:

- In 1968, disturbed land was limited to an area within and directly north of the Former Spokane County Landfill.
- By 1974, the disturbed area associated with the Former Spokane County Landfill had expanded to the east to South Cheney Spokane Road. Most of the Main Landfill, except the northeast corner, had been disturbed by this time.
- By 1979, disturbed areas had extended through most of the northeast portion of the Main Landfill, roughly the southern half of the Five-Acre Landfill, and three relatively small areas within the gravel pit.
- By 1986, disturbed areas had expanded throughout the Five-Acre Landfill and the southwest portion of the gravel pit.
- By 1992, the entire Main Landfill was disturbed and the disturbed portion of the gravel pit had expanded to the north and east.
- Disturbed areas were relatively static during the period from 1992 to 1994.
- The gravel pit expanded to the north and northeast between 1994 and 2011.

Prior to closure, Marshall Landfill received solid waste and demolition debris from southwest Spokane County, including the communities of Cheney, Spangle, Airway Heights, and Medical Lake, and from Colfax in Whitman County, at a rate that exceeded 20,000 cubic yards per month (Fetrow 1991). Between 1975 and 1983, Fetrow (1991) reports that Spokane County Health District (SCHD) files also document the disposal of potentially hazardous liquid waste at the site. The composition and volume of this disposed liquid waste (and/or soil impacted by liquid waste) has been enumerated by both Fetrow (1991) and Pacific Groundwater Group (PGG 2005) and include:

- 38,000 gallons of oily waste water in 1978.
- 1,000 gallons of containerized latex paint in 1978.
- 22,000 cubic yards of pentachlorophenol-contaminated soil in 1981.

- 2,500 gallons of caustic soda solution in 1981.
- More than 100 gallons of used oil and transformer oil in 1982.
- More than 3,000 gallons of waste liquid used to clean electric motor parts in 1982.
- 15,000 gallons of water and lignin sulfonate in 1983.
- 270 cubic yards of tetrachloroethene-contaminated soil in 1975.
- 100,000 gallons of oil and sludge in 1975.
- 40,000 gallons of jet fuel during the 1970's.
- Potentially 18,000 gallons of waste water used for cleaning boilers in 1991.

Corkill (1993) provides additional detail on disposed waste, though some of the description is similar is nature and volume to the above and it is unclear whether Corkill's information is duplicative.

Fetrow (1991) indicates that the precise locations of liquid waste disposal are unknown, but landfill personnel indicated that liquids were disposed of "at the southern end of the five-acre cell and also in the main cell." The latex paint was described as containerized. However, it is unknown if any of the other disposed liquid waste was containerized. PGG (2005) reports that open, unlined pits were used to store oil and sludge during approximately 1975.

2.3. Environmental Setting

See the RI report (GeoEngineers 2018) for a detailed description of the geologic and hydrogeologic setting of the Site.

2.4. Current and Likely Future Land Use

The Site is currently vacant and the use is unlikely to change. Surface conditions primarily consist of vegetated areas. Much of the landfill areas are vegetated with grasses and native plants. The area along the toe of the Main Landfill buttress berm is vegetated with grasses, native plants and trees.

2.5. Summary of Site Assessment and Remedial Investigation Activities

Environmental and/or hydrogeologic conditions at the Site have been investigated sporadically from 1982 to present. These investigations included:

- A hydrogeologic evaluation of the Site (Shannon & Wilson, Inc. 1983; Shannon & Wilson, Inc. 1984).
- A site investigation which included collecting groundwater samples from four existing wells near the Site conducted by the Washington State Department of Ecology (Ecology) in 1987 (Ecology 1987).
- Construction and sampling of five groundwater monitoring wells at the Site (Golder and Century West, 1989).
- Site characterization study prepared by Fetrow, Inc. (Fetrow 1991).
- Site hydrogeologic investigation prepared by PGG (2005).
- Quarterly groundwater monitoring reports prepared by Land and Water Environmental Services, Inc. for the period from 2005 to 2010.

RI activities were conducted at the Site in 2015, 2016 and 2017 to assess the adequacy of the existing groundwater monitoring network; assess the nature and extent of remaining contamination associated with the Site; collect geotechnical data and complete geotechnical analyses to better understand the long-term stability of existing Main Landfill buttress berm.

Explorations associated with RI activities included drilling 33 soil borings, constructing 6 new groundwater monitoring wells, constructing 10 landfill gas monitoring wells, excavating 71 test pits and conducting groundwater, surface water, and landfill gas monitoring events. RI soil results indicate that soil at the landfills does not pose a significant risk to human health or the environment.

Groundwater and surface water monitoring events were conducted during August 2016, November 2016 and February 2017. A supplemental groundwater monitoring event, that included analysis for 1,4-dioxane, was conducted during December 2017. Recent groundwater monitoring results do not indicate evidence of groundwater contamination that can be reproduced during subsequent monitoring events. The results indicate the extent of groundwater with analyte concentrations greater than cleanup levels (CULs) is limited, discontinuous, and variable between monitoring events.

Surface water samples collected during these events comply with applicable MTCA surface water CULs.

Landfill gas monitoring events were conducted during September 2015, August 2016, November 2016 and February 2017. A total of 12 volatile organic compounds (VOCs) were detected at concentrations greater than the MTCA Method B shallow soil gas screening levels (SLs) in at least one sample. Exceedances were observed in eight of the 10 landfill gas monitoring wells. Observed methane concentrations were greater than the lower explosive limit (LEL) of 5 percent in two of four landfill gas monitoring wells at the Five-Acre Landfill and three of six landfill gas monitoring wells at the Main Landfill during at least one monitoring event. The lateral extent of landfill gas contamination was not defined.

Static pressure within landfill gas monitoring wells was measured during the December 2017 monitoring event. Results indicate that, during the December 2017 monitoring event, pressure in each landfill gas monitoring well was minimal. The maximum pressure was 0.21 inches of water, observed in landfill gas monitoring well LFB-4.

3.0 CONCEPTUAL SITE MODEL

3.1. General

As part of the RI (GeoEngineers 2018), a detailed conceptual site model (CSM) was developed for the Site. The CSM is a model of the potential contaminant sources, release mechanisms and transport mechanisms currently present at the Site. The CSM also identifies potential receptors and associated exposure pathways for Site contaminants. The CSM does not quantify potential risks to human health or the environment posed by Site-related contamination. It is intended to focus remedial actions (site investigations, monitoring, cleanup actions, etc.) on those areas of the Site that may warrant further consideration. The CSM is graphically depicted in Conceptual Site Model, Figure 4 and expanded upon below.

3.2. Potential Contaminant Sources, Exposure Pathways and Receptors

GeoEngineers conducted a potential receptor evaluation to identify: (1) contaminant sources and (2) potential receptors (people and sensitive ecological receptors) that could encounter site-related contamination.

The source of contamination at the Site is the landfilled waste. Potentially complete exposure pathways, including release mechanisms, exposure points, and exposure routes for contamination contained within the landfill generally are:

- Direct contact with soil impacted by waste and/or leachate from the landfill (dermal contact and inhalation/incidental ingestion of dust and contaminants).
- Inhalation of landfill gases emanating from the landfill.
- Direct contact and/or ingestion of groundwater and/or surface water impacted by leachate from the landfill.

Potential receptors include workers at the Action Materials facility, nearby residents and occasional trespassers. Potential terrestrial ecological receptors include plants, soil biota and wildlife. The MTCA site-specific Terrestrial Ecological Evaluation (TEE) focuses on mammalian and avian wildlife (specifically shrews, vole and robins) based on the greater availability of toxicity information for these receptors. The shrew, vole and robin are potential receptors at the site. Other species that may occur at the site, but would likely be less exposed due to their greater home ranges, include resident predatory bird species such as red-tailed hawk (*Buteo jamaicensis*) and bald eagle (*Haliaeetus leucocephalus*). There are also numerous other resident and migratory birds common within the Spokane area; however, the robin conservatively assesses their potential exposure. Smaller mammals likely present at the site, such as squirrels and chipmunks, are effectively assessed by the vole surrogate. Larger mammals that could use the site are not directly represented by use of a surrogate; however, mammals such as coyote (*Canis latrans*), porcupine (*Erethizon dorsatum*), white-tailed deer (*Odocoileus virginianus*), and Rocky Mountain elk (*Cervus elaphus nelson*) require large tracks of land for foraging, wintering, breeding and nesting such that their use of the site would be infrequent or unlikely. The home ranges of these species would be an order of magnitude greater than that of the shrew and vole.

3.2.1. Soil

No analyte was detected in soil at a concentration greater than applicable MTCA Method B soil CULs. Methylene chloride was detected in soil at a concentration greater than the MTCA Method A soil CUL based on the protection of groundwater; however, methylene chloride was not identified as a groundwater contaminant of concern. The methylene chloride soil data were subsequently compared to the MTCA Method B soil CUL based on direct contact (soil ingestion); methylene chloride was not detected in soil at concentrations greater than the direct contact CUL.

Dibutylphthalate, cyanide, lube oil-range petroleum hydrocarbons, selenium and vanadium were identified as contaminants of potential ecological concern (COPEC) in the site-specific TEE. However, as discussed in the RI, the results of the site-specific TEE suggest that these analytes are not expected to pose a significant hazard to ecological receptors.

Except for one soil sample, all site soil samples were obtained below the standard point of compliance for direct contact (deeper than 15 feet below ground surface). These deeper soil samples are assumed to conservatively represent shallow soil (that is, soil within the standard point of compliance).

The presence of the sand or clay caps at the two landfills will significantly reduce any potential exposure by people and terrestrial ecological receptors to site-related contamination. Potential exposure is limited to exposed waste at the two landfills.

3.2.2. Groundwater

One or more groundwater analytes were observed to exceed project CULs in slightly greater than half of the project groundwater monitoring wells during the RI monitoring period. However, the results of recent groundwater monitoring during the RI do not indicate evidence of groundwater contamination that can be reproduced during subsequent monitoring events. The results indicate that the extent of groundwater with analyte concentrations greater than CULs is limited, discontinuous, and variable between monitoring events. Observed groundwater exceedances are summarized by the following:

- The groundwater monitoring wells with at least one exceedance during the four monitoring events (MW-1A, MW-5, MW-5A, MW-7B, MW-8A, MW-8B, MW-11A, MW-12A, MW-14, MW-15A, MW-16, and MW-16A) are distributed throughout the Site.
- Exceedances of inorganic analytes (cadmium, lead and nitrate) are limited to the west-central portion of the Site, extending from MW-1A along the south boundary of the Five-Acre Landfill to MW-7B along the north boundary of the Main Landfill.
- MCPA and MCPP were only detected in February 2017, but were more widely-distributed.
- There is some uncertainty associated with the extent of 2,6-dinitrotoluene, MCPA and MCPP groundwater contamination due to elevated reporting limits for these three analytes. However, the laboratory reports the results down to the method detection limits, which only exceed the MTCA Method B groundwater CULs by a factor of two for these three analytes. Therefore, even if these analytes were presented in groundwater samples reported as not detected, the groundwater concentrations would be less than two times the MTCA Method B groundwater CUL.
- 1,4-Dioxane, 2,6-dinitrotoluene or bis(2-ethylhexyl)phthalate were detected at concentrations greater than Method B CULs in groundwater samples from the following monitoring wells: MW-11A (1,4-dioxane), MW-7B and MW-8A (2,6-dinitrotoluene), and MW-5, MW-5A and MW-15A (bis[2-ethylhexyl]phthalate). Except for 2,6-dinitrotoluene in MW-7B and MW-8A, these semi-volatile organic compounds (SVOCs) were detected at elevated concentrations in only one of the groundwater monitoring events; 2,6-dinitrotoluene was detected at elevated concentrations in MW-7B and MW-8A in three and two rounds of groundwater monitoring, respectively.
- Methylene chloride was detected at a concentration greater than the Method B CUL in the groundwater sample collected from MW-12A during the December 2017 monitoring event. Methylene chloride was detected in five monitoring wells in December 2017 but was not detected in any monitoring well during the previous RI monitoring events. Although methylene chloride was identified as a primary contaminants of concern (COC) by PGG (2005), the presence of methylene chloride may be the result of laboratory contamination. Methylene chloride is a common laboratory contaminant, though it was not detected in the applicable method blank samples.

As discussed in the RI, shallow groundwater flow within the glaciofluvial and basement rock units generally mimics topographic conditions and is directed from the area surrounding the Site towards discharge areas situated to the northeast and east. GeoEngineers was not tasked with conducting a survey of active private/community wells. However, based on our review of previous investigations, we estimate that there are a minimum of three groundwater supply or private/community wells within 1,500 feet of the Site. The Marshall Landfill groundwater supply well is located near groundwater monitoring well MW-3; no VOCs were detected in MW-3 during the 2016/2017 monitoring events. The Countryman A&D well is located around 750 feet east of the Main Landfill and the Beck Well is located approximately 1,500 feet northeast of MW-8A and MW-8B. Given the limited and sporadic nature of the groundwater exceedances observed within the Site groundwater monitoring wells during the RI investigation, it is logical to conclude that these groundwater supply wells are unlikely to be affected by Site-related groundwater contamination. However, a detailed evaluation of this pathway, including sampling of nearby groundwater supply wells, was not within the scope of the RI.

3.2.3. Surface Water

As noted in Section 2.3.2, based on the single surface water sampling location, surface water at the Site complies with applicable MTCA Method surface water CULs. In addition, both Minnie Creek and Marshall Creek, when they contain water, are losing streams (discharge to groundwater) near the Site (PGG 2005). Therefore, the direct contact and/or ingestion of surface water exposure pathways are incomplete.

3.2.4. Soil Vapor

Twelve VOCs were detected at concentrations greater than the MTCA Method B shallow soil gas SLs in at least one sample and in 8 of the 10 landfill gas monitoring wells. These 12 VOCs are primarily petroleum-related compounds or chlorinated solvents. Methane concentrations are greater than the LEL of 5 percent in two of four landfill borings at the Five Acre Landfill and three of six landfill borings at the Main Landfill during at least one monitoring event. The boundaries of landfill gas contamination have not been delineated, except for the following:

- VOC exceedances appear to attenuate before the south boundary of the Main Landfill.
- Methane exceedances appear to attenuate before the south and southeast boundaries of the Main Landfill.

A primary concern associated with VOC and methane landfill gas concentrations is the potential for vapor intrusion into overlying or nearby buildings. Buildings are not present on either landfill and are not expected to be constructed on either landfill in the future. The only buildings near either landfill that may be subject to vapor intrusion are the Action Materials' buildings between the gravel pit and the Main Landfill.

3.3. Contaminants of Concern

The RI established COCs for soil vapor associated with the municipal solid waste (MSW) at the Main and Five-Acre Landfills that included:

- Petroleum Compounds: 1,2,4-trimethylbenzene, 1,3-butadiene, benzene, naphthalene, xylene
- Chlorinated Solvents: 1,2-dichloroethane, trichloroethene, vinyl chloride
- Other: 1,4-dichlorobenzene, 1,4-dioxane, benzyl chloride, chloroethene

- Methane

Soil and surface water do not appear to be impacted by site contaminants. Groundwater contaminants were observed. However, their occurrence was intermittent and isolated, as described in Section 4.3 of this FS.

3.4. Cleanup Levels

3.4.1. General

CULs were established as part of the RI (GeoEngineers 2018) for groundwater, air, and landfill gases.

3.4.2. Groundwater

Groundwater CULs were established for analytes detected in groundwater samples obtained at the Site at concentrations greater than either the maximum contaminant level (MCL) or MTCA Method B cleanup level, depending on analyte. The groundwater CULs, in micrograms per liter (µg/L), are summarized in the table below.

COC	Cleanup Level	Basis for Cleanup Level
2,6-dinitrotoluene	0.058 µg/L	Method B
Bis(2-ethylhexyl)phthalate	6.0 µg/L	MCL
Cadmium	5.0 µg/L	MCL
Cyanide	9.6 µg/L	Method B
Lead	15 µg/L	MCL
MCPA	8.0 µg/L	Method B
MCPP	16 µg/L	Method B
Nitrate	10,000 µg/L	MCL

3.4.3. Air

Air CULs were established for analytes that were detected in soil gas samples obtained at the Site at concentrations greater than MTCA Method B shallow soil gas screening levels (Ecology 2015). The air CULs are based on MTCA Method B Air Cleanup Levels, presented in micrograms per cubic meter ($\mu g/m^3$), and summarized in the table below.

COC	Cleanup Level	Basis for Cleanup Level
1,2-dichloroethane	0.096 $\mu g/m^3$	Method B
1,2,4-trimethylbenzene	3.2 $\mu g/m^3$	Method B
1,3-butadiene	0.083 $\mu g/m^3$	Method B
1,4-dichlorobenzene	0.23 $\mu g/m^3$	Method B
1,4-dioxane	0.5 $\mu g/m^3$	Method B
Benzene	0.32 $\mu g/m^3$	Method B
Benzyl chloride	0.051 $\mu g/m^3$	Method B
Chloroethene	4,570 $\mu g/m^3$	Method B

COC	Cleanup Level	Basis for Cleanup Level
Naphthalene	0.074 µg/m^3	Method B
Trichloroethene	0.37 µg/m^3	Method B
Vinyl chloride	0.28 µg/m^3	Method B
Xylenes	46 µg/m^3	Method B

3.4.4. Landfill Gas

WAC 173-304-460 specifies air quality and toxic air emissions standards for explosive gases. Explosive gases (expressed as methane) shall not exceed the following levels:

- 25 percent of the LEL (or 1.25 percent methane) in facility structures. There are currently no facility structures on the Main Landfill or Five-Acre Landfill and no structures are expected to be constructed in these locations in the future.
- The LEL (or 5 percent methane) at the property boundary or beyond.
- 100 parts per million by volume of methane in off-site structures (that is, the Action Material's buildings).

3.5. Exposure Pathways and Receptors

GeoEngineers conducted a potential receptor evaluation as part of the RI (GeoEngineers 2018) to identify: (1) potential contaminant sources; and (2) potential receptors (people and sensitive ecological receptors) that could possibly encounter site-related contamination.

The source of contamination at the Site is the landfilled waste. Potentially complete exposure pathways, including release mechanisms, exposure points, and exposure routes for contamination contained within the landfill generally are direct contact with soil impacted by waste and/or leachate from the landfill, inhalation of landfill gases emanating from the landfill, and direct contact and/or ingestion of groundwater and/or surface water impacted by leachate from the landfill.

Potential receptors include workers at the Action Materials facility, nearby residents and occasional trespassers. Potential terrestrial ecological receptors include plants, soil biota and wildlife.

3.6. Locations and Media Requiring Cleanup Actions

This section identifies the locations and environmental media (landfill gas) at the site that require evaluations.

Based on the results of the RI, the Main and Five-Acre Landfill gases are evaluated in the FS for VOCs and methane. Locations for the areas with COC listed in this section are shown on Soil Gas VOC Exceedances, Figure 5 and Methane Monitoring Results 2016-2017, Figure 6.

The results of groundwater monitoring in 2016 and 2017, as part of remedial investigation, do not indicate significant groundwater contamination. Rather, the results indicate that the extent of groundwater with analyte concentrations greater than CULs is limited, discontinuous and variable between monitoring events.

Given the limited and sporadic nature of groundwater analytes that exceed respective CULs observed within the Site groundwater monitoring wells during the RI investigation, it is logical to conclude that off-Site groundwater supply wells are unlikely to be affected by Site-related groundwater contamination. However, a detailed evaluation of this pathway, including sampling of nearby groundwater supply wells, was not within the scope of the RI. No groundwater remediation appears to be warranted based on the RI results.

3.7. Points of Compliance

Under MTCA, the point of compliance is the point or location on a site where cleanup levels must be attained. The points of compliance for the affected media will be approved by Ecology and presented in the Cleanup Action Plan (CAP). However, it is necessary to identify points of compliance to evaluate the effectiveness of the cleanup action alternatives in the FS.

The standard point of compliance is ambient air throughout the Site; however, the air CULs might also apply to the Action Materials' buildings located between the Gravel Pit and the Main Landfill.

The standard point of compliance for groundwater cleanup levels is all groundwater beneath the site from the top of the saturated zone to the lowest depth which could be affected by the site {WAC 173-340-720(8)(b)}, which likely is bedrock. However, based on the on the results of the groundwater monitoring program, groundwater is not considered an affected media for the purpose of this FS. The remedial alternatives evaluated in this FS do not specifically address potential groundwater contamination.

3.8. Applicable or Relevant and Appropriate Requirements

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a cleanup action. Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710, and referred to as the applicable or relevant and appropriate requirements (ARARs). An evaluation of the ARARs potentially applicable to each alternative was completed and is summarized in Summary of ARARs, Table 4. The alternatives evaluated in this FS comply with the intent of these laws and statutes and are protective of human health and the environment.

4.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

This section identifies the remedial action objectives and the initial screening of remedial alternatives for the site. An evaluation of the alternatives is presented in "Section 5.0."

4.1. Remedial Action Objectives

MTCA requires that cleanup actions meet the threshold requirements identified in WAC 173-340-360. According to this section of the code, the cleanup action shall:

- Protect human health and the environment – Each remedial alternative is assessed for its ability to protect present and future public health, safety, welfare and the environment.

- Comply with cleanup standards – Proposed cleanup standards are identified in "Section 3.4." The MTCA cleanup regulation specifies that a cleanup action alternative that does not comply with cleanup standards is an "interim action" not a "cleanup action."
- Comply with applicable state and federal laws.
- Provide for compliance monitoring – The cleanup action must provide for monitoring to verify that the cleanup action remains effective over time.
- Use permanent solutions to the maximum extent practicable – Permanent solutions are those in which cleanup standards can be met without further action being required such as long-term monitoring and inspection or institutional controls.
- Provide for a reasonable restoration time frame – This refers to the estimate of time required to achieve cleanup standards or other performance standards.
- Consider public concerns – This FS of remedial alternatives will seek to address the potential technical and administrative concerns of state and local regulatory entities.

The primary remedial action objective (RAO) is to mitigate human exposure to contaminants (landfill waste) by inhalation, dermal contact and ingestion. A secondary, although equally important, RAO is to mitigate ecological receptors (plants and animals) from exposure to contaminants.

4.2. General Categories of Response Actions and Initial Screening

The general categories of remedial response actions identified for the site, which are listed in Screening of Response Actions and Removal Alternatives, Table 1 include:

- No Action
- Institutional Controls
- Engineering Controls
- Off-Site Disposal
- Treatment

4.2.1. No Action

The no action alternative does not achieve the remedial action objectives because it does not protect present and future public health, safety, and welfare, and the environment.

4.2.2. Institutional Controls

Institutional controls involve the placement of access barriers such as fencing and barricades to motorized and non-motorized travel, as well as withdrawal or restrictions on development of affected lands from future use (i.e., deed restrictions). The primary purpose of these controls is to minimize development and human activities on contaminated areas and provide protection to an implemented solution.

4.2.3. Engineering Controls

The engineering controls evaluated for this FS involve the use of containment technologies that serve as source control. These controls mitigate or reduce the migration of contaminants off site via the wind pathway and minimize the leaching to groundwater pathway by limiting precipitation infiltration. The engineering controls do not affect the chemical composition of the contaminated materials nor do they reduce the toxicity of the materials. Engineering controls could include such measures as capping, placement of a coarse permeable barrier (to eliminate access to contaminated soil from burrowing animals), placement of a low-permeability (geotextile) liner, grading and revegetation.

Cap and cover designs can vary in complexity from simple soil covers to multi-layered covers. Installation of a soil cover would meet general requirements for landfill closure under WAC 173-304; however, it would not mitigate the potential of landfill gases to migrate off-site or for infiltration of precipitation through the MSW material. Placement of a low-permeability liner would reduce or eliminate the migration of landfill gases and the infiltration of precipitation through MSW material. Based on the results of the RI, groundwater remediation does not appear to be warranted; however, placing a low-permeability liner might reduce the occurrence of sporadic groundwater exceedances observed within the Site groundwater monitoring wells and described in the RI (GeoEngineers 2018).

Revegetation activities involve promoting plant growth, performing grading activities, and additional soil amendments and nutrients to facilitate vegetative growth. Revegetation should include species native to the area and consist of a variety of grasses and forbs. The establishment of vegetative covers can significantly reduce erosion potential and reduces the infiltration of precipitation through the soil cover through the natural evapotranspiration process.

The use of engineering controls meets MTCA requirements and is retained as a stand-alone remedial alternative and in conjunction with other alternatives.

4.2.4. Off-Site Disposal

Off-site disposal options include excavation and transport of contaminated material to an engineered, permitted landfill. Although this alternative can be very costly compared to other alternatives, it meets MTCA requirements and is retained as a stand-alone remedial alternative.

4.2.5. Treatment

Treatment options include methods such as incineration, vitrification, bioremediation, leaching, or waste/soil mixing. These methods are not feasible for the Site due to the depth of the waste, nature of the waste and because the landfill has no leachate collection system. Therefore, this remedial option is eliminated from further consideration.

4.3. Feasibility Study Considerations

The RI activities generally delineated the extent and types of contamination at the Site (with the exception of the Spokane County Landfill, which was not characterized during the RI). However, there are a few items to consider within the FS and during the remedial selection and engineering design components of this project:

- Groundwater Quality. As mentioned in the RI and earlier in this document, contaminants were occasionally detected in groundwater, but at low concentrations and were considered sporadic, discontinuous and not indicative of a plume. The current groundwater monitoring well network is robust and if one or more plumes of contaminants we represent, the network of wells should be well placed to monitor for the presence or absence of contaminants. During the use of the Site as a landfill, large quantities of liquid and solid wastes were disposed of including oil, caustic soda, paint, fuel, chlorinated compounds, and other wastes. Contaminants from these wastes might have attenuated and perhaps are no longer present. However, it is possible these contaminants were not detected during the RI exploration program and remain in vadose-zone soil, and might migrate to groundwater in the future. Additionally, there might be sources at the Former Spokane County Landfill (generally located upgradient from the portion of the Site explored during the RI), which could migrate to groundwater beneath the Site. Furthermore, downgradient domestic wells were not sampled during the RI. These combined factors result in possible data gaps and it is possible that future groundwater monitoring events could identify a contaminant plume.

- Landfill Gas. Results indicate that, during the December 2017 monitoring event, pressure in each landfill gas monitoring well was minimal. However, the extent of landfill gas exceeding cleanup criteria at the Site was not identified during the RI. Five of the 10 vapor points had methane levels exceeding 5 percent LEL and 8 of the 10 vapor points had VOC concentrations exceeding MTCA Method B soil gas screening levels. Until the extent of landfill gas contamination is better defined, a conservative approach should be considered when evaluating remedial options.
- Connection with Former Spokane County Landfill. As mentioned earlier, this property is considered part of the Site, but was not accessed during the RI. Because this portion of the Site has not been characterized, this FS cannot address remedial options for the Spokane County property. However, options for the Spokane County property should be considered and evaluated in a future, separate effort based on the possibility that a future remedial action for the Spokane County property can blend with remedial options listed in this FS. Furthermore, a consequence of having an uncharacterized portion of the Site is that the physical limits for certain remedial options for characterized areas must be set back several feet from the property line with the Spokane County property, and as such, might not fully address the southern limit of the Main Landfill.
- Parcel/Property Boundaries and Extent of MSW. The limits of the MSW at the landfills often is similar to parcel and property boundaries. However, the precise limits of MSW have not been defined and MSW likely extends into other properties (see Parcel Boundaries, Figure 7). For on-site capping remedial alternatives and where practicable, MSW extending slightly into a neighboring parcel will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line. Note: this might not be practical along the property boundary between the Main Landfill and the Former Spokane County Landfill mentioned above.
- Slope Stability. The remedial alternatives listed in the FS do not quantitatively account for the potential impacts to the stability of the slope near the southeast property line. Several alternatives, including consolidation of landfills and cover using a low-permeability geosynthetic liner, will change the geometry of the repository. Certain remedial alternatives could require additional slope stabilization efforts, particularly to the toe buttress, to provide geotechnical stability and protect infrastructure (highway and railroad) at the base of the slope.

4.4. Identification and Description of Cleanup Action Alternatives

Based on the initial screening, seven general remedial alternatives were developed. Summary of Quantities Used in Feasibility Study, Table 2 presents quantities used in the FS to evaluate each alternative. The seven comprehensive remedial alternatives provide an appropriate range of permanent cleanup actions for the Site (refer to Comparison of Remediation Alternatives, Table 3). The proposed alternatives are:

- Alternative 1: Institutional Controls (as a stand-alone alternative).
- Alternative 2: Institutional controls with limited soil cover (soil only placed over exposed MSW).
- Alternative 3: In-place containment of the Main and Five-Acre Landfills and areas between the landfills with a soil cover system.
- Alternative 4: Excavate MSW and MSW-contaminated soil from the Five-Acre Landfill and areas between the landfills and transport to the Main Landfill for placement in a centralized repository. Cap the centralized repository with a soil cover system.
- Alternative 5: In-place containment of the Main and Five-Acre Landfills and areas between the landfills with a low-permeability geosynthetic cover system.
- Alternative 6: Excavate MSW and MSW-contaminated soil from the Five-Acre Landfill and areas between the landfills and transport to the Main Landfill for placement in a centralized repository. Cap the centralized repository with a low-permeability geosynthetic cover system.
- Alternative 7: Excavate MSW and MSW-contaminated soil from the Main and Five-Acre Landfills and transport to a permitted landfill for disposal.

Cleanup action alternatives selected for evaluation represent a reasonable range of potentially applicable cleanup options to provide a basis for evaluation. The design parameters used to develop these cleanup action alternatives are based on engineering judgment and current knowledge of Site conditions. The final design for the selected alternative could require additional characterization and analysis to better define the scope and costs associated with the final cleanup action. Cleanup action alternatives were developed to be generally consistent with the current and anticipated future land uses at the Site. Components of the cleanup action alternatives evaluated for the Site are described below and are summarized in Table 3.

4.4.1. Alternative 1 – Institutional Controls

Alternative 1 includes installing a security fence limiting public access and posting signage warning of site hazards and dangers. A restrictive covenant would be placed on the deed for the property and long-term monitoring would be implemented. Institutional controls are legal or administrative tools or actions taken to reduce potential exposure to hazardous substances. Institutional controls include: easements, use restrictions/covenants, zoning, administrative or judicial orders, and/or public information and education. The effectiveness of the controls is evaluated through site monitoring and periodic review by the regulatory agency.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way).

This alternative does not provide for protection of human health and the environment, does not comply with cleanup standards, and does not meet all ARARs, including WAC Chapter 173-304. It does provide a provision for compliance monitoring.

The approximate cost for Alternative 1 is $1,430,000.

4.4.2. Alternative 2 – Institutional Controls with Limited Soil Cover

Alternative 2 includes placing a soil cover over areas of exposed waste, installing a security fence limiting public access and posting signage warning of site hazards and dangers. This alternative is based on an estimated 5 acres of exposed MSW on the Main Landfill, the Five Acre Landfill and the area between the two landfills. For cost estimating purposes, this alternative includes placing an approximately 1-foot-thick imported soil cap on the exposed MSW. Based on the interpreted presence of MSW and locations of property boundaries, the soil cap could include portions of parcels not part of the Marshall Landfill ownership.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way).

MSW extending slightly into a neighboring parcel will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line.

This alternative provides for protection of human health and the environment as an engineered cleanup action; however, it does not meet all ARARs, including WAC Chapter 173-304. A restrictive covenant would be placed on the deed for the property and long-term monitoring would be implemented.

The approximate cost for Alternative 2 is $1,790,000.

4.4.3. Alternative 3 – In-Place Containment with Soil Cover System: Cover Main Landfill, Five-Acre Landfill, and Areas Between the Landfills; Stabilize Existing Buttress Berm; Install Landfill Gas Collection System; Implement a Restrictive Covenant on the Deed

Alternative 3 consists of in-place containment of the Main Landfill, the Five-Acre Landfill, and the area between the two landfills with a soil cover system. Minimum standards identified for a soil cover under WAC 173-304 require at least 2 feet of soil with a permeability of 1×10^{-6} centimeters per second or lower placed over the landfill. This alternative includes 2 feet of low permeability soil covered with 6 inches of topsoil, and finished with hydroseeding.

A landfill gas collection system would be constructed to mitigate offsite migration of landfill gases. Because of the low volume of gas being generated and the age of the landfill, a passive gas collection system would be appropriate for the Site and would be used to collect landfill gas that accumulates beneath the cover system and vent that landfill gas to ambient air. Depending on the concentrations of VOCs and methane vented, a vent flare might be utilized to control emissions.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way). Survey monuments would be installed along the crest of the buttress berm and would be surveyed annually, or following a seismic event, to measure slope movement.

Additional site grading would be completed to control and mitigate stormwater run-on and run-off. After the cover system is constructed, the regraded areas would be revegetated. MSW extending slightly onto neighboring parcels will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line.

This alternative provides for protection of human health and the environment as an engineered cleanup action. A restrictive covenant would be placed on the deed for the property and long-term compliance monitoring would be implemented.

The approximate cost for Alternative 3 is $5,340,000.

4.4.4. Alternative 4– Consolidated Containment with Soil Cover System: Excavate MSW Fill from Five-Acre Landfill and Place on Main Landfill; Cover MSW on Main Landfill; Stabilize Existing Buttress Berm; Install Landfill Gas Collection System; Implement a Restrictive Covenant on the Deed.

Under Alternative 4, MSW and MSW-contaminated soil from the Five-Acre Landfill and the areas between the landfills, estimated at 292,290 cubic yards, would be excavated and hauled to the Main Landfill for placement into a centralized repository. This would increase the elevation at the Main Landfill, on average, about 6½ to 7 feet. The Five-Acre Landfill and areas between the landfills would be backfilled and regraded. A landfill gas collection system would be constructed to mitigate offsite migration of landfill gases from the centralized repository and the waste would be covered with a soil cover system. The cover system designs would be the same as under Alternative 3. Collectively, this would increase the elevation at the Main Landfill, on average, more than 9 feet.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way). Survey monuments would be installed along the crest of the buttress berm and would be surveyed annually, or following a seismic event, to measure slope movement.

Additional site grading would be completed to control and mitigate stormwater run-on and run-off. Depending on final design, imported material would be used to backfill the Five-Acre Landfill excavation and the area between the two landfills. After the cover system is constructed, the regraded areas would be revegetated.

MSW extending slightly into a neighboring parcel will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line.

This alternative provides for protection of human health and the environment as an engineered cleanup action, increases the beneficial use of the Five-Acre Landfill area by consolidating the MSW and MSW-contaminated soil into one area as opposed to two separate units to be managed and monitored individually. A restrictive covenant would be placed on the deed for the Main Landfill property and long-term compliance monitoring would be implemented.

The approximate cost for Alternative 4 is $14,490,000.

4.4.5. Alternative 5 – In-Place Containment with Low-Permeability Geosynthetic Cover System: Cover Main Landfill and Five-Acre Landfill; Stabilize Existing Buttress Berm; Install Landfill Gas Collection System; Implement a Restrictive Covenant on the Deed

Alternative 5 is the same as Alternative 3 except a cover system would be installed to include a geosynthetic layer to mitigate infiltration of precipitation through the MSW and MSW-contaminated soil. The cover system would consist of a multi-layer cover such as:

1. Top Soil (6 inches) and Vegetation
2. Common Borrow (2-feet)
3. Geonet drainage geotextile
4. 12 oz. nonwoven geotextile
5. 40-mil HDPE geomembrane
6. 12 oz. nonwoven geotextile
7. Bedding Sand (6-inch)
8. Regraded MSW and MSW-contaminated soil.

A landfill gas collection system would be constructed to mitigate offsite migration of landfill gases. Because of the low volume of gas being generated and the age of the landfill, a passive gas collection system would be appropriate for the Site and would be used to collect landfill gas that accumulates beneath the cover system and vent it to ambient air. Depending on the concentrations of VOCs and methane vented, a vent flare might be utilized to control emissions.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way). Survey monuments would be installed along the crest of the buttress berm and would be surveyed annually, or following a seismic event, to measure slope movement.

Additional site grading would be completed to control and mitigate stormwater run-on and run-off. The area near the Spokane County property should be graded such that stormwater does not run off the low permeability liner and infiltrate through the MSW in the Spokane County Landfill. After the cover system is constructed, the regraded areas would be revegetated.

MSW extending slightly into a neighboring parcel will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line. This alternative provides for protection of human health and the environment as an engineered cleanup action and functions to further reduce potential contaminant migration to groundwater. A restrictive covenant would be placed on the deed for the property and long-term compliance monitoring would be implemented.

The approximate cost for Alternative 5 is $9,540,000.

4.4.6. Alternative 6 - Consolidated Containment with Low-Permeability Geosynthetic Cover System: Excavate MSW Fill from Five-Acre Landfill and Place on Main Landfill; Cover MSW on Main Landfill; Stabilize Existing Buttress Berm; Install Landfill Gas Collection System; Implement a Restrictive Covenant on the Deed.

Alternative 6 is the same as Alternative 4 except a cover system identical to the system proposed in Alternative 5 would be installed to mitigate infiltration through the consolidated MSW and MSW-contaminated soil. After the cover system is constructed, the regraded areas would be revegetated. This would increase the elevation at the Main Landfill, on average, about 10 feet.

A landfill gas collection system would be constructed to mitigate offsite migration of landfill gases. Because of the low volume of gas being generated and the age of the landfill, a passive gas collection system would be appropriate for the Site and would be used to collect landfill gas that accumulates beneath the cover system and vent it to ambient air. Depending on the concentrations of VOCs and methane vented, a vent flare might be utilized to control emissions.

The Main Landfill buttress berm would be graded to no steeper than a stable 2.1H:1V slope and a gravity block retaining wall would be constructed as needed (depending on final design and potential encroachment on Spokane-Cheney Road and/or associated right-of-way). Survey monuments would be installed along the crest of the buttress berm and would be surveyed annually, or following a seismic event, to measure slope movement.

Additional site grading would be completed to control and mitigate stormwater run-on and run-off. The area near the Spokane County property should be graded such that stormwater does not run off the low permeability liner and infiltrate through the MSW in the Spokane County Landfill. After the cover system is constructed, the regraded areas would be revegetated.

MSW extending slightly into a neighboring parcel will be pulled onto Marshall Landfill parcels and ideally, at least 10 feet into the Marshall Landfill parcels to establish a 10-foot buffer between the consolidated MSW and the property line.

This alternative provides for protection of human health and the environment as an engineered cleanup action, increases the beneficial use of the Five-Acre Landfill area by consolidating the MSW and MSW-contaminated soil into one area as opposed to two separate units to be managed and monitored individually, and functions to further reduce potential contaminant migration to groundwater. A restrictive covenant would be placed on the deed for the Main Landfill property and long-term compliance monitoring would be implemented.

The approximate cost for Alternative 6 is $18,110,000.

4.4.7. Alternative 7 – Excavation of Main and Five-Acre Landfill and Off-Site Disposal at an Approved Subtitle D Facility

Alternative 7 involves excavating MSW and MSW-contaminated soil and transporting them off-site for disposal in a permitted landfill. The closest landfill that could accept the material is the Waste Management facility in Medical Lake, Washington (10 miles from the Site).

Comprehensive removal and off-site disposal is the most effective remedial alternative for managing risk and provides the highest level of permanence and long-term effectiveness by removing the source material.

MSW fill would be excavated to the extent practicable and disposed at an off-site, permitted landfill. The estimated volume and weight of MSW at the two landfills are as follows (assumes 0.8 tons per cubic yard):

- Main Landfill: 2,001,500 cubic yards (1,601,200 tons).
- Five-Acre Landfill: 268,620 cubic yards (214,896 tons).
- Area between Main and Five-Acre Landfills: 24,300 cubic yards (19,440 tons).

The approximate cost of this action is about $135,420,000.

5.0 MTCA EVALUATION CRITERIA

This section presents a description of the threshold requirements for cleanup actions under MTCA and the additional criteria used in this FS to evaluate the cleanup action alternatives.

5.1.1. Threshold Requirements

Cleanup actions performed under MTCA must comply with several threshold requirements. Cleanup action alternatives that do not comply with these requirements are not considered suitable cleanup actions under MTCA. As provided in WAC 173-340-360(2)(a), cleanup action must:

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring.

5.1.1.1. Protection of Human Health and the Environment

Cleanup actions performed under MTCA must ensure that human health and the environment are protected.

5.1.1.2. Compliance with Cleanup Standards

Compliance with cleanup standards requires, in part, that cleanup levels are met at the applicable points of compliance. If a remedial action does not comply with cleanup standards, the remedial action is an interim action, not a cleanup action. Where a cleanup action involves containment of soils with hazardous substance concentrations exceeding cleanup levels at the point of compliance, the cleanup action may be determined to comply with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met.

Cleanup alternatives must also comply with the ARARs in accordance with WAC 173-340-710. An evaluation of the ARARs potentially applicable to each alternative was completed and is summarized in Summary of ARARs, Table 4. The alternatives evaluated in this FS comply with the intent of these laws and statutes and are protective of human health and the environment.

5.1.1.3. Compliance with Applicable State and Federal Laws

Cleanup actions conducted under MTCA must comply with applicable state and federal laws. The term "applicable state and federal laws" includes legally applicable requirements and those requirements that Ecology determines to be relevant and appropriate as described in WAC 173-340-710.

5.1.1.4. Provision for Compliance Monitoring

The cleanup action must allow for compliance monitoring in accordance with WAC 173-340-410. Compliance monitoring consists of protection monitoring, performance monitoring and confirmational monitoring. Protection monitoring is conducted to confirm that human health and the environment are adequately protected during the construction, operation and maintenance phases of a cleanup action. Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards and/or, if applicable, remediation levels or other performance standards. Confirmational monitoring is conducted to confirm the long-term effectiveness of the cleanup action once cleanup standards and/or, if applicable, remediation levels or other performance standards have been attained.

5.1.2. Other Requirements

Under MTCA, when selecting from the cleanup action alternatives that meet the threshold requirements described above, the alternatives must be further evaluated against the following additional criteria:

- **Use permanent solutions to the maximum extent practicable (WAC 173-340-360[2][b][i]):** MTCA Cleanup Regulation requires that when selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable (WAC 173-340-360[2][b][i]). MTCA specifies that the permanence of these qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives using a "disproportionate cost analysis" in accordance with WAC 173-340-360(3)(e). The criteria for conducting a disproportionate cost analysis are described in Section 5.3.3 below.
- **Provide a reasonable restoration time frame (WAC 173-340-360[2][b][ii]):** In accordance with WAC 173-340-360(2)(b)(ii), selected cleanup actions must provide for a reasonable restoration time frame. The MTCA Cleanup Regulation lists factors to be considered in evaluating whether a cleanup action provides for a reasonable restoration time frame (WAC 173-340-360[4][b]).
- **Consideration of Public Concerns (WAC 173-340-360[2][b][iii]):** Ecology will consider public comments submitted during the RI/FS process in making its preliminary selection of an appropriate cleanup action alternative. This preliminary selection is subject to further public review and comment when the proposed remedy is published in the Draft Cleanup Action Plan.

5.1.3. MTCA Disproportionate Cost Analysis

The MTCA disproportionate cost analysis (DCA) is used to evaluate which of the cleanup action alternatives that meet the threshold requirements are permanent to the maximum extent practicable. This analysis involves comparing the costs and benefits of the alternatives and selecting the alternative whose incremental costs are not disproportionate to the incremental benefits. The evaluation criteria for the DCA are specified in WAC 173-340-360(2) and include protectiveness, permanence, long-term effectiveness, management of short-term risks, implementability, and consideration of public concerns compared to overall cost.

As outlined in WAC 173-340-360(3)(e), the MTCA Cleanup Regulation provides a methodology that uses the criteria below to determine whether the costs associated with each cleanup action alternative are disproportionate relative to the incremental benefit of the alternative over the next lowest cost alternative. The comparison of benefits relative to costs may be quantitative, but will often be qualitative. When possible for this FS, quantitative factors such as mass of contaminant removed or percentage of area of impacts remaining were compared to costs for the alternatives evaluated, but many of the benefits associated with the criteria described below were necessarily evaluated qualitatively. Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved over the lower-cost alternative (WAC 173-340-360[e][i]). Where two or more alternatives are equal in benefits, Ecology selects the less costly alternative (WAC 173-340-360[e][ii][c]).

The MTCA criteria used in the DCA are described below.

5.1.3.1. Protectiveness

The overall protectiveness of a cleanup action alternative is evaluated based on several factors. First, the extent to which human health and the environment are protected and the degree to which overall risk at a site is reduced are considered. Both on-site and off-site reductions in risk resulting from implementing the alternative are considered.

5.1.3.2. Permanence

MTCA specifies that when selecting a cleanup action alternative, preference shall be given to actions that are "permanent solutions to the maximum extent practicable." Evaluation criteria include the degree to which the alternative permanently reduces the toxicity, mobility or mass of hazardous substances, including the effectiveness 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 processes, and the characteristics and quantity of treatment residuals generated.

5.1.3.3. Long-Term Effectiveness

Long-term effectiveness is a parameter that expresses the degree of certainty that the cleanup action alternative will be successful in maintaining compliance with cleanup standards over the long-term performance of the cleanup action. The MTCA Cleanup Regulation contains a specific preference ranking for different types of technologies that is to be considered as part of the comparative analysis. The ranking gives the highest preference to technologies such as reuse/recycling, treatment, immobilization/solidification, and disposal in an engineered, lined, and monitored facility. Lower preference rankings are given to technologies such as on-site isolation/containment with attendant engineered controls, and institutional controls and monitoring.

5.1.3.4. Management of Short-term Risks

Evaluation of this criterion considers the relative magnitude and complexity of actions required to maintain protection of human health and the environment during implementation of the cleanup action. Cleanup actions carry short-term risks, such as potential mobilization of contaminants during construction, or safety risks typical of large construction projects. Some short-term risks can be managed using best practices during project design and construction, while other risks are inherent to project alternatives and can offset the long-term benefits of an alternative.

5.1.3.5. Implementability

Implementability is an overall metric expressing the relative difficulty and uncertainty of implementing the cleanup action. Evaluation of implementability includes consideration of technical factors such as the availability of mature technologies and experienced contractors to accomplish the cleanup work. It also includes administrative factors associated with permitting and completing the cleanup.

5.1.3.6. Consideration of Public Concerns

The public involvement process under MTCA is used to identify potential public concerns regarding cleanup action alternatives. The extent to which an alternative addresses those concerns is considered as part of the evaluation process. This includes concerns raised by individuals, community groups, local governments, tribes, federal and state agencies, and other organizations that may have an interest in or knowledge of the site. The public concerns for this Site would generally be associated with environmental concerns and performance of the cleanup action, which are addressed under other criteria such as protectiveness and permanence.

5.1.3.7. Cost

The analysis of cleanup action alternative costs under MTCA includes all costs associated with implementing an alternative, including design, construction, confirmational monitoring, and institutional controls. Costs are intended to be comparable among different alternatives to assist in the overall analysis of relative costs and benefits of the alternatives. The costs to implement an alternative include the cost of construction and the net present value of any long-term costs. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining institutional controls. Unit costs used to develop cost estimates for the cleanup action alternatives in this FS were derived using a combination of published engineering reference manuals (i.e., R.S. Means), construction cost estimates solicited from applicable vendors and contractors, review of actual costs incurred during similar, applicable projects, and professional judgment.

6.0 EVALUATION AND COMPARISON OF CLEANUP ALTERNATIVES

This section provides an evaluation and comparative analysis of cleanup action alternatives developed for the site. The alternatives are evaluated with respect to the MTCA evaluation criteria described in Section 5.0 and then compared to each other relative to its expected performance under each criterion. The components of the seven remedial alternatives are described above in Section 4.3 and summarized in Table 3. Detailed evaluation of the alternatives is presented in Evaluation of Cleanup Action Alternatives, Table 5, and the results of the evaluation are summarized in Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives, Table 6.

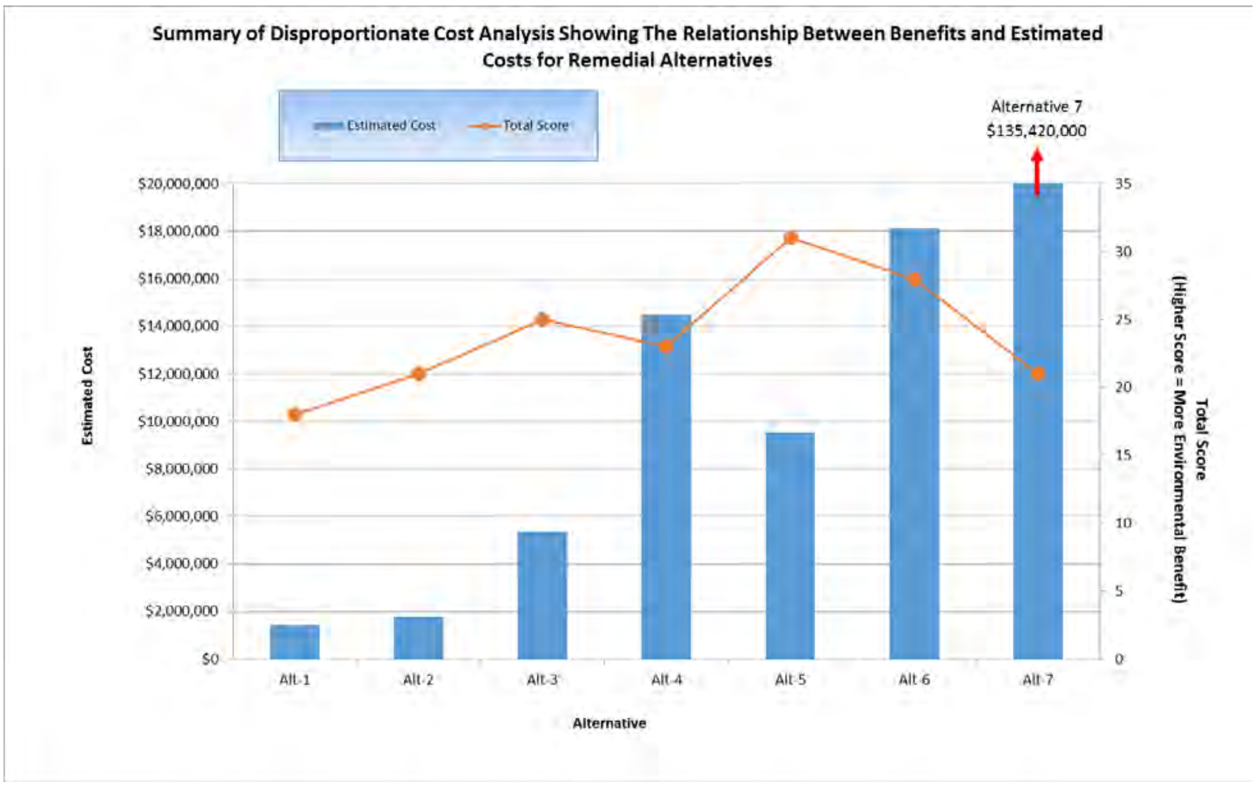
To evaluate reasonableness of costs, planning level estimates were developed for reach remedial alternative. While adequate for decision making purposes, final cost estimates will depend on the scope of the final remedial design. Please note that (1) the estimated costs for each alternative are considered to be within a margin of +/- 20 percent; (2) unit costs were derived from RS Means (2017) or from local vendors; (3) long-term monitoring and maintenance costs beyond 25 years are not included in the estimates; and (4) costs are based on 2017 dollars.

6.1. Threshold Requirements

Five of the seven alternatives developed meet the four MTCA threshold requirements described for cleanup actions: (1) protection of human health and the environment;(2) compliance with cleanup standards; (3) compliance with applicable state and federal regulations; and (4) provisions for compliance monitoring. Alternatives 1 and 2 do not meet the threshold requirements for MTCA.

6.2. MTCA Disproportionate Cost Analysis

As discussed in Section 5.1.3, the MTCA analysis of disproportionate costs is used to determine which cleanup alternative meets threshold requirements and is permanent to the maximum extent practicable. The alternatives were evaluated based on the relative benefits ranking factors of the DCA. Using a numeric scoring scale of 1 (lowest) to 7 (highest) and the methodology described above in Section 5.0 and in Table 5, each individual criterion is evaluated based on how it applies to each alternative. Table 6 presents the analysis of these results, including the summation of the resulting scores for each alternative and the determination of disproportionate cost. The conclusions of this evaluation are summarized in the following sections and the graph below.



6.3. Protectiveness

Alternative 6 achieves the highest level of protectiveness as a result of consolidating and capping MSW and MSW contaminated soil, protecting groundwater quality, and avoiding transport of contaminated materials across public roads. Alternative 5 achieves a higher level of protectiveness compared to Alternatives 1 through 4 because groundwater is better protected. Alternative 4 achieves a higher level of protectiveness than Alternative 3 because the material is consolidated and less widespread. Alternative 7 results in a lower level of protectiveness compared to Alternatives 3 through 6 because large amounts of MSW are transported across public roads. Alternatives 1 and 2 achieve the lowest level of protectiveness because contaminants remain on site with an elevated chance of mobility.

6.4. Permanence

Alternative 7 achieves the highest level of permanence because the contamination is located at a Subtitle D facility that meets current (stringent) landfill standards and is consistently monitored. However, no contaminants are permanently destroyed by this alternative. The remaining alternatives are ranked identically to their alternative number with the highest potential for contaminant mobility with Alternative 1 decreasing with each alternative through Alternative 6.

6.5. Long-Term Effectiveness

Long-term effectiveness of the alternatives has rankings similar to those described above for the permanence category. The long-term effectiveness relies on using proven technologies to remove or contain contaminant mass. Alternatives 1 and 2 have the lowest long-term effectiveness because they have minimal, if any, new cover materials. Alternatives 3 and 4 are ranked equally and are more protective than Alternatives 1 and 2 because they have a thicker and less permeable cover. They rank equally because the same level of long-term effectiveness applied regardless of where the MSW is located. Alternatives 5 and 6 also are ranked equally and are more protective than Alternatives 3 and 4 because they also have a geosynthetic layer and are therefore, more protective of groundwater. For the reasons mentioned above, they rank equally because the same level of long-term effectiveness applied regardless of where the MSW is located. Alternative 7 achieves the highest level of long-term effectiveness because the contamination is located at a Subtitle D landfill.

6.6. Management of Short-Term Risks

Alternative 1 has the lowest short-term risks since minimal site work is required. Alternatives 2 and 3 have the next lowest short-term risks because contaminated material is not moved and because they have shorter remedial construction timeframes than Alternatives 4 through 7. For the same reason, Alternative 5 ranks higher than Alternative 4 because contaminated material is not moved and it has a shorter remedial construction timeframe. Alternative 7 has the highest short-term risks considering the remedial timeframe and the transport of contaminated materials on public roads. Note that the highest rankings in this category offer the highest management of short-term risks.

6.7. Technical and Administrative Implementability

All seven alternatives are generally implementable using commonly available methods. Alternatives 1 through 7 correspondingly rank from the highest degree of implementability (Alternative 1) to the lowest degree (Alternative 7). The degree of implementation generally is correlated to the amount of materials and services needed. Alternative 7, removal of MSW and MSW contaminated soil, is the least implementable, because the volume of waste is large and it would be difficult to procure enough transportation trucks to remove the material from the site within a reasonable timeframe.

6.8. Consideration of Public Concerns

The alternatives proposed vary in expected acceptance to the public. Alternatives 5 and 6 rank the highest and second highest, respectively, because the public is interested in protection of groundwater.

Alternatives 3 and 4 are ranked next highest because the landfills are covered with a low permeability soil cover. These four alternatives meet the public concern regarding protection of groundwater without transporting MSW on public roads. Alternative 2 ranks 5th highest because it has a shorter timeframe and is therefore less disruptive to the public. Alternative 7 has a low ranking because the public might not want thousands of truckloads transporting contaminated materials on public roads for several months. Alternative 1 is least acceptable because it does little for beneficial uses of the site and does not sufficiently address contaminant exposure and migration.

6.9. Reasonable Restoration Time Frame

The restoration time frame for the proposed alternatives is expected to be on the order of one to three years. This time frame includes project design, permitting, contracting and construction. Construction timeframes range from 2 weeks (Alternative 1) to 30 weeks (Alternative 7). Alternatives 1 through 6 anticipate 25 years of long-term groundwater and cover monitoring, whereas Alternative 7 should have 5 years of groundwater monitoring.

6.10. Cost

For purposes of this evaluation, higher cost equates to a reduction in score. Alternative 1 is the lowest cost alternative and therefore ranks highest for cost. Alternative 7 is the highest cost alternative and therefore ranks lowest for cost. The cost estimates for alternatives were developed as described in Section 4.3 and are presented in Tables 7 through 13, respectively. Estimated costs include maintenance and monitoring ranging from 5 to 25 years, dependent upon the alternative.

To quantitatively evaluate if the cost of an alternative was disproportionate to the benefit, the lowest cost alternative that was both a practical and permanent remedy was considered the base cost. The total cost for this alternative was divided by the benefit score for that alternative to determine a cost per point of benefit. For this FS, Alternative 3 was the lowest cost alternative that was both a practical and permanent remedy and therefore its cost per point of benefit was used as the boundary between proportionate and disproportionate costs.

7.0 RECOMMENDED REMEDIAL ACTION

Based on the Disproportionate Cost Analysis, remedial Alternative 3 is the preferred alternative. Alternative 5 had the highest benefit but the costs were on the order of $9.5 million compared to Alternative 3, estimated to cost $5.3 million. The only additional benefit of Alternative 5 is the presence of a geosynthetic layer to further protect groundwater and address groundwater-based public concerns. Although groundwater contaminants were observed, their occurrence was intermittent and isolated. As such, the additional costs for Alternative 5 provide minimal additional benefit. Alternatives 4 and 6, which include consolidation of MSW and related soil onto the Main Landfill, would increase elevations on the Main Landfill by a minimum of 9 feet; this might not be practical from a design perspective. Alternative 1 had the lowest costs, but was least protective. Alternative 2 had lower costs than Alternative 3 but was not in compliance with regulations for landfill closures. In compliance with MTCA [WAC 173-340-360(3)(e)(ii)(c)], Alternative 3 should be the preferred remedial alternative.

8.0 REFERENCES

Fetrow, Inc. 1991. Marshall Landfill Site Characterization Study Final Report (Volume 1 and 2). Prepared for Marshall Landfill, Inc.

GeoEngineers, Inc. 2015. Remedial Investigation/Feasibility Study Work Plan, Marshall Landfill Site, Spokane County, Washington. Prepared by GeoEngineers, Inc. of Spokane, Wash. for the Washington State Department of Ecology, Spokane, Wash., May 14.

GeoEngineers, Inc. 2018. Remedial Investigation, Marshall Landfill Site, Spokane County, Washington. Prepared by GeoEngineers, Inc. of Spokane, Wash. for the Washington State Department of Ecology, Spokane, Wash, May 22.

Golder Associates, Inc. and Century West Engineering Corporation. 1989. Landfill Siting and Development, Spokane Regional Solid Waste Disposal Project, Environmental Impact Analysis, Technical Report 5.

Land And Water Environmental Services, Inc. 2010. "1996 – 2012, Marshal Landfill Quarterly Ground Water Monitoring Reports." Prepared for the Spokane Regional Health District, Spokane, Washington. July 13.

Pacific Groundwater Group. 2005. "Marshall Landfill 2005 Hydrogeologic Summary." Prepared for the Spokane Regional Health District, Spokane, Washington. December 23.

Shannon & Wilson, Inc. 1983. Waste-Disposal Site Investigation, Marshall Sanitary Landfill, Phase 1 Report.

Shannon & Wilson, Inc. 1984. Results of Phase II Groundwater Monitoring, Marshall Sanitary Landfill.

Washington State Department of Ecology. 1987. Phase I and II Site Investigation Report, Marshall Landfill, Marshall, Spokane County, Washington, WAD980511794. December.

Washington State Department of Ecology. 2014. "Work Plan for Marshall Landfill Site, Marshall, Washington."

Washington State Department of Ecology. 2015. CLARC Master Spreadsheet.xlsx. Updated July 2015.

TABLES

Table 1

Screening of Response Actions and Removal Alternatives

Marshall Landfill
Spokane County, Washington

General Response Action	Description	Screening Comments
No Action	No Action	Current condition, no risk reduction.
Institutional Controls	Placement of access barriers, deed restriction	Institutional controls do not accomplish remedial action objective as a stand-alone alternative, but will be used in conjunction with other alternatives (i.e., remediation and engineering controls, signs and fencing).
Containment/Engineering Controls	Capping, revegetation	A physical barrier in the form of a cap would minimize the potential for human health and ecological risks via direct contact, control waste dispersal and over the long-term, reduce leachate generation. Landfill gas would need to be vented via a passive gas extraction system. Based on results of the Marshall Remedial Investigation (RI), the existing clay cap covering the Five Acre Landfill is damaged or malfunctioning. Installing a low-permeability soil and/or geosynthetic cover over the Main and Five Acre Landfills is possible and will be retained as a remedial alternative. Enhancement of the existing Five-Acre Landfill might also be possible, but because the extent of damage to the existing clay cap is unknown, enhancing the existing cover will not be retained as a remedial alternative. Long-term compliance monitoring of the cap is required.
Removal from the Site with Off-Site Disposal	Excavation and disposal at Subtitle D facility	Excavation to remove existing cover soils, waste material and contaminated soil is possible, and will be retained as a remedial alternative. Excavated material would be disposed at an existing permitted disposal facility, or a new project specific facility.
Treatment to reduce toxicity, mobility, and/or volume	Proven technologies such as treatment via incineration, vitrification, bioremediation, leaching or waste/soil mixings are available to treat waste as is. These technologies are not feasible for the site due to the depth of the waste, nature of the waste and because the landfill has no leachate collection system.	This general category of technologies will not be retained as a remedial alternative.

Notes:

Shading represents remedial actions eliminated from consideration

Table 2

Summary of Quantities Used in Feasibility Study

Marshall Landfill

Spokane County, Washington

Item	Units	Quantity				Sources
		Main Landfill	Five Acre Landfill	Area Between Main and Five-Acre Landfills	Site Totals (Main and Five Acre Landfill)	
Municipal Solid Waste (MSW) Areas (Main and Five Acre Landfills)						
Areal extent of MSW	sf	1,008,755	314,204	82,360	1,405,319	From ArcGIS
Areal extent of consolidated MSW (Alternatives 4 and 6)	sf	1,210,506	--	--	1,210,506	Assumes 20 percent increase because of increased containment size
Areal extent of exposed MSW	sf	87,120	87,120	43,560	217,800	Values estimated for budgeting purposes.
Perimeter of MSW	feet	4,382	2,343	1,270	7,995	From ArcGIS
Volume of MSW (in-situ)	cy	2,001,500	268,620	24,300	2,294,420	From Civil 3D
Mass of MSW	ton	1,601,200	214,896	19,440	1,835,536	Assumes 0.8 tons/cy based on published geotechnical data[2].
Volume of cover soil over exposed MSW areas (Alternative 2)	cy	3,225	3,225	1,620	8,070	Values estimated for budgeting purposes. Assumes 1 foot of soil cover above exposed MSW.
Mass of cover soil over exposed MSW areas (Alternative 2)	ton	5,483	5,483	2,754	13,719	Assumes 1.7 ton/cy for imported material
Volume of cover soil over MSW areas (Alternatives 3 and 5)[1]	cy	74,723	23,274	6,101	104,098	From Civil 3D. Assumes 2 feet of cover soil above areal extent of MSW.
Mass of cover soil over MSW areas (Alternatives 3 and 5)[1]	ton	127,028	39,566	10,371	176,966	Assumes 1.7 ton/cy for imported material
Volume of topsoil cover over MSW areas (Alternatives 3 and 5)	cy	18,681	5,819	1,525	26,024	From Civil 3D. Assumes 6 inches of topsoil over cover soil.
Mass of topsoil cover over MSW areas (Alternatives 3 and 5)	ton	22,417	6,982	1,830	31,229	Assumes 1.2 ton/cy for imported material
Volume of cover soil over centralized repository (Alternatives 4 and 6)[1]	cy	89,667	--	--	89,667	Assumes 20 percent increase in volume compared to Alternatives 3 and 5 because of increased containment size.
Mass of cover soil over centralized repository (Alternatives 4 and 6)[1]	ton	152,434	--	--	152,434	Assumes 1.7 ton/cy for imported material
Volume of topsoil cover over centralized repository (Alternatives 4 and 6)	cy	22,417	--	--	22,417	Assumes 20 percent increase in volume compared to Alternatives 3 & 5 because of increased containment size.

Item	Units	Quantity				Sources
		Main Landfill	Five Acre Landfill	Area Between Main and Five-Acre Landfills	Site Totals (Main and Five Acre Landfill)	
Mass of topsoil cover over centralized repository (Alternatives 4 and 6)	ton	26,900	--	--	26,900	Assumes 1.2 ton/cy for imported material
Volume of backfill to replace excavated MSW (Alternatives 4 and 6)	cy	--	268,620	24,300	292,920	From Civil 3D
Mass of backfill to replace excavated MSW (Alternatives 4 and 6)	ton	--	456,654	41,310	497,964	Assumes 1.7 ton/cy for imported material
Volume of bedding sand over MSW areas (Alternative 5)	cy	18,681	5,819	1,525	26,024	From Civil 3D. Assumes 6 inches of bedding sand over MSW
Mass of bedding sand over MSW areas (Alternative 5)	ton	31,757	9,892	2,593	44,242	Assumes 1.7 ton/cy for imported material
Volume of bedding sand over centralized repository (Alternative 6)	cy	22,417	--	--	22,417	Assumes 20 percent increase in volume compared to Alternative 5 because of increased containment size
Mass of bedding sand over centralized repository (Alternative 6)	ton	38,109	--	--	38,109	Assumes 1.7 ton/cy for imported material
Areal extent of liner system (Alternative 5)	sf	1,008,755	314,204	82,360	1,322,959	From ArcGIS
Areal extent of liner system (Alternative 6)	sf	1,210,506	--	--	1,210,506	From ArcGIS
Volume of backfill to replace excavated MSW (Alternative 7)	cy	2,001,500	268,620	24,300	2,294,420	From Civil 3D
Mass of backfill to replace excavated MSW (Alternative 7)	ton	3,402,550	456,654	41,310	3,900,514	Assumes 1.7 ton/cy for imported material
Buttress Berm Stabilization						
Volume of berm to regrade	cy	35,530	--	--	35,530	Assumes 2.1:1 slope for minimum safety factor equal to 1.5
Length of berm to regrade	feet	1,440	--	--	1,440	From Google Earth
Length of retaining wall (optional)	feet	500	--	--	500	From Google Earth
Area of retaining wall	sf	3,000	--	--	3,000	Assumes height of retaining wall equal to six feet
Volume of backfill for retaining wall	cy	35	--	--	35	Assumes backfill wedge equal to height of retaining wall

Item	Units	Quantity				Sources
		Main Landfill	Five Acre Landfill	Area Between Main and Five-Acre Landfills	Site Totals (Main and Five Acre Landfill)	
Erosion Control						
Length for fencing	feet	4,200	2,100	500	6,800	From Google Earth
Length for erosion control	feet	4,200	2,100	500	6,800	From Google Earth

Notes:

[1]For the purposes of this Feasibility Study (FS), it is assumed that vegetated caps will consist of a gravel and quarry spall barrier (to minimize burrowing animals from contacting contaminated materials) beneath hydroseeded topsoil.

[2]Typical values recommended by Subtitle D as developed by Kavazanijian et al., 1995.

sf = square foot; cy = cubic yard; -- = not applicable

Table 3

Comparison of Remediation Alternatives

Marshall Landfill

Spokane County, Washington

Remedial Method	Conceptual Description	Benefits	Limitations	Relative Cost	Construction Feasibility	Duration of O&M	Impacts to Future Development, Adjacent Land Uses	MTCA Preference
Alternative 1 - Institutional Controls	Institutional controls, including a restrictive covenant and fencing, would be established for the landfill areas to reduce the potential for direct contact with exposed waste by humans and wildlife. In this scenario, no active remedial measures would be implemented. Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design).	Easily implemented, low cost. Provides some control on potential exposure to contaminated media.	Provides no active source control, containment or waste volume reduction. Does not address downwind migration of contaminants.	Low	Highly Feasible	Very long (+25 years or longer)	High. Site will be generally unusable, potential for wind-blown migration of contaminants to adjacent land.	Does not meet MTCA requirements for contaminants exceeding cleanup levels or risk thresholds. Lowest MTCA preference, doesn't treat source or create barrier to human and ecological receptors. Typically used in conjunction with other measures.
Alternative 2 - Institutional Controls with Limited Soil Cover	Institutional controls, including a restrictive covenant and fencing, would be established for the landfill areas to reduce the potential for direct contact with exposed waste by humans and wildlife. Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); exposed waste would be covered with 1 foot of soil, seeded and left to naturally revegetate over time.	Easily implemented, low cost. Soil barrier to control human and ecological exposure and wind-blown migration. Contaminated materials not transported on public roadways.	No waste or contaminant volume reduction.	Low	Highly Feasible	Very long (+25 years or longer)	Moderate. Use of site will be limited to passive activities that will not expose waste. Wind-blown migration controlled.	Moderate MTCA preference (containment), creates barrier to human and ecological receptors, but multiple source areas remain. Does not comply with WAC 173-303.
Alternative 3 - In-Place Containment with Soil Cover System	In-place containment of Main and Five Acre Landfill MSW, and areas between the two landfills, with soil cover system (approximately 2 feet of cover material topped with 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed to reduce the buildup and potential offsite migration of gases. The disturbed areas would be seeded and left to naturally revegetate over time.	Permanent closure with long-term monitoring. Stabilized source areas. Landfill gas collection system controls vapor migration. Soil barrier to control human and ecological exposure and wind-blown migration. Contaminated materials not transported on public roadways.	Higher cost than Alternative 2 mainly due to larger volume of imported materials. No waste or contaminant volume reduction.	Moderate	Feasible, uses proven and readily available materials and construction methods.	Moderate (10+ years or longer)	Moderate. Use of site will be limited to passive activities that will not damage the cap. Adverse impacts to adjacent land will be minimized because of the landfill cover system and vegetation. Wind-blown migration controlled.	Moderate MTCA preference (containment), creates barrier to human and ecological receptors, but multiple source areas remain.
Alternative 4 - Consolidated Containment with Soil Cover System	MSW and MSW-contaminated soil would be excavated from the Five Acre Landfill and hauled to the Main Landfill for placement into a centralized repository. Containment of consolidated waste with soil cover system (approximately 2 feet of cover material topped with 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed in consolidated waste to reduce the buildup and potential offsite migration of landfill gases. The disturbed areas would be seeded and left to naturally revegetate over time.	Permanent closure with long-term monitoring. Waste consolidated in one location. Soil Barrier to control human and ecological exposure and wind-blown migration. Landfill gas collection system controls vapor migration. Achieves waste removal from Five Acre Landfill. Contaminated materials not transported on public roadways.	High costs due to waste removal and imported material but does not include costly geosynthetic cover system. Longer construction schedule than Alternative 3. Increased short-term risk to workers. Increase in elevation and/or footprint of Main Landfill	High	Feasible, uses proven and readily available materials and construction methods.	Moderate (10+ years or longer)	Moderate. After construction completion, constraints on Five Acre site use will be removed and adverse impacts to adjacent lands would be eliminated. Use of Main Landfill site will be limited to activities that will not damage the cap. Adverse impacts to land adjacent to Main Landfill will be minimized because of the landfill cover system and vegetation. Wind-blown migration controlled.	Moderate MTCA preference (containment), creates barrier to human and ecological receptors, but one source area remains.

Remedial Method	Conceptual Description	Benefits	Limitations	Relative Cost	Construction Feasibility	Duration of O&M	Impacts to Future Development, Adjacent Land Uses	MTCA Preference
Alternative 5 - In-Place Containment with Low-Permeability Geosynthetic Cover System	In-place containment of Main and Five Acre Landfill MSW with low-permeability geosynthetic cover system (includes 2 feet of cover soil, 0.5 feet of bedding sand, geosynthetic liner, and 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed to reduce the buildup and potential offsite migration of gases. The disturbed areas would be seeded and left to naturally revegetate over time.	Permanent closure with long-term monitoring. Landfill gas collection system controls vapor migration. Soil and geosynthetic barrier to control human and ecological exposure and wind-blown migration. Geosynthetic layer reduces precipitation infiltration and leaching of MSW to groundwater. Contaminated materials not transported on public roadways.	Moderate costs due to imported materials and costly geosynthetic cover system. No waste or contaminant volume reduction.	Moderate	Feasible, uses proven and readily available materials and construction methods.	Moderate (10+ years or longer)	Moderate. Use of site will be limited to passive activities that will not damage the soil cover. Adverse impacts to adjacent land will be minimized because of the landfill soil cover and vegetation. Wind-blown migration controlled.	Moderate MTCA preference (containment), creates barrier to human and ecological receptors, but multiple source areas remain.
Alternative 6 - Consolidated Containment with Low-Permeability Geosynthetic Cover System	MSW and MSW-contaminated soil would be excavated from the Five Acre Landfill and hauled to the Main Landfill for placement into a centralized repository. Containment of consolidated waste with low-permeability geosynthetic cover system (includes 2 feet of cover soil, 0.5 feet of bedding sand, geosynthetic liner, and 0.5 feet of topsoil, then hydroseeded) . Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed in consolidated waste to reduce the buildup and potential offsite migration of landfill gases. The disturbed areas would be seeded and left to naturally revegetate over time.	Permanent closure with long term monitoring. Waste consolidated in one location. Landfill gas collection system controls vapor migration. Geosynthetic and soil barrier to control human and ecological exposure and wind-blown migration. Geosynthetic layer reduces precipitation infiltration and leaching of MSW to groundwater. Achieves waste removal from Five Acre Landfill. Contaminated materials not transported on public roadways.	High costs due to imported materials. Long construction schedule. Increase in elevation and/or footprint of Main Landfill. Increased short-term risk.	High	Feasible, uses proven and readily available materials and construction methods.	Moderate (10+ years or longer)	Construction related impacts such as noise, odors, and dust would substantially impact adjacent properties. After construction completion, constraints on Five Acre site use will be removed and adverse impacts to adjacent lands would be eliminated. Use of Main Landfill site will be limited to activities that will not damage the cap. Adverse impacts to land adjacent to Main Landfill will be minimized because of the landfill cover system and vegetation. Wind-blown migration controlled.	Moderately high MTCA preference, creates barrier to human and ecological receptors, and minimizes precipitation infiltration and leaching of contaminants, but multiple source areas remain. Waste is still being contained only, but part of the site would be completely remediated.
Alternative 7 - Complete Excavation of Main and Five Acre Landfills and Off-Site Disposal at Approved Subtitle D Facility	Waste, cover soil and contaminated soil would be excavated and hauled offsite for disposal in a permitted landfill.	Permanent closure with all waste removed from the Site. Short term monitoring.	Very high costs. Long construction schedule. Increased short-term risk. Contaminated materials hauled on public roadways.	Very High	Feasible, uses proven and readily available materials and construction methods.	Short (5 years)	Low. After construction completion, constraints on site use will be removed and adverse impacts to adjacent lands would be eliminated.	Moderately high MTCA preference. The remedy is still based on containment with no reduction in toxicity or volume, but waste would be removed from the Site to a location with engineered controls.

Notes:

MTCA = Model Toxics Control Act; WAC = Washington Administrative Code

Table 4

Summary of ARARs

Marshall Landfill

Spokane County, Washington

ARAR	Regulated Activity	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Evaluation
Spokane County Codes									
Title 8	Health and Sanitation	Does Not Apply	Applies	Applies	Applies	Applies	Applies	Applies	Waste disposal must comply with this regulation.
Title 9	Rights of Way	Might Apply	Might Apply	Might Apply	Might Apply	Might Apply	Might Apply	Might Apply	Might be needed depending on the location of the work.
Washington State									
Washington Administrative Code 173-60	Noise Levels	Does Not Apply	Applies	Applies	Applies	Applies	Applies	Applies	Maximum noise levels are applicable depending on action selected.
Washington Administrative Code 173-160	Well Construction and Maintenance	Does Not Apply	Does not Apply	Applies	Applies	Applies	Applies	Applies	Minimum standards for construction of water and monitoring wells, and decommissioning.
Washington Administrative Code 173-162	Well Contractors and Operators	Does Not Apply	Does not Apply	Applies	Applies	Applies	Applies	Applies	Procedures for well contractors and operators, applicable to installation and decommissioning of wells and borings.
Washington Administration Code 173-201A	Water Quality Standards for Surface Waters	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup action comply with applicable regulations.
Washington Administration Code 173-304	Solid Waste Handling Standards	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MSW landfill units that stopped receiving waste prior to October 9, 1991 are subject to closure and post-closure rules under chapter 173-304 WAC.
Washington Administration Code 173-340	Toxic Waste Cleanup (MTCA)	Applies	Applies	Applies	Applies	Applies	Applies	Applies	The remedial action will be conducted under MTCA. Remedial alternatives will comply with MTCA regulations.
Washington Administrative Code 173-350	Solid Waste Handling Standards	Does Not Apply	Does not Apply	Does not Apply	Does not Apply	Does not Apply	Does not Apply	Does not Apply	Landfill regulations do not apply to facilities that have closed before April 25, 2013.
Washington Administrative Code 173-351	Solid Waste Handling Standards	Does Not Apply	Does not Apply	Does not Apply	Does not Apply	Does not Apply	Does not Apply	Applies	Landfill regulations apply to MSW landfills that receive waste on or after November 26, 1993.
Washington Administrative Code 173-400	Fugitive Emissions	Does Not Apply	Applies	Applies	Applies	Applies	Applies	Applies	Requires owner to take reasonable precautions to prevent fugitive emissions.
Washington Administrative Code 197-11 and 173-802	State Environmental Policy Act	Applies	Applies	Applies	Applies	Applies	Applies	Applies	A SEPA review is required for projects with potential significant environmental impacts.
Washington Administrative Code 296-155	Safety Standards for Construction Work	Applies	Applies	Applies	Applies	Applies	Applies	Applies	Applicable during construction activities.
Washington Administrative Code 296-62	General Occupational Health Standards	Applies	Applies	Applies	Applies	Applies	Applies	Applies	Applicable during construction activities.
RCW 90.48	Water Pollution Control (Construction Stormwater Permit)	Does Not Apply	Does not Apply	Applies	Applies	Applies	Applies	Applies	A Stormwater Pollution Prevention Plan (SWPPP) is required for each remediation alternative.
Federal Regulations									
Title 40 Code of Federal Regulations 50	Clean Air Act	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 131	Water Quality Standards (National Toxics Rule)	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 141/143	Drinking Water Regulations	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 40 Code of Federal Regulations 260-268	Hazardous Waste (RCRA)	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.
Title 33 of United States Code, Chapter 26	Water Pollution Control (Clean Water Act)	Applies	Applies	Applies	Applies	Applies	Applies	Applies	MTCA requires cleanup actions comply with applicable regulations.

Notes:

ARAR = Applicable or Relevant and Appropriate Requirements; SEPA = State Environmental Policy Act; RCRA = Resource Conservation and Recovery Act; MTCA = Model Toxics Control Act; WAC = Washington Administrative Code

Table 5

Evaluation of Cleanup Action Alternatives

Marshall Landfill
Spokane County, Washington

Alternative Numbers	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Alternative Descriptions	Institutional controls.	Institutional controls with Limited Soil Cover	In-Place Containment of Waste with Soil Cover System.	Consolidated Containment with Soil Cover System	In-Place Containment of Waste with Low-Permeability Geosynthetic Cover System.	Consolidated Containment with Low-Permeability Geosynthetic Cover System	Complete Excavation of Main and Five-Acre Landfills and Off-Site Disposal at approved Subtitle D Facility
	Institutional controls, including a restrictive covenant and fencing, would be established for the landfill areas to reduce the potential for direct contact with exposed waste by humans and wildlife. In this scenario, no active remedial measures would be implemented. Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design).	Institutional controls, including a restrictive covenant and fencing, would be established for the landfill areas to reduce the potential for direct contact with exposed waste by humans and wildlife. Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); exposed waste would be covered with 1 foot of soil, seeded and left to naturally revegetate over time.	In-place containment of Main and Five Acre Landfill MSW, and areas between the two landfills, with soil cover system (approximately 2 feet of cover material topped with 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed to reduce the buildup and potential offsite migration of gases. The disturbed areas would be seeded and left to naturally revegetate over time.	MSW and MSW-contaminated soil would be excavated from the Five Acre Landfill and hauled to the Main Landfill for placement into a centralized repository. Containment of consolidated waste with soil cover system (approximately 2 feet of cover material topped with 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed in consolidated waste to reduce the buildup and potential offsite migration of landfill gases. The disturbed areas would be seeded and left to naturally revegetate over time.	In-place containment of Main and Five Acre Landfill MSW with low-permeability geosynthetic cover system (includes 2 feet of cover soil, 0.5 feet of bedding sand, geosynthetic liner, and 0.5 feet of topsoil, then hydroseeded). Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed to reduce the buildup and potential offsite migration of gases. The disturbed areas would be seeded and left to naturally revegetate over time.	MSW and MSW-contaminated soil would be excavated from the Five Acre Landfill and hauled to the Main Landfill for placement into a centralized repository. Containment of consolidated waste with low-permeability geosynthetic cover system (includes 2 feet of cover soil, 0.5 feet of bedding sand, geosynthetic liner, and 0.5 feet of topsoil, then hydroseeded) . Main Landfill buttress berm would be regraded to a stable slope of 2.1:1 or less (depending on final design); with additional site grading to control and mitigate stormwater run-on and run-off. Landfill gas collection system would be constructed in consolidated waste to reduce the buildup and potential offsite migration of landfill gases. The disturbed areas would be seeded and left to naturally revegetate over time.	Waste, cover soil and contaminated soil would be excavated and hauled offsite for disposal in a permitted landfill.
Alternative Ranking Under MTCA							
1. Compliance with MTCA Threshold							
Protection of Human Health and Environment	**No** - Alternative does not provide protection of human health and environment.	**Yes** - Alternative will protect human health and the environment. Residual MSW managed with limited cover and institutional controls.	**Yes** - Alternative will protect human health and the environment. Residual MSW managed with capping and institutional controls.	**Yes** - Alternative will protect human health and the environment. Residual MSW managed with capping and institutional controls.	**Yes** - Alternative will protect human health and the environment. Residual MSW managed with capping and institutional controls.	**Yes** - Alternative will protect human health and the environment. Residual MSW managed with capping and institutional controls.	**Yes** - Alternative will protect human health and the environment. Contaminated soil will be removed from the site.
Compliance with Cleanup Standards	**No** - Alternative does not comply with cleanup standards.	**Yes** - Alternative is expected to comply with soil cleanup standards through capping.	**Yes** - Alternative is expected to comply with soil cleanup standards through capping.	**Yes** - Alternative is expected to comply with soil cleanup standards through excavation and capping.	**Yes** - Alternative is expected to comply with soil and groundwater cleanup standards through capping with geosynthetic layer.	**Yes** - Alternative is expected to comply with soil and groundwater cleanup standards through excavation and capping with geosynthetic layer.	**Yes** - MSW will be removed to the extent feasible.
Compliance with Applicable State and Federal Regulations	**No** - Alternative will not comply with applicable state and federal regulations.	**No** - Alternative will not comply with applicable state and federal regulations.	**Yes** - Alternative complies with applicable state and federal regulations.	**Yes** - Alternative complies with applicable state and federal regulations.	**Yes** - Alternative complies with applicable state and federal regulations.	**Yes** - Alternative complies with applicable state and federal regulations.	**Yes** - Alternative complies with applicable state and federal regulations.
Provision for Compliance Monitoring	**Yes** - Alternative includes long-term monitoring.	**Yes** - Alternative includes long-term monitoring.	**Yes** - Alternative includes provision for compliance monitoring (i.e. long-term cap monitoring).	**Yes** - Alternative includes provision for compliance monitoring (i.e. compliance sampling during remedial excavation and long-term cap monitoring).	**Yes** - Alternative includes provision for compliance monitoring (i.e. long-term cap monitoring).	**Yes** - Alternative includes provision for compliance monitoring (i.e. compliance sampling during remedial excavation and long-term cap monitoring).	**Yes** - Alternative includes provision for compliance monitoring (i.e. compliance sampling during remedial excavation).
2. Restoration Time Frame							
Restoration Time Frame	Short timeframe for fence installation (estimated at 2 weeks). Long-term monitoring expected for 25+ years.	Short timeframe for fence installation and limited capping (estimated at 6 weeks). Long-term monitoring expected for 25+ years.	Initial restoration time frame is relatively short (estimated at 10 weeks). Long-term monitoring expected for 25+ years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would take less than 1/2 year (estimated at 20 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would take less than 1/2 year (estimated at 15 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would about 1/2 year (estimated at 25 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate to long. Cleanup implementation would take more than 1/2 year but less than one year (estimated at 30 weeks). Groundwater monitoring expected for 5 years.

Alternative Numbers	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Alternative Descriptions	Institutional controls.	Institutional controls with Limited Soil Cover	In-Place Containment of Waste with Soil Cover System.	Consolidated Containment with Soil Cover System	In-Place Containment of Waste with Low-Permeability Geosynthetic Cover System.	Consolidated Containment with Low-Permeability Geosynthetic Cover System	Complete Excavation of Main and Five-Acre Landfills and Off-Site Disposal at approved Subtitle D Facility
3. Disproportionate Cost Analysis - Relative Benefits Ranking (Scored from 1-lowest to 7-highest)[1]							
Protectiveness	**Score = 1** Achieves low level of protectiveness.	**Score = 2** Achieves overall protectiveness. This alternative is less protective than Alternatives 3 through 6 because the soil barrier thickness is less than Alternatives 3 through 6, contamination remains at the Five Acre Landfill (unlike Alternatives 4 and 6), and/or groundwater is less protected without a geosynthetic membrane (compared to Alternatives 5 and 6); it is also less protective than Alternative 7 because contaminated media remains onsite.	**Score = 4** Achieves overall protectiveness. This alternative is less protective than Alternatives 4 and 6 because contamination remains at Five Acre Landfill, and less protective than Alternatives 5 and 6 which offer a greater degree of groundwater protection.	**Score = 5** Achieves overall protectiveness. This alternative is less protective than Alternatives 5 and 6 which offer a greater degree of groundwater protection.	**Score = 6** Achieves overall protectiveness. This alternative is less protective than Alternative 6 because contamination remains at Five Acre Landfill.	**Score = 7** Achieves highest degree of overall protectiveness. Contaminated soil is consolidated and capped, and is protective of groundwater quality.	**Score = 3** Achieves high level of protectiveness because MSW and contaminated soils are removed. However, the off-site risks are highest with this option because of the significant transport of contaminated soil on public roads. Further, the risk is transferred from one landfill to another landfill with minimal overall benefit to human health and the environment. Alternatives 3 through 6 offer slightly less protective caps than a Subtitle D landfill, but the off-site implementation risks outweigh the benefits.
Permanence	**Score = 1** This alternative achieves no reduction in the toxicity, mobility and mass of material onsite.	**Score = 2** Reduces the mobility of waste with limited soil cover. Does not address potential for landfill gases emanating from the landfill.	**Score = 3** Reduces the mobility of waste and contaminated soil with soil cover. Less protective than Alternatives 4 through 7 because of the broader contamination footprint (Alternatives 4 and 6), less groundwater protection (Alternatives 5 and 6) and the lack of a more robust landfill design (Alternative 7), which all result in Alternative 3 having a higher likelihood of a release. Will address potential for landfill gases emanating from the landfill.	**Score = 4** Reduction in volume of hazardous substances at the Five Acre Landfill. Reduces the mobility of waste and contaminated soil with soil cover. Results in a higher likelihood of a release and is less protective than Alternatives 5 and 6 because of less groundwater protection and is less protective than Alternative 7 which has a more robust landfill design. Will address potential for landfill gases emanating from the landfill.	**Score = 5** Reduces the mobility of waste and contaminated soil with soil cover. Higher likelihood of a release and therefore less protective than Alternative 6 because it has a broader contamination footprint. This alternative is less protective than Alternative 7, which has a more robust landfill design. Will address potential for landfill gases emanating from the landfill.	**Score = 6** Reduction in volume of hazardous substances at the Five Acre Landfill. Reduces the mobility of waste and contaminated soil with soil cover. Results in a higher likelihood of a release and is less protective than Alternative 7 which has a more robust landfill design. Will address potential for landfill gases emanating from the landfill.	**Score = 7** This alternative does not permanently reduce toxicity or the volume of hazardous substances, but the contamination is maintained at a full-time operating landfill with a more robust design.
Long-Term Effectiveness	**Score = 1** Limited long-term effectiveness with low degree of certainty that alternative will be successful.	**Score = 2** Covering and institutional controls are used to minimize human contact with waste. Cover soil and contaminated soil are left in place. Less long term effectiveness than Alternatives 3 through 7, which have more robust covers and/or more protective design and operation (Alternative 7). Long-term effectiveness depends on maintaining integrity of soil cover.	**Score = 3** Covering and institutional controls are used to minimize human contact with waste. Long-term effectiveness depends on maintaining integrity of soil cover. Less long term effectiveness than Alternatives 5 through 7, which have more robust covers (geosynthetic layer) and/or more protective landfill design and operations.	**Score = 3** Similar long-term effectiveness as Alternative 3. Although consolidation of the Five-Acre Landfill onto the Main Landfill results in a smaller footprint, the degree of certainty of the long-term success is unchanged.	**Score = 5** Covering, geosynthetic layer and institutional controls are used to minimize human contact with waste and protect groundwater. This alternative has greater certainty of long-term success because of the protection of groundwater, but has less long-term effectiveness than Alternative 7, which has a more robust monitoring and protection system.	**Score = 5** Similar long-term effectiveness as Alternative 5. Covering, geosynthetic layer and institutional controls are used to minimize human contact with waste and protect groundwater. This alternative has greater certainty of long-term success because of the protection of groundwater, but has less long-term effectiveness than Alternative 7, which has a more robust monitoring and protection system.	**Score = 7** Waste, cover soil and contaminated bottom soil from the Main and Five Acre Landfills would be permanently removed from the site and disposed of at a more secure landfill, resulting in greater long-term effectiveness.
Management of Short-Term Risks	**Score = 7** Lowest short-term risk because only a fence is installed and no contaminated material is excavated.	**Score = 6** Placing limited soil cover presents less short term risks than placing a more robust soil cover system because of a shorter construction time frame and a reduction in the volume of imported material. No contaminated material is excavated.	**Score = 5** The construction of the soil cover in general presents less short term risks than excavation (Alternatives 4, 6, and 7) and off-site disposal (Alternative 7). This alternative is similar in terms of short-term risk to Alternative 5, but is ranked higher because of the shorter construction timeframe.	**Score = 3** Excavation and transport of material from the Five Acre Landfill presents short term risk, therefore this alternative ranks lower than Alternatives 3 and 5. It is similar in risk to Alternative 6, but is ranked higher because of a shorter timeframe. This alternative is ranked higher than Alternative 7 because over-the-road off-site traffic is not required.	**Score = 4** The construction of the soil and geosynthetic cover in general presents less short term risks than excavation (Alternatives 4, 6, and 7) and off-site disposal (Alternative 7). This alternative is similar in terms of short-term risk to Alternative 3, but is ranked lower because of the longer construction timeframe.	**Score = 2** Excavation and transport of material from the Five Acre Landfill presents short term risk, therefore this alternative ranks lower than Alternatives 3 and 5. It is similar in risk to Alternative 4, but is ranked lower because of a longer timeframe. This alternative is ranked higher than Alternative 7 because over-the-road off-site traffic is not required.	**Score = 1** This alternative involves excavation of large volumes of material and related over-the-road traffic for disposal. Therefore, this alternative presents higher short term risks than all other alternatives.

Alternative Numbers	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7
Alternative Descriptions	Institutional controls.	Institutional controls with Limited Soil Cover	In-Place Containment of Waste with Soil Cover System.	Consolidated Containment with Soil Cover System	In-Place Containment of Waste with Low-Permeability Geosynthetic Cover System.	Consolidated Containment with Low-Permeability Geosynthetic Cover System	Complete Excavation of Main and Five-Acre Landfills and Off-Site Disposal at approved Subtitle D Facility
Technical and Administrative Implementability	**Score = 7** High level of implementability with construction of a fence. Restrictive covenants would be required on the property. Ranked highest because it is easiest to implement.	**Score = 6** High level of implementability with construction of a fence and placement of soil over exposed areas of waste. Restrictive covenants would be required on the property. Ranked higher than Alternatives 3 through 7 based on less need for services and materials, shorter schedule and less construction monitoring requirements.	**Score = 5** Implementable but relies on long term maintenance. Access for earthwork and transportation equipment is good. Restrictive covenants would be required on the property. Ranked higher than Alternatives 4 through 7 based on less need for services and materials, shorter schedule and less construction monitoring requirements.	**Score = 4** Implementable but relies on long term maintenance. Access for earthwork and transportation equipment is good. Restrictive covenants would be required on the property. Ranked higher than Alternatives 6 and 7 based on less need for services and materials, shorter schedule and less construction monitoring requirements. Ranked equal to Alternative 5, which requires more materials and services, but requires a shorter schedule and less construction monitoring requirements.	**Score = 4** Implementable but relies on long term maintenance. Access for earthwork and transportation equipment is good. Restrictive covenants would be required on the property. Ranked higher than Alternatives 6 and 7 based on less need for services and materials, shorter schedule and less construction monitoring requirements. Ranked equal to Alternative 4, which requires less materials and services, but requires a longer schedule and more construction monitoring requirements.	**Score = 2** Implementable but relies on long term maintenance. Access for earthwork and transportation equipment is good. Restrictive covenants would be required on the property. Ranked higher than Alternative 7 based on less need for services and materials, shorter schedule and less construction monitoring requirements.	**Score = 1** Implementable, technically possible, off-site disposal facilities are available, access for earthwork and transportation equipment is good. The volume of trucks available to transport material off-site will be a limiting factor to the timeframe of construction and likely would prolong construction activities.
Consideration of Public Concerns	**Score = 1** Lowest level of public acceptance because contaminated materials remain onsite with no control on migration offsite.	**Score = 3** Public may be concerned that waste will remain in place. However, this alternative ranks higher than Alternative 7 because it has a shorter timeframe and results in less construction-related disturbance. It ranks lower than Alternatives 3 through 6 because it has a less protective cap and is less protective of groundwater.	**Score = 5** Public may be concerned that waste will remain in place. However, this alternative ranks higher than Alternatives 4 and 7 because it has a shorter timeframe and results in less construction-related disturbance. It ranks lower than Alternatives 5 and 6 because it is less protective of groundwater.	**Score = 4** Public may be concerned that waste will remain in place. However, this alternative ranks higher than Alternative 7 because it has a shorter timeframe and results in less construction-related disturbance. It ranks lower than Alternatives 5 and 6 because it is less protective of groundwater.	**Score = 7** Ranked higher than other Alternatives because public is concerned about groundwater quality and the geosynthetic layer provides greater protection of groundwater.	**Score = 6** Ranked higher than Alternatives 1 through 4 and 7 because public is concerned about groundwater quality and the geosynthetic layer provides greater protection of groundwater. Ranked lower than Alternative 5 because of the additional construction-related disturbance and timeframe associated with excavating the Five-Acre Landfill.	**Score = 2** Public acceptance of this alternative is likely because contaminated soil is removed from the site. However, significant traffic between the site and disposal area might not be acceptable to residents around the Site.
Total Score	18	21	25	23	31	28	21

Notes:

[1]Alternatives were scored using a scale of 1 to 7 with a score of 1 being the least amount of benefits provided by the alternative and a score of 7 being the most amount of benefits provided by the alternative.

MTCA = Model Toxics Control Act; MSW = Municipal Solid Waste

Table 6

Summary of MTCA Evaluation and Ranking of Cleanup Action Alternatives

Marshall Landfill

Spokane County, Washington

	Alternative 1 - Institutional Controls	Alternative 2 - Institutional Controls with Limited Soil Cover	Alternative 3 - In-Place Containment with Soil Cover System	Alternative 4 - Consolidated Containment with Soil Cover System	Alternative 5 - In-Place Containment with Low-Permeability Geosynthetic Cover System	Alternative 6 - Consolidated Containment with Low-Permeability Geosynthetic Cover System	Alternative 7 - Complete Excavation of Main and Five Acre Landfills and Off-Site Disposal at Approved Subtitle D Facility
Evaluation							
Compliance with MTCA Threshold Criteria	**No**	**No**	**Yes**	**Yes**			**Yes**
Restoration Time Frame	Short timeframe for fence installation (estimated at 2 weeks). Long-term monitoring expected for 25+ years.	Short timeframe for fence installation and limited capping (estimated at 6 weeks). Long-term monitoring expected for 25+ years.	Initial restoration time frame is relatively short (estimated at 10 weeks). Long-term monitoring expected for 25+ years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would take less than 1/2 year (estimated at 20 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would take less than 1/2 year (estimated at 15 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate. Cleanup implementation and capping would about 1/2 year (estimated at 25 weeks). Groundwater and cap monitoring expected for 25 years.	Restoration time frame is relatively moderate to long. Cleanup implementation would take more than 1/2 year but less than one year (estimated at 30 weeks). Groundwater monitoring expected for 5 years.
Relative Benefits Ranking							
Protectiveness	1	2	4	5	6	7	3
Permanence	1	2	3	4	5	6	7
Long-Term Effectiveness	1	2	3	3	5	5	7
Management of Short-Term Risks	7	6	5	3	4	2	1
Technical and Administrative Implementability	7	6	5	4	4	2	1
Consideration of Public Concerns	1	3	5	4	7	6	2
Total of Scores	**18**	**21**	**25**	**23**	**31**	**28**	**21**
Disproportionate Cost Analysis							
Probable Remedy Cost	**$1,427,287**	**$1,789,790**	**$5,340,268**	**$14,489,925**	**$9,535,093**	**$18,112,407**	**$135,418,811**
Costs Disproportionate to Incremental Benefits	No	No	No	Yes	Yes	Yes	Yes
Practicability of Remedy	Not Practicable	Not Practicable	Practicable	Practicable	Practicable	Practicable	Not Practicable
Remedy Permanent to Maximum Extent Practicable	Not Permanent	Yes	Yes	Yes	Yes	Yes	Yes
Overall Alternative Ranking	**7th**	**6th**	**1st**	**3rd**	**2nd**	**4th**	**5th**

Notes:

MTCA = Model Toxics Control Act

Table 7

Alternative 1. Institutional Controls

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Project Management				
Design, work plan and procurement	lump sum	$20,000	1	$20,000
			Task Sub-Total	**$20,000**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yard	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yard	$20.20	35	$707
			Remedial Action Sub-Total	**$582,597**
Fencing				
8-foot Chain Link Fence	foot	$15.00	6,800	$102,000
			Task Sub-Total	**$102,000**
			Remedial Action Sub-Total	**$684,597**
			Remedial Action Contingency (15%)	**$102,690**
			Engineering, Construction Oversight, Project Management, Reporting	**$20,000**
			Remedial Action Estimated Total	**$807,287**
Maintenance and Monitoring (25 Additional Years)				
Quarterly Groundwater Monitoring/Inspection and Reporting	event	$6,000.00	100	$600,000
Occasional repairs	event	$2,000.00	10	$20,000
			Maintenance and Monitoring Total	**$620,000**
			Total Estimated Costs for Alternative 1	**$1,427,287**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 8

Alternative 2. Institutional Controls with Limited Soil Cover

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$60,000.00	1	$60,000
			Task Sub-Total	**$90,000**
Construction Oversight / Project Management / Reporting				
Construction monitoring/oversight - assume 6 weeks construction	day	$1,500.00	30	$45,000
Remedial action report	lump sum	$40,000.00	1	$40,000
			Task Sub-Total	**$85,000**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yard	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yard	$20.20	35	$707
			Remedial Action Sub-Total	**$582,597**
Cover Exposed MSW				
Purchase, place, grade and compact cover soil	cubic yard	$20.20	8,070	$163,014
Hydroseeding	square foot	$0.08	217,800	$17,424
			Task Sub-Total	**$180,438**
Fencing				
8-foot Chain Link Fence	foot	$15.00	6,800	$102,000
			Task Sub-Total	**$102,000**
			Remedial Action Sub-Total	**$865,035**
			Remedial Action Contingency (15%)	**$129,755**
			Engineering, Construction Oversight, Project Management, Reporting	**$175,000**
			Remedial Action Estimated Total	**$1,169,790**

Scope Item	Unit	Unit Cost	Quantity	Extended
Maintenance and Monitoring (25 Additional Years)				
Quarterly Groundwater Monitoring/Inspection and Reporting	event	$6,000.00	100	$600,000
Occasional repairs	event	$2,000.00	10	$20,000
			Maintenance and Monitoring Total	**$620,000**
			Total Estimated Costs for Alternative 2	**$1,789,790**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 9

Alternative 3. In-Place Containment with Soil Cover System

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Work Plan / Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$80,000.00	1	$80,000
			Task Sub-Total	**$110,000**
Construction Oversight / Project Management / Reporting				
Construction monitoring/oversight - assume 10 weeks construction	day	$1,500.00	50	$75,000
Remedial action report	lump sum	$40,000.00	1	$40,000
			Task Sub-Total	**$115,000**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yard	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yard	$20.20	35	$707
			Task Sub-Total	**$582,597**
Construct Gas Collection System (Main and Five Acre Landfill)				
Construct Gas Collection trench, install drain rock and piping	foot	$17.00	6,000	$102,000
Purchase and install vent flares (optional)	each	$3,100.00	10	$31,000
			Task Sub-Total	**$133,000**
Construct Soil Cover System (Main and Five Acre Landfill)				
Purchase, place, grade and compact cover soil	cubic yard	$20.20	104,098	$2,102,774
Purchase, place and grade topsoil	ton	$28.25	31,229	$882,228
Hydroseeding	square foot	$0.08	1,405,319	$112,426
			Task Sub-Total	**$3,097,427**
Additional Costs				
Erosion control	foot	$7.00	6,800	$47,600
Construction Surveying	day	$2,000.00	10	$20,000
Dust suppressant (water) during construction	day	$300.00	50	$15,000
Fencing	foot	$15.00	6,800	$102,000
			Task Sub-Total	**$184,600**
			Remedial Action Sub-total	**$3,997,624**
			Remedial Action Contingency (15%)	**$599,644**
			Engineering, Construction Oversight, Project Management, Reporting	**$225,000**
			Remedial Action Estimated Total	**$4,822,268**

Scope Item	Unit	Unit Cost	Quantity	Extended
Maintenance and Monitoring (5 Years)				
8 Groundwater Monitoring Events (Yr 1 -Quarterly, then Annual)	event	$6,000.00	8	$48,000
Monthly Inspection/Quarterly Reporting	event	$1,500.00	60	$90,000
Occasional repair/regrading	event	$10,000.00	2	$20,000
			Task Sub-Total	**$158,000**
Maintenance and Monitoring (20 Additional Years)				
Annual Groundwater Monitoring	event	$6,000.00	20	$120,000
Quarterly Inspection/Quarterly Reporting	event	$2,500.00	80	$200,000
Occasional repair/regrading	event	$10,000.00	4	$40,000
			Task Sub-Total	**$360,000**
			Maintenance and Monitoring Total	**$518,000**
			Total Estimated Costs for Alternative 3	**$5,340,268**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 10

Alternative 4. Consolidated Containment with Soil Cover System

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Work Plan / Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$80,000.00	1	$80,000
			Task Sub-Total	**$110,000**
Construction Oversight / Project Management / Reporting				
Construction monitoring/oversight - assume 20 weeks construction	day	$1,500.00	100	$150,000
Remedial action report	lump sum	$40,000.00	1	$40,000
			Alternative 3A Task Sub-Total	**$190,000**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yards	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yards	$20.20	35	$707
			Task Sub-Total	**$582,597**
Construct Gas Collection System (Main and Five Acre Landfill)				
Construct Gas Collection trench, install drain rock and piping	foot	$17.00	4,000	$68,000
Purchase and install vent flares (optional)	each	$3,100.00	6	$18,600
			Task Sub-Total	**$86,600**
MSW Removal (Five Acre Landfill and Area Between Main and Five Acre Landfills)				
Excavate, transport and place MSW at Main Landfill	cubic yards	$8.25	292,920	$2,416,590
Site grading	acres	$2,500.00	9	$22,760
Backfill	cubic yard	$20.20	292,920	$5,916,984
Hydroseeding	square foot	$0.08	396,564	$31,725
			Task Sub-Total	**$8,388,059**
Construct Soil Cover System (Main Landfill)				
Purchase, place, grade and compact cover soil	cubic yard	$20.20	89,667	$1,811,276
Purchase, place and grade topsoil	ton	$28.25	26,900	$759,929
Hydroseeding	square foot	$0.08	1,210,506	$96,840
			Task Sub-Total	**$2,668,045**

Scope Item	Unit	Unit Cost	Quantity	Extended
Additional Costs				
Erosion control	foot	$7.00	6,800	$47,600
Construction Surveying	day	$2,000.00	10	$20,000
Dust suppressant (water) during construction	day	$300.00	100	$30,000
Fencing	foot	$15.00	4,382	$65,730
			Task Sub-Total	**$163,330**
			Remedial Action Sub-total	**$11,888,631**
			Remedial Action Contingency (15%)	**$1,783,295**
			Engineering, Construction Oversight, Project Management, Reporting	**$300,000**
			Remedial Action Estimated Total	**$13,971,925**
Maintenance and Monitoring (5 Years)				
8 Groundwater Monitoring Events (Yr 1 -Quarterly, then Annual)	event	$6,000.00	8	$48,000
Monthly Inspection/Quarterly Reporting	event	$1,500.00	60	$90,000
Occasional repair/regrading	event	$10,000.00	2	$20,000
			Task Sub-Total	**$158,000**
Maintenance and Monitoring (20 Additional Years)				
Annual Groundwater Monitoring	event	$6,000.00	20	$120,000
Quarterly Inspection/Quarterly Reporting	event	$2,500.00	80	$200,000
Occasional repair/regrading	event	$10,000.00	4	$40,000
			Task Sub-Total	**$360,000**
			Maintenance and Monitoring Total	**$518,000**
			Total Estimated Costs for Alternative 4	**$14,489,925**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 11

Alternative 5. In-Place Containment with Low-Permeability Geosynthetic Cover System

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Work Plan / Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$100,000.00	1	$100,000
			Task Sub-Total	**$130,000**
Construction Oversight / Project Management / Reporting				
Construction monitoring/oversight - assume 15 weeks construction	day	$1,500.00	75	$112,500
Remedial action report	lump sum	$40,000.00	1	$40,000
			Task Sub-Total	**$152,500**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yard	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yard	$20.20	35	$707
			Task Sub-Total	**$582,597**
Construct Gas Collection System (Main and Five Acre Landfill)				
Construct Gas Collection trench, install drain rock and piping	foot	$17.00	6,000	$102,000
Purchase and install vent flares (optional)	each	$3,100.00	10	$31,000
			Task Sub-Total	**$133,000**
Construct Soil Cover System (Main and Five Acre Landfill)				
Purchase, place, grade and compact bedding sand	ton	$17.62	44,242	$779,536
Purchase and install liner system	square foot	$2.00	1,405,319	$2,810,638
Purchase, place, grade and compact cover soil	cubic yard	$20.20	104,098	$2,102,774
Purchase, place and grade topsoil	ton	$28.25	31,229	$882,228
Hydroseeding	square foot	$0.08	1,405,319	$112,426
			Task Sub-Total	**$6,687,601**

Scope Item	Unit	Unit Cost	Quantity	Extended
Additional Costs				
Erosion control	foot	$7.00	6,800	$47,600
Construction Surveying	day	$2,000.00	10	$20,000
Dust suppressant (water) during construction	day	$300.00	75	$22,500
Fencing	foot	$15.00	6,800	$102,000
			Task Sub-Total	**$192,100**
			Remedial Action Sub-total	**$7,595,298**
			Remedial Action Contingency (15%)	**$1,139,295**
			Engineering, Construction Oversight, Project Management, Reporting	**$282,500**
			Remedial Action Estimated Total	**$9,017,093**
Maintenance and Monitoring (5 Years)				
8 Groundwater Monitoring Events (Yr 1 -Quarterly, then Annual)	event	$6,000.00	8	$48,000
Monthly Inspection/Quarterly Reporting	event	$1,500.00	60	$90,000
Occasional repair/regrading	event	$10,000.00	2	$20,000
			Task Sub-Total	**$158,000**
Maintenance and Monitoring (20 Additional Years)				
Annual Groundwater Monitoring	event	$6,000.00	20	$120,000
Quarterly Inspection/Quarterly Reporting	event	$2,500.00	80	$200,000
Occasional repair/regrading	event	$10,000.00	4	$40,000
			Task Sub-Total	**$360,000**
			Maintenance and Monitoring Total	**$518,000**
			Total Estimated Costs for Alternative 5	**$9,535,093**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 12

Alternative 6. Consolidated Containment with Low-Permeability Geosynthetic Cover System

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Work Plan / Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$100,000.00	1	$100,000
			Task Sub-Total	**$130,000**
Construction Oversight / Project Management / Reporting				
Construction monitoring/oversight - assume 25 weeks construction	day	$1,500.00	125	$187,500
Remedial action report	lump sum	$40,000.00	1	$40,000
			Alternative 3A Task Sub-Total	**$227,500**
Buttress Berm				
Grade and compact berm to 2.1:1 slope	cubic yards	$13.00	35,530	$461,890
Construct gravity block retaining wall	square foot	$40.00	3,000	$120,000
Place and compact backfill	cubic yards	$20.20	35	$707
			Task Sub-Total	**$582,597**
Construct Gas Collection System (Main and Five Acre Landfill)				
Construct Gas Collection trench, install drain rock and piping	foot	$17.00	4,000	$68,000
Purchase and install vent flares (optional)	each	$3,100.00	6	$18,600
			Task Sub-Total	**$86,600**
MSW Removal (Five Acre Landfill and Area Between Main and Five Acre Landfills)				
Excavate, transport and place MSW at Main Landfill	cubic yards	$8.25	292,920	$2,416,590
Site grading	acres	$2,500.00	9	$22,760
Backfill	cubic yard	$20.20	292,920	$5,916,984
Hydroseeding	square foot	$0.08	396,564	$31,725
			Task Sub-Total	**$8,388,059**
Construct Soil Cover System (Main Landfill)				
Purchase, place, grade and compact bedding sand	ton	$17.62	38,109	$671,472
Purchase and install liner system	square foot	$2.00	1,210,506	$2,421,012
Purchase, place, grade and compact cover soil	cubic yard	$20.20	89,667	$1,811,276
Purchase, place and grade topsoil	ton	$28.25	26,900	$759,929
Hydroseeding	square foot	$0.08	1,210,506	$96,840
			Task Sub-Total	**$5,760,529**

Scope Item	Unit	Unit Cost	Quantity	Extended
Additional Costs				
Erosion control	foot	$7.00	6,800	$47,600
Construction Surveying	day	$2,000.00	10	$20,000
Dust suppressant (water) during construction	day	$300.00	125	$37,500
Fencing	foot	$15.00	4,382	$65,730
			Task Sub-Total	**$170,830**
			Remedial Action Sub-total	**$14,988,615**
			Remedial Action Contingency (15%)	**$2,248,292**
			Engineering, Construction Oversight, Project Management, Reporting	**$357,500**
			Remedial Action Estimated Total	**$17,594,407**
Maintenance and Monitoring (5 Years)				
8 Groundwater Monitoring Events (Yr 1 -Quarterly, then Annual)	event	$6,000.00	8	$48,000
Monthly Inspection/Quarterly Reporting	event	$1,500.00	60	$90,000
Occasional repair/regrading	event	$10,000.00	2	$20,000
			Task Sub-Total	**$158,000**
Maintenance and Monitoring (20 Additional Years)				
Annual Groundwater Monitoring	event	$6,000.00	20	$120,000
Quarterly Inspection/Quarterly Reporting	event	$2,500.00	80	$200,000
Occasional repair/regrading	event	$10,000.00	4	$40,000
			Task Sub-Total	**$360,000**
			Maintenance and Monitoring Total	**$518,000**
			Total Estimated Costs for Alternative 6	**$18,112,407**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Table 13

Alternative 7. Complete Excavation of Main and Five-Acre Landfills and Off-Site Disposal at Approved Subtitle D Facility

Marshall Landfill

Spokane County, Washington

Scope Item	Unit	Unit Cost	Quantity	Extended
Design/Work Plan / Project Management				
Permitting	lump sum	$30,000.00	1	$30,000
Design, Work Plan, Plans/Specs, Project Management	lump sum	$80,000.00	1	$80,000
			Task Sub-Total	**$110,000**
Construction Oversight / Project Management				
Construction monitoring/oversight - assume 30 weeks construction	day	$1,500.00	150	$225,000
Remedial action report	lump sum	$40,000.00	1	$40,000
			Task Sub-Total	**$265,000**
Excavate and Transport MSW to an approved Subtitle D Landfill				
Excavation and loading on trucks	cubic yard	$2.48	2,294,420	$5,690,162
Transportation	ton	$7.20	1,835,536	$13,215,859
Disposal (Subtitle D Landfill)	ton	$28.17	1,835,536	$51,707,049
			Task Sub-Total	**$70,613,070**
Backfill Main and Five Acre Landfills				
Purchase, transport, place and compact select fill	cubic yard	$20.20	2,294,420	$46,347,284
			Task Sub-Total	**$46,347,284**
Additional Costs				
Erosion control	foot	$7.00	6,800	$47,600
Construction surveying	day	$2,000.00	10	$20,000
Dust suppressant (water) during construction	day	$300.00	150	$45,000
Site Grading	acre	$2,500.00	35	$87,500
Hydroseeding	square foot	$0.08	1,405,319	$112,426
			Task Sub-Total	**$312,526**
			Remedial Action Sub-Total	**$117,272,879**
			Alternative 5 Remedial Action Contingency (15%)	**$17,590,932**
			Engineering, Construction Oversight, Project Management, Reporting	**$375,000**
			Remedial Action Estimated Total	**$135,238,811**

Scope Item	Unit	Unit Cost	Quantity	Extended
Maintenance and Monitoring (5 Years)				
Quarterly Groundwater Monitoring/Inspection and Reporting	event	$6,000.00	20	$120,000
Occasional repair/regrading	event	$10,000.00	6	$60,000
			Task Sub-Total	**$180,000**
			Total Estimated Costs for Alternative 7	**$135,418,811**

Notes:

Unit costs derived from either RS Means, estimates from local vendors, and experience. Estimated costs are considered to be within a margin of +/- 30 percent.

Refer to Table 2 for assumptions used to generate material quantities.

Assumes site backfilled to restore existing topography.

FIGURES

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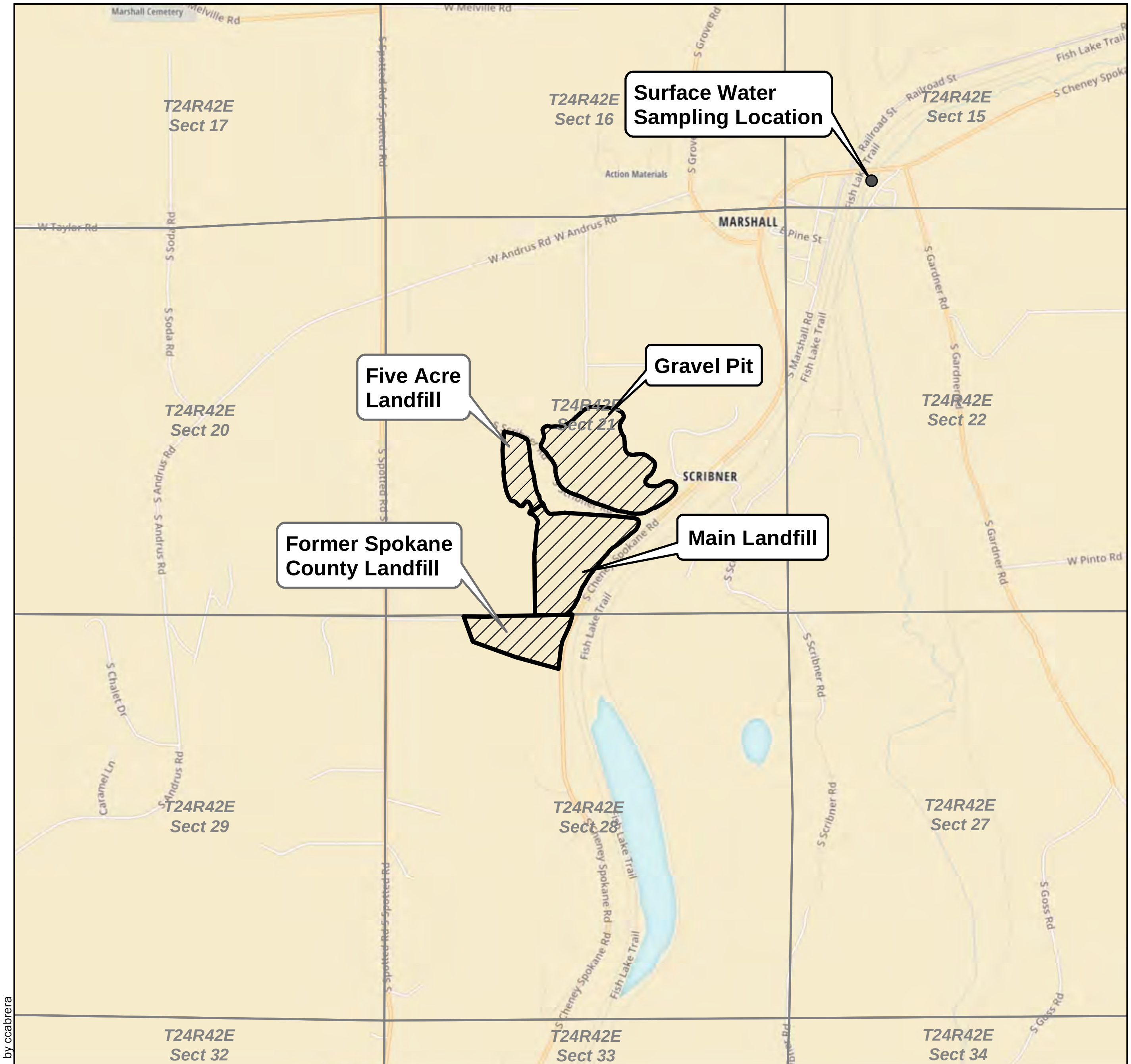

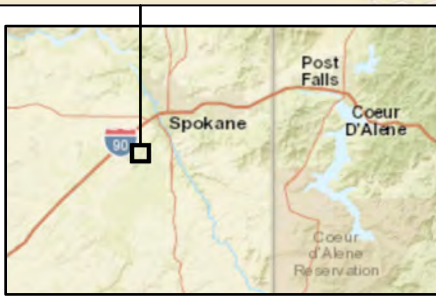

N
W E
S

2,000 0 2,000
Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 11N

Vicinity Map

Marshall Landfill
Spokane County, Washington

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Figure 1

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Legend

Monitoring Well (installed by GeoEngineers) Designation and Approximate Location

Monitoring Well (installed by others) Designation and Approximate Location

Marshall Landfill Groundwater Supply Well Approximate Location

Private and/or Community Well Designation and Approximate Location (Fetrow Engineering, 1991)

Abandoned Exploratory Boring and Approximate Location (Fetrow Engineering, 1991)

Ephemeral Stream

Approximate Landfill Boundaries[3]

Approximate Limits of Adjacent Landfill or Mining Land Use[3]

400 0 400

Feet

Data Source: Aerial from ESRI Data Online. Water features from PNW Hydrography.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Boundaries of landfill and mining land use were adapted from Fetrow Engineering (1991) based on Remedial Investigation explorations and aerial photography. The Former Spokane County landfill boundaries have not been modified from Fetrow Engineering (1991).

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Site Plan and Monitoring Well Map

Marshall Landfill
Spokane County, Washington

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Figure 2

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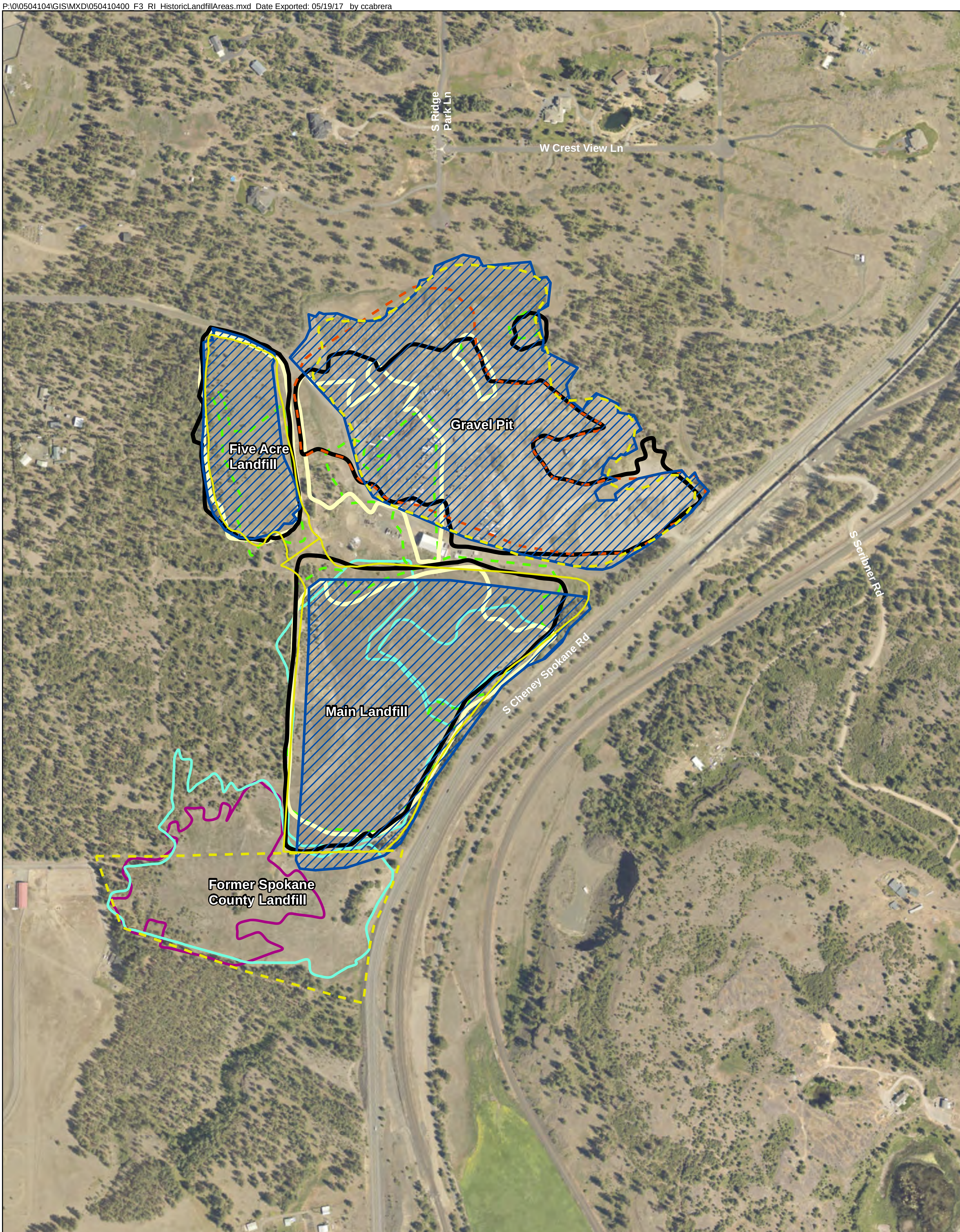

Approximate Areas of Disturbed Land[3]

2011	1992	1974
2000	1986	1968
1994	1979	

Approximate Landfill Boundaries[4]

Approximate Limits of Adjacent Landfill or Mining Land Use[4]

N W E S

450 0 450

Feet

*Layers not shown for a specific landfill area indicate the disturbed area did not vary from an earlier aerial photograph.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Areas of disturbed land were approximated based on examination of Washington State Department of Natural Resources Aerial Photographs taken during the specified years.
4. Boundaries of landfill and mining land use were adapted from Fetrow Engineering (1941) based on Remedial Investigation explorations and aerial photography. The Former Spokane County landfill boundaries have not been modified from Fetrow Engineering (1991).

Data Source: ArcGIS Online; Aerial photograph from ESRI Data Online 2014.

Projection: NAD 1983 UTM Zone 11N

Historic Limits of Disturbed Land Use

Marshall Landfill
Spokane County, Washington

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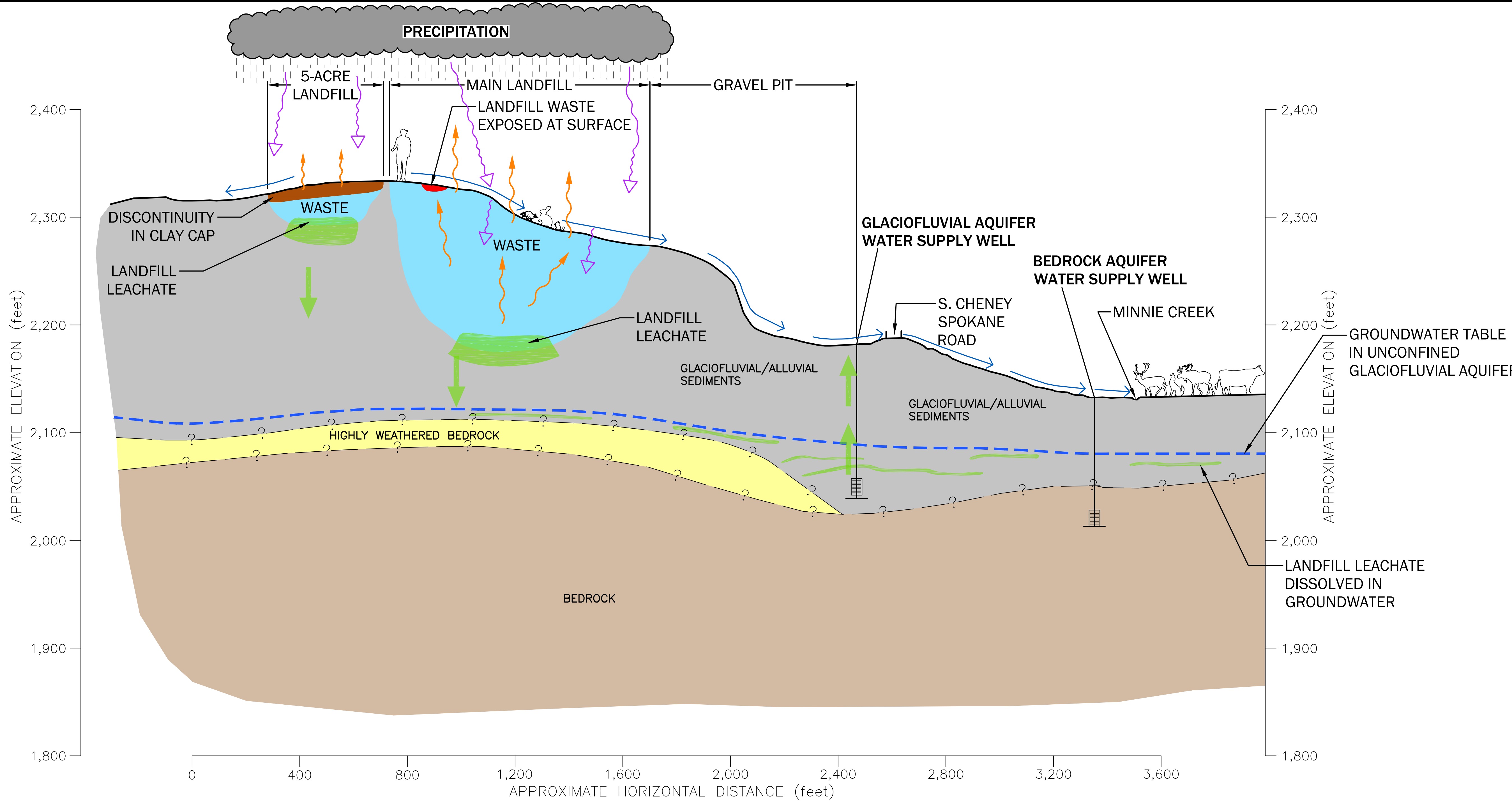
Figure 3



EXPLANATION:

- WELL CASING
- WELL SCREENS
- BOTTOM OF BORING / WELL
- SURFACE WATER RUNOFF RELEASE MECHANISM
- LANDFILL LEACHATE EXPOSURE MECHANISM
- LANDFILL GASES MIGRATION MECHANISM
- PRECIPITATION/INFILTRATION MIGRATION MECHANISM

400 0 400
Horizontal Scale in Feet
100 0 100
Vertical Scale in Feet
Vertical Exaggeration: 4X

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.
3. This is a diagrammatic representation of subsurface conditions and potential exposure pathways for conceptual purposes. All elevations, locations, and dimensions shown are approximate.
4. Elevations refer to the North American Vertical Datum of 1988.

Conceptual Site Model

Marshall Landfill
Spokane County, Washington

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Figure 4

Legend

- VOC Concentrations in Landfill Gas Monitoring Well were Greater than MTCA Method B CULs During One or More Monitoring Events
- VOC Concentrations in Landfill Gas Monitoring Well were Less than MTCA Method B CULs for All Monitoring Events
- Approximate Limits of Adjacent Landfill or Mining Land Use[3]
- Approximate Landfill Boundaries[3]

N W E S

300 0 300

Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Boundaries of landfill and mining land use were adapted from Fetrow Engineering (1991) based on Remedial Investigation explorations and aerial photography. The Former Spokane County landfill boundaries have not been modified from Fetrow Engineering (1991).
VOC = volatile organic compound; MTCA = Model Toxics Control Act; CUL = Cleanup level.

Data Source: Aerial from ESRI Data Online.
Water features from PNW Hydrography.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Soil Gas VOC Exceedances

Marshall Landfill
Spokane County, Washington

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Figure 5

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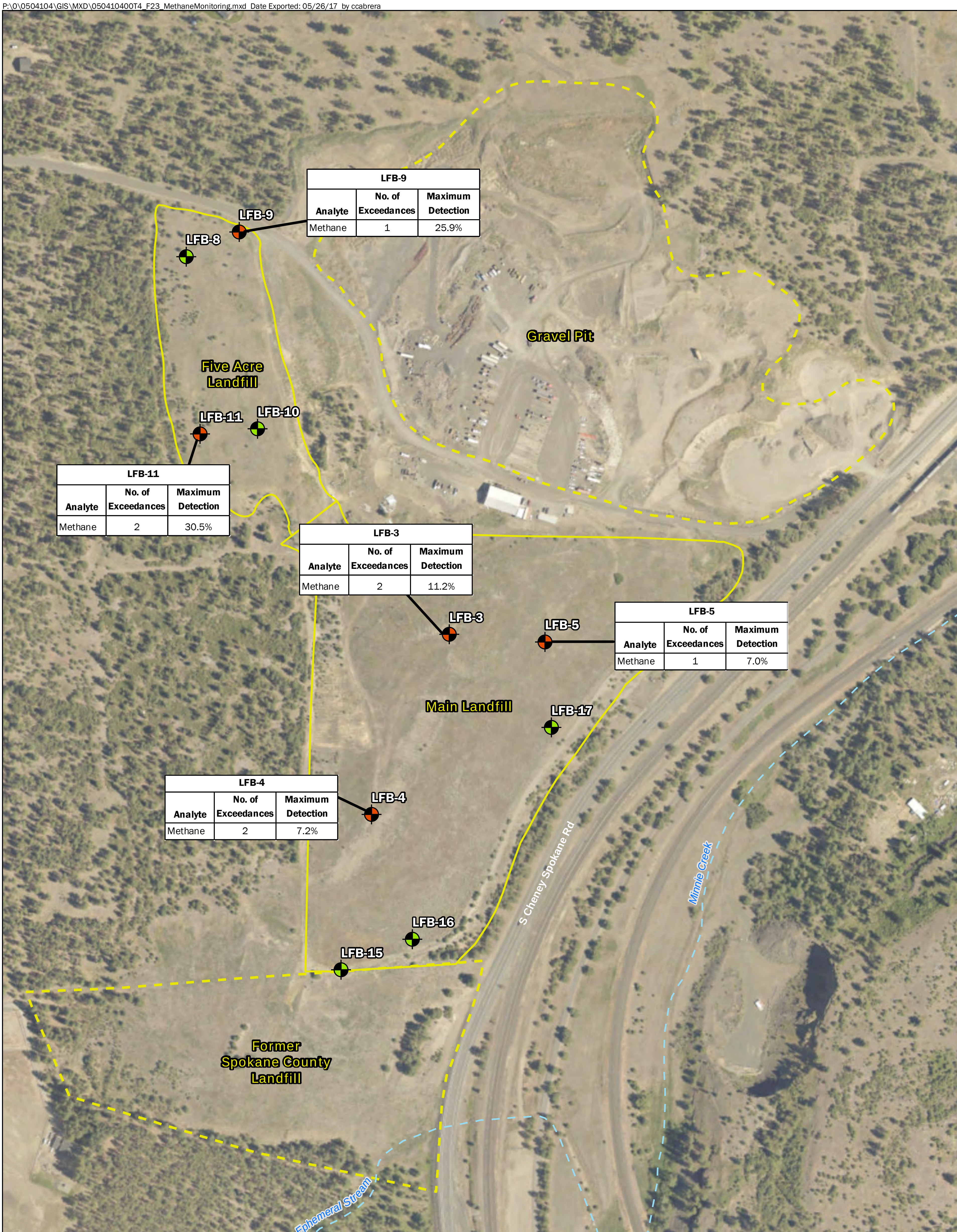

Legend

- Methane Concentrations in Landfill Gas Monitoring Well were Greater Than 5% During One or More of the 2016-2017 Monitoring Events
- Methane Concentrations in Landfill Gas Monitoring Well were Less Than 5% During the 2016-2017 Monitoring Events
- Approximate Limits of Adjacent Landfill or Mining Land Use[4]
- Approximate Landfill Boundaries[4]

N W E S

300 0 300

Feet

Notes:

1. Please refer to Table 17 for the full dataset and applicable cleanup levels.
2. The locations of all features shown are approximate.
3. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
4. Boundaries of landfill and mining land use were adapted from Fetrow Engineering (1991) based on Remedial Investigation explorations and aerial photography. The Former Spokane County landfill boundaries have not been modified from Fetrow Engineering (1991).

Data Source: Aerial from ESRI Data Online.
Water features from PNW Hydrography.

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Methane Monitoring Results 2016-2017

Marshall Landfill
Spokane County, Washington

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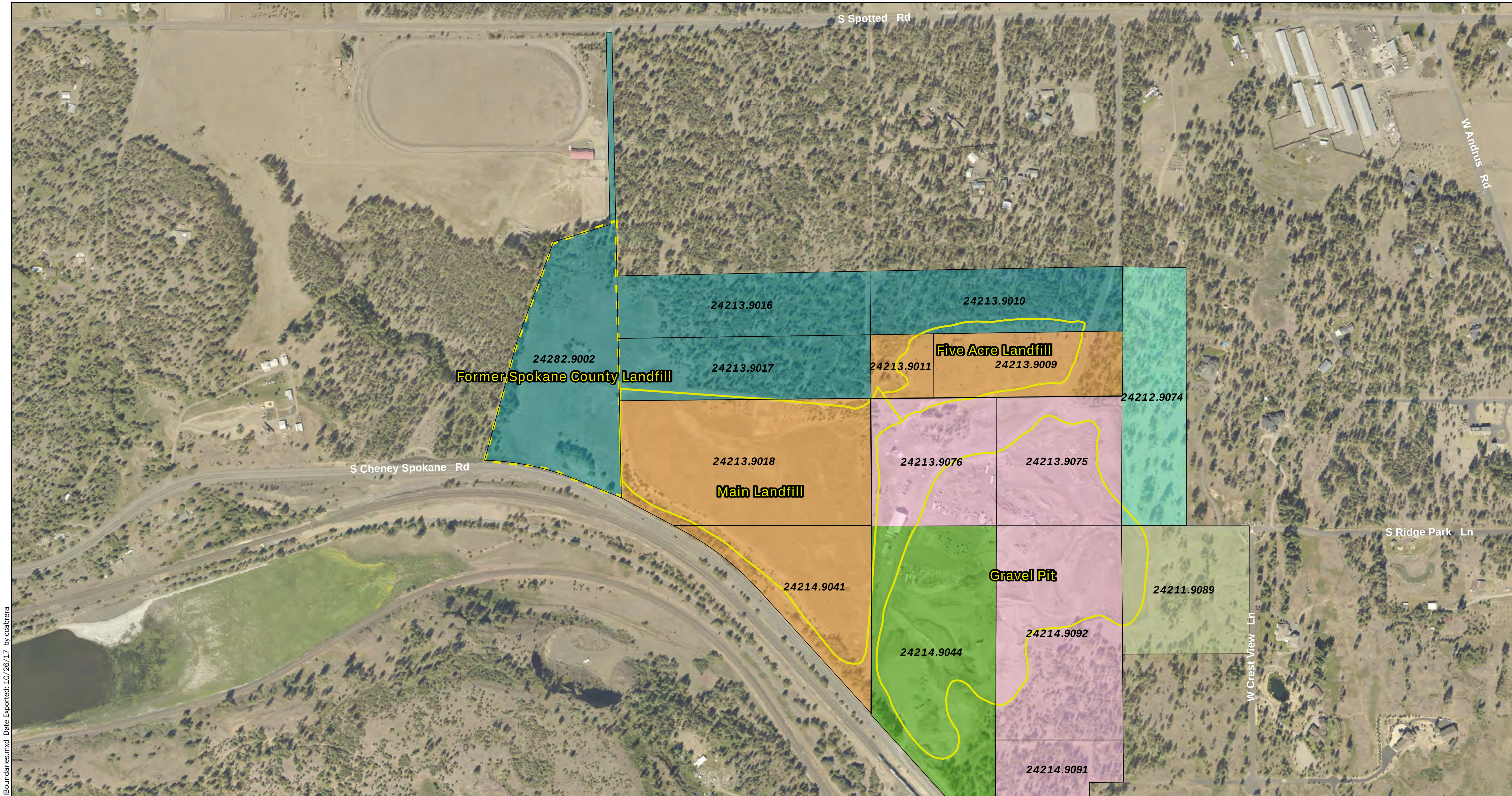
Figure 6



Data Source: Street labels, parcels and imagery from Spokane County GIS.

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Boundaries of landfill and mining land use were adapted from Fetrow Engineering (1941) based on Remedial Investigation explorations and aerial photography. The Former Spokane County landfill boundaries have not been modified from Fetrow Engineering (1991).

Projection: NAD 1983 UTM Zone 11N

Legend

Parcel Owner
- Marshall Properties
- Spokane County Engineers
- Jongeward
- Castle Materials, Inc.
- Gillingham
- Seals/ Zorb-Seals
- Approximate Landfill Boundaries[3]
- Approximate Limits of Adjacent Landfill or Mining Land Use[3]

24214.9044: Parcel Number

500 0 500
Feet

Parcel Boundaries

Marshall Landfill
Spokane County, Washington

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Figure 7

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