

# Deschutes County Solid Waste Management Facility (SWMF) Final Site Evaluation

*Prepared for*  
Deschutes County Solid Waste Department



May 2024

**ParametriX**

*page intentionally blank  
for double-sided printing*

# **Deschutes County Solid Waste Management Facility (SWMF) Final Site Evaluation**

*Prepared for*

**Deschutes County Solid Waste Department**  
61050 SE 27th Street  
Bend, OR 97702

*Prepared by*

**Parametrix**  
150 NW Pacific Park Lane, Suite 110  
Bend, OR 97701  
T. 541.508.7710 F. 1.855.542.6353  
[www.parametrix.com](http://www.parametrix.com)

May 2024 | 553-2509-011

# Citation

Parametrix. 2024. Deschutes County Solid Waste Management Facility (SWMF) Final Site Evaluation. Prepared for Deschutes County Solid Waste Department by Parametrix, Bend, Oregon. May 2024.

# Contents

<b>1. Executive Summary.....</b>	<b>1-1</b>
<b>2. Introduction.....</b>	<b>2-1</b>
2.1 Background.....	2-1
2.2 Purpose of Study.....	2-1
2.3 County, State, and Federal Landfill Siting Restrictions.....	2-2
2.3.1 Federal.....	2-2
2.3.2 State.....	2-3
2.3.3 County.....	2-3
2.4 Moon Pit Site Information.....	2-3
2.5 Roth East Site Information.....	2-4
<b>3. Conceptual Facility Layouts.....</b>	<b>3-1</b>
3.1 Landfill Footprint.....	3-1
3.2 Perimeter Access Road and Ditch.....	3-1
3.3 Excavation Plan.....	3-2
3.4 Liner System.....	3-2
3.5 Primary Leachate Collection and Removal System.....	3-2
3.6 Secondary Leachate Collection and Removal System.....	3-3
3.7 Cell Construction and Fill Sequence.....	3-4
3.8 Final Configuration.....	3-4
3.9 Closure and End Use.....	3-4
<b>4. Existing Conditions, Impacts, and Mitigation.....</b>	<b>4-1</b>
4.1 Site Development and Permitting.....	4-1
4.1.1 Location and Topography.....	4-1
4.1.2 Zoning and Existing Land Use.....	4-1
4.1.3 Potential Permits.....	4-3
4.2 Transportation System.....	4-4
4.2.1 Daily Landfill Activities at Both Sites.....	4-4
4.2.2 Moon Pit Site.....	4-4
4.2.3 Roth East Site.....	4-4
4.2.4 Overall Conclusions.....	4-5
4.3 Water Infrastructure Assessment.....	4-5

# Contents (continued)

4.3.1	Moon Pit.....	4-6
4.3.2	Roth East.....	4-6
4.4	Electrical Power Supply.....	4-7
4.4.1	Moon Pit Electrical Infrastructure Needs.....	4-7
4.4.2	Roth East Electrical Infrastructure Needs.....	4-7
4.5	Flood Risks.....	4-7
4.5.1	Moon Pit Site.....	4-7
4.5.2	Roth East Site.....	4-8
4.6	Geology/Hydrogeology.....	4-8
4.6.1	Geology.....	4-8
4.6.2	Hydrogeology.....	4-9
4.7	Preliminary Geotechnical Feasibility.....	4-10
4.7.1	Moon Pit.....	4-10
4.7.2	Roth East.....	4-12
4.8	Environmental Site Assessment Phase I.....	4-14
4.8.1	Moon Pit.....	4-14
4.8.2	Roth East.....	4-15
4.9	Air Quality, Weather, and Greenhouse Gas Emissions.....	4-16
4.9.1	Moon Pit.....	4-17
4.9.2	Roth East.....	4-18
4.10	Natural Resources.....	4-20
4.10.1	Moon Pit Site Characteristics.....	4-20
4.10.2	Moon Pit Site Protected Species, Habitat, and Permitting.....	4-20
4.10.3	Moon Pit Site Development Compensatory Mitigation.....	4-22
4.10.4	Moon Pit Site Summary.....	4-23
4.10.5	Roth East Site Characteristics.....	4-23
4.10.6	Roth East Site Protected Species, Habitat, and Permitting.....	4-23
4.10.7	Roth East Site Development Compensatory Mitigation.....	4-25
4.10.8	Roth East Site Summary.....	4-26
4.11	Archaeology and Cultural Heritage.....	4-26
4.11.1	Archaeological and Historical Resources.....	4-26
4.11.2	Cultural Resources Literature Search and Records Review.....	4-26
4.11.3	Cultural Resources Reconnaissance Survey.....	4-27

# Contents (continued)

4.11.4 Cultural Resources Impacts .....	4-28
4.11.5 Cultural Resources Mitigation .....	4-28
4.12 Community Assessment.....	4-29
4.12.1 Site-Specific Community Assessment Summary .....	4-29
4.12.2 Community Characteristics .....	4-29
4.12.3 Continued Outreach.....	4-30
4.12.4 Siting Evaluation Outreach Summary.....	4-30
<b>5. Cost Analysis .....</b>	<b>5-1</b>
5.1 Capacity and Projected Life .....	5-1
5.2 Population to be Served .....	5-1
5.3 Accepted and Prohibited Wastes.....	5-1
5.4 Rate of Waste Disposal .....	5-1
5.5 Mineral Resources.....	5-2
5.6 Initial Development Costs .....	5-2
5.6.1 Moon Pit Site .....	5-2
5.6.2 Roth East Site.....	5-2
5.7 Refuse Cell Construction.....	5-3
5.8 Description of Operation .....	5-4
5.9 Daily and Intermediate Cover .....	5-5
5.10 Landfill Closure .....	5-5
5.11 DEQ Permitting.....	5-5
5.12 Summary of Cost Analysis.....	5-6
<b>6. Conclusion.....</b>	<b>6-1</b>

## FIGURES

Figure 1. Final SWMF Sites in Deschutes County.....	2-2
Figure 2. Moon Pit Site Map.....	2-4
Figure 3. Moon Pit Site Photograph.....	2-4
Figure 4. Roth East Site Map .....	2-5
Figure 5. Roth East Site Photo .....	2-5

# Contents (continued)

## TABLES

Table 1. Soil Usage Summary for Moon Pit.....	4-11
Table 2. Soil Usage Summary for Roth East .....	4-14
Table 3. Public Comments Received by County (December 2022-October 2023).....	4-30
Table 4. Estimate of per acre Cost for Landfill Cell Development at Moon Pit.....	5-3
Table 5. Estimate of per acre Cost for Landfill Cell Development at Roth East .....	5-4
Table 6. Comparison of Estimated Annual Operating Costs .....	5-5
Table 7. Landfill Site Cost Comparison.....	5-7

## APPENDICES

- A [Site Comparison Summary Table](#)
- B [Site Screening Report](#)
- C [Site Owner Solicitation Responses](#)
- D [Preliminary Design Drawings](#)
- E [Development and Permitting Evaluation](#)
- F [Transportation Assessment](#)
- G [Water Assessment](#)
- H [Electrical Power Supply Review](#)
- I [Flood Risk Analysis](#)
- J [Geology/Hydrogeology Assessment](#)
- K [Preliminary Geotechnical Feasibility Report](#)
- L Phase I Environmental Site Assessment ([Moon Pit link](#)) ([Roth East link](#))
- M [Air Quality, Weather, and Greenhouse Gas Analysis](#)
- N [Natural Resource Assessment](#)
- O [Archaeological Reconnaissance Survey](#)
- P [Community Assessment](#)
- Q [SMWF Cost Estimates](#)
- R [Comments from Agencies and Organizations](#)



# Acronyms and Abbreviations

#H:#V	horizontal to vertical
µg/m <sup>3</sup>	micrograms per cubic meter
AAGR	average annual growth rate
AST	aboveground storage tank
ASTM	ASTM International
bgs	below ground surface
BLM	Bureau of Land Management
CEC	Central Electric Cooperative
DCC	Deschutes County Code
DEQ	Oregon Department of Environmental Quality
DOGAMI	Oregon Department of Geology And Mineral Industries
ECSI	Environmental Cleanup Site Information
EFU	Exclusive Farm Use zone
EFUHR	Exclusive Farm Use – Horse Ridge zone
EPA	U.S. Environmental Protection Agency
ESA	environmental site assessment
F	Fahrenheit
FEMA	Federal Emergency Management Agency
GCL	geosynthetic clay liner
gpd	gallons per day
gpm	gallons per minute
HDPE	high-density polyethylene
LCRS	leachate collection and removal system
LF	linear foot
LM	Landscape Management Combining zone
MCL	maximum contaminant levels
MSW	municipal solid waste
NWI	National Wetland Inventory
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish And Wildlife
PM	particulate matter
RCRA	Resource Conservation and Recovery Act
REC	recognized environmental condition

## Acronyms and Abbreviations (continued)

SF	square feet
SHPO	State Historic Preservation Office
SM	Surface Mining zone
SMIA	Surface Mining Impact Area zone
SPT	standard penetration tests
SWAC	Solid Waste Advisory Committee
SWMF	solid waste management facility
USFWS	United States Fish and Wildlife Service
WA	Wildlife Area Combining zone
WillametteCRA	Willamette Cultural Resources Associates, Ltd

# 1. Executive Summary

Deschutes County is faced with the imminent challenge of Knott Landfill reaching capacity by 2029, necessitating the selection of a new solid waste management facility (SWMF) that will include a landfill to serve the County for at least 100 years. As recommended in the 2019 Deschutes County Solid Waste Management Plan and directed by the Board of County Commissioners, the Solid Waste Department has been working with the County's Solid Waste Advisory Committee (SWAC) through a public process to identify potential locations for a new SWMF in Deschutes County. Following a rigorous site selection process, the Moon Pit and Roth East sites, both situated east of Bend near US 20, emerged as the final candidate sites. The County and its consultant team, led by Parametrix, commenced an exhaustive multidisciplinary investigation to evaluate the efficacy of each site for development. This report offers a comprehensive analysis of the findings for each site, aiming to guide the County in the selection of a preferred location for the new SWMF.

The Moon Pit site property shape results in a complex layout that is less efficient than that at the Roth East site. Despite a lower capacity-to-acreage ratio, Moon Pit benefits from existing infrastructure including an access road, gate, scales, and well, potentially reducing some upfront development costs. However, its active surface mine status and zoning complexities require careful consideration. The site has an established paved access road with direct access to US 20, but it crosses through Bureau of Land Management lands which could lead to a lengthy federal environmental review process for a change in use. Moon Pit also offers existing water supplies, though securing future water right permits may pose challenges.

Conversely, the Roth East site features a more efficient layout, resulting in a better capacity-to-acreage ratio. As an undeveloped grazing property, it lacks existing infrastructure, demanding upfront capital for access road construction. Zoned as Exclusive Farm Use, Roth East faces a conditional use permit process including a Farm Impact Test which is subject to appeals filed with the land use board of appeals (LUBA). New water infrastructure and water rights permits would be needed at the Roth East site to meet anticipated water demands.

Significant geological differences also exist between the two sites. Moon Pit is in a ridge-bounded valley with shallow bedrock that would require blasting for excavation. As a result, cell development costs are expected to be substantially higher at Moon Pit. However, the potential aggregate resource value, established mining operation, Surface Mine zoning, and Oregon Department of Geology and Mineral Industries permit for the site present the opportunity for aggregate resource extraction to subsidize landfill excavation costs. Roth East, on the other hand, lies in the Millican Valley with unconsolidated alluvial deposits that could be excavated with conventional equipment and used on-site for development and landfill cover needs.

As part of the public process for the siting evaluation, the County received and responded to comments from community members, public agencies, and other interested parties. Many of the public comments about the finalist sites note potential impacts to area wildlife and recreation use that may be caused by landfill development or operations. Comments about the Moon Pit site note the nearby Badlands Wilderness Area, while comments about the Roth East site raise its proximity to Millican Valley residents and the Pine Mountain Observatory.

Moon Pit's development is perceived to have fewer visual and residential impacts, given its remote location and topographic screening by ridges on three sides. It also faces fewer archaeological risks due to its prior disturbance for gravel mining. In terms of wildlife impact, the Moon Pit site poses

potential impacts to a golden eagle nest and essential habitat for mule deer, elk, pronghorn, and sage-grouse. Mitigation costs for these potential wildlife impacts are estimated at \$700,000, with additional operations and maintenance costs of up to \$800,000 for mitigation sites.

Roth East is expected to endure longer permitting, review, and appeal timelines because it is largely undeveloped, may possess archaeological resources, and is challenged by public concerns about potential disturbances to nearby residences and recreational activities. In terms of wildlife impact, Roth East faces greater potential impacts to mule deer, elk, pronghorn, and sage-grouse habitat (sage-grouse has a potential for future listing as an endangered species if population declines continue). The estimated wildlife mitigation costs of \$1.5-8.1 million and additional operations and maintenance costs of up to \$2.5 million for mitigation sites.

The Parametrix team prepared planning level opinions of probable cost (costs) for both sites. These opinions have ranges of -30% to +50%, which is an appropriate level of accuracy for comparison of sites. Moon Pit initial development costs range between \$50 to \$64 million, which includes \$15.4 to \$15.9 million for land acquisition. Roth East development costs are approximately \$36 to \$44 million, with \$5.5 to \$7 million allocated for land acquisition. Moon Pit's landfill cell development costs range from \$705,000 to \$1,075,000 per acre, while Roth East's cell development cost is approximately \$394,000 per acre. Moon pit annual operating costs are \$7.6 million, with Roth East higher at \$8.4 million. Moon Pit's average cost per ton for disposal (capital plus operations) ranges between \$43 to \$48, while Roth East's average cost is just under \$45 per ton. The cost ranges presented here for Moon Pit depend on the extent and cost of cell excavation that could occur as a part of aggregate mining operations on-site. Initial capital costs are significantly higher at Moon Pit, which will necessitate higher tip fees for the first 20 years. However, total cumulative costs are estimated to be similar over the projected lifespans.

The decision between Moon Pit and Roth East hinges on a nuanced evaluation of advantages, challenges, and costs. Moon Pit provides existing infrastructure and potential cost offsets but faces zoning and access road complexities as well as substantially higher upfront development costs. Roth East boasts efficiency and favorable soil conditions, but is challenged by greater infrastructure needs, water availability risks, wildlife impacts, landowner concerns, recreational concerns, and longer haul routes (resulting in higher haul costs and related greenhouse gas emissions). Because the Moon Pit site is already disturbed and will continue to support surface mining (regardless of landfill siting), development of a new landfill at the Roth East would be expected to cause a greater incremental disruption to the surrounding area than at the Moon Pit site. Deschutes County's ultimate selection should prioritize long-term sustainability, environmental protection, and economic viability, ensuring the chosen site best aligns with the County's waste management goals and community values.

See Appendix A for the site comparison summary table.

## **2. Introduction**

### **2.1 Background**

The 2019 Deschutes County Solid Waste Management Plan (SWMP) outlined a roadmap for managing solid waste in the county over the next 20 years. The plan was developed with the input of various stakeholders, including residents, institutions, businesses, cities, and service providers. The SWMP evaluated alternatives for managing the county's waste, including new technologies and the option to transport waste outside the county to other solid waste management facilities.

The SWMP revealed that 84% of survey respondents supported the position that waste generated in Deschutes County should be disposed of within the county, with 93% supporting the recommendation to site a new landfill in the county. Two primary options were considered:

1. Transport waste to regional landfills located between 135 and 185 miles from Deschutes County near the Columbia Gorge.
2. Site and build a new landfill in Deschutes County.

After evaluating these options, the Solid Waste Advisory Committee (SWAC) reached a consensus that the best approach for providing a long-term and cost-effective waste management system was to site and construct a new in-county landfill. This decision was based on several key factors, including the ability to control decisions for managing the county's waste stream, environmental and other impacts resulting from transporting waste, favorable conditions in Deschutes County for siting a new landfill, and the cost-effectiveness of building and operating an in-county landfill.

The SWMP also acknowledged the challenges of siting a new landfill and the potential for a protracted process to successfully obtain permits. However, it was noted that the geographic and demographic conditions in the county are favorable compared to locations west of the Cascade Mountains where siting has not been successful.

The goal is to have a solid waste management facility sited, developed, and operational prior to the closure of Knott Landfill, the County's current solid waste management facility, which is expected to reach capacity by 2029. The new landfill would meet all regulatory requirements and any new state and local requirements that supersede previous regulations for environmental protection. The new landfill will have the capacity to satisfy the County's waste projections for at least 100 years.

In 2023, the Site Screening Evaluation was completed as part of the process to site a new landfill within Deschutes County, including siting criteria development, site identification, broad site screening, and focused site screening. This site screening study identified and evaluated potential landfill sites based on regulatory requirements, environmental considerations, and engineering considerations. In regular coordination with the SWAC as a part of a public process with opportunities for public comment, this process initially identified over a hundred potential sites and narrowed this list down to two final candidate sites through identification of fatal flaws, broad site screening, and focused site screening. A copy of the site screening report is included in Appendix B.

### **2.2 Purpose of Study**

Two finalist sites for the new County solid waste management facility (SWMF), referred to as Moon Pit and Roth East, have progressed to the final evaluation stage. See Figure 1 for a map showing site

locations. The County is now in the last phase of selecting the landfill site. During this final phase, the County will determine which of the two sites is more suitable for developing a sanitary landfill that complies with all relevant local, state, and federal regulations. A key aspect of this selection process is to assess the potential for addressing existing conditions that could hinder development. Other critical factors for evaluation include the projected costs of development and the site-specific risks that could delay development and initial operations beyond 2029, when Knott Landfill is projected to reach capacity.

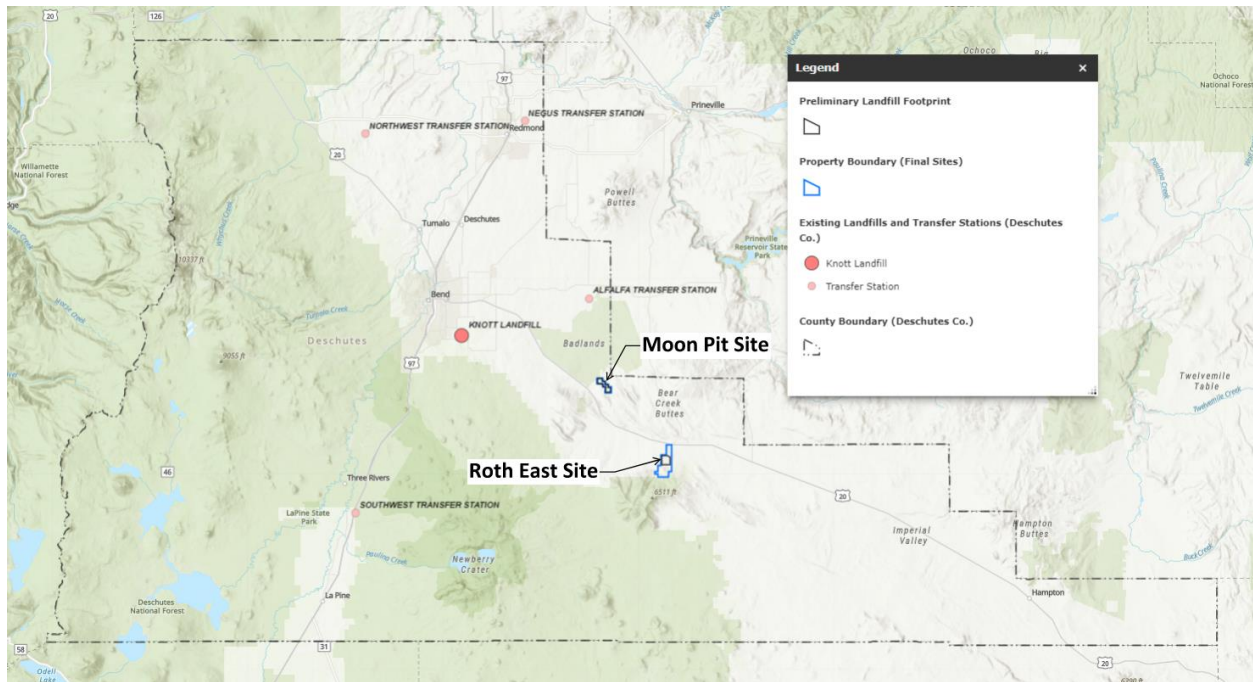


Figure 1. Final SWMF Sites in Deschutes County

## 2.3 County, State, and Federal Landfill Siting Restrictions

In 1989, the Environmental Protection Agency initiated authority under the existing Resource Conservation and Recovery Act (RCRA) to regulate the siting of new municipal solid waste (MSW) landfill units. Subpart B of the RCRA Subtitle D (40 CFR 258.60) regulations restrict the siting of new landfills based on the six federal criteria listed below, followed by state and local criteria also applicable to landfills.

### 2.3.1 Federal

- Airport Safety: Airport safety is not a concern at either of the two sites.
- Floodplains: No floodplains are present on either site.
- Wetlands: No wetlands are present on either site.
- Fault Areas: Previous studies and the current investigations revealed no faults active in the past 10,000 years (Holocene period) at either site.
- Seismic Impact Zones: No seismic impact areas are located on either site.
- Unstable Areas: No unstable areas are located on either site.

### 2.3.2 State

- Floodplains: See federal, above.
- Critical habitat for threatened or endangered species: No sensitive species or habitat are located on either site.
- Sensitive hydrogeological environments: None are located on either site.

### 2.3.3 County

- The proposed site shall not create a fire hazard, litter, insect or rodent nuisance, or air or water pollution in the area: These hazards will be controlled by final site design and operations (not part of this report).
- The proposed site shall be located at least 0.25 miles from any existing dwelling, home, or public road (except the access road): Both sites meet this criterion.
- The proposed site shall be provided with a maintained all-weather access road: The need to construct an all-weather road is assumed for both sites as part of the cost evaluation.
- The Moon Pit site will require a change to the Deschutes County Comprehensive Plan to allow a landfill as a reclamation use in the Surface Mine (SM) zone.

## 2.4 Moon Pit Site Information

Location:	Deschutes County, Township 19S, Range 14E, Sections 1-2, 12
Situs Address:	26300 Hwy 20, Bend, OR 97702
Tax Lot Number:	1914000000200
Owner:	Moon Pit, LLC (owned by Hooker Creek Companies, LLC)
Area:	440 acres
Existing Use:	Aggregate Surface Mine
Terrain:	Flat to rolling in the northwest, rising toward the southeast, bounded by ridges
Proximity:	Approximately 16 miles southeast of Bend
Nearby Features:	Adjacent to the Oregon Badlands Wilderness and its trails, including the Badlands Rock Trailhead (approximately 700 feet from the site boundary)

See Appendix C for Site Owner Solicitation Responses with terms and prices for acquisition.

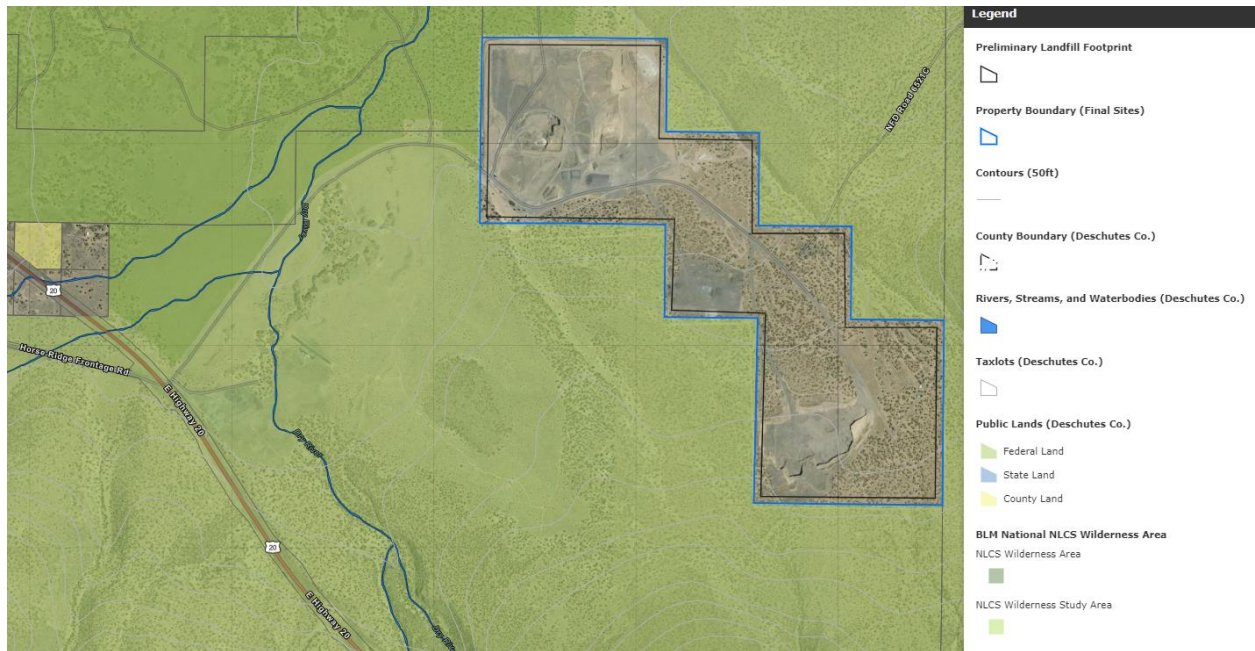


Figure 2. Moon Pit Site Map



Figure 3. Moon Pit Site Photograph

## 2.5 Roth East Site Information

Location: Deschutes County, Township 20S, Range 15E, Sections 1, 11, 12, 13, 14  
 Situs Address: 56200 Pine Mountain Rd, Bend, OR 97701  
 Tax Lot Number: 2015000000301  
 Owner: Roth, Stephen F & Clancy R  
 Area: Approximately 1,706 acres  
 Terrain: Flat to rolling, gradually rising toward the southern portions  
 Proximity: Approximately 24 miles southeast of Bend  
 Nearby Features: Adjacent to a rural residential property in the northeast, OHV trails of the Millican Valley OHV Trail System to the north and west, Bureau of Land Management (BLM)-managed land to the south, and Pine Mountain (a paragliding launch area and observatory site) within the Deschutes National Forest to the south



See Appendix C for Site Owner Solicitation Responses with terms and prices for acquisition.

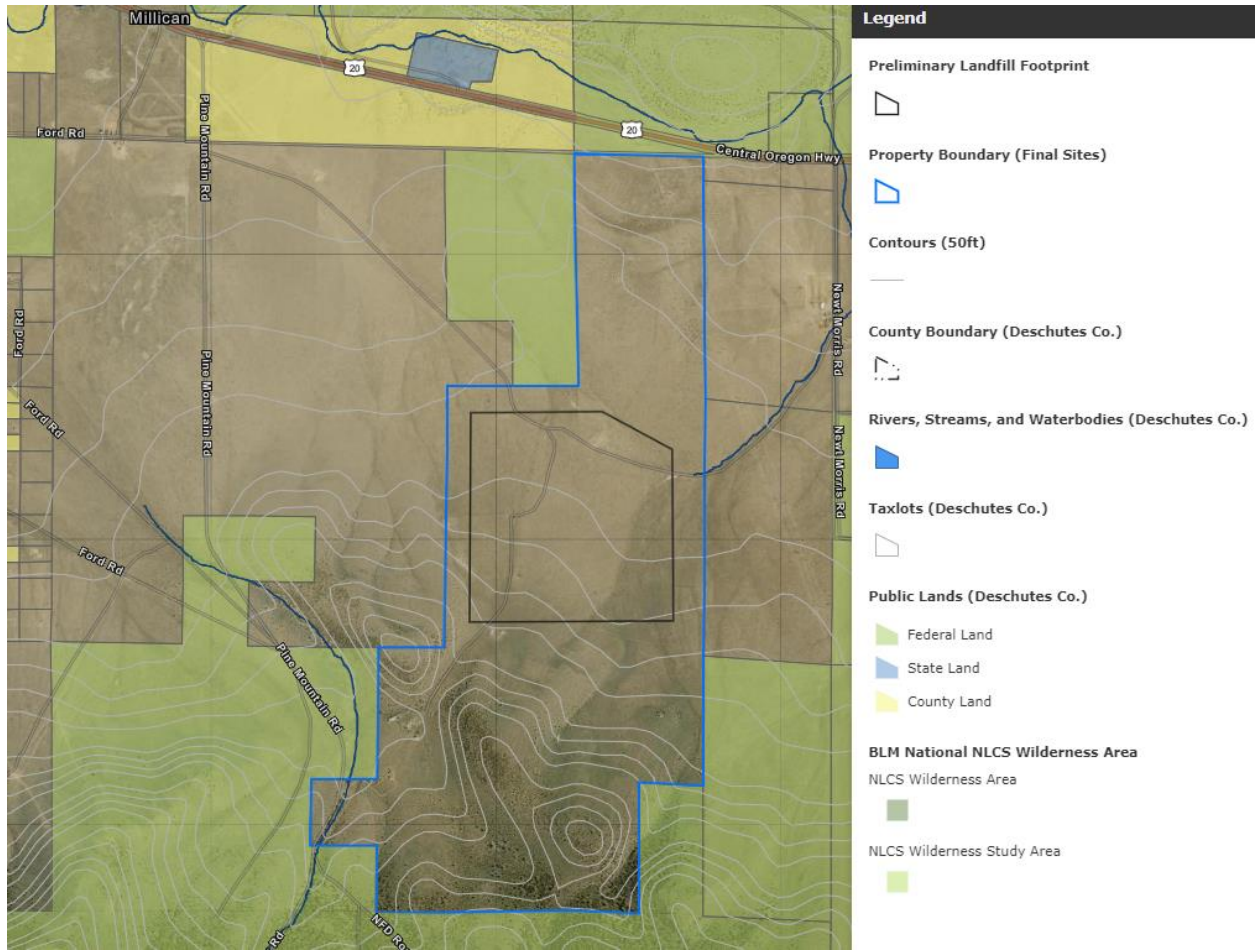


Figure 4. Roth East Site Map



Figure 5. Roth East Site Photo

*page intentionally blank  
for double-sided printing*

## 3. Conceptual Facility Layouts

This section describes the design criteria used in the development plans for each site and shows how these criteria were used to determine the shape of each landfill in its final configuration.

The layouts for Moon Pit and Roth East that were developed for this evaluation are conceptual. These conceptual layouts represent a level of accuracy that will remain undefined until the actual landfill is designed. These conceptual layouts are based on regulatory agency requirements, state-of-the-art standard landfill design practices, typical operating procedures for a municipal solid waste landfill and site-specific geologic information generated for this evaluation. Conceptual landfill layouts can be more accurately designed as more information becomes known or made available. The information gathered for this study is preliminary and does not represent the level of information necessary to design a landfill beyond a conceptual level.

### 3.1 Landfill Footprint

Each conceptual landfill footprint was dictated by the following site constraints and design criteria:

- Develop a landfill with at least 100 years of solid waste disposal capacity.
- Provide a 150-foot buffer between the property line and refuse disposal area at Moon Pit.
- Provide a 550-foot buffer between the property line and refuse disposal area at Roth East.
- Provide an area for leachate (liquid resulting from water flowing through solid waste) and surface water management at the downstream side of each landfill.
- Continue to maintain the on-site wells at Moon Pit.

Based on these constraints, the footprint for each of the sites was established as shown on Drawings C1 and D1 (Appendix D).

### 3.2 Perimeter Access Road and Ditch

Drawings C2 and D2 (Appendix D) show the perimeter access roads that would be constructed as landfilling progresses. This road would provide access for vehicles hauling refuse to the landfill and for future maintenance activities.

Located adjacent to the access road would be a perimeter ditch. On Moon Pit, this ditch would channel surface water flow around the landfill to a discharge point on the west perimeter adjacent to the landfill entrance. On Roth East, the ditch system would channel surface water flow around the landfill to a discharge point on the north perimeter.

Design criteria that have been established for the perimeter road and ditch system are as follows:

- Minimum slope of 1.0% to enable the perimeter road ditch to drain.
- Minimum 50-foot bench width for liner, final cover system anchor trenches, and access road.
- Minimum roadway width of 24 ft.
- Minimum exterior side slope of 2 horizontal to 1 vertical.

- Minimum interior side slope of 3 horizontal to 1 vertical.
- Surface water run-on and run-off control system sized to handle the 24-hour, 25-year design storm.

### 3.3 Excavation Plan

The bottom elevation for the landfill at each site was established by the need to provide proper drainage slopes to the leachate collection system. Drawings C2 and D2 (Appendix D) show the subgrade plan for each of the two sites.

At Moon Pit, leachate drains by gravity to 8 leachate collection sumps located along the west perimeter. At Roth East, leachate drains by gravity to 4 leachate collection sumps located along the north perimeter.

Design criteria used to develop the subgrade plans are as follows:

- Minimum bottom slope toward the leachate transmission line of 4% to promote drainage.
- Minimum leachate transmission line slope of 2%.
- Maximum excavated side slope of 3 horizontal to 1 vertical.
- Ability to access and clean leachate transmission lines.

### 3.4 Liner System

The design for the primary landfill liner system proposed for both sites is shown in Detail 1 of Drawings A6 and B6 (Appendix D). Components from top to bottom for the landfill floor area include:

- A separating geotextile used to prevent clogging of the drainage layer and provide additional protection to the liner system.
- A 12-inch drainage layer used to transmit leachate to the leachate collection system that maintains less than 1 foot (30 cm) of hydraulic head on the liner.
- A geonet composite used to transmit leachate to the leachate collection system and protect the underlying geosynthetics.
- A 60-mil high-density polyethylene (HDPE) geomembrane which is used to contain leachate.
- A geosynthetic clay liner (GCL) used as the lower component within the liner system.
- A cushioning layer (1/4-inch minus material) used to provide a stable foundation for the liner system and protect the overlying GCL from the excavated subgrade.
- A prepared subgrade that is used to provide a uniform surface for liner system construction.

This liner profile meets the requirements for an alternative liner system under RCRA Subtitle D and applicable Oregon rules. The GCL is being used in place of compacted soil due to the lack of availability of fine-grained, cohesive, low-permeability soils at or within the vicinity of either site.

### 3.5 Primary Leachate Collection and Removal System

The leachate collection and removal system (LCRS) includes the drainage layer within the liner system, perforated leachate collection pipes and collection trenches. Each landfill has been

designed with a series of leachate collection trenches, with the collection pipes located within these trenches as shown in Detail 3 of Drawings A6 and B6 (Appendix D). The LCRS has been designed to operate by gravity and maintain less than 1-foot (30 cm) depth of leachate over the liner as required by RCRA Subtitle D. The leachate collection lines extend up both the east and west sidewalls at Moon Pit and the north and south sidewalls at Roth East as solid pipe to allow for clean-out access from both ends.

The entire base of Moon Pit slopes toward the west so that both the drainage layer and the leachate collection lines drain to collection sumps located along the base of the sideslope on the west side of the landfill (Drawing C2). The entire base of Roth East slopes toward the north so that both the drainage layer and the leachate collection lines drain to collection sumps located along the base of the sideslope on the north side of the landfill (Drawing D2). These collection sumps are depressed, lined areas within the landfill where leachate will be temporarily stored. An 18-inch HDPE riser will allow a pump to be used for the removal of leachate from the sump. The sideslope riser would be accessible from the perimeter of the landfill during all phases of the landfill development. Liquid level sensors would be used within the sumps to detect the depth of leachate on the liner system.

The following design criteria were used in the analysis:

- Granular drainage layer in-place hydraulic conductivity greater than or equal to 1 cm/sec.
- Less than 3% of the granular drainage layer fines passing No. 40 sieve.
- Collection pipe slope greater than or equal to 2%.
- Drainage layer slope toward the leachate collection trench greater than or equal to 4%.
- Cleanouts would be provided at both ends of all collection pipes with sweep bends used to allow cleanout equipment access.

Average annual precipitation at both sites is less than 10 inches per year. For the analysis, it is assumed that a 1-acre double composite-lined leachate pond would be required at each of the sites for evaporation and/or containment for leachate recirculation.

### **3.6 Secondary Leachate Collection and Removal System**

A secondary LCRS beneath the leachate collection trenches and sumps, as shown in Detail 3 on Drawings A6 and B6 (Appendix D), is provided in the cost analysis for each of the sites.

Components of the secondary leachate collection and removal system from top to bottom include:

- A 16-ounce cushioning geotextile.
- A geonet composite to transmit leachate.
- A 60-mil HDPE geomembrane.
- A GCL as the lower component within the secondary liner system.
- A cushioning layer (1/4-inch minus material) used to provide a stable foundation for the liner system and protect the overlying GCL from the excavated subgrade.
- A prepared subgrade used to provide a uniform surface liner system construction.

### 3.7 Cell Construction and Fill Sequence

The landfill planned for each of the sites would be developed in a series of stages. Each stage, or refuse cell, would be developed as additional refuse disposal capacity is required. The landfill at Moon Pit has been divided into 33 refuse cells, and at Roth East into 37 refuse cells. The order of cell development is shown on Drawings C200 and C200, respectively (Appendix D). Each of these cells, when combined with previous cells, would generally provide 3 years of landfill capacity.

The following criteria served as the basis for layout of the individual cells and construction sequencing:

- To control capital expenditures and minimize leachate production, each cell would provide a minimum of 3 years of disposal capacity.
- Each cell would have a minimum dimension of 300 feet in any direction to allow for truck turnaround.
- To minimize construction cost, excavation for future refuse cells would be performed as part of daily and intermediate cover borrow operations, liner system construction, final cover system construction, or access road construction.
- To conserve space and minimize costs, on-site stockpiling would be kept to a minimum.
- To minimize leachate production, each cell would be filled to final closure elevation and closed with a final cover cap as quickly as possible.

### 3.8 Final Configuration

The final grading plan for each landfill site when fully developed is shown in drawings C4 and D4 (Appendix D). Filling to these elevations would provide a total of 64 million cubic yards of air space (capacity) at Moon Pit and 80 million cubic yards of net air space at Roth East. The grading that is shown is based on the following design criteria:

- Minimum top of landfill slope of 3%.
- Maximum final outer side slope of 4H:1V.
- Match access road grade around the landfill perimeter.

At Moon Pit, the depth of refuse at completion would vary from zero at the landfill perimeter to 240 feet at the landfill center. At Roth East, the depth of refuse at completion would vary from 0 at the landfill perimeter to 180 feet at the landfill center. Drawings C5 and D5 show the MSW fill depths when each landfill is completed.

### 3.9 Closure and End Use

The objective in closing either landfill would be to minimize potential threats to human health and the environment. RCRA Subtitle D requires at least 30 years of post-closure monitoring and maintenance activities. In addition, it specifies that a final cover system be installed that:

- Minimizes infiltration and erosion.
- Minimizes the escape of waste or waste constituents to the groundwater, surface water or the atmosphere.

- Minimizes the maintenance activities that would be required.

The final end use for either site after closure is limited due to (1) potential settlement within the landfilled area; (2) the generation of landfill gas as refuse decomposes; and (3) the presence of landfill gas, leachate and surface water control facilities. Consequently, final land uses are typically passive recreation or open space, including vegetative restoration for wildlife.

*page intentionally blank  
for double-sided printing*



## 4. Existing Conditions, Impacts, and Mitigation

### 4.1 Site Development and Permitting

See Appendix E for full reports and more information on site development and permitting.

#### 4.1.1 Location and Topography

##### 4.1.1.1 Moon Pit Site

The Moon Pit site is a 440-acre property located in Deschutes County at Township 19S, Range 14E, Sections 1-2, 12, with tax lot number 1914000000200. The site is located about 16 miles southeast of Bend. The site consists of flat to rolling terrain in the northern portion of the site and gradually rises to the central and southeastern portions.

The northern portion of the site is adjacent to the Oregon Badlands Wilderness (managed by the BLM) and its hiking and horseback riding trails, including the Badlands Rock Trailhead, which is located approximately 700 feet from the site boundary.

##### 4.1.1.2 Roth East Site

The Roth East site is located in Deschutes County about 24 miles southeast of Bend at Township 20S, Range 15E, Sections 1, 11, 12, 13, 14. The tax lot number is 2015000000301, and the site is approximately 1,700 acres. The site consists of flat to rolling terrain that gradually rises to the south.

The northeastern portion of the site is adjacent to a rural residential property that includes a residence and farm outbuildings. Off-highway vehicle (OHV) trails associated with the Millican Valley OHV Trail System are north and west of the site. BLM-managed land is located adjacent to the southern portion of the property. Pine Mountain, a well-known paragliding launch area and the site of the University of Oregon's Pine Mountain Observatory is located within the Deschutes National Forest to the south of the site.

#### 4.1.2 Zoning and Existing Land Use

##### 4.1.2.1 Moon Pit Site

The Moon Pit site is zoned Surface Mining (SM) with a Wildlife Area Combining Zone (WA) overlay. Adjacent zoning includes Exclusive Farm Use – Horse Ridge (EFUHR), Flood Plain (FP) zone, Surface Mining Impact Area (SMIA) overlay, and Sage Grouse Habitat Area (General and Low-Density). Nearby zoning includes Open Space and Conservation (OS&C), Landscape Management Combining Zone (LM) overlay, and WA overlay. There is an area of floodplain located north and northwest of the site.

The existing use consists of an active surface mine. *Land disposal sites* are listed as a conditional use in the SM zone (Deschutes County Code [DCC] 18.52.050), with the requirement that a “valid DEQ permit on the effective date of Ordinance No. 92-066 for a Land Disposal Site,” exists for the use. This means that only Oregon Department of Environmental Quality (DEQ)-permitted landfills in place prior to the 1992 ordinance are allowed as conditional uses in the SM zone. As there is currently no landfill in operation at the site, land disposal is not a permitted use in the current zone.

Three potential land use approval pathways were identified that could provide the necessary zoning changes that would allow landfill operations on the Moon Pit site. See Appendix E for additional information.

3. Requesting a zone map amendment to change the base zoning from SM to Multiple Use Agriculture 10-Acre Minimum (MUA10). This option requires showing the protected mineral resource has been exhausted.
4. Proposing a text amendment to the Comprehensive Plan to allow landfill use as an approved reclamation action to use on a site after mining is complete. This option requires coordination with the Oregon Department of Geology And Mineral Industries (DOGAMI) and the Department of Land Conservation and Development. A text amendment would maintain the SM zone and SMIA combining zone, but it would require two separate hearings (hearings officer followed by Board of Commissioners).
5. Proposing a new landfill overlay zone for the site that would allow land disposal sites on lands designated with the overlay zone. This option requires a map and text amendment to County code and adoption of the landfill overlay to the site. During discussions with the County Planning Department, the County noted that the overlay should have occurred before the landfill siting process and overlays are used to limit uses or provide more restrictive development standards, not to add allowed uses and less restrictive standards.

#### **4.1.2.2 Roth East Site**

The Roth East property is zoned EFUHR with the overlays of Forest Use 1 (F1), LM, Sage Grouse Habitat Area – Low Density, SMIA, and WA. The SMIA overlay only covers a small area in the northernmost portion of the lot.

Surrounding zoning includes EFUHR, SM, and F1. The existing use is rural undeveloped land that is used for grazing.

Land disposal sites are listed as a conditional use on non-high value farmland zoned Exclusive Farm Use (EFU; DCC 18.16.031). The site is designated as containing farmland of statewide importance only, which corresponds to soil types identified as non-high value farmland, therefore land disposal is a conditional use on this site.

A conditional use review would be required to approve a landfill operation at this site in compliance with DCC Chapter 18.128 Conditional Use, and specifically with DCC 18.128.015 General Standards, which require the applicant to demonstrate that there is adequate transportation access to the site, the natural and physical features of the site are considered suitable, and demonstrating that the use will be compatible with existing and projected surrounding uses.

The standards for disposal sites as conditional uses found at DCC 18.128.120 Disposal Site would also apply. These standards were used as part of the screening criteria to identify and evaluate potential new landfill sites.

Additionally, because the site is within an EFU zone, DCC 18.16.040 requires that conditional uses must meet the requirements of what is known as a Farm Impacts Test, described in ORS 215.296(1) and included in the DCC at 18.16.040.A. which states that the proposed use will not force a significant change or significantly increase the cost in accepted farm or forest practices on surrounding lands devoted to farm or forest practices, and that the actual site on which the use is to be located is the least suitable for the production of farm crops or livestock. The Farm Impacts Test could lead to the Land Use Board of Appeals. See Appendix E for more information.

### 4.1.3 Potential Permits

#### 4.1.3.1 Moon Pit Site

The following are potential required permits. See Appendix E for more information.

Depending on the zoning strategy chosen for the site, one or more County land use approval permits would be required including a **Conditional Use Permit** and **Site Plan Review**.

The Moon Pit site's existing access road crosses land owned and managed by the BLM and granting the County access rights could constitute a new **right-of-way easement** which would be subject to the National Environmental Policy Act because BLM would be issuing a permit or making a decision. An environmental assessment would be prepared if it is deemed unlikely that a proposed action would have a significant effect on the environment, or an environmental impact statement would be prepared if the proposed action would have a significant effect on the environment.

Oregon Revised Statutes 459 requires that a solid waste facility apply to the DEQ for a **Solid Waste Disposal Permit** prior to starting operation.

A DOGAMI **Transfer of Surface Mining Permit** may be required. However, if this permit process is not applicable to the site, then an **Operating Permit** may be required. Unless the County is mining aggregate for off-site export and use, mining operations related to landfill development and operations are not considered surface mining operations under DOGAMI and are covered under DEQ's permitting process (see ORS 517.750(16)(b)(F)).

Oregon DEQ requires monitoring point sources and diffuse area-wide sources for potential air contaminants. An Oregon **Title V Air Quality Operating Permit** will also be required. Under this permit program, the facility has to report on compliance with conditions of its permit at least every six months.

Natural Resource permits or compliance approvals that would be required include an **Eagle Incidental Take Permit**; Oregon Department of Fish and Wildlife (ODFW) **Wildlife Habitat Mitigation Policy** (OAR 635-415-0000); **Greater Sage-Grouse Area Combining Zone** (DCC 18.89.060); and **Wildlife Area Combining Zone** (DCC 18.88.030).

#### 4.1.3.2 Roth East Site

The following are potential required permits. See Appendix E for more information.

One or more County land use approvals or permits would be required for the EFU zoned site including a **Conditional Use Permit**, **Site Plan Review**, and **Landscape Management Review** (either Visible or Non-Visible).

An Oregon DEQ **Solid Waste Disposal Permit** would be required for this site.

Similar to the Moon Pit site, the Roth East site would be required to monitor point sources and diffuse area-wide sources for potential air contaminants. It would also be required to apply for and follow the regulations under Oregon's **Title V Air Quality Operating Permit**.

Natural Resource permits or compliance approvals that would be required include ODFW's **Wildlife Habitat Mitigation Policy** (OAR 635-415-0000); **Wildlife Area Combining Zone** (DCC 18.88.030); **Greater Sage-Grouse Area Combining Zone** (DCC 18.89.060); **Sage-Grouse** (OAR 635-140-0000).

## 4.2 Transportation System

A brief description of the daily transportation activities anticipated at both sites, as well the location and the associated findings with each is presented below. Appendix E Appendix F provides a summary of the overall transportation-related considerations and findings for both sites.

### 4.2.1 Daily Landfill Activities at Both Sites

The Solid Waste Department anticipates that the daily activities would be comprised of the following:

- The landfill would not be open to public use so all traffic generated by the site would be associated with employees, the transfer of materials via truck, and service providers.
- Seven employees would be on-site per day for operations and maintenance.
- Approximately 35 haul trucks would transfer materials to the site per day, 7 days per week.

Based on these estimates, either site would generate a total of 84 vehicle trips on a typical day (i.e., seven employee trips in and seven trips out and 35 truck trips in and 35 truck trips out). All the existing transfer stations are located to the northwest of both sites being considered so the majority of traffic would use US 20 to travel to/from the northwest of each.

### 4.2.2 Moon Pit Site

The Moon Pit site is located between Bend and Millican and currently functions as an active surface mine. The mine is accessed via an existing roadway that intersects US 20 opposite the Horse Ridge Frontage Road to the south. The use of this existing roadway would minimize the upfront capital expenditures needed if this site were selected.

The existing access road to the mine also provides access to the Badlands Wilderness area and trailhead, which could create a perception about the interaction between large trucks and trail users. Given that large trucks use the road today, it is suggested that if this site is selected, the County add signage along the route to alert landfill drivers to the location of the Badlands Trailhead parking lot.

Field observations revealed that pavement repair and some roadway widening may be needed at various locations along the existing access. Given that the access road abuts BLM lands, any widening of the roadway to accommodate the landfill trucks would be subject to BLM review which could be timely and costly, depending on the extent of repairs/widening needed.

As such, if this site is selected, a detailed engineering evaluation of the structural sufficiency of the existing roadway and the need to re-pave and/or widen in places would need to occur and can inform overall costs of this site. However, this site offers transportation and cost-related benefits that are more optimal than those offered at the Roth East location.

### 4.2.3 Roth East Site

The Roth East site is located southwest of the Newt Morris Road/US 20 intersection. There is an existing dirt road to the property that connects to Pine Mountain Road. As such, access to a landfill at this site would occur via the existing Pine Mountain Road/US 20 intersection or via construction of a new access between Pine Mountain Road and Newt Morris Road that would connect to US 20. If the existing dirt roadway connecting to Pine Mountain Road is used for access, this road would need to be reconstructed to provide for both employee and truck traffic. In addition to anticipated trips

described above for both sites, up to 5 water truck trips may be needed per day to supplement exempt well water supplies at the Roth East site during the summer months.

Given that this site has no existing improved access road to US 20, the primary cost and siting considerations relate to the construction of an access roadway of sufficient width and structural integrity between the site and US 20. The need for a new roadway would require more upfront capital expenditures compared to the Moon Pit site. A detailed engineering study would be needed to assess the potential routes between the site and US 20. A preliminary review of possible alignments identified at least four potential routes but more detailed evaluation is needed. This evaluation will need to consider the length of the route between the site and US 20, how and where the route intersects with US 20 (particularly related to the availability of sight distance along US 20), the potential for impacts to and/or avoiding the adjacent BLM properties, and the availability of right-of-way.

Finally, if the Roth East site were selected and the existing Pine Mountain Road/US 20 intersection were the preferred access to the landfill, it is recommended that the County consider improving the intersection to a traditional intersection design (T intersection) and adding wayfinding signage at both the US 20 intersection and along the site access route.

#### **4.2.4 Overall Conclusions**

From a transportation perspective, it appears that the Moon Pit site might be the optimal site given the presence of the existing access road and its use by large trucks serving the existing surface mine. However, if either site is selected, it is recommended that a detailed engineering study of roadway construction (and/or reconstruction) feasibility be conducted to better understand potential capital expenditures as well as impacts to adjacent BLM lands.

### **4.3 Water Infrastructure Assessment**

Examination of Knott Landfill's 2020 water usage data revealed that average daily water demand drops below 5,000 gallons per day (gpd) in the winter months and peaks around 50,000 gpd in the summer months. The total annual water use for landfill operations in 2020 was approximately 6.8 million gallons. See Appendix G for more information.

Based on these historical water usage patterns, it is recommended that water rights are obtained with an annual duty of 21.5 acre-feet, based on an estimated annual use of 7.0 million gallons per year. Maximum daily demand for future operations is estimated to be 100,000 gallons per day (gpd), assuming a peak month average daily flow of 50,000 gpd multiplied by a peak day factor of 2. A well production rate of 208 gallons per minute (gpm) is recommended to supply this maximum daily demand of 100,000 gpd during an 8-hour time frame. Additionally, a water storage capacity of 200,000 gallons is recommended to sustain maximum day demand and fire suppression water storage needs in the event well or power supply issues.

Both sites are located within the Deschutes Groundwater Study Area, where mitigation is required for new water right permits. In late 2023, the Oregon Water Resources Department declared an indefinite basin-wide pause on processing new water right applications in this area, citing injury to the hydrologic health of the basin. As a result of these two factors, the timeframe for securing and mitigating for new water rights permits may extend beyond 2029 when the new landfill will need to be operational. If Oregon Water Resources Department considers these two sites to be part of the General Zone of Impact, General Zone temporary mitigation rights may be a viable short-term option with an understood cost of around \$3,300 per year. General Zone permanent mitigation credits

could also be a possible long-term option from private water rights brokers at around \$200,000 to \$250,000.

### **4.3.1 Moon Pit**

There are two wells on-site at Moon Pit, referred to as Well A and Well B. Well A was installed in 1986 and is currently inactive. Well B has been operational since 1994, is capable of producing 1,000 gpm, and is primarily utilized for on-site dust suppression. Water right permit G-12860 is appurtenant to the Moon Pit site property for industrial use (dust control and gravel washing). The maximum use rate for this permit is 1.09 cubic feet per second, which is equivalent to 490 gpm and significantly greater than the anticipated future landfill operation water requirements. Although transfer the water rights is not offered with the property acquisition, the seller is willing to lease a partial water right to the County for landfill operational needs at a reasonable cost until the County can secure its own water rights.

The Moon Pit site is located inside the Deschutes Groundwater Study area and the General Zone of Impact Area. If a new water right permit is needed, General Zone temporary mitigation rights may be a viable short-term option until permanent mitigation requirements can be satisfied. The estimated costs for water infrastructure upgrades are \$215,000 for water rights, \$100,000 for well improvements, \$400,000 for a water storage tank, and \$50,000 for site water piping, totaling an estimated \$765,000. See Appendix G for more information.

### **4.3.2 Roth East**

The Roth East site, located within the Deschutes Groundwater Study area and the General Zone of Impact Area, has one existing well, the Powell Well (DESC 194), which is primarily used by a nearby residence and for stock watering. The occurrence of groundwater at the Roth East proposed facility site area is unknown, and available data suggest depth to first water is around 500 feet. The Powell well can produce 50 gpm with no drawdown, suggesting it can produce water at a higher rate. However, the reported well production occurred in 1990 following well installation, and the current well yield capacity is unknown. The well would need to be upgraded or replaced to function as a supply well for a future solid waste facility.

The existing Powell Well (also referred to as the “Deep Well”) on the Roth East site does not have water rights and is thus limited to the exempt well production rate of 5,000 gallons per day. Until water rights can be secured, it is assumed that water trucks from Knott Landfill would be needed to meet elevated water demands in March-October. It may be possible to purchase and transfer water rights from an existing water rights holder in the vicinity.

There are no identified water rights appurtenant to the Roth property. The closest identified water right to the Roth East site is a water right issued to the Bend Trap Club (water right permit G-16505). If a new water right permit is needed, General Zone temporary mitigation rights may be a viable short-term option until permanent mitigation requirements can be satisfied. The estimated costs for water infrastructure upgrades are \$215,000 for water rights, \$500,000 for well improvements, \$400,000 for a water storage tank, \$50,000 for site water piping, and a new water truck fill station, totaling an estimated \$1,190,000. See Appendix G for more information.

## **4.4 Electrical Power Supply**

### **4.4.1 Moon Pit Electrical Infrastructure Needs**

The Moon Pit landfill site, served by Central Electric Cooperative (CEC), necessitates significant upgrades to the existing electrical infrastructure to meet both initial and future power demands. The site requires a new electrical service that is adequately sized to power initial landfill loads and future landfill gas power generation.

The specific anticipated landfill electrical loads at Moon Pit include a Scale House/Electric Gate, Office/Admin Building, Maintenance Building, Water Supply Well Pump, eight Leachate Pump Stations, and a Gas Vacuum Blower. The need for 8 Leachate Pump Stations distinguishes Moon Pit from Roth East in terms of power demand.

To accommodate these needs, CEC would need to upgrade and extend about 9.5 miles of existing overhead utility lines from the closest three-phase power connection point to the Moon Pit location. This includes upgrading 2.6 miles of an existing single-phase pole line and extending new three-phase power lines (overhead or underground) for an additional 7 miles along US 20 with potential easements through BLM property. The estimated utility cost for these upgrades is approximately \$2,000,000. See Appendix H for more information.

### **4.4.2 Roth East Electrical Infrastructure Needs**

Roth East also falls under the jurisdiction of CEC for its electrical needs. Similar to Moon Pit, Roth East will need a new electrical service tailored to support both the initial landfill operational requirements and future landfill gas power generation.

Anticipated landfill electrical loads for Roth East are similar to those at Moon Pit but with only four Leachate Pump Stations indicating a lower power demand compared to Moon Pit.

The infrastructure upgrade for Roth East involves approximately 2.3 miles of overhead utility line enhancements from the nearest three-phase connection point. This comprises upgrading about 1.2 miles of an existing single-phase pole line and extending new three-phase lines (overhead or underground) an additional 1.1 miles toward the landfill location possibly requiring easements through private property. The estimated utility upgrade cost is \$700,000; this is significantly lower than that of Moon Pit. See Appendix H for more information.

## **4.5 Flood Risks**

### **4.5.1 Moon Pit Site**

The flood risk assessment for the Moon Pit site reveals that while the site itself is not directly within mapped flood hazard areas, the northern part of the site is near the 100-year floodplain for the Dry River, an ephemeral stream. This proximity increases the risk of flood impacts, especially from intense thunderstorms and periods of rapid snowmelt, which can lead to flash flooding. The site is influenced by a relatively large upstream drainage basin of approximately 3 square miles, which further elevates the risk of flash flooding.

Several existing drainage channels on the site convey runoff from the upstream drainage basin northwest toward Dry River. The assessment emphasizes the potential impacts of climate change, which may increase flood frequencies and extents. To mitigate these risks, the assessment

recommends further study and the implementation of mitigation strategies, such as conservatively sized perimeter ditches, to manage and reduce flood risks effectively. See Appendix I for more information.

## 4.5.2 Roth East Site

The flood risk assessment for the Roth East site indicates that the site is not directly within mapped flood hazard areas. However, there is an upstream drainage basin of approximately 1 square mile that presents a moderate risk of flash flooding. This risk is particularly pronounced during intense thunderstorms and periods of rapid snowmelt, which can result in significant runoff.

Several channels on the site collect runoff from the northeast slope of Pine Mountain and drain north through the site, discharging to Dry River, an ephemeral stream, near US 20. The assessment highlights that the mapped floodplain for Dry River crosses US 20 in several locations, posing a secondary flood risk to site access. To address this risk, coordination with state transportation and hazard mitigation agencies is recommended to identify detours and alternate routes in case of disruptions to US 20 due to flooding. See Appendix I for more information.

## 4.6 Geology/Hydrogeology

### 4.6.1 Geology

The Moon Pit site is located within the High Lava Plains physiographic province with pre-Holocene northwest trending normal faults bounding Moon Pit, expressed by the site's fault bounded basin (Appendix J). This setting provides the opportunity to readily screen the operations from public view. In the southeastern two-thirds of Moon Pit, the surface geology consists of mid-Miocene-aged basalts that erupted from vents within the Brothers Fault Zone and High Lava Plains to create the Bear Creek Buttes. In the northwestern third of the site, the surface geology comprises alluvium that is believed to have been deposited by the Dry River drainage. Gravel-rich alluvium and the underlying basalt bedrock are quarried in this portion of the site. The northwest portion of the Site contains up to 42 feet of layered sand and gravel alluvial sediment overlying approximately 20 to 30 feet of basalt. This unit of basalt is underlain by approximately 6 feet of inter-flow sediment.

Test pits excavated in 1993, boreholes advanced in 1996, and test pits advanced in 2023 (Delve) identified the following general strata in the alluvial (northwest; approximately 135-acre) portion of Moon Pit:

- Sand with silt topsoil – Lightweight pumiceous topsoil, loamier and more organic than underlying sediment, thickness up to about 5 feet.
- Gravel with sand and cobbles – Horizontally bedded, thickness about 8 to 10 feet.
- Sand with fine gravel – The predominant soil type in this portion of the site; thickness up to 42 feet.
- Quaternary basalt – Believed to be a continuation of the Oregon Badlands basalt that has been capped with alluvial sediment deposited within fault-bounded basins at the northwest edge of Bear Creek Buttes.

The Roth East site is also located within the High Lava Plains physiographic province with only pre-Holocene faults present nearby that affected the deposition of volcanic features surrounding Roth East (Appendix J). Unlike Moon Pit, there are no visible expressions of these older faults. Roth East lies southeast of the Millican Valley, a dry high desert perched basin bordered to the south by



the Pine Mountain and to the north by Bear Creek Buttes. The Roth East development area would require more effort to screen operations as compared to Moon Pit as it lies atop alluvial deposits forming the northern flank of Pine Mountain. The deposits include talus, slope wash, fanglomerates and windblown material.

A geophysical study carried out by Siemens and Associates in 2023 estimated at least 300 feet of unconsolidated alluvial deposits overlying bedrock beneath the proposed development area. During the 2023 geotechnical investigation, borings drilled in the upper 150 feet of subsurface strata encountered subrounded basalt and tuff gravel mixed with varying proportions of silt and sand in 6- to 12-inch layers typical of alluvial deposits. Groundwater or saturated strata was not encountered in the borings. Bedrock was also not encountered. Roth East's surface soil includes a notable quantity of pebbles and cobbles, which gradually diminishes in size and quantity downslope toward the lacustrine Millican Valley floor to the northwest. See Appendix J for more information.

## 4.6.2 Hydrogeology

The Moon Pit site is located near the eastern edge of the Upper Deschutes Basin. The regional groundwater flow direction from Moon Pit within the basin is to the north-northwest. Two water wells are located on-site, DESC 5750 (Well A), which was developed in 1986 and is currently not in use, and DESC 9126 (Well B), which was developed in 1994 and is currently used. Well B is located at an elevation of approximately 3,600 feet and reports a depth to water of 852 feet, indicating a groundwater elevation of approximately 2,750 feet. The yield for Well B is estimated at 1,000 gpm based on purging rates from the owner during the well sampling procedure.

Given the depth to groundwater is greater than 800 feet and the geology consists of a heterogeneous and disconnected suite of volcanic units the potential for vertical migration of fluids from Moon Pit to reach groundwater is low.

Water samples collected from Well B and analyzed for the typical suite of landfill parameters indicate very good quality with no constituents reported above the EPA Maximum Contaminant Levels (MCL) and only one parameter (iron) at a concentration above the OAR 340-40 numerical groundwater quality reference levels. Slight exceedances of trace metals can be expected from water supply well grab samples not specifically designed for compliance groundwater monitoring.

Roth East is located along the far east margin of the Upper Deschutes Basin. The regional groundwater flow direction from the Millican Valley is likely to the north-northwest, roughly following topography and the path of Dry River, which once catastrophically drained Lake Millican. There are no wells in close proximity to the proposed development area. However, based on modelling using existing water wells the regional groundwater elevation at the proposed development area is anticipated to be approximately 3,800 feet above mean level.

A well located near the southwestern corner of Roth East (DESC 194; a.k.a., the Powell Well or Deep Well) and situated approximately 1.1 miles from the proposed development area at an elevation of roughly 4,800 feet (600 feet above the Millican Valley floor), reports a depth to water of 970 feet (groundwater elevation of approximately 3830 feet) and a yield of 50 gpm. Given this well was designed for residential uses the yield for a larger diameter well designed for industrial uses would likely provide a higher yield. The geophysical investigation conducted by Siemens and Associates indicates that first bedrock is located at a depth of greater than 300 feet below the surface of the proposed development area, corresponding to an approximate elevation range of 4,150 to 4,300 feet.

Water wells within the presumed footprint of prehistoric Lake Millican (below an elevation of approximately 4,300 feet) have reportedly encountered a saturated zone near the bottom of the

approximately 450-foot-thick sedimentary sequence, with low yields. It is unknown whether this shallower saturated zone is present beneath Roth East's development area. Assuming there is no saturated zone above the bedrock in the development area, the groundwater would be expected to be at least 500 feet below the development area. The potential for vertical migration of fluids from Roth East through the thick sedimentary sequence and the unknown thickness of volcanic bedrock to groundwater is low.

Groundwater samples were collected from the Powell Well (DESC 194) following purging and the stabilization of the field indicator parameters and analytical results of typical landfill parameters indicate very good water quality with no constituents reported above the EPA MCL or the OAR 340-40 numerical groundwater quality reference levels. See Appendix J for more information.

## 4.7 Preliminary Geotechnical Feasibility

### 4.7.1 Moon Pit

Delve Underground conducted a preliminary geotechnical feasibility assessment related to the siting of a new landfill on a 346-acre portion of the Moon Pit property. A copy of the preliminary geotechnical feasibility report is included in Appendix K.

The preliminary geotechnical feasibility assessment included a combination of a desktop study and limited geotechnical explorations consisting of test pits to provide a preliminary summary of the subsurface conditions. The subsurface exploration program included 12 test pits excavated to depths ranging from 2.6 to 7.0 feet below ground surface (bgs). All but two test pits were terminated as a result of practical refusal of equipment on shallow bedrock. Bedrock observations were limited to exposures created by quarrying activities, which indicated a variability within the underlying rock mass. No laboratory tests have been performed to assess the adequacy of bedrock for future use as a construction aggregate.

The preliminary assessment of the site did not identify geotechnical critical flaws for future development as a municipal solid waste landfill. However, because of the shallow nature of bedrock encountered, earthwork and site excavation will require extensive drilling and blasting methods to excavate future waste cells to their proposed depths. Additional key summaries include:

- Faults that bound the graben (geologic term for earth crust between two faults and on which the Moon Pit quarry is situated) are not included within the U.S. Geological Survey Quaternary Fault and Fold Database. Alluvial units and the Newberry Volcano lava flow do not exhibit offsets along the northwest projections of the faults; therefore, the faults are interpreted to be inactive.
- Shallow bedrock is persistent throughout the site and covered with a thin (less than 10 feet thick) veneer of undifferentiated alluvium and loess. Thicker amounts of alluvium may be present where it has not been mined out in the northwestern portion of the site.
- Practical refusal with conventional equipment occurred during the excavation of all test pits which resulted in termination less than 10 feet bgs. Shallow bedrock conditions will likely require drilling and blasting techniques to excavate the desired depth of the waste cells.
- Bedrock exposed in quarry exposures in the southeastern portion of the site consisted of a complex sequence of basaltic lava flows and cinder-filled interbeds. Both lava flow and interbeds generally varied between 2 and 10 feet thick.
- Review of seismic surveys and cross sections compiled by Siemens & Associates within the David Evans and Associates, Inc. report entitled "Deschutes County Landfill Site Evaluation"

(prepared for Deschutes County Department of Solid Waste, dated August 7, 1996) indicated an irregular bedrock contact with varying depths of sediment accumulation within the northwest portion of the site. Some drill and blast mining (for basalt rock products) was conducted in this area but was discontinued because of poor rock quality.

- Depth to groundwater is anticipated to be well below the bottom of the proposed landfill cells (see Section 4.6.2).
- Based on the shallow bedrock conditions and the waste cells excavated into the underlying bedrock, Delve does not anticipate issues with bearing capacity or settlement associated with future site development.
- On-site materials will require laboratory testing to assess whether materials meet the specification of intended use per Oregon Standard Specifications for Construction.
- Site Class B is preliminarily recommended for future seismic design based on the materials encountered in the subsurface exploration program.
- Review of the site development plans by G. Friesen Associates, Inc., dated September 26, 2023, indicate 3H:1V (horizontal to vertical) slopes along the perimeter of the waste cells. These slopes are suitable at this time based on the current understanding of the subsurface conditions and that waste cells will be excavated into the underlying bedrock.

As noted above, the results of this study are based on a limited subsurface investigation and should be considered preliminary in nature. Additional site characterization will be required to complete the geotechnical characterization of this site if it is selected for final design, as well as to determine the quality of rock for potential on-site use.

The estimated thickness of subsurface materials encountered at the time of exploration and the anticipated use of materials is presented in Table 1. Across the site, the average thickness of overburden materials (alluvium, loess, and colluvium) is estimated to be 5 feet, plus or minus 3 feet. No laboratory tests have been performed to assess the durability of bedrock for future use as a construction aggregate. Note that the current coverage of test pits is inadequate for fully assessing the subsurface conditions for a 346-acre development, and lateral variations of materials likely exist.

**Table 1. Soil Usage Summary for Moon Pit**

Geologic Unit	ASTM Classification	Estimated Thickness (feet)	Anticipated Use <sup>1</sup>
Alluvium/Loess <sup>2</sup>	Silty SAND (SM)	1 to 5.5	Daily cover
	Well-graded GRAVEL with sand and cobbles (GW)		
	Well-graded SAND with silt (SW-SM)		
Colluvium <sup>3</sup>	Well-graded GRAVEL (GW)	>6	Daily cover
Bedrock (extremely weathered) <sup>4</sup>	Well-graded GRAVEL with silt and SAND (GW-GM)	1 to 4	Daily cover for gravel-sized or finer; crush/screen oversize rock clasts for drain rock, structural fill, and road base
	Well-graded GRAVEL with sand (GW)		
	Silty SAND with gravel and cobbles (SW)		
Bedrock <sup>5</sup> (unweathered)	N/A	Unknown	Crush for drain rock, structural fill, and road base

Notes:

1. Anticipated uses are assumed. No laboratory testing has been performed and bedrock quality is currently unknown. Laboratory testing is required for approval of on-site use.

- 2 Alluvium and loess accumulation throughout the undisturbed areas of the site and overlies bedrock, and old alluvial gravels previously mined in the northwest portion of the site.
- 3 Colluvium limited to areas adjacent to fault scarp and only encountered in TP-3 and TP-4.
- 4 Bedrock encountered within test pits represents the upper weathering profile and contains varying amounts of sand and fines. Bedrock quality is currently unknown and requires evaluation and laboratory testing to determine durability and quality.
- 5 Bedrock quality determination is beyond the scope of this exploration although visual observations of cuts and other exposures suggest high variability ranging from poor to moderate.

## 4.7.2 Roth East

Delve Underground conducted a preliminary geotechnical feasibility assessment related to the siting of a new landfill on a 382-acre portion of the Roth East property. A copy of the preliminary geotechnical feasibility report is included in Appendix K.

The preliminary geotechnical feasibility assessment included a combination of a desktop study and limited geotechnical explorations consisting of four geotechnical borings, and two parallel geophysical surveys utilizing electrical resistivity and seismic resistivity. Borings were advanced to depths ranging from between 46.5 to 150 feet bgs and were terminated in predominantly gravelly alluvial fan deposits. Bedrock was not encountered within the borings and is estimated to be at a depth of approximately 400 feet based on the results of the geophysical surveys.

Disturbed soil samples were collected in conjunction with standard penetration tests (SPT) using a standard split-spoon sampler and a modified California split-barrel sampler. However, because of the relatively small sampler opening sizes (i.e., 1.375 to 2.4 inches), they do not provide an adequate sample size to accurately describe a predominantly gravel soil type.

The preliminary assessment of the site did not identify geotechnical critical flaws for future development as a municipal solid waste landfill. Additional key summaries include the following:

- The unnamed faults near Millican Valley (U.S. Geological Survey fault ID 841) have an age constraint of less than 750 thousand years (ka); considerably older than the 12,000 years Holocene age defined by RCRA Subtitle D.
- The Pine Mountain catchment basin now drains to the northwest of Pine Mountain, and the paleochannel that previously supplied sediment for the alluvial fan beneath the site is now separated from the upslope catchment basin, and thus inactive. The elimination of this sediment supply likely resulted from faulting of the linear ridge with a poor age constraint but is likely older than mid Quaternary (>750,000 years), and considerably older than the Holocene.
- The geomorphic relationship between the alluvial fan and surrounding topography suggests that the fan is mid Quaternary or older in age, and that the upslope sediment supply for the fan was disconnected around the same time, or before the faulting and uplift of the knob by the unnamed faults near Millican Valley.
- Faulting of the knob is likely older than the Holocene (12,000 years) and not a hazard for the future development of the site. However, a lack of Holocene deposition of sediments within the site makes the age constraint relative to preliminary observations elsewhere within Millican Valley.
- Preliminary review of the limited extent of lidar (light detection and ranging) within the western extent of Millican Valley near Horse Ridge does not indicate any offsets of Newberry Volcano lava flows, alluvial fans, or sediments associated with Lake Millican. All units within this area are late Pleistocene in age, thus indicating faulting along the unnamed faults of Millican Valley is older than 12,000 years, and not active by the RCRA Subtitle D definition of Holocene (10,000 years to 12,000 years). However, the lack of deformation and offset within

these units may indicate (1) a lack of deformation within the last 100,000 years, (2) geomorphic overprinting as a result of a prolonged recurrence interval, and (3) discontinuous fault structures across the basin.

- Preliminary geotechnical drilling encountered coarse-grained soils to a maximum depth of 150 feet bgs that largely consist of gravels of varying sizes, consistent with materials generally encountered within an alluvial fan. The materials appear to be predominantly gravels, but SPT samples limit the ability to quantify the amount of gravel because of sampling intervals and the limited size of what can enter the sampling tube.
- Geophysical surveys indicate that up to 400 feet of what are interpreted as coarse-grained soils are within the limits of the survey profiles. The boundary of the site has changed from the time of original planning of the subsurface program, and it has since been moved farther to the southwest; this area currently lacks coverage from the geophysical survey. Shallowing of bedrock should be anticipated toward the south of the site near the linear ridge.
- Based on the materials encountered, conventional earth-moving equipment for mass grading and excavation of soil is anticipated; however, large boulders on the order of 4-foot diameter may be encountered.
- Based on the materials encountered, issues with bearing capacity or settlement associated with future site development are not expected.
- On-site materials are likely suitable for use in site development pending future lab testing to identify the durability of the material.
- Site Class C is recommended for future seismic design based on the materials encountered in the subsurface exploration program.
- Site development plans by G. Friesen Associates, Inc., dated September 26, 2023, indicate 3H:1V (horizontal to vertical) slopes along the perimeter of the waste cells. These slopes are suitable at this time based on the current understanding of the subsurface conditions, but additional input may be required as plans for site development progress.
- Site development plans by G. Friesen Associates, Inc., dated September 26, 2023, indicate excavation extending to close proximity of the linear ridge. This area lacks subsurface information because of the limitation of the exploration program, and shallow bedrock may be encountered. To reduce cost overrun, a comprehensive geotechnical exploration program should be completed as a future phase of work if this site is selected for future development.

As noted above, the results of this study are based on a very limited subsurface investigation and should be considered preliminary in nature. Additional site characterization will be required to complete the geotechnical characterization of this site if it is selected for final design, as well as to determine the quality of gravels within the alluvial fan deposit for potential on-site use.

The estimated thickness of subsurface materials encountered at the time of the explorations and the anticipated use of materials is presented on Table 2. Across the site, the average thickness of overburden materials (alluvial fan deposits) is estimated to be greater than 150 feet. No laboratory tests have been performed to assess the durability of gravels within the overburden materials for future use as a construction aggregate. Note that the current coverage of borings and geophysical surveys is inadequate for fully assessing the subsurface conditions for a 382-acre development, and lateral variations of materials likely exists.

**Table 2. Soil Usage Summary for Roth East**

Geologic Unit	ASTM Classification	Estimated Thickness	Anticipated Use <sup>1</sup>
Alluvial Fan Deposits <sup>2</sup>	Silty SAND (SM)	>150 feet	Daily cover; crush/screen for drain rock, structural fill, and road base
	Well-graded SAND with silt (SW-SM)		
	Silty GRAVEL (GM)		
	Well-graded GRAVEL with silt and sand (GW-GM)		
	Well-graded GRAVEL with sand (GW)		
Bedrock <sup>3</sup>	N/A	Unknown	Unknown

Notes:

- 1 Anticipated uses are assumed. No laboratory testing has been performed to determine the durability of on-site gravel. Durability tests will be required before final approval of on-site use.
- 2 Gravel percentage poorly constrained due to the limited opening diameter within the SPT and ModCal sampling tube.
- 3 Bedrock was not encountered in the geotechnical drilling exploration and estimated at around 400 feet below grade by geophysical exploration.

## 4.8 Environmental Site Assessment Phase I

### 4.8.1 Moon Pit

Parametrix conducted a Phase I Environmental Site Assessment (ESA) of the Moon Pit Alternative including a review of available documentation pertaining to the subject property, a site reconnaissance, and a review of relevant public agency documents. The Phase I ESA was conducted in general accordance with ASTM Standard E1527-21, which defines the generally accepted industry practices and procedures currently applicable at the time and place of this study. The purpose of the Phase I ESA was to identify recognized environmental conditions (RECs) on or near the subject property.

A review of historical aerial photographs, topographic maps, and the Hooker Creek construction materials website indicate that the subject property was undeveloped until the late 1980s/early 1990s, when aggregate mining operations began. A former asphalt plant was reportedly located on the subject property. Historical aerials can be referenced in the Phase I ESA, Appendix L.

As part of the Phase I ESA, regulatory database-listed sites by federal and Oregon agencies were reviewed. Additionally, a compilation of historical uses of the subject property and site vicinity was reviewed to determine whether past operations pose a risk to the subject property. The subject property is listed on the Environmental Cleanup Site Information (ECSI) database. A comment dated April 24, 1997, notes that there is no release reported and that the site was added to the ECSI list for tracking purposes. The listing indicates that historical site use at the subject property is unknown, but it may have been used by the military during World War II (historical document review did not indicate any military usage on the subject property). No contamination at the site has been documented. Listing of the site on the ECSI database for tracking purposes does not represent a REC to the subject property. A full list of the databases reviewed can be found in Appendix L.

Parametrix conducted a site examination on October 5, 2023. The site examination consisted of observing the area, providing observations of the general environmental conditions, and visually assessing the area for evidence of hazardous substances and petroleum products. Two diesel aboveground storage tanks (ASTs) are in use at the property: an approximately 250-gallon AST near the gate and a 10,000- to 20,000-gallon AST that provides fuel to the generator for the groundwater

supply well on-site. Minor staining was noted near the 250-gallon AST. De minimis staining was also noted near the site entrance, in operation areas, at the equipment boneyard, and in the vicinity of the former asphalt plant. None of the staining appeared to be extensive or associated with active releases. A number of labeled and unlabeled drums (some still containing liquids) were also noted throughout the site, primarily in the boneyard and near the generator building. Photographs taken during the site reconnaissance can be found in the Phase I ESA, Appendix L.

#### **4.8.1.1 Recognized Environmental Conditions**

The former presence of the asphalt plant operations, as well as observed petroleum staining in several areas of the property, represents a REC to the subject property.

#### **4.8.1.2 Recommendations**

Based upon the conclusions of this investigation of the subject property, a limited Phase II ESA is recommended on the subject property to delineate shallow soil contamination, if any, and to establish baseline conditions. The Phase II ESA should include surface and shallow depth soil sampling in the former asphalt plant area, as well as other operational areas, near ASTs, and in areas of observed petroleum staining.

#### **4.8.2 Roth East**

Parametrix conducted a Phase I ESA of the Roth East Alternative including a review of available documentation pertaining to the subject property, a site reconnaissance, and a review of relevant public agency documents. The Phase I ESA was conducted in general accordance with ASTM Standard E1527-21, which defines the generally accepted industry practices and procedures currently applicable at the time and place of this study. The purpose of the Phase I ESA was to identify RECs on or near the subject property.

A review of historical aerial photographs and topographic maps indicate that the subject property has been undeveloped, aside from a single residence (constructed after 1994), since at least 1951. Historical aerials can be referenced in the Phase I ESA, Appendix L.

As part of the Phase I ESA, regulatory database-listed sites by federal and Oregon agencies were reviewed. Additionally, a compilation of historical uses of the subject property and site vicinity was reviewed to determine whether past operations pose a risk to the subject property. The subject property and adjacent properties are not listed on any regulatory database that would indicate a past or current release or storage of hazardous materials. A full list of the databases reviewed can be found in Appendix L.

Parametrix conducted a site examination on October 4, 2023. The site examination consisted of observing the area, providing observations of the general environmental conditions, and visually assessing the area for evidence of hazardous substances and petroleum products. There is one residence on the subject property along with a couple of outbuildings and ranch infrastructure (corrals, cattle watering trough, etc.). A domestic water well is located on the subject property, and a large water storage tank was noted on the ridge above the well. Two small (approximately 250-gallon), locked fuel ASTs were noted in the vicinity of the other ranch infrastructure. The ASTs appeared to contain residual fuel. No staining or distressed vegetation was noted in the vicinity. Photographs taken during the site reconnaissance can be found in the Phase I ESA, Appendix L.

#### **4.8.2.1 Recognized Environmental Conditions**

No RECs were identified for the Roth East site during Phase I ESA.

#### **4.8.2.2 Recommendations**

Based upon the conclusions of this investigation of the subject property, no further environmental investigation is warranted at this time.

### **4.9 Air Quality, Weather, and Greenhouse Gas Emissions**

Parametrix prepared a technical memorandum that summarizes local air quality data, weather data, and a greenhouse gas (GHG) analysis for the Moon Pit and Roth East sites. Please see Appendix M. It also discusses facilities in close proximity to the site that may contribute to local air quality issues. The weather data from the past five years were acquired from two weather stations east of Bend, Oregon. The data included minimum and maximum temperatures, daily precipitation, PM2.5 and ozone (air quality) data, and wind speed and direction data.

The wind rose diagram from Redmond Roberts Field indicates dominant wind directions out of the northwest and southeast, with the most frequently occurring wind speeds between 8 and 13 miles per hour (mph). The Moon Pit site is located between two weather stations, and the Roth East site is located farther east of the Horse Ridge station. General sustained wind speeds and gusts at the Horse Ridge station are higher than at the Calgary Loop station indicating that wind conditions at Roth East are likely more intense than at the Moon Pit site, though these station data do not necessarily represent site conditions. During development and operation of the landfill, an on-site weather station will be located at the site to inform the County's adaptation of landfill operations based on current weather conditions.

Local air quality data was reviewed from the past five years, which were downloaded from the Oregon Department of Environmental Quality (DEQ) website. The closest publicly owned air quality monitoring station is located at Prineville Davidson Park. The maximum PM2.5 level measured at this station was recorded on September 12, 2020. The spikes in monitored PM2.5 are likely associated with large wildfires in Oregon, Washington, and California during those time periods. The maximum ozone level was recorded on September 12, 2020. The vicinity of both sites is predominantly vacant, undeveloped land. There are no industrial or power-generating plants within a 3-mile radius of either site that would contribute to areawide air quality conditions.

Mapped wildfire risk data indicate that both the Moon Pit and the Roth East sites have a high burn probability. According to the U.S. Forest Service, burn probability is based on the likelihood of over 250 acres burning at a given location (determined by wildfire simulation modeling). A high probability indicates between 1 in 500 and 1 in 50 chance of a wildfire over 250 acres in a single year. For both sites, fire protection measures would be in-place and the selected site is expected to function as a fire break – relatively devoid of fuel sources - that would interrupt the continuation of wildfires moving towards the site.

GHG emissions were calculated for scenarios involving the haul transportation of municipal solid waste from transfer stations to Moon Pit and Roth East. The baseline fleet transition that was evaluated (diesel to renewable natural gas [RNG] to electric) resulted in a contribution of Moon Pit of ~50,000 MT CO<sub>2</sub>e whereas Roth East would generate ~75,000 MT CO<sub>2</sub>e of GHG emissions over the 2029 to 2129 timeframe. The transition to renewable diesel is already underway, and RNG is also a reasonable, present-day option. These fuel transitions would reduce GHG emissions further but also offer opportunities for cost reduction and revenue streams.



## 4.9.1 Moon Pit

### 4.9.1.1 Temperature

The 5-year record of temperature data collected at the BEND station reported a minimum temperature of -7 degrees Fahrenheit (F) on February 23, 2022, and a maximum temperature of 107 degrees F on June 30, 2021. Temperature data at this station are spotty for the latter part of 2022 and 2023. Additional station data can be referenced in the Air Quality Technical Report, Appendix M.

### 4.9.1.2 Precipitation

The 5-year record of precipitation data collected at the BEND station reported sixteen precipitation events exceeding 0.5 inches in a day, occurring in fall, winter, and spring. Fewer significant precipitation events occurred during summer. Average daily precipitation data collected at the BEND station reported eleven daily averages above 0.2 inches and significantly lower averages during summer months. Additional station data can be referenced in the Air Quality Technical Report, Appendix M.

Lightning susceptibility in the vicinity of the Moon Pit site is relatively low (a risk index score of 20.7 based on FEMA National Risk Index methodology <sup>1</sup>).

### 4.9.1.3 Wind Speed

Dominant wind directions at the Redmond Roberts Field station (22 miles northwest of the site) are out of the southeast. Most often occurring wind speeds are between 8 and 13 miles per hour. The Calgary Loop (EW8160) weather station reports sustained winds up to 18 miles per hour and gusts up to 31 miles per hour. The US 20 Horse Ridge station reports sustained winds up to 26 miles per hour and gusts up to 43 miles per hour. Winds speeds at the Moon Pit site are expected to be between these ranges.

### 4.9.1.4 Air Quality

Available relevant air quality data from the past 5 years were downloaded from the DEQ website.<sup>2</sup> The closest publicly owned air quality monitoring station is located at Prineville Davidson Park, approximately 25.4 miles northeast of the site. Air quality data from this station monitors particulate matter, or PM<sub>2.5</sub>, and ozone. PM<sub>2.5</sub> is atmospheric particulate matter with a diameter less than 2.5 micrometers. Ozone can cause oxidation of electronics and sensitive instruments.

The maximum PM<sub>2.5</sub> level (518.1 micrograms per cubic meter [ $\mu\text{g}/\text{m}^3$ ]) measured at the Prineville Davidson Park station was recorded on September 12, 2020. These data were supplemented with PM<sub>2.5</sub> data from the Bend NE 8th and Emerson station, which is 16 miles northwest of the site. The maximum PM<sub>2.5</sub> level (547.1  $\mu\text{g}/\text{m}^3$ ) measured at the Bend NE 8th and Emerson station was recorded on August 16, 2021. The spikes in monitored PM<sub>2.5</sub> are likely associated with large wildfires in Oregon, Washington, and California during those time periods. Local and regional wildfires are generally the largest contributor to spikes in airborne particulates in eastern Oregon.

---

<sup>1</sup> <https://hazards.fema.gov/nri/lightning>

<sup>2</sup> <https://oraqi.deq.state.or.us/Report/stationreport>

The maximum ozone level (39 parts per billion) was recorded on September 12, 2020.

#### **4.9.1.5 Local Air Quality Activities and Impacts**

The vicinity of the site is predominantly vacant, undeveloped land. There are no industrial or power-generating plants within a 3-mile radius that would contribute to areawide air quality conditions.

#### **4.9.1.6 Wildfire Risk**

The Moon Pit site is mapped by the US Forest Service as having a high burn probability. Although the frequency of lightning strikes is higher near Moon Pit, the extent of historical fires suggests that fires near the Moon site are typically smaller and less-likely to propagate. The soils and landforms of the Moon Pit site have low vegetation production potential which limits the accumulation of fuels. Thus, fire events historically have been typically limited to a few trees. Stand replacement, and mixed-severity fire events were infrequent (more than 150 years).

### **4.9.2 Roth East**

#### **4.9.2.1 Temperature**

The 5-year record of temperature data collected at the BEND station reported a minimum temperature of -7 degrees Fahrenheit (F) on February 23, 2022, and a maximum temperature of 107 degrees F on June 30, 2021. Temperature data at this station are spotty for the latter part of 2022 and 2023. Additional station data can be referenced in the Air Quality Technical Report, Appendix M.

#### **4.9.2.2 Precipitation**

The 5-year record of precipitation data collected at the BEND station reported sixteen precipitation events exceeding 0.5 inches in a day, occurring in fall, winter, and spring. Fewer significant precipitation events occurred during summer. Average daily precipitation data collected at the BEND station reported eleven daily averages above 0.2 inches and significantly lower averages during summer months. Additional station data can be referenced in the Air Quality Technical Report, Appendix M.

Lightning susceptibility in the vicinity of the Roth East site is relatively low (a risk index score of 20.7 based on FEMA National Risk Index methodology <sup>3</sup>).

#### **4.9.2.3 Wind Speed**

Dominant wind directions at the Redmond Roberts Field station (22 miles northwest of the site) are out of the southeast. Most often occurring wind speeds are between 8 and 13 miles per hour. The US 20 Horse Ridge station reports sustained winds up to 26 miles per hour and gusts up to 43 miles per hour. Wind speeds at the Roth East site are expected to generally resemble what has been observed at this weather station.

Concerns have been raised by the public regarding high winds, whirlwinds carrying dust and debris, and thermal draft that are utilized by paragliders. These concerns relate to landfill operations, as

---

<sup>3</sup> <https://hazards.fema.gov/nri/lightning>

strong winds can exacerbate various environmental and operational challenges. Wind has the potential to spread litter and debris beyond the landfill boundaries. Additionally, airborne particles carrying odors from decomposing waste may be dispersed, causing nuisance to nearby communities.

Operationally, high winds can disrupt daily landfill activities, affecting waste deposition and compaction processes. To mitigate wind-related risks, landfill operators often implement engineering controls such as windbreaks, cover systems, and dust suppression measures. Regular monitoring and contingency plans are crucial to promptly address adverse weather conditions and ensure the effective and environmentally responsible management of landfill sites.

#### **4.9.2.4 Air Quality**

Available relevant air quality data from the past 5 years were downloaded from the DEQ website.<sup>4</sup> The closest publicly owned air quality monitoring station is located at Prineville Davidson Park, approximately 31 miles northeast of the site. Air quality data from this station monitors particulate matter, or PM<sub>2.5</sub>, and ozone. PM<sub>2.5</sub> is atmospheric particulate matter with a diameter less than 2.5 micrometers. Ozone can cause oxidation of electronics and sensitive instruments.

The maximum PM<sub>2.5</sub> level (518.1 µg/m<sup>3</sup>) measured at the Prineville Davidson Park station was recorded on September 12, 2020. These data were supplemented with PM<sub>2.5</sub> data from the Bend NE 8th and Emerson station, which is 25 miles northwest of the site. The maximum PM<sub>2.5</sub> level (547.1 µg/m<sup>3</sup>) measured at the Bend NE 8th and Emerson station was recorded on August 16, 2021. The spikes in monitored PM<sub>2.5</sub> are likely associated with large wildfires in Oregon, Washington, and California during those time periods. Local and regional wildfires are generally the largest contributor to spikes in airborne particulates in eastern Oregon.

The maximum ozone level (39 parts per billion) was recorded on September 12, 2020.

#### **4.9.2.5 Local Air Quality Activities and Impacts**

The vicinity of the site is predominantly vacant, with a handful of rural residential properties located throughout the area. There are no industrial or power-generating plants within a 3-mile radius that would contribute to areawide air quality conditions.

#### **4.9.2.6 Wildfire Risk**

The Roth East site is mapped by the US Forest Service as having a high burn probability. This site has more productive soils supporting sage steppe and more invasive species, especially cheatgrass, that have a higher potential of carrying wildfire. Where there is an abundance of invasive nonnative species such as cheatgrass, areas that used to burn once every 20 to 100 years can now burn every 7.5 to 15 years in sage steppe habitat.

---

<sup>4</sup> <https://oraqi.deq.state.or.us/Report/stationreport>

## 4.10 Natural Resources

### 4.10.1 Moon Pit Site Characteristics

#### 4.10.1.1 Landscape Setting and Site Use

The site is located in the Smith Canyon-Dry River (HUC 170703050710) watershed, with general slope to the northwest. The site consists of an active aggregate material mine interspersed with juniper woodland and shrubland. The site is incidentally grazed by cattle entering through gaps in fencing. The site is bordered by BLM land and is nearby to Oregon Badlands Wilderness. The topography of the site is slightly sloped to the northwest with hillsides directly outside the site to its north, east, and south. The site elevation ranges from 3,600 to 3,860 feet.

#### 4.10.1.2 Vegetation

Present within the site is 167.1 acres of juniper woodland and 10.9 acres of shrub steppe. The remainder of the site consist of disturbed mined out areas, roads, and buildings (206.82 acres). The vegetation in the juniper woodland was dominated by western juniper (*Juniperus occidentalis*), big sagebrush (*Artemisia tridentata*), rubber rabbitbrush (*Ericameria nauseosa*), cheatgrass (*Bromus tectorum*), bluebunch wheat grass (*Pseudoroegneria spicata*), and Idaho fescue (*Festuca idahoensis*). Shrub steppe habitat was dominated by big sagebrush, rubber rabbitbrush, cheatgrass, bluebunch wheat grass, and Idaho fescue. Other native species found include antelope bitterbrush (*Purshia tridentata*), cushion wild buckwheat (*Eriogonum ovalifolium*), common yarrow (*Achillea millefolium*), needle and thread (*Hesperostipa comata*), and Sandberg bluegrass (*Poa secunda*). Common weedy species found within disturbed areas include cheatgrass, night-flowering catchfly (*Silene noctiflora*), Russian thistle (*Salsola tragus*), Mexican fireweed (*Bassia scoparia*), and tumble mustard (*Sisymbrium altissimum*). Mexican fireweed is listed as a noxious weed by the Oregon Department of Agriculture.

### 4.10.2 Moon Pit Site Protected Species, Habitat, and Permitting

#### 4.10.2.1 Wetland and Waters

An artificial pond built within uplands adjacent to a mine cell in the site's northwest was found to have wetland characteristics (Appendix N). The pond was originally used for gravel and sand washing but is now used for dust control and for fire suppression. Three streambeds are mapped as intermittent seasonally flooded riverine features by National Wetland Inventory to occur within the eastern half of the site. These features are located in gullies with upland vegetation. The gullies lacked stream bed and bank features and did not contain hydric soils or hydrophytic vegetation (Appendix N). These gullies are likely ephemeral systems that only have flow during spring melt in high snowpack years. The artificial pond and the ephemeral gullies would not be considered jurisdictional. No other wetland or water features were observed on-site. Site development would not require permitting under Sections 404 and 401 of the Clean Water Act and Oregon's Removal-Fill Law (OAR 196-795-990).

#### 4.10.2.2 Federal and State Listed Species

Federally listed threatened and endangered species or designated critical habitat are not likely to be present using habitat found within the site (Appendix N); therefore, site development would not initially require permitting under Section 10 or Section 7 of the Endangered Species Act. If greater

sage grouse ([sage-grouse] *Centrocercus urophasianus*) or pygmy rabbit (*Brachylagus idahoensis*) are listed as threatened or endangered during planning and construction of the SWMF or during major operational changes once constructed, the County would need to consult with USFWS for compliance under Section 10 or Section 7 of the ESA (Appendix M).

#### **4.10.2.3 Bald and Gold Eagle Protection Act**

The site is within 2 miles of a golden eagle nest and its development will result in a permanent alteration of habitat and an Eagle Incidental Take Permit may be required for project development. The permit would be used for consultation and to determine a take statement and associated required mitigation. Potential mitigation can be conducted via an in-lieu fee which is calculated as take over time. Alternatively, Deschutes County could allocate money to a local utility company to retrofit utility poles to protect raptors and other birds from electrocution through a Memorandum of Agreement. See Appendix N for further information Bald and Gold Eagle Protection Act and requirements for permitting site development.

#### **4.10.2.4 Migratory Bird Treaty Act**

Various migratory birds that are protected under the Migratory Bird Treaty Act of 1918 may forage on or nest on the site. To avoid and minimize effects to migratory birds, initial site development (vegetation clearing and grubbing) should be conducted during the non-nesting season. If vegetation disturbance occurs during the nesting season, the site should be surveyed for nesting birds by a qualified biologist. See Appendix N for further information on Migratory Bird Treaty Act species that may be present on-site and for construction best management practice to minimize impacts.

#### **4.10.2.5 Big Game Range**

The site is entirely within mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) winter range designated by ODFW and is partially in a Wildlife Area Combining Zone for North Paulina Winter Range designated by Deschutes County. The site is also entirely within essential and limited pronghorn (*Antilocapra americana*) habitat as designated by ODFW. Tracks and scat of mule deer and elk were observed throughout the site. The habitat on-site is of low to moderate quality for these big game species (Appendix N). Site development would result in a permanent loss of 167.1 acres of juniper woodland and 10.9 acres of shrub steppe which would require mitigation (see below in Section 4.10.3)

#### **4.10.2.6 Sage-Grouse**

The Site is not sage-grouse habitat (Appendix N). However, site development would result in indirect impacts that would impact low density sage-grouse habitat. Indirect impacts can include sound disturbance and from increased densities of ravens (*Corvus corax*). Landfills can result in elevated densities of ravens due to additional food sources and roosting locations. Ravens predate on sage-grouse and higher abundance of the species within sage-grouse habitat has been linked with lower sage-grouse reproductive success.

In coordination with ODFW, the estimated impact of site development on sage-grouse is a loss of 7.8 functional acres which would require mitigation (see below in Section 4.10.3).

## 4.10.3 Moon Pit Site Development Compensatory Mitigation

### 4.10.3.1 Big Game Habitat

Mule Deer and elk winter range and essential and limited pronghorn habitat are considered Category 2 habitat by ODFW's Wildlife Habitat Mitigation Policy (OAR 635-415-0000). Category 2 habitat is deemed to be essential for a species, populations, or species assemblage (OAR 635-415-0025). Avoidance of impacts through alternatives to the proposed action are recommended. If impacts are unavoidable, mitigation of impacts would be required through in-kind, in-proximity, habitat mitigation to achieve "no net loss" and a "net benefit" of habitat quantity or quality (OAR 635-415-0025(B)).

A mitigation plan would need to be developed to characterize compensatory mitigation to impacts to 167.1 acres of juniper woodland and 10.9 acres of shrub steppe. Because impacts to mule deer and elk winter range essential and limited pronghorn habitat spatial overlap, mitigation for each can be stacked into one mitigation project. Mitigation may involve making on-site habitat improvements or acquiring a parcel of land with those habitats to prevent its development (avoided loss) or improve its habitat (enhancement). Enhancement can include a combination of actions that may include livestock grazing restrictions, weed treatment, native revegetation/restoration, fire readiness, and fence removal/fence upgrade. Further information on mitigation options for mule deer, elk and pronghorn habitat can be found in Appendix N.

### 4.10.3.2 Sage-Grouse

Site development would be considered a large-scale development (>40 acres) which would impact significant sage-grouse habitat and thus is considered a conflicting use (OAR 660-023-0115(7)). Conflicting uses require compliance with the mitigation hierarchy and ODFW's Sage-grouse Mitigation Program and Policy. The development of the site must show that the overall public benefits outweigh the damage to the significant sage-grouse habitat (DCC 18.89.110). The development of the SWMF at the site must demonstrate that impacts to sage-grouse habitat are unavoidable and the project was developed to minimize impacts. The extent of direct and indirect impacts on significant sage-grouse habitats must be mitigated for and provide a net conservation benefit to sage-grouse (OAR 635-140-0010(e)).

Site development would result in the loss of 7.8 functional acres of sage-grouse habitat. To achieve a net conservation benefit, ODFW requires compensatory mitigation to restore 115% of impacted functional acres. Thus, a mitigation plan would need to be developed to characterize the restoration of 9 functional acres of sage-grouse habitat. Mitigation actions include acquisition of bank credits, payment in-lieu, and permittee responsible on or off-site mitigation. At present, there is no mitigation bank available with approved credits. ODFW is currently reviewing documents for a mitigation bank that could be a future option for mitigation for site development. The estimated in-lieu fee cost provided by ODFW is \$500,000. The in-lieu fee cost should be considered as the maximum cost for sage-grouse mitigation. Permittee-responsible on-site mitigation is not possible given the extent of the SWMF on the site. Off-site mitigation could involve acquiring a parcel of land and performing mitigation actions or working with private or public landowners on a conservation plan. Common mitigation measures that could result in restoration of sage-grouse habitat include juniper removal, cattle grazing management, reseeding of native forbs and grasses, fence removal, and invasive removal. Further information on mitigation options for sage-grouse habitat can be found in Appendix N.

#### 4.10.4 Moon Pit Site Summary

The development of the SWMF at the site would require minimization and avoidance through site design, employing best management practices during construction and operations to avoid impacts to Migratory Bird Treaty Act-protected species, and to mitigate for impacts to golden eagle habitat, mule deer and elk winter range, essential and limited pronghorn habitat, and significant sage-grouse habitat. The initial cost of mitigation is estimated to be \$700,000 with \$800,000 in operations and maintenance. These values are approximations of costs for site development and should only be used for site selection comparisons for the SWMF. Further development of a mitigation plan and coordination with ODFW, the County, and others would be required to determine the cost of natural resource mitigation for the development of the SWMF at Moon Pit. Further information on cost estimates can be found in Appendix N.

#### 4.10.5 Roth East Site Characteristics

##### 4.10.5.1 Landscape Setting and Site Use

The site is located in the Mahogany Butte-Dry River (HUC 170703050706) watershed, with general slope to the northwest. The site consists of sage brush steppe environment with native and non-native grasses and bunchgrasses and is currently used for grazing. The site is bordered by private lands that are also used for grazing. The topography of the site is slightly sloped to the north. The site elevation ranges from 4,480 to 4,600 feet.

##### 4.10.5.2 Vegetation

The site is entirely composed of shrub steppe habitat. Vegetation within the site is dominated by big sagebrush, rubber rabbitbrush, crested wheat grass (*Agropyron cristatum*), and Idaho fescue. Other native species found include western juniper, bluebunch wheat grass, cushion wild buckwheat, antelope bitterbrush, lupine (*Lupinus species*), and prairie June grass (*Koeleria macrantha*). Invasive and non-native species present in low densities included cheatgrass, spotted knapweed (*Centaurea stoebe*), tumble mustard, medusahead rye (*Taeniatherum canput-medusae*), and clasping pepper weed (*Lepidium perfoliatum*). Medusa rye and spotted knapweed are listed as noxious weeds by the Oregon Department of Agriculture.

#### 4.10.6 Roth East Site Protected Species, Habitat, and Permitting

##### 4.10.6.1 Wetland and Waters

Within the site, nine streambeds are mapped as intermittent seasonally flooded riverine streambeds by National Wetland Inventory. These features are located in gullies with upland vegetation. The gullies lacked stream bed and bank features and did not contain hydric soils or hydrophytic vegetation (Appendix N). These gullies are likely relict topographical features from previous climatic conditions and are currently ephemeral systems that may only have flowing water during spring of high snow pack years. No other wetland or water features were observed on-site. Site development would not require permitting under Sections 404 and 401 of the Clean Water Act and Oregon's Removal-Fill Law (Oregon Administrative Record [OAR] 196.795-990) as features present on-site are not jurisdictional.

#### **4.10.6.2 Federal and State Listed Species**

Federally listed threatened and endangered species or designated critical habitat are not likely to be present using habitat found within the site (Appendix N); therefore, Site development would not initially require permitting under Section 10 or Section 7 of the Endangered Species Act. If sage-grouse or pygmy rabbit are listed as threatened or endangered during planning and construction of the SWMF or during major operational changes once constructed, the County would need to consult with USFWS for compliance under Section 10 or Section 7 of the ESA (Appendix M).

#### **4.10.6.3 Bald and Gold Eagle Protection Act**

The site is not within 2 miles of a golden eagle or bald eagle nest and thus site development is unlikely to impact these species. Site development would not require permitting under the Bald and Gold Eagle Protection Act.

#### **4.10.6.4 Migratory Bird Treaty Act**

Various migratory birds that are protected under the Migratory Bird Treaty Act of 1918 may forage on or nest on the site. To avoid and minimize effects to migratory birds, initial site development (vegetation clearing and grubbing) should be conducted during the non-nesting season. If vegetation disturbance occurs during the nesting season, the site should be surveyed for nesting birds by a qualified biologist. See Appendix N for further information on Migratory Bird Treaty Act species that may be present on-site and for construction best management practice to minimize impacts.

#### **4.10.6.5 Big Game Range**

The site is entirely within mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) winter range designated by Oregon Department of Fish and Wildlife (ODFW) and is partially in a Wildlife Area Combining Zone for Deer Winter Range designated by Deschutes County. The site is also entirely within essential and limited pronghorn (*Antilocapra americana*) habitat as designated by ODFW and is within a Wildlife Area Combining Zone for Antelope Range as designated by Deschutes County.

No tracks or scat of these big game species were observed on-site. The habitat on-site is of moderate to high quality for these big game species. Site development would result in a permanent loss of 309.3 acres intact shrub steppe habitat which would require mitigation (see below in Section 4.10.7)

#### **4.10.6.6 Sage-Grouse**

The site is entirely within low-density greater sage-grouse habitat and is adjacent to core area sage-grouse habitat as designated by ODFW. The site is used lightly by sage-grouse during the summer and winter and is located within a corridor that connects leks located to the site's east and west (Appendix N).

The habitat on-site is of moderate quality for sage-grouse. Site development would result in direct and indirect impacts to sage-grouse habitat. Direct habitat includes habitat removal whereas indirect impacts can include noise disturbance during construction and operations and predation from increased densities of ravens (*Corvus corax*). Landfills can result in elevated densities of ravens due to additional food sources and roosting locations. Ravens predate on sage-grouse and higher abundance of the species within sage-grouse habitat has been linked with lower sage-grouse reproductive success.



In coordination with ODFW, the estimated impact of site development on sage-grouse is a loss of 173.3 functional acres which would require mitigation (see below in Section 4.10.7).

## **4.10.7 Roth East Site Development Compensatory Mitigation**

### **4.10.7.1 Big Game Habitat**

Mule Deer and elk winter range and essential and limited pronghorn habitat are considered Category 2 habitat by ODFW's Wildlife Habitat Mitigation Policy (OAR 635-415-0000). Category 2 habitat is deemed to be essential for a species, populations, or species assemblage (OAR 635-415-0025). Avoidance of impacts through alternatives to the proposed action are recommended. If impacts are unavoidable, mitigation of impacts would be required through in-kind, in-proximity, habitat mitigation to achieve "no net loss" and a "net benefit" of habitat quantity or quality (OAR 635-415-0025(B)).

A mitigation plan would need to be developed to characterize compensatory mitigation to impacts to 309.3 acres of shrub steppe. Because impacts to mule deer and elk winter range essential and limited pronghorn habitat spatial overlap, mitigation for each can be stacked into one mitigation project. Mitigation may involve making on-site habitat improvements or acquiring a parcel of land with those habitats to prevent its development (avoided loss) or improve its habitat (enhancement). Enhancement can include a combination of actions that may include livestock grazing restrictions, weed treatment, native revegetation/restoration, fire readiness, and fence removal/fence upgrade. Further information on mitigation options for mule deer, elk and pronghorn habitat can be found in Appendix N.

### **4.10.7.2 Sage-Grouse**

Site development would be considered a large-scale development (>40 acres) which would impact significant sage-grouse habitat and thus is considered a conflicting use (OAR 660-023-0115(7)). Conflicting uses require compliance with the mitigation hierarchy and ODFW's Sage-grouse Mitigation Program and Policy. The development of the site must show that the overall public benefits outweigh the damage to the significant sage-grouse habitat (DCC 18.89.110). The development of the SWMF at the site must demonstrate that impacts to sage-grouse habitat are unavoidable and the project was developed to minimize impacts. The extent of direct and indirect impacts on significant sage-grouse habitats must be mitigated for and provide a net conservation benefit to sage-grouse (635-140-0010(e)).

Site development would result in the loss of 173.7 functional acres of sage-grouse habitat. To achieve a net conservation benefit, ODFW requires compensatory mitigation to restore 115% of impacted functional acres. Thus, a mitigation plan would need to be developed to characterize the restoration of 199.3 functional acres of sage-grouse habitat. Mitigation actions include acquisition of bank credits, payment in-lieu, and permittee responsible on or off-site mitigation. At present, there is no mitigation bank available with approved credits. ODFW is currently reviewing documents for a mitigation bank that could be a future option for mitigation for site development. The estimated in-lieu fee cost provided by ODFW is \$7.6 million. The in-lieu fee cost should be considered as the maximum cost for sage-grouse mitigation. On-site mitigation would involve improving habitat conditions within the parcel of land on or adjacent to the impact site, whereas off-site mitigation could involve acquiring a parcel of land and performing mitigation actions or working with private or public landowners on a conservation plan. Common mitigation measures that could result in restoration of sage-grouse habitat include juniper removal, cattle grazing management, reseeding of native forbs and grasses, fence removal, and invasive removal. Further information on mitigation options for sage-grouse habitat can be found in Appendix N.

## 4.10.8 Roth East Site Summary

The development of the SWMF at the site would require minimization and avoidance through site design, employing best management practices during construction and operations to avoid impacts to Migratory Bird Treaty Act–protected species, and to mitigate for impacts to mule deer and elk winter range, essential and limited pronghorn habitat, and significant sage-grouse habitat. The initial cost of mitigation is estimated to be \$1,500,000 with \$2,500,000 in operations and maintenance. The maximum cost of mitigation is estimated to be \$8,800,000 with \$7,600,000 for in-lieu payment to ODFW for sage-grouse habitat impacts. These values are approximations of costs for site development and should only be used for site selection comparisons for the SWMF. Further development of a mitigation plan and coordination with ODFW would be required to determine the cost of natural resource mitigation for the development of the SWMF at Roth East. Further information on cost estimates can be found in Appendix N.

## 4.11 Archaeology and Cultural Heritage

### 4.11.1 Archaeological and Historical Resources

A reconnaissance survey for archaeological and historical resources was completed by Willamette Cultural Resources Associates, Ltd. (WillametteCRA) at the Moon Pit and Roth East locations in September 2023. The intent of the reconnaissance survey was to assess the potential for cultural resources at each location and provide further actions that may be necessary to address cultural resources requirements. The reconnaissance was not a compliance-level survey (by state or federal standards) as the project areas were not surveyed systematically to cover all of the potential impact areas, and identified resources were not formally recorded with the Oregon State Historic Preservation Office (SHPO). The following is a summary of WillametteCRA's reports, which are included in their entirety in Appendix O.

### 4.11.2 Cultural Resources Literature Search and Records Review

WillametteCRA performed a records and literature review of sites and survey data on file with the Oregon SHPO, General Land Office maps and survey notes, historic topographic maps and aerial photographs, and historical references in the WillametteCRA in-house library.

#### 4.11.2.1 Moon Pit.

Three previous archaeological surveys have occurred within portions of the Moon Pit location. These prior surveys resulted in the identification of two archaeological resources within Moon Pit, and three archaeological resources immediately adjacent to Moon Pit. These resources are primarily single precontact lithic artifacts and small lithic scatters. The exception to this is a large multicomponent site near to Moon Pit. This site (35DS2384) is comprised of multiple precontact rock art panels, several concentrations of lithic debitage, multiple formed tools, and remnant features of a historic period farmstead/ranch bracketing a slot canyon located north of Moon Pit. The site has been recommended as eligible for listing in the National Register of Historic Places (NRHP).

Historic maps and aerial imagery depict no developments within Moon Pit with the exception of informal roads/trails. Historically, no buildings or structures were present.

Moon Pit is located on a parcel that encompasses both a relatively level lowland and gentle slopes leading up to Horse Ridge in the south, as well as a level upland area in the northwest. Relic drainages bisect the property in the southeast and east. Intensive mining and quarrying activity has

modified the topography and hydrology of the project parcel over the last 20 to 30 years. Given the proximity of a large, NRHP-eligible archaeological site (35DS2384), the presence of drainages, and the distribution pattern of previously identified sites in the broader vicinity, portions of the parcel undisturbed by mining activity have a moderate to high probability of containing precontact archaeological resources. Based on previous archaeological investigations, sparse lithic scatters and/or lithic isolates that may represent ephemeral habitation areas related to 35DS2384 are likely present.

Extant buildings and structures within the parcel do not date to the historic period and there are no historic built environment resources within or in the immediate vicinity of Moon Pit. WillametteCRA suspects there is a low probability for historic-period archaeological resources.

#### **4.11.2.2 Roth East.**

There has only been one previous archaeological study within Roth East; however, it did not involve field survey. As a result, the Roth East location has never been surveyed and there are no previously recorded archaeological resources.

A review of historic maps and aerial imagery of Roth East shows historic development limited to informal roads and trails and limited agricultural activity. There is one structure present in the north central portion of Roth East visible as early as the 1960s. Modern aerial imagery suggests the ruins of the structure may still be present.

Roth East is located on a parcel that encompasses both a relatively level lowland, and gentle slopes leading up to Pine Mountain in the south and a level upland area in the northeast part of the project that overlooks the valley. Relic drainages bisect the property. Given the lack of previous survey, presence of drainages, and the distribution pattern of previously identified sites in the broader vicinity, the area has a high probability of containing precontact archaeological resources. Based on previous archaeological investigations, sparse lithic scatters and/or lithic isolates that may represent ephemeral habitation areas are likely present.

There are no historic built environment resources in Roth East. Historic map research shows little to no historic-period development within or near the project area. WillametteCRA suspects there is a low probability of historic-period archaeological resources in Roth East. The exception to this would be the potential ruins of the 1960s structure, which would be recorded as an archaeological resource.

### **4.11.3 Cultural Resources Reconnaissance Survey**

The reconnaissance-level field survey consisted of meandering transects spaced approximately 20 meters apart within each quadrant. Archaeological resources were noted and mapped with a GPS (global positioning system) but were not formally recorded or delineated.

#### **4.11.3.1 Moon Pit.**

WillametteCRA staff conducted a visual inspection of approximately 100 of the 560 total acres. The previously recorded resources were not relocated during the reconnaissance. Five new archaeological resources (three sites and two isolates) were identified. The sites were all small lithic scatters comprised of flakes, flaked tools, and formed tools, including a possible Plateau side-notched point. Obsidian was among the raw materials represented. The isolates were both single historic hole-in-top cans.

#### **4.11.3.2 Roth East.**

WillametteCRA staff conducted a visual inspection of approximately 128 of the 645 total acres. Twelve archaeological resources (six sites and six isolates) were identified during the reconnaissance. The majority of resources (n=10) were precontact lithic isolates (one artifact) or sparse lithic scatters. The precontact sites vary in size and content, with the largest and most diverse site consisting of 14 artifacts. This artifact assemblage included a projectile point, flakes, and flaked tools. The projectile point resembled a Plateau side-notched point which dates to ca. 1500 years before present.

In general, the precontact archaeological resources at Roth East consisted of flakes and formed tools made from obsidian and fine-grained volcanic material. The historic resources consisted of a scatter of cans and lumber, and a spoked wheel.

#### **4.11.4 Cultural Resources Impacts**

A comparison of the relative density of cultural resources between Moon Pit and Roth East indicates that Roth East has more abundant cultural resources. Both locations are considered to have a moderate to high probability for precontact archaeological resources and a low probability for historic-period archaeological resources. No historic built environment resources are anticipated. Present land use is a relevant factor contributing to the difference in cultural resource densities between Moon Pit and Roth East. At Moon Pit, half of the proposed landfill footprint is disturbed by gravel and rock mining, which greatly reduces the potential for cultural resources, particularly intact archaeological resources. Since Roth East is largely undisturbed, the potential for discovery of intact cultural resources is greater.

#### **4.11.5 Cultural Resources Mitigation**

Based on the available data, Roth East carries the greatest degree of schedule and cost risk. A formal survey of both Roth East and Moon Pit would better define the potential schedule and cost implications. Below is the general process for addressing cultural resources which impacts the schedule and cost.

A systematic pedestrian survey of the entire area proposed for development is recommended. If an archaeological site or isolate is identified, and the project has the potential to impact it, then the resource needs to be delineated and formally evaluated under Oregon state law (assuming there is no federal nexus to the project). With some exceptions, evaluating whether an archaeological resource is significant requires an Oregon SHPO archaeological permit. To obtain a SHPO permit, a Secretary of Interior-qualified archaeologist on the Oregon SHPO's approved list must apply. The application requires a research design, which takes time to prepare. Once submitted, the application goes through a 30-day review period (realistically closer to 35 days) with SHPO during which time interested Tribes may comment. SHPO or tribal comments or questions about the application may delay the process. Once the permit is obtained, field investigations may commence. The duration of the field investigations depends on the complexity of the resource. Once field investigations and post-field analysis are completed, the permit holder presents the findings (report and resource forms) to SHPO for concurrence. SHPO has 30 days to review the findings.

If the resource is determined significant, then impacts to the resource will need to be avoided or mitigated (e.g., archaeological data recovery, public interpretation, etc.); mitigation is specific to the individual resource and impact. If the resource is determined not significant, then the resource is not protected by Oregon law and requires no avoidance or mitigation, and the project may proceed as planned. If SHPO disagrees with a finding or requests more information to support a finding, the

SHPO review clock starts over at 30 days. Under state law, Oregon SHPO has the final say as to whether a resource is significant.

## 4.12 Community Assessment

### 4.12.1 Site-Specific Community Assessment Summary

The Deschutes County Department of Solid Waste is working with a SWAC to evaluate siting options for the new solid waste management facility. The SWAC has been meeting regularly since April 2022 to review and discuss information during the multi-step siting evaluation. In June 2023, the SWAC recommended further study of the Moon Pit and Roth East finalist sites.

### 4.12.2 Community Characteristics

The County is looking to enter into negotiations with a willing seller and is engaged in direct outreach with the Moon Pit and Roth East property owners. Both sites are in the same census tract in Deschutes County (41017000100). The census tract population is approximately 1,962 people and is not identified as disadvantaged.

- For the Moon Pit site, there are no known residences within 1 mile of the site and one residence within 2 miles of the site. There are a variety of active recreational uses in the vicinity of the site, including the Badlands Rock Trailhead and parking area and general outdoor use by mountain bikers (outside the Badlands Wildlands Wilderness) and others.
- For the Roth East site, there are two known residences within 1 mile of the site and eight within 2 miles of the site location. There are a variety of active recreational uses in the vicinity of the site, including an off-road vehicle trail system, a Pine Mountain launch area for paragliders and hang gliders, a shooting range, and general outdoor use by mountain bikers, hikers, birdwatchers, and others.

Throughout the siting evaluation, the County has been working to share information with interested parties and the community and collect public input in writing and during public meetings held with the SWAC. As part of ongoing outreach, the County has contacted area residents, public agencies, Tribes, recreation and environmental interests, and others. No response has been received from contacted Tribes (as of May 22, 2024). In addition to individual community members, agencies and organizations that submitted comments included the Bureau of Land Management, US Fish and Wildlife Service, East Cascades Audubon Chapter, Oregon Natural Desert Association, Central Oregon Landwatch, League of Conservation Voters, University of Oregon Department of Physics/Pine Mountain Observatory, and the United States Hang Gliding and Paragliding Association. These written comments from agencies and organizations are included in Appendix R.

Based on the comments received, the Moon Pit and Roth East site locations in a comparatively less developed part of the county have been viewed as a positive by some community members, while others highlight considerations about operational hauling costs and winter roadway conditions.

Site-specific concerns expressed by local community members generally relate to potential environmental issues, health risks or other local impacts. For the Moon Pit site, this includes consideration of the proximity to the Badlands Wilderness, concerns about nearby cultural resources, and potential disruption of area recreation uses. For the Roth East site, this includes consideration of potential local impacts to Millican Valley landowners, light pollution and related impacts to the Pine Mountain Observatory, and potential disruption of area recreation uses such as paragliding.

Specifically, the potential for high winds at Roth East to spread debris and dust and concerns about contamination of local groundwater have been noted.

For both sites, there are concerns about potential impacts to habitat and area wildlife resulting from site development and operation. Of the two sites, development of Roth East is generally viewed as having more potential visual and residential impacts while development of Moon Pit is perceived as having minimal new impacts because of its current use as a gravel mine. Because the Moon Pit site is already disturbed and will continue to support surface mining (regardless of landfill siting), concerns were raised that development of a new landfill at the Roth East site would cause a greater disruption to the surrounding area than at the Moon Pit site.

An abbreviated tabular summary of public comments for the two sites is presented below in Table 3. These comments are part of the public record for the siting evaluation work and have been made available to the project team, SWAC, and Board of County Commissioners.

**Table 3. Public Comments Received by County (December 2022-October 2023)**

	<b>Moon Pit Site</b>	<b>Roth East Site</b>
<b>Total Public Comments</b>	<b>224</b>	<b>300</b>
Top Categories (over 100 mentions)	<b>Wildlife</b> 218 sage grouse, 218 eagles and raptors, 216 deer <b>Environment</b> 218 noise <b>Recreation</b> 206 general <b>Zoning</b> 206 wildlife	<b>Wildlife</b> 274 sage grouse, 227 general, 245 deer, 208 elk, 205 cougar <b>Environment</b> 267 noise <b>Zoning</b> 243 wildlife <b>Recreation</b> 225 general, 131 paragliding

Notes: Some comments identified in this summary referenced the area near the site (e.g., Badlands Wilderness or Millican Valley) not the specific site. The full record is available through the County’s project webpage at [deschutescounty.gov/managethefuture](https://deschutescounty.gov/managethefuture).

### 4.12.3 Continued Outreach

Once a final site is selected, the site permitting process is expected to include additional outreach and public process such as notifications and opportunities for comment. This consultation with federal, state, and local agencies, along with Tribal governments, can help identify strategies to mitigate potential impacts during site development and operations. Along with informative outreach for the broader community, providing ongoing opportunities for two-way communication with adjacent property owners, local community groups, and interested parties is recommended to invite feedback and help identify concerns and potential solutions. For example, continued briefings and small group discussions with stakeholder organizations and interested parties, backyard and small group engagement with neighbors to discuss property-specific considerations, and periodic meetings with the SWAC are suggested methods of sharing information and inviting input.

### 4.12.4 Siting Evaluation Outreach Summary

The County is committed to a transparent process and is working with a SWAC to evaluate siting options. SWAC members are appointed and represent incorporated cities, franchise haulers, the Environmental Center, and the community at-large. The SWAC has been meeting regularly since April 2022 to review and discuss information during the multi-step siting evaluation. The meetings allow for in-person and online attendance and include public comment periods.

As part of the siting evaluation process, County staff have received and responded to hundreds of public comments. These comments are part of the public record for the siting evaluation work and have been made available to the project team, SWAC, and Board of County Commissioners.

In addition to the SWAC meetings, the County has been sharing information and inviting community input using a range of outreach tools including updates to the Board of County Commissioners, direct outreach and mailings to property owners and site neighbors, direct outreach to Tribes, briefings to community groups and public agencies, news media interviews and press releases, e-news updates, group mailings to interested parties, and a community open house. The County has also created a project webpage and a StoryMap dedicated to the siting evaluation process with information about the project timeline, maps, frequently asked questions, and various resource links. See Appendix P for more information in the Community Assessment.

*page intentionally blank  
for double-sided printing*



## 5. Cost Analysis

The Parametrix team prepared planning level opinions of probable cost (costs) for both sites. These opinions have ranges of -30% to +50%, which is an appropriate level of accuracy for comparison of sites. See Appendix C for Site Owner Solicitation Responses with terms and prices for acquisition. See Appendix Q for SWMF waste projections and cost estimates for development and operations at each site.

### 5.1 Capacity and Projected Life

Moon Pit has an estimated airspace capacity of 64 million cubic yards over 346 acres. The available airspace on this footprint provides a project lifespan of 100 years.

Roth East has a footprint of 387 acres with an estimated 80 million cubic yards of airspace. The projected life of the landfill is 125 years based on the preliminary design. The MSW disposal area footprint on the site has the possibility of expansion horizontally and vertically and could provide over 250+ years of solid waste disposal capacity for Deschutes County residents if needed.

### 5.2 Population to be Served

As with the existing Knott Landfill, the new Deschutes County landfill would serve the population of Deschutes County. Portland State University Population Research Center issued the Coordinated Population Forecast for Deschutes County (2022–2072) in 2022 with estimates of current and future population. The population estimate for Deschutes County in 2022 is 207,921. The forecast predicts that the population in Deschutes County will continue to grow over the next 50 years, but with a declining average annual growth rate (AAGR) that falls from 2.2% in 2022 down to 1.1% 2047. For the remainder of the forecast period (2047–2072) it is projected that the AAGR will hold steady at 1.1%. For municipal solid waste projections, it was assumed that this terminal 1.1% AAGR would continue into the future for the remainder of the 100-year landfill planning period. See Appendix Q for population projection tables.

### 5.3 Accepted and Prohibited Wastes

The SWMF will accept MSW from Deschutes County transfer stations. The site will continue following the current waste screening and acceptance policies that are currently in place at Knott Landfill. Hazardous waste will not be accepted for disposal at the new landfill site.

### 5.4 Rate of Waste Disposal

It is estimated that the annual total waste generated in Deschutes County in 2020 was 296,500 tons. Of this total, it is estimated that 98,000 tons of material was recycled which computes to a recovery rate of 33%. In 2020, the quantity of waste that was landfilled at Knott Landfill was 198,000 tons. Deschutes County has implemented a recovery rate goal of 45% waste diversion by 2025. For municipal solid waste projections, it was assumed that the recovery rate would increase at a rate of 1% per year, up to 45% in 2038, and then remain at 45%. The annual waste disposed is still estimated to grow even with the increased recovery rate due to population growth in the county.

The current annual per capita waste generation in Deschutes County is approximately 3,050 lbs./capita. It is assumed that this per capita waste generation rate will remain steady through planning period. Waste generation, recovery rates, and waste projections were based on the Deschutes County Solid Waste Management Plan (2019), 2018-2021 Material Recovery and Waste Generation Rates Reports, and 2022 Knott Landfill Tonnage Analysis provided by Deschutes County Solid Waste. See Appendix Q for waste projection tables.

## 5.5 Mineral Resources

Moon Pit has potential for mineral and surface mining operations on site due to the existing surface mine. The mining can continue in areas where the landfill is planning future fill and expansion. This can assist in subsidizing the initial and ongoing operations cost associated with the landfill. Surface mining can be utilized to subsidize landfill operation costs through re-purposing of mined areas. This dual utilization optimizes the economic potential of the land, helping offset the expenses associated with landfill development and operation. By repurposing mined areas for waste disposal, operators can effectively rehabilitate the land for a new purpose, contributing to sustainable land use practices. Balancing economic benefits with environmental stewardship is essential to ensure a sustainable and responsible approach to resource extraction and waste management.

Roth East has enough material on-site for all the current and future landfill needs. This includes drainage, daily cover, and final cap cover.

## 5.6 Initial Development Costs

The Parametrix team prepared planning-level opinions of probable cost (costs) for both sites. These opinions have ranges of -30% to +50%, which is an appropriate level of accuracy for comparison of sites. See Appendix C for Site Owner Solicitation Responses with terms and prices for acquisition. See Appendix Q for SWMF Cost Estimates for development and operations at each site.

### 5.6.1 Moon Pit Site

Initial development costs are estimated at \$50 to \$64 million, which includes \$15.4-15.9 million for land acquisition. Landfill cell development costs are estimated at \$705,000 to \$1,075,000 per acre. Annual operating costs are estimated at \$7.6 million per year, which includes \$2.5 million/year for waste hauling. The estimated average cost per ton is \$43 to \$48 in 2023 dollars, to dispose of 37.6 million tons over a 100-year lifespan. The cost estimate ranges presented here depend on the extent and cost of cell excavation that could occur as a part of on-site aggregate mining operations.

### 5.6.2 Roth East Site

Initial development costs are estimated at \$36 to \$44 million, which includes \$5.5-7.0 million for land acquisition and \$1.5-7.6 million for natural resource mitigation. Landfill cell development costs are estimated at \$393,000 per acre. Annual operating costs are estimated at \$8.4 million/year, which includes \$3.3 million/year for waste hauling. The estimated average cost per ton is \$44 in 2023 dollars, to dispose of 46.3 million tons over a 113-year lifespan. If the disposal capacity is increased beyond 200 years, the cost per ton could be significantly reduced.

## 5.7 Refuse Cell Construction

Moon Pit cell construction costs are estimated at \$1.1 million per acre, primarily due to the presence of rock at the site. Excavation for refuse cells will require rock drilling, blasting and crushing to produce daily, intermediate, and final cover material, as well as materials for cell development and roads. Table 4 shows the estimated cost for the development of future landfill cells. The construction costs that are shown are based on the most recent prices paid by Deschutes County at the Knott Landfill.

If the required Rock Drilling, Blasting, and Crushing (2-inch Minus) can be completed by contractors at a reduced unit cost of \$4 per cubic yard in consideration for the aggregate resource, the estimated cost of cell development reduces to \$705,240 per acre. If this rock removal work is not subsidized by the aggregate resource value and a unit cost of \$12 per cubic yard is assumed, the estimated cost of cell development is \$1,074,600 per acre, as shown below in Table 4. Due to fluctuating aggregate and construction market conditions, the cost of cell development is expected to fall within the range of \$700,000 to \$1.1 Million per acre at Moon Pit. The range of costs presented for Moon Pit in this section and in Appendix Q are predominantly driven by these assumed unit costs for Rock Drilling, Blasting, and Crushing.

**Table 4. Estimate of per acre Cost for Landfill Cell Development at Moon Pit**

Item	Unit	Quantity	Cost	Estimated Cost (2023\$)
Excavation	CY	38,000	\$ 4.00	\$ 152,000
Rock Drilling, Blasting, and Crushing (2-inch Minus)	CY	34,200	\$ 12.00	\$ 410,400
Embankment	CY	6,000	\$ 2.00	\$ 12,000
6-inch Soil Cushion Layer	CY	900	\$ 10.00	\$ 9,000
Geosynthetic Clay Liner	SF	48,000	\$ 1.00	\$ 48,000
Geomembrane	SF	48,000	\$ 0.90	\$ 43,200
Cushioning Geotextile	SF	12,000	\$ 0.85	\$ 10,200
Geonet Composite	SF	48,000	\$ 0.95	\$ 45,600
12-inch Drainage Layer	CY	1,600	\$ 10.00	\$ 16,000
Separating Geotextile	SF	36,000	\$ 0.85	\$ 30,600
8-inch Leachate Collection Pipe	LF	300	\$ 30.00	\$ 9,000
Landfill Gas Collection System	Lump Sum	1	\$ 10,000.00	\$ 10,000
Subtotal				\$ 796,000
Engineering and Administration (15%)				\$ 119,400
Contingencies (20%)				\$ 159,200
<b>Estimated per acre Cell Development Cost</b>				<b>\$ 1,074,600</b>

Assumptions:

1. Approximately 90% of the excavation volume will require rock drilling, blasting and crushing.
  2. Rock drilling, blasting, and crushing cost assumes no contractor mining, just processing for County uses.
- CY = cubic yards; SF = square feet

The MSW disposal area at Roth East is located in an area that can be excavated by the County as part of their Daily, Intermediate and Final Cover Borrow operations. Because of this, the estimated cost for the development of future landfill cells at the Roth East site is considerably less than Moon Pit. Table 5 shows the estimated cost for the development of future landfill cells at Roth East. The estimated cell construction cost is \$394,000 per acre which is about one-third of the cost for cell development at Moon Pit.

**Table 5. Estimate of per acre Cost for Landfill Cell Development at Roth East**

Item	Unit	Quantity	Unit Cost	Estimated Cost (2023 \$)
Rough Excavation <sup>1</sup>	CY	-	\$ 4.00	\$ 0
Finish Excavation <sup>2</sup>	CY	15,000	\$ 4.00	\$ 60,000
Embankment	CY	5,000	\$ 2.00	\$ 10,000
6-inch Soil Cushion Layer	CY	900	\$ 10.00	\$ 9,000
Geosynthetic Clay Liner	SF	48,000	\$ 1.00	\$ 48,000
Geomembrane	SF	48,000	\$ 0.90	\$ 43,200
Cushioning Geotextile	SF	12,000	\$ 0.85	\$ 10,200
Geonet Composite	SF	48,000	\$ 0.95	\$ 45,600
12-inch Drainage Layer	CY	1,600	\$ 10.00	\$ 16,000
Separating Geotextile	SF	36,000	\$ 0.85	\$ 30,600
8-inch Leachate Collection Pipe	LF	300	\$ 30.00	\$ 9,000
Landfill Gas Collection System	Lump Sum	1	\$ 10,000.00	\$ 10,000
Subtotal				\$ 291,600
Engineering and Administration (15%)				\$ 43,740
Contingencies (20%)				\$ 58,320
<b>Estimated per acre Cell Development Cost</b>				<b>\$ 393,660</b>

Assumption:

1. Two thirds of cell excavation would occur as a part of daily cover borrow operations by Deschutes County Solid Waste staff.
  2. One-third of total excavation if fine grading to cell subgrade design elevations.
- CY = cubic yards; SF = square feet

## 5.8 Description of Operation

The landfill will not be open to the public and will therefore have minimal landfill staff when compared to a landfill that has a high volume of commercial haulers and the public. The daily operation of the landfill involves a systematic process to manage waste disposal efficiently. Scale house operators will weigh, screen, and direct inbound waste materials to their proper locations. It is anticipated that disposal, waste compaction, daily cover and other fill operations will be similar to what is currently happening at Knott Landfill.

Table 6 shows the estimated total annual operating costs for hauling waste to Moon Pit and Roth East from the County’s transfer stations and disposing of it in the landfill.

**Table 6. Comparison of Estimated Annual Operating Costs**

	Moon Pit	Roth East
Administrative Labor Subtotal	\$ 1,288,000	\$ 1,288,000
Equipment Owning and Operating Subtotal	\$ 1,614,000	\$ 1,614,000
Environmental Monitoring Subtotal	\$ 868,000	\$ 902,000
Haul Cost Subtotal	\$ 2,536,000	\$ 3,280,000
Miscellaneous Subtotal	\$ 1,269,000	\$ 1,332,000
<b>Total Annual Operating Costs</b>	<b>\$ 7,576,000</b>	<b>\$ 8,417,000</b>

## 5.9 Daily and Intermediate Cover

Daily cover and intermediate cover operations are critical aspects of landfill management. Daily cover involves the application of a protective layer of soil or alternative materials over the exposed waste at the end of each operational day. This cover helps control odors, prevents the attraction of pests, and reduces windblown debris. It also contributes to overall site aesthetics. Intermediate cover, on the other hand, is applied periodically during active landfill operations to control erosion, manage surface water runoff, and create a barrier between waste and the environment. Both daily and intermediate covers play key roles in minimizing environmental impacts and maintaining regulatory compliance within the landfill operation. The cover cost for Moon Pit and Roth East has a negligible difference, both sites will operate under the same cover assumptions with similar cost. The additional costs of obtaining cover materials at Moon Pit are captured in the cell development capital costs noted above.

## 5.10 Landfill Closure

It is anticipated that Moon Pit and Roth East will have similar closure costs. The total estimated cost for each site includes final contouring and grading, landfill gas collection systems, geotextile cushion, geosynthetic clay liner (GCL), geomembrane, geonet composite layer, 24-inch topsoil/soil protective layer, seed, fertilizer and mulch, cover system irrigation, and monitoring and maintenance. The final cost for closure at both site locations is estimated to be \$378,000 per acre. Again, the additional costs of obtaining cover materials at Moon Pit are captured in the cell development capital costs noted above.

## 5.11 DEQ Permitting

Both landfill sites will require a Solid Waste Disposal Site Permit from DEQ. The DEQ permit for landfill operations is to ensure that the landfill operates in compliance with environmental laws and regulations. This permit outlines specific conditions and requirements that the landfill must adhere to, including waste acceptance criteria, operational practices, monitoring procedures, and closure plans. DEQ permits are designed to mitigate potential environmental hazards associated with landfills, such as soil and water contamination, air pollution, and wildlife disruption. The permit process involves a comprehensive review of the landfill's design, construction, and operational plans,

with a focus on minimizing the impact on surrounding ecosystems and communities. Moon Pit and Roth East both have an estimated initial permitting cost of \$1.5 million.

## 5.12 Summary of Cost Analysis

Each site has a unique set of design challenges that contribute to their overall cost over the life of the landfill. Initial development, land acquisition, operations, and final cover all play a part in the total cost to design, operate, and close a landfill. The SWMF will accept MSW from Deschutes County transfer stations, any increased cost to the public is reflected in the tipping fees in table 6.

For the Moon Pit site, upfront costs are expected to be higher, but annual operational costs are expected to be lower. Initial development costs are estimated at \$50 to \$64 million, which includes \$15.9 million for land acquisition. Landfill cell development costs are estimated at \$705,000 to \$1,075,000 per acre. Annual operating costs are estimated at \$7.6 million per year, which includes \$2.5 million per year for hauling waste. The estimated average cost per ton is \$43 to \$48, to dispose of roughly 38 million tons over a 100-year lifespan.

The cost estimate ranges presented for Moon Pit depend on the extent and cost of cell excavation that could occur as a part of aggregate mining operations on-site. If permitting and aggregate market conditions are favorable, there is greater upside potential for the Moon Pit site with the opportunity for aggregate mining to subsidize landfill excavation costs. Initial capital costs are significantly higher at Moon Pit, which would necessitate higher tip fees for the first 30 years.

For the Roth East site, upfront costs are expected to be lower, but annual operational costs are expected to be higher due to the extended haul distance. Initial development costs are estimated at \$36-44 million, which includes \$5.5-7.0 million for land acquisition. Landfill cell development costs are estimated at \$393,000 per acre. Annual operating costs are estimated at \$8.4 million per year, which includes \$3.3 million per year for waste hauling. The estimated average cost per ton is \$44, to dispose of roughly 46 million tons over a 113-year lifespan. While the Roth East site is offered at a lower acquisition price and will have lower cell excavation costs, the additional operational costs for further waste hauling are projected to drive total cumulative costs beyond that of Moon Pit around year 83 of operations (circa 2112).

For both sites, it is assumed that upfront acquisition and development costs would be financed with a 30-year bond at a 4.75% interest rate. The total cost of debt service, landfill operations, and cell expansion have been analyzed for the first 30-years to estimate the cost per ton and related tipping fees required to cover these costs during this time period (2030-2059). For Moon Pit, the estimated 30-yr cost per ton is \$59-\$68 and the tipping fee is \$106-\$115 per ton. For Roth East, the estimated 30-yr cost per ton is \$53-\$55 and the tipping fee is \$100-102 per ton.

To further understand these costs in terms of impacts to County residents, increases to household garbage collection bills and self-haul disposal costs were estimated. Household garbage collection bills are estimated to increase from the assumed current rate of \$25 per month to around \$29 per month with Moon Pit and \$28 per month with Roth East. Self-haul household waste and construction debris disposal costs are estimated to increase from the current rate of \$14 (for up to 400lb load covered & secured) to \$21-\$23 with Moon Pit and around \$20 with Moon Pit. Table 7 below compares the estimated costs and disposal fees associated with each site.

**Table 7. Landfill Site Cost Comparison**

Item	Moon Pit	Roth East
Operating Period	2029–2129	2029–2142
Estimated Lifespan (years)	100	113
Land Acquisition Costs	\$15,870,000	\$5,500,000 to \$6,898,000
Initial Development Costs	\$35,266,900 to \$49,036,900	\$30,580,740 to \$37,215,609
Total Initial Costs (Land + Development)	\$51,136,900 to \$64,906,900	\$36,080,740 to \$44,113,609
Landfill Cell Development Costs	\$193,125,000 to \$347,094,000	\$142,905,000
Closure Costs	\$131,404,000	\$146,548,000
Operating Costs	\$1,259,744,358	\$1,720,346,129
Post-Closure Operations Costs	\$9,068,316	\$9,068,316
Total Lifespan Costs	\$1,643,978,574 to \$1,812,217,574	\$2,054,948,185 to \$2,062,981,054
Total Waste Disposal Projection (tons)	37,686,654	46,319,902
Avg. Cost per Ton over Lifespan	\$43 to \$48	\$44
Upfront Capital Costs Financed <sup>1</sup>	\$79,551,043 to \$101,969,346	\$68,419,316 to \$83,651,914
30-yr Operational Costs (2030–2059)	\$96,021,924 to \$123,081,891	\$328,800,270
30-yr Total Costs (2030–2059)	\$344,700,390 to \$386,439,390	\$397,219,586 to \$412,452,184
30-yr Waste Disposal Projection (tons)	7,462,195	7,462,195
30-yr Cost per Ton	\$59 to \$68	\$53 to \$55
30-yr Tipping Fee	\$106 to \$115	\$100 to \$102
Est. Monthly Residential Collection Bill <sup>2</sup>	\$28.05 to \$28.83	\$27.56 to \$27.73
Monthly Res. Collection Bill \$ Increase <sup>2</sup>	\$3.05 to \$3.83	\$2.56 to \$2.73
Monthly Res. Collection Bill % Increase <sup>2</sup>	12% to 15%	10% to 11%
Est. Self-Haul Disposal Cost <sup>3</sup>	\$21.18 to \$23.02	\$20.01 to \$20.42
Self-Haul Disposal Cost \$ Increase <sup>3</sup>	\$7.18 to \$9.02	\$6.01 to \$6.42
Self-Haul Disposal Cost % Increase <sup>3</sup>	51% to 64%	43% to 46%

1. Acquisition and development costs financed with 30-yr bond at a 4.75% annual interest rate.

2. Increase of \$0.85 for every \$10 increase above current \$70/ton tipping fee. Residential collection bill assumed at \$25/month.

3. Based on current cost of \$14 for up to 0-400 lbs of household/construction waste disposal with load covered & secured.

*page intentionally blank  
for double-sided printing*



## 6. Conclusion

The selection of a new site for the Deschutes County SWMF is a complex decision that requires careful consideration of various factors. The two candidate sites, Moon Pit and Roth East, each present unique advantages and challenges.

Moon Pit offers the advantage of existing infrastructure, including an access road, gate, scales, and well, which could reduce site development costs. The site's current use as a gravel mine provides some "free" airspace and reduces initial excavation needs. However, the site's layout is more complex and less efficient than Roth East, resulting in a lower capacity-to-acreage ratio and the need for more leachate pump stations. The presence of shallow bedrock increases excavation costs, although this could be offset by potential aggregate mining operations. Risks may emerge from the land use approval process and a potentially extended National Environmental Policy Act process for the access road. The Moon Pit site has upside potential and downside risk related to aggregate mining for cell excavation, depending on marketability of on-site rock. Initial capital costs are significantly higher at Moon Pit, which would necessitate higher tip fees for the first 20 years. However, the existing and useful transportation network that provides direct access from US 20 is a significant advantage. The Moon Pit site is generally viewed as having fewer visual and residential impacts, and because the site is currently used as a gravel mine, there is a perception that use as a landfill would pose minimal new impacts.

Roth East, on the other hand, has a more efficient square shape, resulting in a better capacity-to-acreage ratio and fewer leachate sumps/pumps. The mix of sand, gravel, and cobbles within the excavation depth on-site is very favorable for efficient landfill development and operation. However, there is no existing infrastructure on-site and no existing improved access road between the site and US 20 support landfill operations. Potential risks may arise from the Farm Impacts Test which could lead to a Land Use Board of Appeals appeal which can be a lengthy process. While the Roth East site is offered at a lower acquisition price and would have lower cell excavation costs, the additional operational costs for further waste hauling are projected to drive total cumulative costs beyond that of Moon Pit around year 83 of operations (circa 2112). Of the two sites, development of Roth East is generally viewed as having more visual and residential impacts, Appendix P.

Given these considerations, both sites appear to be viable options for the new County SWMF. The Moon Pit site is appealing due to its existing infrastructure, lower haul costs, and lower degree of impacts to residences and wildlife. The Roth East site is appealing with its efficient layout, favorable excavation conditions, and potential for a longer lifespan. This decision is a significant step toward ensuring the long-term sustainability of waste management in Deschutes County. The selection of either site will ultimately depend on the specific priorities and needs of the County.

This process for selection of the preferred SWMF site involved thorough review, discussion, and consideration of study findings, leading to a formal recommendation to the Board of County Commissioners. The process for reviewing information and selecting the preferred Deschutes County SWMF site involves several key milestones in 2024:

- February 20 SWAC Meeting: Review executive summary, site comparison table, and study findings with the SWAC, providing the SWAC opportunity to submit written comments.
- March 8: Distribute draft report for SWAC members, commissioners, and other relevant parties for detailed review and consideration, prior to March SWAC meeting.
- March 19 SWAC Meeting: Review and discuss draft report with the SWAC.

- April 5: Submit final report to Deschutes County Solid Waste for distribution to SWAC members, commissioners, and other relevant parties for detailed review and consideration.
- April 16 SWAC Meeting: SWAC members provide a formal recommendation to the Board of County Commissioners regarding their preferred site for the new County SWMF.
- June 12: First Board of County Commissioners Public Hearing.
- July (date TBD): Second Board of County Commissioners Public Hearing and Board selection of preferred County SWMF site.

On April 16, 2024, the Solid Waste Advisory Committee unanimously recommended the Moon Pit site for Board of County Commissioners consideration as the location for the new Solid Waste Management Facility. Key reasons for this recommendation included:

- The site is currently being used as an aggregate surface mine and is already disturbed
- Based on the current use, there is less likelihood of new impacts to area wildlife or recreation
- The site is comparatively closer to existing facilities which will help manage haul costs and greenhouse gas emissions

The Committee also recommended that the Board of County Commissioners:

- Work with stakeholders to develop and implement a robust and comprehensive mitigation strategy that reflects community values to minimize impacts to area wildlife and recreation
- Prioritize waste prevention and recovery and move as quickly as possible to implement those strategies to reduce the overall costs and greenhouse gas emissions of the new landfill