# APPENDIX E

## SOILS

# WHARF RESOURCES (USA) INC.
# 2021 BASELINE SOIL ASSESSMENT
# BOSTON EXPANSION AREA

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# SOILS

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**Introduction**

The Wharf Expansion Area was evaluated by BKS Environmental Associates, Inc. (BKS) of Gillette, Wyoming in August and October 2010. A total of 600.50 acres were included in the final soil mapping of the 2010 Wharf Expansion Area. Of those 600.50 mapped acres, 49.75 mapped acres comprise the Boston Expansion Area. During the 2010 evaluation, 32 soil profiles were exposed, and two road cuts were described for soil mapping. Of the 2010 soil profiles, three profiles are within the Boston Expansion Area. Within the Boston Expansion Area, four road cuts are visible on 2020 aerial photography; in 2010, only two road cuts were visible. The 2010 soils mapping is viable for the Boston Expansion Area because there has been no change in land use since 2010.

Soil salvage depths for the Boston Expansion Area will be evaluated and presented based on the 2010 mapping. Soil depths within a given mapping unit vary based on any combination of the five primary soil forming factors, i.e., climate including effective precipitation, organisms, relief or topography, parent material, and time. Subtle differences in any one of the previously mentioned factors will impact development between series and within series designation; however, it may not be as noticeable as when topography is a major factor. The proposed topsoil salvage depths for the Boston Expansion Area are based on field observations of 2010 soils profiles found within this specific area as well as practical limits based on equipment type.

Soils in the Boston Expansion Area are typical for soils formed under a mixed coniferous and deciduous forest occurring on the mountainous hillslopes of the Black Hills. Parent material included colluvium, residuum, and alluvium. Soil map units for the Boston Expansion Area are similar to those identified during the 2010 evaluation. Soils were classified taxonomically as Typic Palecryolls, Haplic Glossudalfs, and Pachic Hapludolls.

All soils have at least some suitable topsoil and/or subsoil except for rock outcrops and rubbleland. The primary limiting factor within the Boston Expansion Area is coarse fragments. Rocks inhibited soil augering on every hole except for one in 2010. That is still the case for the Boston Expansion Area.

Refer to Addendum A for the Boston Expansion Area acreage. Refer to Addendum B for the Soil Mapping Unit Descriptions for the Boston Expansion Area. Refer to Addendum C for the Soil Series Descriptions of the three locations found within the Boston Expansion Area. Refer to Addendum D for corresponding photographs to those series. Refer to Addendum E for the soil map of the Boston Expansion Area.

## Methodology

### General

Baseline soils inventories for the 2010 Wharf Expansion Area consisted of refinement of the current Natural Resources Conservation Service (NRCS) mapping for Lawrence County, South Dakota. The soil map for the Boston Expansion Area is a subset of the larger map derived in 2010 for the Wharf Expansion Area.

### Review of Existing Literature

NRCS mapping within the 2010 Wharf Expansion Area and historical soils information was reviewed. Such information was reviewed for the Boston Expansion Area for appropriateness to this specific area.

### Soil Survey

Field mapping was conducted in 2010 according to techniques and procedures outlined in the National Cooperative Soil Survey. Wyoming Department of Environmental Quality (WDEQ) Land Quality Division (LQD) Guideline 1 (1994) was used as a guide during all phases of the 2010 study. Since 2010, this guideline has been revised into WDEQ-LQD Guideline 1A (2015). However, this does not impact the current requirements for this area.

A reconnaissance survey of the Wharf Expansion Area was completed by field personnel during 2010 which included the Boston Expansion Area. Following the reconnaissance survey, an Order 2 soil survey was conducted during August 2010. Soil profiles were examined on a widely scattered basis according to physiographic configuration. Information derived from these profiles was used to determine which soils are likely to occur on specific landscape positions. The soil boundaries were delineated on a 1:7,200 topographic base map, for purposes of permit submittal. This map formed the basis of the Boston Expansion Area soil map. No additional field verification points were evaluated within the Boston Expansion Area in 2021.

### Soil Mapping and Description

Laboratory analysis of soil series was not required within the 2010 Wharf Expansion Area.

All soil profiles were collected in 2010 with a Giddings truck mounted auger or hand auger to paralithic contact or a maximum depth of 60 inches, whichever was shallower. Most holes were obstructed by rocks, due to the high coarse fragment content of the soils. Sample profiles were described in the field, to the extent possible, by the physical and chemical nature of each profile

horizon. Road cuts were viewed, whenever possible, to view a vertical profile. Backhoe pits were not utilized for soil mapping in 2010.

Soil mapping verification locations in 2010 were identified on a base map and global positioning system (GPS) locations were collected with hand-held Garmin GPS units.

**Results and Discussion**

Soil Survey – General

General topography of the 2010 Wharf Expansion Area ranged from valleys to very steep hills and mountainous slopes. The soils occurring on the Wharf Expansion Area were generally loamy with deep and rocky soils. Soils within the Boston Expansion Area are also loamy with numerous coarse fragments which would be considered skeletal loamy.

Refer to Table 1 for permit acreages within the Boston Expansion Area.

Soil Mapping Unit Interpretation

The primary purpose of the 2010 fieldwork was to characterize the soils in terms of topsoil salvage depths and related physical and chemical properties. The evaluation of the Boston Expansion Area is based on this 2010 information. Soil map units present in 2010 but NOT within the Boston Expansion Area include: Citadel silt loam, Rock Outcrop/Rubbleland, Sawdust channery loam, Trebor silt loam, Vanocker gravely silt loam, Virkula silt loam, and Winetti gravelly sandy loam. The three soil map units that are present in the Boston Expansion Area are: Goldmine loam, Grizzly very gravelly silt loam, and Hisega loam.

Refer to Addendum B and C for soil mapping unit descriptions and soil series descriptions, respectively, for only those map units present in the Boston Expansion Area.

Evaluation of Soil Suitability as a Plant Growth Medium

Approximate salvage depths of each soil map unit identified within the Boston Expansion Area are presented in Table 2 and ranged from 0 to 9 inches. Within the 2010 Wharf Expansion Area, suitability of soil as a plant growth medium was generally affected by the physical factor of coarse fragments. Chemical limiting factors such as electrical conductivity (EC) and sodium adsorption ratio (SAR) were not considered to be an issue because no salts were noted within the profiles. It is assumed that pH levels were strongly acidic to moderately alkaline. Calcium carbonate was only noted in two profiles within the Winetti soil series in 2010; this map unit is not within the Boston Expansion Area. Similar physical and chemical factors exist in the Boston Expansion Area for those soil map units and soil series appliable to this specific area.

Topsoil Volume Calculations

Based on the 2010 fieldwork with associated field observations, the recommended topsoil average salvage depth over the Boston Expansion Area (based on the three locations within this specific area) was determined to be approximately 4 inches. Refer to Table 2, Summary of Approximate Soil Salvage Depths.

During exploration activities in the Boston Expansion Area, where possible, all salvaged topsoil is temporarily piled near the end of exploration access trails or adjacent to these trails in berms. Topsoil during exploration activity is not actively moved to a larger, separate stockpile within the mining disturbance or within the Boston Expansion Area. Minimizing the handling of such topsoil during exploration helps to maintain the biological integrity and reduce harm that may occur during removal to a stockpile at some distance. Therefore, salvaged topsoil that is temporarily piled or bermed during the exploration phase will be available during the active mining phase for salvage for replacement on larger mine disturbance within the Boston Expansion Area. As a result, the topsoil volume calculations for the Boston Expansion Area presented in Table 2 do not include this minimally handled material, separately. Instead, this material is considered as part of the average topsoil salvage depth utilized in the topsoil volume calculations presented in Table 2. Trails and drill pads will be reclaimed with the adjacent material in berms and small stockpiles closest to this disturbance.

Soil Erosion Properties and Impacts

Based on the soil mapping unit descriptions within the Boston Expansion Area, the hazard for wind and water erosion varies from negligible to moderate. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the loamy texture of the surface horizons throughout the majority of the Boston Expansion Area the soils are more susceptible to erosion from water than wind. See Table 3 for a summary of wind and water erosion hazards within the Boston Expansion Area.

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# ADDENDUM A

# TABLES

Table 1: Soil Map Unit Acreages

| Map Symbol | Map Unit Description | Extension Acreage | % Total Extension Area |
|---|---|---|---|
| Go | Goldmine loam | 27.29 | 54.86 |
| Gr | Grizzly very gravelly silt loam | 4.33 | 8.70 |
| Hi | Hisega loam | 18.13 | 36.44 |
| **Total** | | **49.75** | **100.00** |

Table 2: Approximate Soil Salvage Depths[1]

| Map Symbol | Map Unit Description | Extension Acreage[2] | % | Salvage Depth[3] (Inches) | Total Volume of Topsoil[4] (Acre Feet) | Total Volume of Topsoil[5] (Cubic Yards) |
|---|---|---|---|---|---|---|
| Go | Goldmine loam | 27.29 | 54.86 | 2.00 | 4.55 | 7,337.98 |
| Gr | Grizzly very gravelly silt loam | 4.33 | 8.70 | 0.00 | 0.00 | 0.00 |
| Hi | Hisega loam | 18.13 | 36.44 | 9.00 | 13.60 | 21,937.3 |
| **Average Salvage Depth of Extension Area[6]** | | **---** | **---** | **4.38** | **---** | **---** |
| **Total** | | **49.75** | **100** | **---** | **18.15** | **29,275.28** |

[1]Salvage depths are those found in 2010 for locations within the Boston Expansion Area only
[2]Found in Table 1 of this report
[3]Found in Addendum B of this report, under Topsoil Suitability, for locations within the Boston Expansion Area only
[4]Calculated by multiplying extension acreage by salvage depth in inches converted to feet
[5]Calculated by multiplying affected area acreage in feet squared by salvage depth in feet and then dividing by 27
[6]Calculated as the average of the weighted (by acreage) salvage depths found in Addendum B

Table 3: Wind and Water Erosion Hazards

| Map Unit Symbol | Soil Series | Water Erosion Hazard[1] | Wind Erosion Hazard[2] |
|---|---|---|---|
| Go | Goldmine loam | Slight | Slight |
| Gr | Grizzly very gravelly silt loam | Slight | Negligible |
| Hi | Hisega loam | Slight | Slight |

[1]Based on Kw factor of the A horizon from the NRCS Web Soil Survey {https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx }
[2]Based on Wind Erodibility Group from the NRCS Web Soil Survey {https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx }

# ADDENDUM B
# SOIL MAP UNIT DESCRIPTIONS

**Goldmine loam[1] – Go**

This map unit consists of very deep, well drained soils that formed in colluvium and residuum derived from igneous rocks. Slopes range from 3 to 75 percent. The Goldmine soil occurs on mountain hillslopes at elevations between 5,100 and 7,000 feet.

The average annual precipitation is approximately 30 inches. The mean annual air temperature is approximately 37 degrees Fahrenheit, and the average frost-free season is approximately 60 to 100 days.

Permeability within the Goldmine soil is moderate. The available water capacity is moderate. Effective rooting depth is greater than 60 inches. Surface runoff is high. The hazard of water or wind erosion is slight.

**Topsoil Suitability**

This map unit is a fair source of topsoil to 5 inches based on an average of 2010 sample locations across the Wharf Expansion Area. The 2-inch salvage depth was used in Table 2 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Goldmine series in the Boston Expansion Area.

[1]Map unit description based on current and 1979 Lawrence County NRCS information.

**Grizzly very gravelly silt loam[1] – Gr**

This map unit consists of very deep, well drained soils formed in residuum from igneous rocks. Slopes range from 6 to 80 percent. The Grizzly soil occurs on mountains at elevations between 4,400 and 6,400 feet.

The average annual precipitation is approximately 30 inches. The mean annual air temperature is approximately 37 degrees Fahrenheit, and the average frost-free season is approximately 60 to 100 days.

Permeability within the Grizzly soil is moderately low to moderately high. The available water capacity is moderate. Effective rooting depth is greater than 60 inches. Surface runoff is medium to very rapid. The hazard of water is slight and the hazard of wind erosion is negligible.

**Topsoil Suitability**

This map unit is a fair source of topsoil to 2 inches based on an average of 2010 sample locations across the Wharf Expansion Area. The 0-inch salvage depth was used in Table 2 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Grizzly series in the Boston Expansion Area.

[1]Map unit description based on current and 1979 Lawrence County NRCS information.

**Hisega loam[1] – Hi**

This map unit consists of deep and very deep, well drained soils formed in residuum from micaceous metamorphic rocks. Slopes range from 15 to 65 percent. The Hisega soil occurs on mountains at elevations between 3,600 and 6,300 feet.

The average annual precipitation is approximately 30 inches. The mean annual air temperature is approximately 37 degrees Fahrenheit, and the average frost-free season is approximately 60 to 100 days.

Permeability within the Hisega soil is moderate. The available water capacity is low. Effective rooting depth is greater than 60 inches. Surface runoff is medium to very high. The hazard of water or wind erosion is slight.

**Topsoil Suitability**

This map unit is a fair source of topsoil to 8 inches based on an average of 2010 sample locations across the Wharf Expansion Area. The 9-inch salvage depth was used in Table 2 Approximate Soil Salvage Depths to calculate topsoil salvage volumes for the Hisega series in the Boston Expansion Area.

[1]Map unit description based on current and 1979 Lawrence County NRCS information.

# ADDENDUM C
# SOIL SERIES DESCRIPTIONS

**Grizzly very gravelly loam**

SOIL MAPPING UNIT: Gr

SOIL SAMPLE LOCATION: 17

TYPICAL PEDON: Grizzly very gravelly silt loam, on a southwest facing, convex slope of 50 percent, under a ponderosa pine forest at an elevation of about 1719 meters. (Colors are for moist soil unless otherwise stated.)

The Grizzly series consists of very deep, well drained soils formed in residuum from igneous rocks on mountains. They have moderate or moderately slow saturated hydraulic conductivity. Slopes range from 6 to 80 percent. The mean annual air temperature is about 6 degrees C, and the mean annual precipitation is about 635 mm.

**E1**--0 to 3 inches; brown (10YR 4/3) very gravelly loam, very pale brown (10YR 7/3), dry; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; 35 percent angular rhyolite fragments; few worm casts; moderately acid; gradual wavy boundary.

**E2**--3 to 10 inches; brown (10YR 5/3) very gravelly loam, very pale brown (10YR 8/3) dry; weak medium and thick platy structure parting to weak very fine and fine granular; soft, very friable, nonsticky and nonplastic; common fine roots; 45 percent angular rhyolite fragments; few worm casts; moderately acid; gradual wavy boundary.

**--Hit rock in drilling, the rest of the profile is taken from the NRCS soil series description--**

**E3**--10 to 21 inches; brown (10YR 5/3) very gravelly silt loam, very pale brown (10YR 8/3) dry; weak medium and thick platy structure; slightly hard, very friable, nonsticky and nonplastic; common fine and coarse roots; 50 percent angular rhyolite fragments; moderately acid; gradual wavy boundary. (Combined thickness of the E horizon is 35 to 60 cm.)

**Bt/E**--21 to 33 inches; about 60 percent dark yellowish brown (10YR 4/4) very gravelly clay loam, yellowish brown (10YR 5/4) dry (Bt part), and 40 percent brown (10YR 5/3) very gravelly silt loam, very pale brown (10YR 8/3) dry (E part); weak medium and coarse subangular blocky structure; slightly hard, friable, sticky and plastic; common fine roots; 60 percent angular rhyolite fragments; moderately acid; gradual wavy boundary. (25 to 50 cm thick)

**Bt**--33 to 43 inches; strong brown (7.5YR 4/6) very gravelly clay loam, strong brown (7.5YR 5/6) dry; moderate medium and coarse angular blocky structure; very hard, firm, sticky and plastic; few fine roots; 60 percent angular rhyolite fragments; many distinct brown (7.5YR 4/3) clay films on vertical ped faces; slightly acid; gradual wavy boundary. (23 to 90 cm thick)

**BC**--43 to 52 inches; strong brown (7.5YR 4/6) extremely gravelly clay loam, strong brown (7.5YR 5/6) dry; weak medium and coarse subangular blocky structure; very hard, friable, sticky and plastic; 70 percent angular rhyolite fragments; neutral; gradual wavy boundary. (0 to 25 cm thick)

**C**--52 to 60 inches; light olive brown (2.5Y 5/4) extremely gravelly clay loam, pale yellow (2.5Y 7/4) dry; common fine distinct mottles of yellowish brown (10YR 5/6); massive; very hard, friable, slightly sticky and slightly plastic; 70 percent angular rhyolite fragments; neutral.

TYPE LOCATION: Lawrence County, South Dakota; refer to waypoint 17 on the map included in this report.

RANGE IN CHARACTERISTICS (according to official series description):

Soil moisture: Udic SMR
Mean annual soil temperature: 5 to 8 degrees C
Mean summer soil temperature: 10 to 13 degrees C
Depth to glossic horizon: 36 to 61 cm

Particle-size control section:
Clay content (weighted average): 28 to 35 percent
Sand content: 10 to 25 percent fine and coarser sand

E Horizon:
Hue: 7.5YR, 10YR
Value: 4 to 6, 5 to 8 dry
Chroma: 2 or 3
Texture: L, SIL, or FSL (fine earth fraction)
Rock fragments: 20 to 70 percent angular to subangular igneous rock fragments
Reaction: moderately acid to neutral

Bt/E Horizon:
Hue, Value, and chroma have the same range as for their respective parts
Texture: L, SIL, CL, or SICL (fine earth fraction)
Rock fragments: 35 to 70 percent angular or subangular igneous fragments, of which 30 to 70 percent are gravel and 0 to 15 percent are cobble
Reaction: moderately acid to neutral

Bt horizon:
Hue: 7.5YR, 10YR
Value: 3 or 4, 4 to 6 dry
Chroma: 3 to 6
Texture: CL or SICL (fine earth fraction
Rock fragments: 35 to 80 percent angular or subangular igneous rocks, of which 35 to 75 percent are gravel, and 5 to 25 percent are cobble
Reaction: moderately acid to neutral

BC Horizon:
Hue: 7.5YR or 10YR
Value: 3 or 4, 4 to 6 dry
Chroma: 4 to 6
Texture: CL or SICL (fine earth fraction)
Rock fragments: 40 to 85 percent angular or subangular igneous rocks, of which 30 to 65 percent are channers or gravel, 5 to 30 percent cobble, and 0 to 10 percent stones
Reaction: slightly acid to slightly alkaline

C Horizon:
Hue: 7.5YR, 10YR, or 2.5Y
Value: 4 to 7, 5 to 8 dry
Chroma: 4 to 6
Texture: L, CL, or SICL (fine-earth fraction)
Clay content: 20 to 32 percent
Rock fragments: 40 to 85 percent angular or subangular igneous rocks, of which 30 to 65 percent are channers or gravel, 5 to 30 percent cobble, and 0 to 10 percent stones
Reaction: slightly acid to slightly alkaline

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, frigid Haplic Glossudalfs

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): Estimated salvage depth is 0 inches. In the 2010 assessment, a total of five sites were evaluated, and the range of suitability varied from 0-4 inches.

GEOGRAPHIC SETTING (according to official series description):

Parent material: residuum or local colluvium over residuum derived from igneous rocks (monzonite, phonolite, rhyolite, rhyolite porphyry, trachyte, and similar igneous materials)
Landform: hillslopes and broad ridges on mountains
Slopes: 6 to 80 percent
Elevation: 1,340 to 1,950 meters
Mean annual temperature: 4 to 7 degrees C
Mean annual precipitation: 558 to 762 mm
Precipitation pattern: over one-half the mean annual precipitation falls as snow and rain during the period March through July
Frost-free season: 60 to 100 days

VARIATION FROM TYPICAL SERIES: There is no typical Oi horizon.

**Goldmine loam**

SOIL MAPPING UNIT: Go

SOIL SAMPLE LOCATION: 19

TYPICAL PEDON: Goldmine loam, on a west-northwest facing, linear slope of 24 percent, in a mixed coniferous and deciduous woodland community at an elevation of about 1900 meters (Colors are for moist soil unless otherwise stated)

The Goldmine series consists of very deep, well drained soils that formed in colluvium and residuum derived from igneous rocks. Goldmine soils are on mountain hillslopes. Slopes range from 3 to 75 percent. Mean annual precipitation is about 735 cm and the mean annual temperature is about 7 degrees C.

**Oi**--0 to 1 inch; slightly to moderately decomposed woody residue from pine trees and aspen, and herbaceous plant material. (Combined thickness of the O horizon is 1 to 5 cm)

**A**--1 to 2 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and strong fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine, fine, and medium and common coarse roots; about 5 percent angular igneous rock fragments as channers, gravel, and cobbles; neutral; abrupt smooth boundary. (7 to 15 cm thick)

**E**--2 to 10 inches; dark grayish brown (10YR 4/2) channery loam, light gray (10YR 7/2) moist; moderate medium platy structure parting to moderate fine and medium subangular blocky; soft, friable, nonsticky and nonplastic; common very fine and few fine, medium and coarse roots; about 20 percent angular igneous channers and 10 percent subangular gravel; slightly acid; gradual wavy boundary. (20 to 51 inches thick)

**--Hit rock in drilling, the rest of the profile is taken from the NRCS soil series description--**

**E/Bt**--10 to 29 inches; about 70 percent dark grayish brown (10YR 4/2) very channery loam (E), light gray (10YR 7/2) dry, and 30 percent dark yellowish brown (10YR 4/4) very channery clay loam (Bt), light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few fine and medium roots; about 30 percent faint yellowish brown (10YR 5/6) clay films on ped faces and rock fragments (Bt part); about 35 percent angular igneous channers and 5 percent flagstones; slightly acid; gradual wavy boundary. (0 to 33 cm thick)

**Bt1**--29 to 37 inches; yellowish brown (10YR 5/4) very channery clay loam, light yellowish brown (10YR 6/4) dry; weak coarse and moderate medium subangular blocky structure; slightly hard, firm, moderately sticky and slightly plastic; about 50 percent faint dark yellowish brown (10YR 4/6) clay films on ped faces and 20 percent faint dark yellowish brown (10YR 4/6) clay films on rock fragments; few medium and fine roots; about 60 percent angular igneous rock

fragments, of which 40 percent are channers, 10 percent cobbles, and 10 percent are flagstones; slightly acid; gradual irregular boundary.

**Bt2**--37 to 60 inches; yellowish brown (10YR 5/4) extremely channery clay loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; slightly hard, firm, moderately sticky and slightly plastic; few medium and fine roots; about 50 percent faint dark yellowish brown (10YR 4/6) clay films on ped faces and 15 percent faint dark yellowish brown (10YR 4/6) clay films on rock fragments; about 85 percent igneous rock fragments, of which 65 percent are angular channers and 20 percent are flagstones; neutral. (Combined Bt horizons greater than 50 cm thick)

TYPE LOCATION: Lawrence County, South Dakota; refer to waypoint 19 on the map included in this report.

RANGE IN CHARACTERISTICS (according to official series description):

Soil moisture: The soil moisture control section is typic udic.
Mean annual soil temperature: 5 to 8 degrees C
Mean summer soil temperature: 9 to 12 degrees c
Depth to lithic contact: greater than 152 cm to hard igneous bedrock

Particle-size control section (weighted average):
Clay content: 28 to 35 percent
Sand content: 10 to 25 percent
Rock fragments: 35 to 90 percent igneous rocks; 30 to 65 percent of which are angular channers, 5 to 15 percent subangular gravel, 0 to 40 percent angular cobbles, and 0 to 20 percent angular flagstones.

A horizon:
Hue: 10YR
Value: 2, 3 or 4 dry
Chroma: 1 or 2
Texture: L, CN-L, GR-L
Clay content: 12 to 22 percent
Rock fragments: 5 to 25 percent
Reaction: Neutral or slightly acid

AE horizon (EA in some pedons):
Hue: 10YR
Value: 3, 4 or 5 dry
Chroma: 2
Texture: CN-L, GR-L, CNV-SIL, L
Clay content: 12 to 22 percent
Rock fragments: 10 to 35 percent
Reaction: Neutral or slightly acid

E horizon:
Hue: 10YR
Value: 4 to 6, 6 or 7 dry
Chroma: 2 or 3
Texture: CN-L, CNV-L, GRV-L, CBV-L
Clay content: 10 to 20 percent
Rock fragments: 20 to 55 percent
Reaction: Neutral to medium acid

The E/Bt horizon (Bt/E in some pedons) has combined properties of the E and Bt horizons. It typically consists of about 60 percent E horizon material and 40 percent Bt horizon material.

Bt horizon:
Hue: 10YR
Value: 5 or 6, 6 or 7 dry
Chroma: 3 to 6
Texture: CNV-CL, CNX-CL, CBX-SICL
Clay content: 28 to 35 percent weighted average; upper part of horizon may have 35 to 40 clay
Rock fragments: 35 to 90 percent
Reaction: Neutral or slightly acid

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Typic Palecryolls

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): Estimated salvage depth is 2 inches. In the 2010 assessment, a total of nine sites were evaluated, and the range of suitability varied from 0-5 inches.

GEOGRAPHIC SETTING (according to official series description):

Parent material: Colluvium or residuum derived from Tertiary-aged igneous rock
Landform: Gently sloping to steep mountain hillslopes
Slopes: 3 to 75 percent
Elevation: 1575 to 2125 meters
Mean annual air temperature: 6 to 9 degrees F
Mean annual precipitation: 650 to 760 mm
Precipitation pattern: In most years, about half the annual precipitation occurs as snow or rain during the period March through June. The driest period normally is from late summer (September) through early winter (January).
Frost-free period: 60 to 100 days.

VARIATION FROM TYPICAL SERIES: There are no typical Oe or AE horizons in the profile.

**Hisega loam**

SOIL MAPPING UNIT: Hi

SOIL SAMPLE LOCATION: 22

TYPICAL PEDON: Hisega loam - on a 30 percent convex south-facing slope under a ponderosa pine forest at 5800 feet. (Colors are for dry soil unless otherwise stated.)

The Hisega series consists of deep and very deep, well drained soils formed in residuum from micaceous metamorphic rocks on mountains. They have moderate permeability. Slopes range from 15 to 65 percent. Mean annual temperature is about 40 degrees F, and the annual precipitation is about 24 inches.

**A**--0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium and coarse subangular blocky structure; soft, very friable; many fine and medium roots; 10 percent by volume fragments of schist; neutral; clear wavy boundary. (1 to 7 inches thick)

**Bw**--3 to 9 inches; brown (10YR 4/3) channery loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; soft, friable; many fine and medium roots; 20 percent by volume fragments of schist; slightly acid; clear wavy boundary. (9 to 20 inches thick)

**--Hit rock in drilling, the rest of the profile is taken from the NRCS soil series description--**

**C1**--9 to 30 inches; brown (10YR 5/3) very channery loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable; many coarse and medium roots; 50 percent by volume fragments of schist; neutral; gradual wavy boundary.

**C2**--30 to 60 inches; grayish brown (2.5Y 5/2) extremely flaggy loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable; common medium roots along fractures and cleavage planes of the bedrock; 80 percent by volume fragments of schist oriented toward the northwest at about 65 degrees; neutral.

TYPE LOCATION: Lawrence County, South Dakota; refer to waypoint 22 on the map included in this report.

RANGE IN CHARACTERISTICS (according to official series description): Depth to consolidated bedrock typically is below 60 inches but ranges from 40 inches. Depth to fractured bedrock containing soil material and with evidence of rock structure typically is between depths of 20 and 40 inches. Content of coarse fragments of rock range from 10 to 50 percent by volume in the solum and 50 to 80 percent by volume in the C horizon. The mollic epipedon is 16 to 24 inches thick. Dark colors extend to 60 inches or more in some pedon but the organic carbon is

less than 0.6 percent. The control section averages 8 to 15 percent clay. Free carbonates are below a depth of 40 inches in some pedons. The solum is slightly acid or neutral.

The A horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 3 to 5 and 2 to 4 moist; and chroma of 1 to 3. It is loam or silt loam with 10 to 30 percent by volume channers.

The Bw horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6 and 3 to 5 moist; and chroma of 2 to 4. It is loam or silt loam with 15 to 50 percent by volume channers.

The C horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6 and 3 to 5; and chroma of 2 to 4. It is loam or silt loam with 50 to 80 percent by volume channers or flagstones. It ranges from slightly acid to slightly alkaline.

TAXONOMIC CLASS: Loamy-skeletal, micaceous, frigid Pachic Hapludolls

SUITABILITY FOR TOPSOIL (according to WDEQ Guideline 1, 1994): Estimated salvage depth is 9 inches. In the 2010 assessment, a total of eight sites were evaluated, and the range of suitability varied from 0-24 inches.

GEOGRAPHIC SETTING (according to official series description): Hisega soils are steep on mountains at elevations of 3600 to 6300 feet. Slope gradients range from 15 to 65 percent. These soils formed in residuum derived from micaceous metamorphic rocks. Mean annual air temperature ranges from 34 to 45 degrees F, and mean annual precipitation ranges from 18 to 27 inches.

VARIATION FROM TYPICAL SERIES: There is no typical Oi horizon found in this profile.

# ADDENDUM D
# PHOTOGRAPHS


Photo 32: Profile view of Sample Point 17, Grizzly very gravelly loam


Photo 33: General view of Sample Point 17, Grizzly very gravelly loam


Photo 36: Profile view of Sample Point 19, Goldmine loam

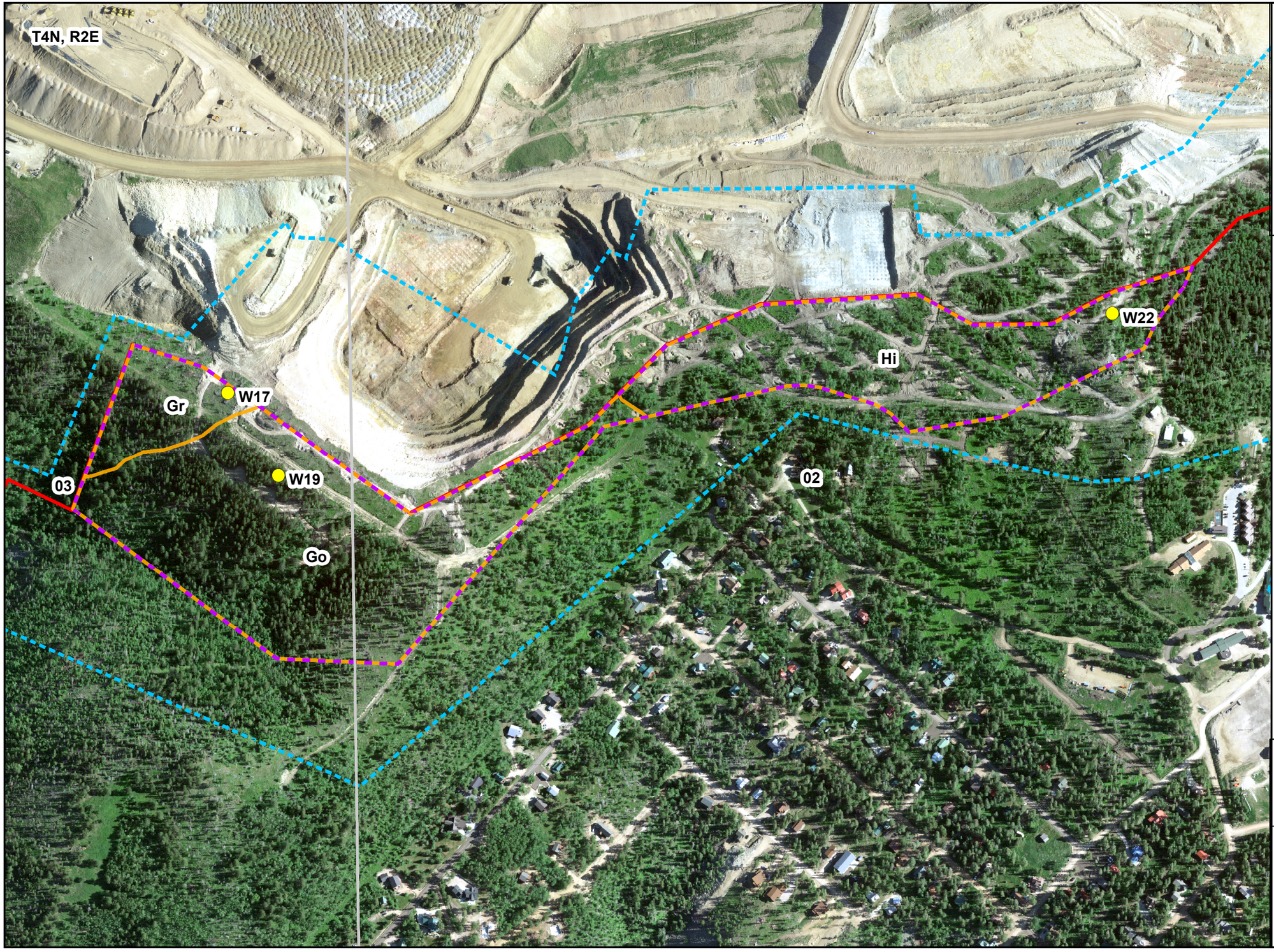

Photo 37: General view of Sample Point 19, Goldmine loam


Photo 42: Profile view of Sample Point 22, Hisega loam


Photo 43: General view of Sample Point 22, Hisega loam

ADDENDUM E

MAP




# Wharf Resources (USA), Inc. RESPEC

## Wharf Boston Expansion Area Baseline Soils

Lawrence County, South Dakota

**Legend**

- Township/Range Boundary
- Section Boundary
- Wharf Permit Boundary
- 2021 Boston Expansion Boundary
- 2010 Wharf Expansion Soil Study Area
- Soil Series
- 2010 Soil Sample Locations

| Symbol | Soil Series |
|---|---|
| Go | Goldmine loam |
| Gr | Grizzley very gravelly silt loam |
| Hi | Hisega loam |

N

0 0.035 0.07 0.14

Miles

1:4,609

BKS Environmental Associates, Inc.

Map Created By: BKS - Nichole Rubeck
Map Created On: August 10, 2021
Map Projection: NAD 1983 UTM Z 13N
K:\Projects\RESPEC\2108_RESPEC_Boston Expansion_2021\Maps\Wharf_BostonExpan_Soils_08102021.mxd