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GEOTECHNICAL ENGINEERING AND GEOLOGIC HAZARDS REPORT ON

CAMAS WELL 6-14 TRANSMISSION MAIN PROJECT
CAMAS, WASHINGTON

by
Haley & Aldrich, Inc.
Vancouver, Washington

for
WSP USA Inc.
Portland, Oregon

File No. 0208144-000
July 2024

HALEY & ALDRICH, INC.
300 W. 15th Street
Vancouver, WA 98660
360.448.4189

12 July 2024
File No. 0208144-000

WSP USA Inc.
851 SW 6th Avenue #1600
Portland, Oregon 97204

Attention: Sarah Merrill, P.E., Senior Water/Wastewater Engineer

Subject: Geotechnical Engineering and Geologic Hazards Report
Camas Well 6-14 Transmission Main
1615 SE 6th Avenue
Camas, Washington

Dear Sarah Merrill:

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to present this report to WSP USA Inc. (WSP) summarizing our geotechnical engineering services for the proposed Camas Well 6-14 Transmission Main project located in Camas, Washington.

We understand that WSP is designing a proposed 18-inch-diameter water transmission main for the City of Camas (City), the intent of which is to provide increased capacity to the City water system at times when both Wells 6 and 14 are pumping. The subject portion of the proposed transmission main alignment is approximately 1,500 feet in length, located within properties owned by Jensen Precast and the City, and bordered by the Washougal River to the north. The site is currently developed with existing wells and well houses, as well as structures and staging areas associated with production of concrete "Jersey" barriers by Jensen Precast. The new alignment will tie into existing lines in-between existing Well Houses 7 and 11/12 on the west end, and near Well 6 on the east end. Based on our conversations with you, we understand the new water transmission main will likely consist of flexible ductile iron pipe.

We have developed our geotechnical findings, conclusions, and recommendations based on our subsurface exploration program, laboratory testing, our discussions regarding the project with you, and our knowledge of the regional geology in the project area as summarized in our draft report titled, "Geologic Hazards Assessment, Well 6/14 Water Transmission Main Project," dated 7 November 2023. Trench cuts for the pipeline installation will be achievable with conventional earthmoving equipment; however, materials encountered during excavation will include cobble and boulder-sized rocks, and concrete debris. High surcharge pressures from storage of concrete products above the pipeline must be considered in design. Our recommendations regarding utility installation, earthwork, and other geotechnical aspects of this project are presented in this report.

We appreciate the opportunity to provide our services to you on this project. If you have any questions, please call.

Sincerely yours,
HALEY & ALDRICH, INC.

Micah D. Hintz, P.E.
Geotechnical Engineer

Enclosures

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HALEY & ALDRICH, INC.
6420 S. MACADAM AVENUE
SUITE 100
PORTLAND, OR 97239-3517
503.620.7284

SIGNATURE PAGE FOR

GEOTECHNICAL ENGINEERING AND GEOLOGIC HAZARDS REPORT ON
CAMAS WELL 6-14 TRANSMISSION MAIN PROJECT
CAMAS, WASHINGTON

PREPARED FOR
WSP USA INC.
PORTLAND, OREGON

PREPARED BY:

Isaac Kreitzer, E.I.T.
Staff Engineer
Haley & Aldrich, Inc.

REVIEWED AND APPROVED BY:

Micah D. Hintz, P.E.
Geotechnical Engineer
Haley & Aldrich, Inc.

Daniel J. Trisler, P.E.
Principal Geotechnical Engineer
Haley & Aldrich, Inc.

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1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this report to WSP USA Inc. (WSP) summarizing our geotechnical engineering services for the proposed Camas Well 6-14 Water Transmission Main project located at 1615 SE 6th Avenue in Camas, Washington (Site).

We understand that WSP is designing a proposed 18-inch-diameter water transmission main for the City of Camas (City), the intent of which is to provide increased capacity to the City water system at times when both Wells 6 and 14 are pumping. The subject portion of the proposed transmission main alignment is approximately 1,500 feet in length, located within properties owned by Jensen Precast and the City, and bordered by the Washougal River to the north. The site is currently developed with existing wells and well houses, as well as structures and staging areas associated with production of concrete Jersey barriers by Jensen Precast.

Based on our review of design drawings provided by you, we understand that the proposed transmission main will be buried with a minimum backfill cover of 3 feet. The new alignment will tie into existing lines in between existing Well Houses 7 and 11/12 on the west end, and near Well 6 on the east end. The majority of the proposed alignment runs along the crest of an existing slope at the north end of the Jensen Precast facility. Based on our conversations with you, we understand the new water transmission main will likely consist of flexible ductile iron pipe.

The report is divided into several sections. The first section provides an overview of the project information discussed in the text and the main body of the report presents our geotechnical engineering findings and recommendations in detail. The report is organized as follows:

- Introduction
- Scope of Services
- Site Conditions
- Seismic Considerations
- Global Stability Evaluation
- Conclusions
- Recommendations
- Additional Geotechnical Services
- Limitations
- References

Following the main text are three figures and three appendices. The Site location is shown on *Figure 1 – Vicinity Map*. An image depicting the proposed alignment relative to site topography and aerial imagery is presented as *Figure 2 – Site and Exploration Plan.* An image of hillshade topography generated from publicly available LiDAR data is presented as *Figure 3 – LiDAR Hillshade*. Figures presenting the proposed alignment relative to mapped landslide, erosion, and liquefaction hazards are presented as Figures 4 through 6, respectively. *Figure 7 – Fault Lines* provides an image of the site relative to mapped local faults.

Appendix A contains logs of subsurface explorations and a description of exploration methods and equipment. Appendix B contains results of geotechnical laboratory testing. Appendix C includes the results of our slope stability analyses. Appendix D includes historical photos showing site conditions over time.

2. Scope of Services

The purpose of our services was to evaluate the subsurface conditions at the Site and to provide geotechnical engineering recommendations for design and construction of the project elements. This report also includes details pertaining to a geologic hazards assessment intended to satisfy the requirements of Camas Municipal Code (CMC) Chapter 16.59. This report supersedes our draft geologic hazards assessment report dated 7 November 2023, in which we identified potential for issues pertaining to slope instability at the site (Haley & Aldrich, 2023). We completed the following tasks in general accordance with Amendment No. 1 to the professional services subcontract between WSP and Haley & Aldrich, amendment date 13 February 2024:

- Review literature available from the City, State of Washington, our files, and other public resources relevant to the evaluation of geologic conditions and geologic hazards within the study area including geologic maps, well logs, and available geotechnical exploration data.
- Observe, log, and sample subgrade conditions at two boring locations drilled with sonic drilling methods along the proposed transmission line alignment, with borings extending to depths of about 25 to 29 feet below existing ground surface (bgs).
- Observe, log, and sample subgrade conditions at six test pit locations along the proposed alignment, with excavations extending to depths of 14 to 14-1/2 feet bgs.
- Conduct a program of laboratory testing on select soil samples collected to evaluate engineering properties of the materials, including moisture content and grain size distribution determinations, and a suite of tests to identify soil corrosion potential.
- Evaluate soil conditions encountered during field exploration work; evaluate seismic hazards; and develop geotechnical design recommendations and general construction guidelines for pipelines. Our analyses include the following:
  - Development of seismic design parameters and evaluation of the potential for liquefaction, seismic settlement, lateral spread, and seismic slope instability.
  - Geotechnical engineering assessments and recommendations for the pipeline including subgrade properties, corrosion potential, and bedding and backfill material requirements.
  - Soil settlement potential under pipe and backfill loads.
  - Anticipated subgrade conditions and potential need for pipe subgrade stabilization.
  - Recommendations for open excavation, trenchless construction, subgrade stabilization, shoring, and groundwater control during construction.
  - Backfill recommendations for the pipeline and compaction criteria.
- Prepare this geotechnical engineering and geologic hazards report, including:
  - Results of the geologic reconnaissance and research;
  - A map of areas of potential slope instability and other geologic hazards near the alignment;
  - Conclusions regarding alignment vulnerability to geologic hazards;
  - A summary of subsurface conditions;

- Results of our engineering analyses; and
- Recommendations for the pipeline design and construction.

- Provide project management and support services, including staff coordination, subcontractor coordination, and telephone consultations with the design team.

3. Site Conditions

3.1 SURFACE CONDITIONS

The proposed western tie-in point for the alignment is located within the City's well field south of the Washougal River, west of Well 7, and southeast of a single-story warehouse structure. The tie-in will be located beneath a gravel road that descends to the east at an approximately 13-percent grade, with an initial surface elevation at the tie-in of approximately 48 feet (mean sea level [MSL]). The slope levels out at approximately Elevation 40 feet (MSL), gradually descending to Elevation 38 feet (MSL) as the alignment runs east. Surface conditions along this stretch consist of relatively level ground covered with grass and gravel-covered access roads for approximately 300 feet until ascending a moderately vegetated, approximately 3- to 4-foot-tall incline. Over the next approximately 500 hundred feet heading east, surface grades along the alignment gradually increase to Elevation 45 feet (MSL).

A steep slope inclined at roughly 1H:1V (horizontal:vertical) is located approximately 20 to 30 feet to the south of the alignment within the first several hundred feet of the alignment. To the north of the alignment, slopes as steep as 1H:1V descend towards the Washougal River and an abandoned gravel pit appearing as two separate ponds. The slopes north and south of the alignment are generally vegetated with grasses, shrubs, and large trees. Trees along the slope separating the Jensen Precast facility from the well field appeared to tilt or have pistol-butted bases, suggesting potential slope creep in this area. Trees north of the Jensen Precast facility in areas east of the well field did not appear to have tilted. During our site visits, we noted exposed soil and what appeared to be undocumented fill along the northern slope.

Surface conditions along this portion of the alignment consist of industrial staging grounds, including gravel-covered lots with stacked precast Jersey barriers from operations at Jensen Precast. The final portion of the alignment turns south, encountering an approximately 10-foot-tall, vegetated slope that ascends at an inclination of about 1.5H:1V. The proposed eastern tie-in is located along this slope according to project drawings.

Based on our review of historical aerial photos included in Appendix D, the eastern portion of the alignment likely consists of undocumented artificial fill of unknown thickness. Between 1955 and 1960, the natural treeline and slope at the northern edge of the Jensen Precast lot appears to have undergone significant grading, pushing the limits of the graded lot further to the north. Further modification to site grades appears between 1963 and 1970 aerial images, and then again between 1984 and 1990. The thickness of undocumented fill along the proposed alignment is unknown except where identified within our explorations. Based on current site elevations and our exploration data, typical fill thicknesses on the order of 10 to 15 feet can be reasonably assumed.

In summary, the alignment is largely artificially graded and covered by either grass, gravel roads, or precast Jersey barriers placed for storage. Based on information provided by WSP, the stacked Jersey barriers are understood to induce ground-level bearing pressures on the order of 16,000 pounds per square foot (psf). The slopes to the north and south are generally covered with native vegetation including dense canopy and moderately dense undergrowth. Portions of both slopes had exposed soils and the north slope appeared to have "bumps" of undocumented fill that was pushed over the native slope to create more storage space for the precast barricades.

3.2 GEOLOGIC MAPPING

The geology of the site is mapped in the *Geologic map of the Camas quadrangle, Clark County, Washington, and Multnomah County, Oregon* (Evarts and O'Connor, 2008) and the *Geologic map of the Vancouver quadrangle, Washington* (Phillips, 1987). Evarts and O'Connor (2008) map the alignment and surrounding vicinity as Terrace deposits of lower Washougal River and as gravel facies. The Terrace deposits consist of sand and gravel usually thinner than 30 feet. The gravel facies range in size from boulders to cobbles, gravel, and sand. The northwest portion of the site is mapped as alluvium. Phillips (1987) also maps the site vicinity as Quaternary alluvium and basaltic-andesite and basalt flows.

The near surface soils at the site are mapped by the U.S. Department of Agriculture (USDA) in the Web Soil Survey (USDA, 2023). According to this source, soils within the alignment limits are mapped as Hillsboro silt loam and Fill land. Hillsboro silt loam soils are described as excessively drained fine sand to very gravelly sand with a moderately high to high (0.6 to 2.0 inches per hour [in/hr]) hydraulic conductivity in the most restrictive layer. The Hillsboro silt loam soils in this area are divided into those with 0 to 3 percent slopes, and those with 30 to 65 percent slopes. The depth to the water table is estimated to be more than 80 inches.

A review of nearby water well and geotechnical boring logs generally indicates regional groundwater levels in the site vicinity range from approximately 45 to 50 feet bgs, which due to the difference between this depth and the elevation of the Washougal River is likely representative of conditions within a deeper aquifer (Ecology, 2023).

3.3 SUBSURFACE CONDITIONS

3.3.1 General

Subsurface conditions interpreted from the explorations performed at the site as part of our current study, in conjunction with soil properties inferred from field and laboratory tests, formed the basis for the conclusions and recommendations in this report. The locations and depths of our explorations were selected considering the Site features, under the constraints of surface access, time, and budget.

We completed field explorations at the Site by advancing two sonic borings, one hand auger exploration, and six test pits at the Site between 6 and 7 March 2024. The sonic borings, designated B-1 and B-2, were drilled to depths of 25 and 29 feet bgs. The shallow hand auger, designated HE-1, was drilled near the eastern end of the project alignment in the vicinity of Well 6, in a location that appeared to feature a dense collection of underground utility lines (which prevented exploration via test pit in this area). The test pits, designated TP-1 through TP-6, were typically excavated to depths of about 14 to 14.5 feet bgs.

Generally, our explorations encountered from 2 feet to over 15 feet of fill typically described as silty sand with gravel, but also containing layers of silt with sand, lean clay, poorly graded sand with silt, and poorly graded gravel with silt and sand. The fill is generally thicker near the northern slope leading down to the former gravel pit and was likely placed as part of mining activities and historical expansion of the work area in and around what is not the Jensen Precast property. This fill was found to overlie native Terrace deposits consisting primarily of silty sand with gravel up to 21 feet bgs, which typically overlies well-graded sand with silt to the maximum explored depth of 29 feet bgs. A layer of fine-grained alluvial soil was encountered at one exploration and appeared to be interbedded within the Terrace deposits. Based on our understanding of local geology, including our review of nearby geotechnical reports by others, we understand that these native deposits are underlain by Troutdale Formation materials at a depth of about 50 feet bgs. We divided the encountered soils into three engineering soil units (ESUs), which are grouped by similar geologic origin and/or engineering properties. Descriptions of these ESUs are provided below:

- ESU 1: Artificial Fill
- ESU 2: Granular Terrace Deposits
- ESU 3: Fine-Grained Alluvium

These ESUs are discussed in detail in the following sections.

3.3.2 ESU 1 – Artificial Fill

This ESU is composed of artificial fill materials consisting of medium dense to very dense silty sand with gravel, silt with sand, lean clay, poorly graded sand with silt, and poorly graded gravel with silt and sand. This unit at times includes significant fill debris, including concrete pieces and wood debris (e.g., a piece of concrete over 2.5 feet thick was bored through at a depth of 13 feet bgs at boring B-1). Cobble-sized and boulder-sized materials up to 4 feet in largest dimension were encountered within this unit as well. The thickness of this unit with respect to our explorations near the proposed alignment was typically on the order of 6 to over 15 feet, though shallower fills on the order of 2 feet were identified in some locations. The lateral extents of the fill are not well-defined, but limits estimated by USDA and Haley & Aldrich based on review of historical aerial photos are presented on Figure 2.

Fines contents within this ESU typically range from 10 to 31 percent; however, an approximately 5-foot-thick layer of lean clay was encountered in boring B-2. The moisture content of materials within this ESU ranged from 9 to 17 percent.

3.3.3 ESU 2 – Granular Terrace Deposits

This ESU is typically characterized by medium dense to very dense, silty sand with gravel, but also contains layers of well-graded sand, well-graded sand with silt, poorly graded gravel with silt and sand, poorly graded sand, and silt with sand. Cobbles between 3 and 6 inches in diameter were commonly observed within this unit, and boulders up to 3.5 feet in largest dimension were noted in some test pit explorations through this material. This unit is present beginning at the ground surface in the western and far southeastern portions of the alignment, and is beneath ESU 1 in the central portion of the alignment. This ESU is understood to extend to depths of about 50 feet bgs across the Site, in some places being interbedded by a layer of ESU 3 materials.

Fines content for this ESU range from 7 to 28 percent. The moisture content of materials within this ESU range from 6 to 19 percent.

3.3.4 ESU 3 – Fine-Grained Alluvium

This unit, composed of stiff, native Elastic Silt, was identified only in the deepest boring, B-2, between depths of 23 feet bgs and the bottom of the boring at 29 feet bgs. Based on our understanding of local geology, including the fact that areas immediately adjacent to the north of the Site were quarried for sand and gravel, we anticipate that this layer transitions back into granular ESU 2 materials at depths slightly greater than 29 feet bgs.

3.3.5 Groundwater

Groundwater was encountered at a depth of about 21 feet bgs at boring B-2 on 6 March 2024, perched about 2 feet above a layer of elastic silt. This equates to an elevation of about 20 feet (NAVD88). Groundwater was not encountered at any other exploration advanced as part of this study, including boring B-1, which reached a maximum depth of 25 feet bgs.

As described above, a review of nearby water well and geotechnical boring logs generally indicates regional groundwater levels in the Site vicinity range from approximately 45 to 50 feet bgs (Ecology 2023), which equates to an elevation of 0 to 5 feet (NAVD88). Groundwater elevations may fluctuate seasonally due to rainfall or the stage of the Washougal River.

Based on the findings from our explorations and our review of publicly available data, we conclude that the groundwater table at the Site is located at depths similar to that of the neighboring Washougal River. Relatively shallow locally perched groundwater conditions may be present within the subsurface, especially where layers of fine-grained soils are present.

3.3.6 Limitations

The subsurface information used for this study represents conditions at discrete locations within the project Site. Actual conditions in other areas could vary. The nature and extent of any variations in subsurface conditions may not become evident until construction begins. If significant variations are observed at that time, we may need to modify our conclusions and recommendations to reflect actual Site conditions.

Note that measured groundwater levels in Haley & Aldrich borings and historical water well logs represent conditions at the times indicated. Fluctuations in groundwater levels may occur due to variations in rainfall, temperature, seasons, and other factors.

4. Geologic and Seismic Hazards

4.1 GEOLOGIC HAZARDS

The City defines a geologic hazard area as an area subject to severe risk of damage due to erosion hazard, landslide hazard, seismic hazard, or other geological events including: mass wasting, debris flows, rock falls, and differential settlement. These hazards are discussed in the following sections.

4.1.1 Erosion Hazard

The City defines erosion hazard areas in CMC Chapter 16.59.020A as, “Areas where there is not a mapped or designated landslide hazard, but where there are steep slopes equal to or greater than forty percent slope. Steep slopes which are less than ten feet in vertical height and not part of a larger steep slope system, and steep slopes created through previous legal grading activity are not regulated steep slope hazard areas.”

As shown on *Figure 5 – Erosion Hazard*, the majority of the proposed alignment lies within an area mapped by Clark County GIS as susceptible to erosion hazards.

Though not visible on available site topographic maps, the slope north of the Jensen Precast facility features artificial fill berms at the crest. These berms are typically 2 to 5 feet in height and appear to be composed on non-engineered fill derived from on-site soils and materials. The presence of these berms significantly reduces the potential rainwater runoff flowing over the slope crest, thus reducing the potential for slope erosion. Furthermore, as previously discussed, the slopes are vegetated, and we did not observe signs of active or past erosion during our site visit.

Based on observations from our site visit and due to the presence of berms along the crests of slopes along the alignment, we conclude that the potential for erosion hazards impacting the proposed pipeline is low and that installation of the pipeline is unlikely to cause an erosion hazard.

4.1.2 Landslide Hazard

The City defines landslide hazard areas in CMC Chapter 16.59.020I(B) as, “areas potentially subject to landslides based on a combination of geologic, topographic, and hydrologic factors.” They include areas susceptible because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors. Examples of these may include, but are not limited to the following:

1. Areas of previous slope failures including areas of unstable old or recent landslides.
2. Areas with all three of the following characteristics:
   a. Slopes steeper than 15 percent;
   b. Hillsides intersecting geologic contacts with permeable sediment overlying a low permeability sediment or bedrock; and
   c. Any springs or groundwater seepage.
3. Slopes that are parallel or sub-parallel to planes of weakness, such as bedding planes, joint systems, and fault planes in subsurface materials.

4. Areas mapped by:

    a. The Washington State Department of Natural Resources (WA DNR) Open File Report: Slope Stability of Clark County, 1975, as having potential instability, historical or active landslides, or as older landslide debris, and

    b. The WA DNR Open File Report Geologic Map of the Vancouver Quadrangle, Washington, and Oregon, 1987, as landslides.

5. Slopes greater than 80 percent, subject to rock fall during earthquake shaking.

6. Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and stream undercutting the toe of a slope.

7. Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows, debris torrents, or catastrophic flooding.

The location of the proposed alignment relative to areas mapped by Clark County GIS as landslide hazard zones is presented on *Figure 4 – Landslide Hazard*. As seen on the figure, the slopes adjacent to (north of) the alignment are mapped as "potential" landslide hazards because they are steeper than 15 percent; however, we did not observe groundwater seepage from these slopes, meaning that Item 2 of the CMC landslide hazard criteria is not satisfied.

The Site topography features relatively flat plateaus within the Washougal Well Field and throughout the Jensen Precast facility, bordered by moderate to steep slopes that appear to exceed inclinations of 1H:1V in some places. Based on our review of historical aerial photos included in Appendix D, this Site topography appears to have been artificially created through historical earthwork activities, including cuts and fills potentially on the order of 10 to 15 feet. Grading activities at the Site are undocumented and unengineered to our knowledge. The slope is generally vegetated with grasses, shrubs, and large trees. Trees along the slope separating the Jensen Precast facility from the Washougal Well Field appeared to tilt or have pistol-butted bases, suggesting potential slope creep in this area; however, trees north of the Jensen Precast facility in areas east of the well field did not appear to have tilted. Evidence of existing large-scale landslides, such as the presence of crown cracks and scarps, was not observed during our Site visit.

A historical sand and gravel pit is near the toe of slopes descending from the Site and has created a pond of unknown depth. This slope has remained stable under static conditions for several decades and we did not observe evidence of instability. However, there is a potential hazard that a critical global slope failure surface descending from the crest of the slope at the proposed alignment could extend down to the base of the old pit excavation under seismic conditions.

The Site will be subject to strong seismic shaking resulting from the design earthquake. Seismically induced landslides have the potential to occur at sites where marginally stable slopes are present, especially where those slopes are composed of granular soils with low cohesion, where slopes are underlain by materials that may lose strength due to liquefaction or cyclic softening, or where pre-existing weak planes exist within the subsurface, such as an inclined contact plane dividing artificial fill from native materials.

In general, natural slopes with inclinations of 2H:1V or flatter are typically considered stable under static conditions, while flatter slopes may be necessary to resist failure under seismic forces. However, existing slopes that border the proposed alignment are as steep as 1H:1V in places and are thought to be composed fully or at least partially of undocumented and unengineered fill. For these reasons, we performed slope stability analyses to determine the potential for static-condition and earthquake-induced landslides to impact the proposed alignment. A discussion of these analyses is presented in *Section 5 - Global Stability Evaluation*.

4.2 SEISMIC CONSIDERATIONS

Western Washington sits at the contact between two large crustal tectonic plates. The Juan de Fuca Plate forms the floor of the Pacific Ocean off the coast of the northwestern United States and moves northeastward from its spreading ridge boundary with the North American Plate at an average rate of approximately 1.5 inches per year. As it converges with the continental North American Plate, the Juan de Fuca Plate dips below (or "subducts") beneath the North American Plate, forming a shallow, eastward-dipping contact interface. This boundary is known as the Cascadia Subduction Zone (CSZ) and is responsible for the seismicity in the western Washington region, producing earthquakes associated with three types of source zones: subduction interface, subduction intraslab, and crustal.

We obtained a deaggregation of the seismic sources contributing to the expected peak bedrock acceleration shown above from the USGS Unified Hazard Tool website. Seismic sources contributing to this potential ground shaking include the CSZ megathrust source and local crustal faults.

Interface Sources. As mentioned above, the Juan de Fuca Plate moves toward the North American Plate at a rate of approximately 1.5 inches per year, on average. However, this displacement does not manifest as slip between the two plates; rather, it is absorbed by compression of the North American Plate at the interface at relatively shallow depths. This compression, based on geologic and historical evidence, is released every 500 to 600 years in the form of magnitude 8 to 9 earthquakes, the last such event occurring in 1700. Characteristics of this type of earthquake may include very large ground accelerations, shaking durations in excess of two minutes, and particularly strong, long-period ground motions.

Intraslab Sources. A deeper zone of seismicity is associated with a steeper bending of the Juan de Fuca Plate and the breaking of the plate under its own weight below the Puget Sound region. This region, termed the Benioff Zone, produces intraslab earthquakes at depths of 40 to 70 kilometers (km). Such past events in western Washington include the 1949 Puget Sound, 1965 Olympia, and 2001 Nisqually earthquakes. Deep, intraslab earthquakes tend to be felt over larger areas than shallower interface events, and generally lack significant aftershocks. Intraslab earthquakes tend to have magnitudes on the order of 5.5 to 7.5.

Our review of the interactive deaggregations indicate that interface and intraslab earthquakes near the CSZ contribute about 52 percent of the total hazard to the Site considering the maximum considered earthquake (MCE) event.

Crustal Sources. The Lacamas Lake Fault is located in approximately 1,400 feet east of the eastern end of the proposed alignment and contributes to the crustal seismicity of the Camas region. The northwest-striking Lacamas Lake Fault forms a part of the northeastern margin of the Portland Basin and has been mapped as a steeply southwest dipping (greater than 75 degrees) normal fault capable of a magnitude 6.7 event. This fault contributes very little to the total seismic hazard at the Site (less than 3 percent for periods ranging from 0 to 1 seconds). Most of the regional crustal hazard (approximately 5 to 10 percent for periods ranging from 0 to 1 seconds) instead comes from gridded crustal seismicity, which represents seismic hazard determined by gridding and smoothing historical seismicity from unidentified or uncharacterized faults in the area. Crustal sources contribute about 48 percent of the total seismic hazard to the Site.

The data review indicates that the "mean source" for shaking at the Site is a magnitude 7.15 earthquake epicentered approximately 98 kilometers from the Site. The mean source generally signifies the earthquake with the highest contribution to the Site earthquake hazard; however, in this instance, the mean magnitude appears to be representative of seismic action along either a crustal source or one along the CSZ.

4.2.1 Seismic Shaking

We evaluated potential seismic shaking at the Site in accordance with the 2021 International Building Code (IBC; International Code Council, Inc., 2021) and the American Society of Civil Engineers (ASCE) 7-16 Minimum Design Loads for Buildings and Other Structures (ASCE/Structural Engineering Institute, 2016), which considers the maximum considered earthquake to be seismic shaking having a 2 percent probability of exceedance in 50 years (approximately 2,475-year return period).

We evaluated potential seismic shaking at the Site using data obtained from the U.S. Seismic Design Maps (USGS, 2019). The expected peak bedrock acceleration having a 2 percent probability of exceedance in 50 years (2,475-year return period) is 0.362g. This value represents the peak acceleration on bedrock beneath the Site and does not account for ground motion amplification due to Site-specific effects. The peak ground acceleration (PGA) is determined by applying a Site class factor to the peak bedrock acceleration. Refer to *Section 4.2.2 - Seismic Site Class* for a discussion of ground motion amplification. For IBC specified motions, the "mean source" should be used for shaking at the Site at all potential periods of interest (0.0 to 2.0). This is a magnitude 7.15 earthquake with an epicenter approximately 53 km from the Site.

4.2.2 Seismic Site Class

The "Site Class" is a designation used by the ASCE 7-16 to quantify ground motion amplification. The classification is based on the stiffness in the upper 100 feet of soil and bedrock materials at a site. The upper 100 feet of subsurface stratigraphy at the project Site predominantly consists of medium dense to very dense silty sand. The WA DNR map estimates that the Vs_{30} at the Site is 360 meters per second, based on a study nearby to the Site, which corresponds to Site Class C conditions.

4.2.3 Design Response Spectra

We obtained the seismic design parameters shown below from the updated ASCE 7-16 at Latitude 45.5842 and Longitude –122.3875. The parameters provided in Table 1 are appropriate for 2021 IBC code-based seismic design.

Table 1. Seismic Design Parameters	
Parameter	**Value**
Site Class	C
Spectral Response Acceleration at Short Periods (S_S)	0.806
Spectral Response Acceleration at 1-Second Period (S_1)	0.349
Site coefficient for Short Periods (F_a)	1.2
Site coefficient for 1-Second Period (F_v)	1.5
Peak Ground Acceleration (PGA)	0.362
Site Coefficient for PGA (F_{PGA})	1.2
Spectral Response Acceleration for Short Period, S_{DS}	0.645
Spectral Response Acceleration for 1-second period, S_{D1}	0.349
PGA Adjusted for Site Amplification, PGA_M	0.435

4.2.4 Liquefaction

When cyclic loading occurs during an earthquake, the shaking can increase the pore pressure in loose to medium dense saturated sand and cause liquefaction. The rapid increase in pore water pressure reduces the effective normal stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils, which rely on interparticle friction for strength, are susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. In general, loose, saturated sand soils with low silt and clay contents are the most susceptible to liquefaction. Silty soils with low plasticity are moderately susceptible to liquefaction under relatively higher levels of ground shaking. For any soil type, the soil must be saturated for liquefaction to occur.

CMC Chapter 16.59.040(A) references WA DNR seismic hazard maps for western Washington shown in *Figure 6 – Liquefaction Susceptibility*. The map describes the alignment to have a moderate to high liquefaction hazard.

The native deposits encountered within our sonic borings were generally found to be very dense, with the exception of our unsaturated 20-foot bgs sample at boring B-2, which was medium dense. These deposits often included a significant volume of gravels, cobbles, and boulders, which are typically resistant to liquefaction. Additionally, the deposits logged in nearby City water well logs were reportedly dense to very dense. Based on these findings, we estimate that the potential for liquefaction and secondary effects of liquefaction, including the potential for lateral spreading, is low.

4.2.5 Fault Surface Rupture

Historically, ground surface displacements closely follow the trace of geologically young faults. The closest mapped fault according to WA DNR is the Lacamas Lake Fault, which is approximately 1,400 feet to the northeast of the alignment. Due to the distance between this fault and the Site, the risk of surface fault rupture at the Site is very low, unless occurring on a previously unmapped fault. A map showing the Site in relation to this fault is presented as *Figure 7 – Fault Lines*.

5. Global Stability Evaluation

5.1 GENERAL

We performed global stability evaluations on two cross sections drawn perpendicular to the slope bordering much of the proposed pipeline alignment. The locations of these cross sections are shown on *Figure 2 – Site and Exploration Plan*. Our global stability evaluations addressed the state of the slope under static and seismic conditions.

Global stability analyses for this study were performed using the commercial code Slide2 by RocScience. The Slide program performs two-dimensional limit equilibrium analyses to analyze slope stability and to determine a factor of safety (FS) against global failure. The FS against failure can be generalized as the ratio of the forces resisting slope movement (soil strength, soil mass, etc.) and the forces driving slope movement (gravity, earth pressure, and earthquake shaking). A FS value equal to or less than 1 indicates a condition when the shear stresses required to maintain equilibrium in the slope reach or exceed the available shear resistance.

5.2 MATERIAL PROPERTIES

Material properties used in our slope stability analyses were developed based on empirical correlations with data collected during the field explorations (e.g., SPT blow counts), laboratory testing, our review of nearby geotechnical reports, and our experience with similar earth materials. The material properties used for our stability analyses are provided in Table 2 and are shown on the stability analyses output presented in Appendix C.

Table 2. Material Properties for Stability Analyses

ESU	Unit Weight (pcf)	Strength Type	Friction Angle (degrees)	Cohesion (psf)
1 – Artificial Fill	120	Mohr-Coulomb	34	25
2 – Flood Deposits	125	Mohr-Coulomb	36	0
3 – Elastic Silt	120	Mohr-Coulomb	30	0

5.3 STABILITY ANALYSES

Our stability analyses evaluated two loading cases based on static and seismic conditions, as follows:

- Case 1: Static (non-seismic) loading conditions with full soil strength properties; and
- Case 2: Seismic (pseudo-static) loading conditions with the horizontal seismic coefficient, $k_h = 1/2\ PGA_M$ and full soil strength properties.

A vertical load of 8,000 psf was applied across a limited portion of the upland area set back from the slope crest to account for average loading imposed by concrete products stored in the Jensen Precast yard. Bathymetric data for the former gravel quarry ponds was not available; an assumed maximum depth of about 15 feet was used as a reasonable assumption for these analyses.

Stability analyses were performed on two cross sections (designated Cross Sections A-A’ and B-B’), which were drawn at critical locations where the proposed pipeline will traverse closest to existing steep slopes, as shown on Figure 2. Our analyses indicate that the slopes north of the Site bordering the quarry ponds are marginally stable under static conditions, with calculated FSs of 1.1 to 1.2 for Cross Sections A-A’ and B-B’, respectively; however, the failure surfaces with FSs of less than 1.5 were offset from the proposed transmission main alignment by a lateral distance of at least 15 feet. Accordingly, a slope failure under static conditions is not expected to impact the proposed transmission main.

Analyses performed for seismic conditions indicate that seismic slope failures are expected to occur along the slopes analyzed at Cross Sections A-A’ and B-B’. Similar to the findings from the static condition analyses, the seismic failures are largely expected to occur along the slope face at a significant lateral distance offset from the proposed transmission main alignment. No failure surfaces with a seismic FS of less than 1.1 were identified as crossing closer than 5 feet laterally from the proposed transmission main at Section A-A’.

Several surfaces with seismic FSs between 1.0 and 1.1 were identified as crossing beneath the proposed alignment at Section B-B’. As a result of this finding, we performed a displacement analysis using the simplified procedure for estimating seismic slope displacements in subduction zones by Bray et al. (2018). The analysis indicates that the mean level of expected displacement at the pipeline under the design seismic event is on the order of 2-1/2 inches.

Based on the results of these analyses, we conclude that the proposed transmission main has a low potential for being affected by issues pertaining to slope instability under static and seismic conditions. However, the nearby slope is marginally stable under static conditions and is expected to fail under seismic conditions. Analysis results are shown in the Slide output Figures C1 through C4 included in Appendix C.

6. Conclusions

Based on our explorations, testing, and analyses, it is our opinion that the Site is suitable for the proposed pipeline, provided the recommendations in this report are included in design and construction. We offer the following general summary of our conclusions.

- Near-surface Site soils generally consist of native Terrace deposits and alluvium in the western and southeastern portions of the proposed alignment, whereas the central portion of the alignment is largely composed of fill. Both native and fill near-surface soils are largely composed of sands and gravels with a significant constituent of cobbles and boulders up to 4 feet in largest dimension. The fill contains large pieces of concrete and other debris. Excavation of oversize materials should be expected during pipeline construction. If excavation spoils are used for pipeline trench backfill, these oversize materials will require segregation and removal or will require crushing to reduce to an acceptable size for re-use as fill.
- Handling of and excavation into the Site soils should be accomplished with conventional earthwork equipment, although difficult excavation may be encountered due to the presence of cobbles, boulders, and oversize fill debris including large concrete pieces. The concrete debris may include large sections of slabs, footings, or similar features that will require hydraulic hammers to break up or large excavations to remove. Additionally, the soils are coarse-grained with very little in the way of a stabilizing matrix of finer materials; therefore, caving conditions should be anticipated.
- Groundwater is not expected to be encountered along the project alignment within the anticipated depth of excavation, though localized zones of perched water may be present, especially depending on the season in which excavation is performed.
- The proposed transmission line alignment crosses through an active storage yard for a precast concrete product supplier. The stored concrete products induce high bearing pressures on the supporting subgrade, and these pressures will not significantly dissipate until a depth of tens of feet below the surface grade is reached. The design pipe material will need to be capable of tolerating these pressures.
- The slopes descending from the Site and proposed alignment to the former quarry area north of the Site are unstable, though their instability does not appear to extend back into the alignment of the proposed pipeline. The construction of the proposed pipeline will not in itself adversely affect the stability of the adjacent slopes.

The performance standards set forth in the CMC state that utility lines and pipes are permitted to be constructed in geological hazard areas, provided the lines are designed so that they will continue to function in the event of an underlying failure. We expect that ground displacement on the order of about 2-1/2 inches may occur at the pipeline alignment under design-level seismic shaking. We understand this level of displacement can typically be addressed through engineering controls such as use of flex-tolerant piping or connectors.

The following sections present our recommendations for geotechnical aspects of the project design. We have developed our conclusions and recommendations based on our current understanding of the project. If the nature of the project or location-specific project elements are altered from those described in this report, Haley & Aldrich should be notified so we can confirm or modify our recommendations.

7. Recommendations

This section of the report presents our conclusions and recommendations regarding the geotechnical aspects of design and construction for the proposed transmission line. We have developed our recommendations based on our current understanding of the project and the subsurface conditions revealed by our explorations and research. If the nature or location of the proposed improvements are different than we have assumed, Haley & Aldrich should be notified so we can review, change, and/or confirm our recommendations.

7.1 EARTHWORK

Earthwork for the project is primarily expected to consist of trench excavations and backfilling up to approximately 6 feet deep/thick. Limited mass grading is expected to occur. All trench and earthwork should be completed in accordance with the recommendations in this report and the Washington State Department of Transportation (WSDOT) Washington Standard Specifications (WSS; WSDOT, 2023).

7.1.1 Site Preparation

Portions of the Site receiving new improvements or undergoing earthwork activities should be cleared of existing improvements, vegetation and trees, abandoned utilities, and other obstructions. Concrete products stored along the project alignment and within the surcharge influence zone of proposed excavations will require temporary relocation during construction.

Once demolished and relocated materials have been removed, exposed soils should be excavated to subgrade elevation and evaluated by an experienced geotechnical engineer. Shallow subgrade should be evaluated under the direction of a qualified geotechnical engineer or representative by probing with a steel foundation probe.

Soft or loose zones supporting other improvements should be overexcavated and backfilled with compacted structural fill or stabilization material, as appropriate for the overlying improvement.

7.2 EXCAVATION

7.2.1.1 Excavations

Installation of the transmission main will require trench excavations up to approximately 6 to 7 feet in depth. Existing Site soils within the zone of excavation for the pipe alignment are expected to consist primarily of sands and gravels containing significant quantities of cobbles, boulders, concrete, and other debris. Boulders and concrete with dimensions up to 4 feet have been observed in geotechnical explorations, though larger materials (particularly concrete debris) may potentially be encountered in trench excavation. Excavations into these materials should be possible with conventional earthwork equipment, though localized difficult excavation may occur when cobbles or boulders are encountered. The presence of these materials will likely require over-sized trench excavation that will result in greater than anticipated backfill quantities.

The earthwork contractor is responsible for providing equipment and following procedures as needed to excavate the Site soils, as described in this report.

7.2.1.2 Temporary Excavations and Shoring

Excavated soils are expected to be medium dense to very dense granular sands, gravels, cobbles, and boulders in a moist but unsaturated condition. Even shallow temporary open cuts are likely to run and slough during construction. Therefore, we recommend that the contractor assume all cuts will need to be cut back or supported with shoring or trench boxes.

We recommend that all temporary open soil cuts be sloped back to prevent sloughing and collapse, in accordance with Occupational Safety and Health Administration (OSHA) guidelines.

The stability and safety of cut slopes depend on a number of factors, including:

- Type and density of the soil;
- Presence and amount of groundwater seepage;
- Depth of cut;
- Proximity and magnitude of the cut to any surcharge loads, including equipment loads;
- Duration of the open excavation; and
- Care and methods used by the contractor.

Because of the variables involved, actual slope angles required for stability in temporary cut areas can only be estimated before construction. It is the responsibility of the contractor to ensure that the excavation is properly sloped or braced for worker protection, in accordance with OSHA guidelines. Based on conditions observed in our borings and test pits, near-surface soils are expected to generally consist of medium dense to very dense granular soils that would be classified as OSHA Class C for excavation purposes. However, differing conditions may be present within the undocumented fill materials present throughout the central portion of the alignment. The contractor should be prepared to potentially deal with varying soil conditions.

If the contractor chooses to utilize shoring, we consider shoring selection and design to solely be the responsibility of the contractor. If shored excavations are left open for extended periods of time, caving of the sidewalls may occur between the cut and shoring if voids between the shoring and cut are not filled. The presence of caved material will limit the ability to properly backfill cuts. The voids between box shoring and the sidewalls of cuts should be properly filled with sand or gravel before caving occurs. It is the contractor's responsibility to employ trenching, excavation, and shoring methods that ensure proper compaction will be achieved and adjacent facilities protected.

7.2.2 Dewatering

Groundwater is not expected to be encountered within the planned excavation depths for the proposed pipeline. Localized seepage or perched water conditions may be encountered within some portions of the alignment during construction. We anticipate that this water, if encountered, can effectively be removed from the trenches using a sump pump.

7.2.3 Structural Fill and Backfill

Structural fill should include fill intended to support structures or which exist within the influence zone of structures. Structural fill should only be placed over a subgrade that has been prepared in conformance with the prior sections of this report. A variety of material may be used as structural fill. However, all material used as structural fill should be free of debris, clay balls, roots, organic matter, frozen soil, man-made contaminants, particles with greatest dimension exceeding 4 inches, other deleterious materials, and should meet the appropriate specification provided in the WSS.

Fill and backfill materials should be placed and compacted in lifts with maximum uncompacted thicknesses and relative densities as recommended in the table in *Section 7.2.4 - Fill Placement and Compaction*.

7.2.3.1 On-Site Soils

On-Site soils encountered at shallow depths in our explorations consist of sands and gravels with significant cobble and boulder content. These materials are generally suitable for reuse as structural fill, provided oversize materials (those in excess of 4 inches in largest dimension) are segregated. Removal of the oversize materials may require significant effort and result in a significant volume of unusable materials, which will need to be disposed and/or stockpiled. However, we anticipate that reuse of on-Site soils for trench backfill is likely to be cost-efficient compared to importing select structural fill as backfill for large portions of the transmission main alignment.

7.2.3.2 Imported Select Structural Fill

Should imported granular material be required for use as structural fill, this material should be pit or quarry run rock, crushed rock, or crushed gravel and sand and should meet the specifications provided in WSS 9 03.9(1) – Ballast, WSS 9 03.14(1) – Gravel Borrow, or WSS 9 03.14(2) – Select Borrow. However, the imported granular material should also have a maximum size of 2 inches, be angular and fairly well graded between coarse and fine material, have less than 5 percent by dry weight passing the U.S. Standard No. 200 Sieve, and have at least two mechanically fractured faces.

7.2.3.3 Trench Bedding Fill

Trench bedding fill placed beneath, adjacent to, and for at least 6 inches above utility lines (i.e., the pipe zone) should consist of well-graded granular material with a maximum particle size of 1 inch and should meet the specifications provided in WSS 9 03.12(3) – Gravel Backfill for Pipe Zone Bedding and the pipe manufacturer.

7.2.3.4 Stabilization Material

If imported granular material is required for stabilization of the bases of excavations, we recommend that material consist of pit or quarry run rock or crushed rock. The material should generally be sized between 2 and 6 inches, have less than 5 percent by dry weight passing the U.S. Standard No. 4 Sieve, and have at least two mechanically fractured faces. The material should be free of organic matter and other deleterious material.

Material meeting the gradations of WSS 9-03.9(2) – Shoulder Ballast, WSS 9-03.12(1)B – Gravel Backfill for Foundations (Class B), WSS 9-03.12(5) – Gravel Backfill for Drains, WSS 9-13.1(2) – Light Loose Riprap, WSS 9-03.12(5) – Gravel Backfill for Drywells, or WSS 9-13.6 – Quarry Spalls is generally acceptable for use. Stabilization material should be placed in lifts between 12 and 18 inches thick, and be compacted to a well-keyed condition.

Stabilization material should be separated from the base of soft or fine-grained subgrades (if present) with a layer of subgrade geotextile that meets the specifications provided in WSS 9-33.2(1) Table 3 - Geotextile for Separation or Soil Stabilization. The geotextile should be installed in conformance with the specifications provided in WSS 2-12 – Construction Geosynthetic.

7.2.4 Fill Placement and Compaction

Structural fill should be placed and compacted in accordance with the following guidelines.

- Place fill and backfill on a prepared subgrade that consists of firm, inorganic on-Site soils or approved structural fill.
- Place fill or backfill in uniform horizontal lifts with a thickness appropriate for the material type and compaction equipment. Table 3 provides general guidance for uncompacted lift thicknesses.

Table 3. Guidelines for Uncompacted Lift Thickness

Compaction Equipment	Guidelines for Uncompacted Lift Thickness (inches)		
	Native Soils	Granular and Crushed Rock Maximum Particle Size ≤ 1½ inch	Crushed Rock Maximum Particle Size > 1½ inch
Plate Compactors and Jumping Jacks	4 to 8	4 to 8	Not Recommended
Rubber-Tire Equipment	6 to 8	8 to 12	6 to 8
Light Roller	8 to 10	8 to 12	8 to 10
Heavy Roller	10 to 12	12 to 18	12 to 16
Hoe Pack Equipment	12 to 16	18 to 24	12 to 16

Notes:

The above table is based on our experience and is intended to serve as a guideline. The information provided in this table should not be included in the project specifications.

- Do not place fill and backfill until the required tests and evaluation of the underlying materials have been made and the appropriate approvals have been obtained.
- Limit the maximum particle size within the fill to two-thirds of the loose lift thickness.
- Control the moisture content of the fill to within 3 percent of the optimum moisture content based on laboratory Proctor tests. The optimum moisture content corresponds to the maximum attainable Proctor dry density.
- Perform a representative number of in-place density tests on structural fill in the field to verify adequate compaction.
- Compact fill soils to the percentages of maximum dry density as shown in Table 4.

Table 4. Fill Compaction Criteria		
Fill Type	**Percent of Maximum Dry Density Determined in Accordance with ASTM International D 1557**	
	0 to 2 Feet Below Subgrade	**> 2 Feet Below Subgrade**
Structural Fill / Structural Trench Backfill	95	92
Nonstructural Trench Backfill	88	88
Nonstructural Zones	88	88

7.3 PIPE ZONE BACKFILL

We understand that the transmission main is expected to consist of an 18-inch-diameter ductile iron pipe, to take advantage of high strengths under significant surface loading and ductility under seismic loading.

The transmission main trenches should be excavated to a minimum of 6 inches below the bottoms of the pipe and have clearances of at least 6 inches on both sides. Any cobbles, boulders, or debris which protrude into this zone shall be removed. Gravel backfill for pipe zone bedding material shall be placed to a minimum thickness of 6 inches around the entire pipe.

7.4 SOIL CORROSIVITY

One soil sample was collected and tested for corrosivity characteristics by CERCO of Concord, California. The tested sample consisted of near-surface soils sampled from boring location B-2. The sample was tested for resistivity, redox potential, sulfate and chloride ion concentrations, and pH. The test results indicate that near-surface soils should be considered “moderately corrosive” to buried iron and steel improvements, based on laboratory resistivity measurements, according to CERCO. Chloride ion concentrations were non-detect and were determined by CERCO to be insufficient to attack steel embedded in concrete mortar coating. Sulfate ion concentration results were 37 milligrams per kilogram and were determined by CERCO to be insufficient to damage reinforced concrete structures and cement mortar coated steel. Per CERCO, pH levels were measured to be 8.33 and are not a corrosion concern for buried iron, steel, mortar-coated steel, and reinforced concrete structures.

The results of our corrosion testing and a copy of CERCO’s brief evaluation are presented in Appendix B.

8. Additional Geotechnical Services

Satisfactory earthwork and pipeline performance depends to a large degree on quality of construction. Sufficient monitoring of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions are expected to be variable because of the presence of fill and they should be observed during construction and compared with those encountered during subsurface explorations. Recognition of changed conditions often requires experience; therefore, Haley & Aldrich or their representative should visit the Site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

We recommend that, before construction begins, we review the final design plans and specifications to verify that the geotechnical engineering recommendations have been properly interpreted and implemented into the design. Further, we recommend that Haley & Aldrich be retained to monitor construction at the Site to confirm subsurface conditions in excavations are consistent with the Site explorations, and confirm the intent of project plans and specifications relating to earthwork are being met. The purpose of these observations and services is to note compliance with the design concepts, specifications, or recommendations, as well as to allow design changes or evaluation of appropriate construction measures in the event that subsurface conditions differ from those anticipated prior to the start of construction.

9. Limitations

This report has been prepared for specific application to the proposed construction as understood at this time. In the event that changes in the nature, design, or location of the project are planned, the conclusions and recommendations contained in this report should not be considered valid, unless the changes are reviewed by Haley & Aldrich and the conclusions of this report modified or verified in writing.

The geotechnical analyses and recommendations are based, in part, upon the data obtained from the referenced subsurface exploration. The nature and extent of variations between explorations may not become evident until construction. If variations appear at that time, it may be necessary to re-evaluate the recommendations of this report.

This report is prepared for the exclusive use of WSP USA Inc., the City of Camas, and their subconsultants in pursuit of the proposed Camas Well 6-14 Transmission Main Project in Camas, Washington. There are no intended beneficiaries other than WSP USA Inc., and their subconsultants. Haley & Aldrich shall owe no duty whatsoever to any other person or entity on account of the Agreement or the report. Use of this report by any person or entity other than WSP USA Inc., the City of Camas, and their subconsultants for any purpose whatsoever is expressly forbidden unless such other person or entity obtains written authorization from WSP USA Inc., and Haley & Aldrich. Use of this report by such other person or entity without the written authorization of WSP USA Inc., and Haley & Aldrich, shall be at such other person's or entity's sole risk and shall be without legal exposure or liability to Haley & Aldrich.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments, are only a copy of the original document. The original document is stored by Haley & Aldrich and will serve as the official document of record.

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FIGURES

MAP SOURCE: ESRI
SITE COORDINATES: 45°35'01"N, 122°23'13"W

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

VICINITY MAP

APPROXIMATE SCALE: 1 IN = 2000 FT
JULY 2024

FIGURE 1

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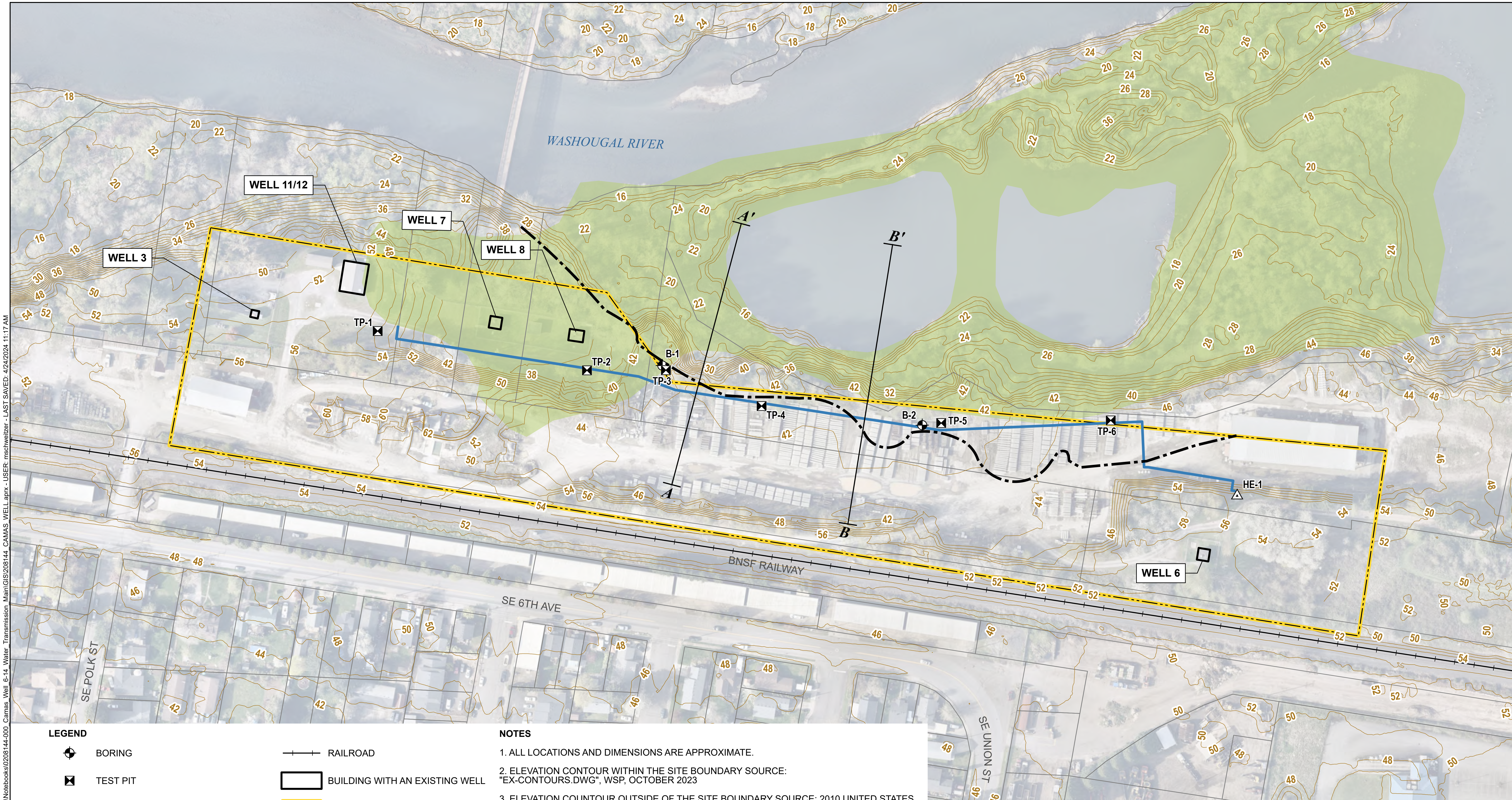

LEGEND

- BORING
- TEST PIT
- HAND EXPLORATION
- CROSS SECTION
- PROPOSED WATERLINE
- APPROXIMATE LIMITS OF MINING DISTURBANCE (1963)
- TOPOGRAPHIC ELEVATION CONTOUR, 2-FT INTERVAL (NAVD 88)
- RAILROAD
- BUILDING WITH AN EXISTING WELL
- SITE BOUNDARY
- PARCEL BOUNDARY
- MAPPED FILL SOIL

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ELEVATION CONTOUR WITHIN THE SITE BOUNDARY SOURCE: "EX-CONTOURS.DWG", WSP, OCTOBER 2023
3. ELEVATION COUNTOUR OUTSIDE OF THE SITE BOUNDARY SOURCE: 2010 UNITED STATES ARMY CORPS OF ENGINEERS LIDAR DIGITAL ELEVATION MODEL: COLUMBIA RIVER (OR, WA, ID, MT)
4. NAVD 88 = NORTH AMERICAN VERTICAL DATUM 1988
5. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN"; FIGURE 1, BERGER ABAM, APRIL 2018
6. PARCEL DATA SOURCE: WASHINGTON STATE PARCELS PROJECT
7. MAPPED FILL SOIL SOURCE: SOIL SURVEY STAFF, NATURAL RESOURCES CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE (USDA), WEB SOIL SURVEY, 6 NOVEMBER 2023
8. AERIAL IMAGERY SOURCE: NEARMAP, 26 APRIL 2023

0 150 300
SCALE IN FEET

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CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

SITE AND EXPLORATION PLAN

JULY 2024

FIGURE 2

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LEGEND

- PROPOSED WATERLINE
- TOPOGRAPHIC ELEVATION CONTOUR, 2-FT INTERVAL (NAVD 88)
- RAILROAD
- SITE BOUNDARY
- PARCEL BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. ELEVATION CONTOUR WITHIN THE SITE BOUNDARY SOURCE: "EX-CONTOURS.DWG", WSP, OCTOBER 2023
3. NAVD 88 = NORTH AMERICAN VERITCAL DATUM 1988
4. ELEVATION COUNTOUR OUTSIDE OF THE SITE BOUNDARY SOURCE: 2010 UNITED STATES ARMY CORPS OF ENGINEERS LIDAR DIGITAL ELEVATION MODEL: COLUMBIA RIVER (OR, WA, ID, MT)
5. LIDAR HILLSHADE SOURCE: 2010 UNITED STATES ARMY CORPS OF ENGINEERS LIDAR DIGITAL ELEVATION MODEL: COLUMBIA RIVER (OR, WA, ID, MT)
6. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN", FIGURE 1, BERGER ABAM, APRIL 2018
7. PARCEL DATA SOURCE: WASHINGTON STATE PARCELS PROJECT

HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

LIDAR HILLSHADE

JULY 2024

FIGURE 3

GIS FILE PATH: \\haleyaldrich.com\share\pdx_data\Notebooks\0208144-000_Camas_Well_6-14_Water_Transmission_Main\GIS\208144_CAMAS_WELL.aprx - USER: mtoner - LAST SAVED: 4/5/2024 6:26 PM

LEGEND

- PROPOSED WATERLINE
- TOPOGRAPHIC ELEVATION CONTOUR, 2-FT INTERVAL (NAVD 88)
- RAILROAD
- LANDSLIDE HAZARD: SLOPE > 15%
- SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. LANDSLIIDE HAZARD DATA SOURCE: CLARK COUNTY, WASHINGTON GEOGRAPHIC INFORMATION SYSTEM
3. ELEVATION CONTOUR WITHIN THE SITE BOUNDARY SOURCE: "EX-CONTOURS.DWG", WSP, OCTOBER 2023
4. NAVD 88 = NORTH AMERICAN VERTICAL DATUM 1988
5. ELEVATION COUNTOUR OUTSIDE OF THE SITE BOUNDARY SOURCE: 2010 UNITED STATES ARMY CORPS OF ENGINEERS LIDAR DIGITAL ELEVATION MODEL: COLUMBIA RIVER (OR, WA, ID, MT)
6. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN" FIGURE 1, BERGER ABAM, APRIL 2018
7. AERIAL IMAGERY SOURCE: NEARMAP, 26 APRIL 2023

N

0 150 300
SCALE IN FEET

HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

LANDSLIDE HAZARD

JULY 2024

FIGURE 4

GIS FILE PATH: \\haleyaldrich.com\share\pdx_data\Notebooks\0208144-000_Camas_Well_6-14_Water_Transmission_Main\GIS\208144_CAMAS_WELL.aprx - USER: MToner - LAST SAVED: 11/7/2023 8:02 AM

LEGEND

- PROPOSED WATERLINE
- RAILROAD
- EROSION HAZARD
- SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. EROSION HAZARD DATA SOURCE: CLARK COUNTY, WASHINGTON GEOGRAPHIC INFORMATION SYSTEM
3. EROSION HAZARD AREAS INCLUDE AREAS IDENTIFIED BY THE UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE (USDA-NCRS) AS HAVING "MODERATE TO SEVERE", "SEVERE", OR "VERY SEVERE" EROSION HAZARD AND AREAS WITH SLOPE GREATER THAN 15%.
4. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN" FIGURE 1, BERGER ABAM, APRIL 2018
5. AERIAL IMAGERY SOURCE: NEARMAP, 26 APRIL 2023

HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

EROSION HAZARD

JULY 2024

FIGURE 5

LEGEND

- PROPOSED WATERLINE
- RAILROAD
- LIQUEFACTION SUSCEPTIBILITY: MODERATE TO HIGH
- SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. LIQUEFACTION SUSCEPTIBILITY DATA SOURCE: CLARK COUNTY, WASHINGTON GEOGRAPHIC INFORMATION SYSTEM
3. ONLY MODERATE TO HIGH LIQUEFACTION SUSCETIBILITY IS PRESENT IN THE SITE AREA.
4. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN" FIGURE 1, BERGER ABAM, APRIL 2018
5. AERIAL IMAGERY SOURCE: NEARMAP, 26 APRIL 2023

0 150 300
SCALE IN FEET

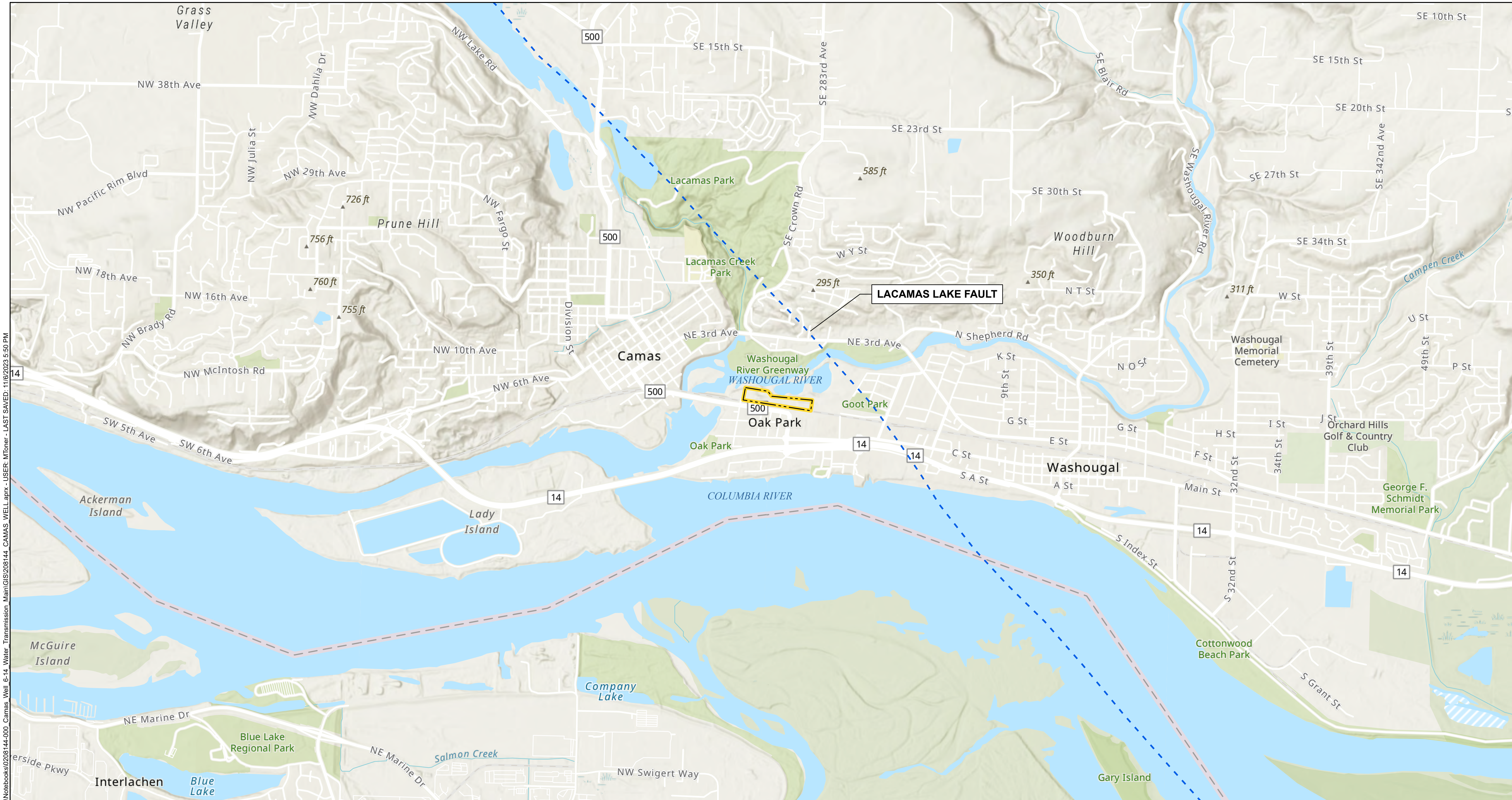
CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

LIQUEFACTION SUSCEPTIBILITY

JULY 2024

FIGURE 6

GIS FILE PATH: \\haleyaldrich.com\share\pdx_data\Notebooks\0208144-000_Camas_Well_6-14_Water_Transmission_Main\GIS\208144_CAMAS_WELL.aprx - USER: MToner - LAST SAVED: 11/7/2023 8:02 AM



LEGEND

INFERRED FAULT TRACE

SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. FAULT LINE DATA SOURCE: WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES DIVISION OF GEOLOGY AND EARTH RESOURCES
3. ONLY INFERRED FAULT TRACE CATEGORY IS KNOWN OR SUSPECTED IN THE SITE VICINITY
4. SITE BOUNDARY DATA SOURCE: "CRITICAL AREAS ASSESSMENT: WELL 6-14 WATER TRANSMISSION MAIN" FIGURE 1, BERGER ABAM, APRIL 2018

N

0 0.5 1

SCALE IN MILES

HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

FAULT LINES

JULY 2024

FIGURE 7

GIS FILE PATH: \\haleyaldrich.com\share\pdx_data\Notebooks\0208144-000_Camas_Well_6-14_Water_Transmission_Main\GIS\208144_CAMAS_WELL.aprx - USER: MToner - LAST SAVED: 11/6/2023 5:50 PM

APPENDIX A
Exploration Logs

APPENDIX A

Exploration Logs

We evaluated subsurface conditions at the site by completing two drilled borings on 6 March 2024, and by excavating six test pits and one shallow hand exploration on 7 March 2024. The field explorations were coordinated and overseen by geotechnical staff from Haley & Aldrich, Inc., who classified the various soil units encountered, obtained representative soil samples for geotechnical testing, and maintained a detailed log of each exploration. Exploration logs are included in this appendix. Figure 2 of the report shows the approximate locations of the explorations. Explorations were located in the field using landmarks on site. Results of the laboratory testing are indicated on the exploration logs and are included in Appendix B.

BORINGS

The borings were advanced using sonic methods using a track-mounted TSi 150 drill rig operated by Holt Services, Inc. The sonic borings created holes approximately 6 inches in diameter. The shallow hand exploration HE-1 was advanced under manual effort using a 3-inch-diameter hand auger. Each boring was backfilled with grout upon completion.

TEST PITS

The test pits were excavated using a CASE 580N backhoe operated by Dan J. Fischer Excavating, Inc. The test pits were excavated to depths of 14 to 14.5 feet below ground surface. The test pits were backfilled with excavation spoils upon completion.

SOIL SAMPLING AND CLASSIFICATION

Materials encountered in the explorations were classified in the field in general accordance with ASTM International (ASTM) Standard Practice D 2488 "Standard Practice for the Classification of Soils (Visual-Manual Procedure)."

The exploration logs in this appendix show our interpretation of the exploration, sampling, and testing data. The logs indicate the depth where the soils change. Note that the change may be gradual. In the field, we classified the samples taken from the explorations according to the methods presented on the *Figure A - 1 Key to Exploration Logs*. This figure also provides a legend explaining the symbols and abbreviations used in the logs.

Sampling of soils was completed at regular intervals throughout the depth of each boring and at select depths within each test pit. The boring samples were collected with a Standard Penetration Test sampler used in general conformance with ASTM Test Method D 1586 "Standard Method for Penetration Test and Split-Barrel Sampling of Soils." The sampler was driven by a 140-pound auto-trip hammer falling 30 inches. The *N* value, or number of blows required to drive the sampler 1 foot, or as otherwise indicated into the soils, is shown adjacent to the sample symbols on the boring logs. Disturbed samples were obtained from the sampler for subsequent classification and testing.

Sample Description

Identification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. ASTM D 2488 visual-manual identification methods were used as a guide. Where laboratory testing confirmed visual-manual identifications, then ASTM D 2487 was used to classify the soils.

Relative Density/Consistency

Soil density/consistency in borings is related primarily to the standard penetration resistance (N). Soil density/consistency in test pits and probes is estimated based on visual observation and is presented parenthetically on the logs.

SAND or GRAVEL Relative Density	N (Blows/Foot)	SILT or CLAY Consistency	N (Blows/Foot)
Very loose	0 to 4	Very soft	0 to 1
Loose	5 to 10	Soft	2 to 4
Medium dense	11 to 30	Medium stiff	5 to 8
Dense	31 to 50	Stiff	9 to 15
Very dense	>50	Very stiff	16 to 30
		Hard	>30

Moisture

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

USCS Soil Classification Chart (ASTM D 2487)

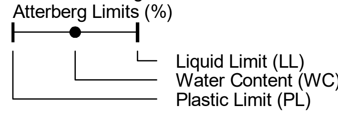
Major Divisions			Symbols Graph	Symbols USCS	Typical Descriptions
Coarse Grained Soils More than 50% of Material Retained on No. 200 Sieve	Gravel and Gravelly Soils More than 50% of Coarse Fraction Retained on No. 4 Sieve	Clean Gravels *(<5% fines)*		GW	Well-Graded Gravel; Well-Graded Gravel with Sand
				GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Gravels *(5-12% fines)*		GW-GM	Well-Graded Gravel with Silt; Well-Graded Gravel with Silt and Sand
				GW-GC	Well-Graded Gravel with Clay; Well-Graded Gravel with Clay and Sand
				GP-GM	Poorly Graded Gravel with Silt; Poorly Graded Gravel with Silt and Sand
				GP-GC	Poorly Graded Gravel with Clay; Poorly Graded Gravel with Clay and Sand
		Gravels with Fines *(>12% fines)*		GM	Silty Gravel; Silty Gravel with Sand
				GC	Clayey Gravel; Clayey Gravel with Sand
	Sand and Sandy Soils More than 50% of Coarse Fraction Passing No. 4 Sieve	Sands with few Fines *(<5% fines)*		SW	Well-Graded Sand; Well-Graded Sand with Gravel
				SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Sands *(5-12% fines)*		SW-SM	Well-Graded Sand with Silt Well-Graded Sand with Silt and Gravel
				SW-SC	Well-Graded Sand with Clay; Well-Graded Sand with Clay and Gravel
				SP-SM	Poorly Graded Sand with Silt; Poorly Graded Sand with Silt and Gravel
				SP-SC	Poorly Graded Sand with Clay; Poorly Graded Sand with Clay and Gravel
		Sands with Fines *(>12% fines)*		SM	Silty Sand; Silty Sand with Gravel
				SC	Clayey Sand; Clayey Sand with Gravel
Fine Grained Soils More than 50% of Material Passing No. 200 Sieve	Silts			ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
				MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
	Silty Clay *(based on Atterberg Limits)*			CL-ML	Silty Clay; Silty Clay with Sand or Gravel; Gravelly or Sandy Silty Clay
	Clays			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
				CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
	Organics			OL/OH	Organic Soil; Organic Soil with Sand or Gravel; Sandy or Gravelly Organic Soil
Highly Organic *(>50% organic material)*				PT	Peat - Decomposing Vegetation - Fibrous to Amorphous Texture

Minor Constituents — Estimated Percentage

Sand, Gravel	
Trace	<5
Few	5 - 15
Cobbles, Boulders	
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45

Soil Test Symbols

%F	Percent Passing No. 200 Sieve
AL	Atterberg Limits (%)



CA	Chemical Analysis
CAUC	Consolidated Anisotropic Undrained Compression
CAUE	Consolidated Anisotropic Undrained Extension
CBR	California Bearing Ratio
CIDC	Consolidated Drained Isotropic Triaxial Compression
CIUC	Consolidated Isotropic Undrained Compression
CK0DC	Consolidated Drained k0 Triaxial Compression
CK0DSS	Consolidated k0 Undrained Direct Simple Shear
CK0UC	Consolidated k0 Undrained Compression
CK0UE	Consolidated k0 Undrained Extension
CRSCN	Constant Rate of Strain Consolidation
DS	Direct Shear
DSS	Direct Simple Shear
DT	In Situ Density
GS	Grain Size Classification
HYD	Hydrometer
ILCN	Incremental Load Consolidation
K0CN	k0 Consolidation
kc	Constant Head Permeability
kf	Falling Head Permeability
MD	Moisture Density Relationship
OC	Organic Content
OT	Tests by Others
P	Pressuremeter
PID	Photoionization Detector Reading
PP	Pocket Penetrometer
SG	Specific Gravity
TRS	Torsional Ring Shear
TV	Torvane
UC	Unconfined Compression
UUC	Unconsolidated Undrained Triaxial Compression
VS	Vane Shear
WC	Water Content (%)

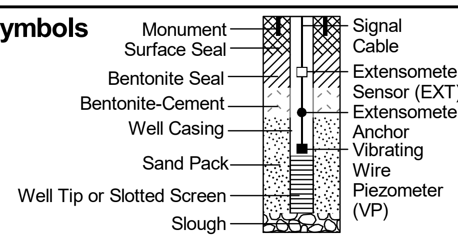
Groundwater Indicators

- Groundwater Level on Date or At Time of Drilling (ATD)
- Groundwater Level on Date Measured in Piezometer
- Groundwater Seepage (Test Pits)

Sample Symbols

1.5" I.D. Split Spoon	Rock Core Run	Grab
3.0" I.D. Split Spoon	Sonic Core	Cuttings
Modified California Sampler	Thin-walled Sampler	Push Probe

Well Symbols



HALEY ALDRICH

Project: Camas Well 6-14 Transmission Main
Location: Camas, Washington
Project No.: 0208144-000

Key to Exploration Logs

Figure **A-1**
Sheet **1 of 1**

HA KEY TO EXP LOGS (SOIL ONLY) - \\HALEYALDRICH.COM\SHARE\SEA_DATA\GINT\HC_LIBRARY.GLB - 4/25/24 08:25 - \\HALEYALDRICH.COM\SHARE\PDX_DATA\NOTEBOOKS\0208144-000_CAMAS_WELL_6-14_WATER_TRANSMISSION_MAIN\FIELD DATA\PERM_GINT FILES\0208144-000_CAMAS WATER MAIN_GINT.GPJ - kbubel

Date Started: 03/06/2024	Date Completed: 03/06/2024
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz
Location: Lat: 45.584153 Long: -122.387517 (WGS 84)	
Ground Surface Elevation: 41.07 feet (NAVD 88)	
Comments: Blow counts for >1.5" split spoon adjusted to approximate SPT N-values (see report text).	
Drilling Contractor/Crew: Holt Services, Inc. / Javier	
Drilling Method: Sonic	
Rig Model/Type: TSi 150 / Track-mounted drill rig	
Hammer Type: Auto-hammer	
Hammer Weight (pounds): 140	Hammer Drop Height (inches): 30
Measured Hammer Efficiency (%): 90.8	
Hole Diameter: 6 inches	Well Casing Diameter: NA
Total Depth: 25.3 feet	Depth to Groundwater: Not Identified

Elevation (feet)	Depth (feet)	Blow Count	Recovery	Length (inches)	Number / Tests	Material Description	WC (%) / Fines Content (%) / SPT N Value
40	0				GB-1	SILTY SAND WITH GRAVEL (SM), little cobbles up to 5-inch diameter, medium dense, moist, dark gray. [FILL]	
	3				GB-2	SILT WITH SAND (ML), stiff, moist, light brown, high plasticity.	
35	5	3, 20, 18	11in.	18	S-1	SILTY SAND WITH GRAVEL (SM), little cobbles up to 6-inch diameter, dense, moist, light brown.	38
		21, 32	4in.	8	GB-3, S-2		
	8					Concrete debris.	
30	10	50	2in.	4	S-3	SILTY GRAVEL WITH SAND (GM), little cobbles up to 6-inch diameter, very dense (relative density possibly elevated due to presence of cobbles), moist, light gray. [NATIVE]	50/4"
					GB-4 GS, WC		16
25	15	50	1in.	2	S-4		50/2"
					GB-5 GS, WC		13
20	20	50	0in.	3	S-5	no recovery	50/2.5"
					GB-6 GS, WC	SILTY SAND WITH GRAVEL (SM), little cobbles up to 6-inch diameter, very dense (relative density possibly elevated due to presence of cobbles), moist, light gray.	28
15	25	50	4in.	4	S-6		50/3.5"

Bottom of Borehole at 25.3 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH

Project: Camas Well 6-14 Transmission Main
Location: Camas, Washington
Project No.: 0208144-000

Boring Log **B-1**

Figure **A-2**
Sheet **1 of 1**

Date Started: 03/06/2024	Date Completed: 03/06/2024	Drilling Contractor/Crew: Holt Services, Inc. / Javier	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Drilling Method: Sonic	
Location: Lat: 45.583921 Long: -122.385901 (WGS 84)		Rig Model/Type: TSi 150 / Track-mounted drill rig	
Ground Surface Elevation: 41.26 feet (NAVD 88)		Hammer Type: Auto-hammer	
Comments: Blow counts for >1.5" split spoon adjusted to approximate SPT N-values (see report text).		Hammer Weight (pounds): 140	Hammer Drop Height (inches): 30
		Measured Hammer Efficiency (%): 90.8	
		Hole Diameter: 6 inches	Well Casing Diameter: NA
		Total Depth: 29.0 feet	Depth to Groundwater: 21 feet

Elevation (feet)	Depth (feet)	Blow Count	Recovery Length (inches)	Length (inches)	Number / Tests	Material Description	Water Level	WC (%) / Fines Content (%) / SPT N Value
	0					SILTY SAND WITH GRAVEL (SM), little cobbles up to 6-inch diameter, medium dense, moist, dark gray. [FILL]		
40					GB-1 GS, WC			Fines 23
35	5	7 29 50	12in.	18	S-1	grades to very dense (relative density possibly elevated due to presence of cobbles)		N = 79
					GB-2			
30	10	2 3 4	11in.	18	S-2	LEAN CLAY (CL), trace cobbles up to 5-inch diameter, medium stiff, moist, dark gray, low plasticity.		N = 7
					GB-3			
25	15	7 61	11in.	12	S-3a S-3b	WELL-GRADED SAND WITH SILT (SW-SM), very dense, moist, light brown, fine to coarse rounded to subrounded sand. [NATIVE]		N = 61/6"
					GB-4 GS, WC			Fines 9
20	20	1 5 7	14in.	18	S-4 GB-5	becomes medium dense, wet	ATD	N = 12
					GB-6	ELASTIC SILT (MH), stiff, moist, light gray, low plasticity, laminated layers of gray and light brown.		
15	25	1 3 12	15in.	18	S-5			N = 15
					GB-7			

Bottom of Borehole at 29.0 feet.

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024	Date Completed: 03/07/2024	Contractor/Crew: Haley & Aldrich, Inc.	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Rig Model/Type: Hand Auger	
Location: Lat: 45.583655 Long: -122.383944 (WGS 84)		Hole Diameter: inches	Well Casing Diameter: NA
Ground Surface Elevation: 53.54 feet (NAVD 88)		Total Depth: 2.5 feet	Depth to Groundwater: Not Identified
Comments:			

Elevation (feet)	Depth (feet)	Graphic Log	Material Description	Depth (feet)
	0		Topsoil (2-inches thick).	0
			SILTY SAND WITH GRAVEL (SM), (medium dense), moist, brown, rounded to subrounded gravel. [FILL]	
			more gravel	
			Bottom of Borehole at 2.5 feet.	
50				
	5			5
45				
	10			10
40				
	15			15
35				
	20			20
30				
	25			25
25				

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024 | Date Completed: 03/07/2024 | Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig

Logged by: T. Slothower/J. Hein | Checked by: M. Hintz | Rig Model/Type: CASE 580N / Backhoe

Location: Lat: 45.584273 Long: -122.389282 (WGS 84) | Total Depth: 14.0 feet | Depth to Seepage: Not Encountered

Ground Surface Elevation: 50.38 feet (NAVD 88)

Comments:

Elevation (feet)	Depth (feet)	Sample Data: Number / Tests	Material Description	WC / Fines Content (%)
50.38	0	S-1 GS, WC	POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), little rounded cobbles up to 4-inch diameter, (medium dense), moist, gray, frequent pockets of clean coarse angular sand. [FILL]	7
	6	S-2, S-3	WELL-GRADED SAND (SW), (medium dense), wet, light brown, some roots. [NATIVE] little gravel up to 3-inch diameter	
	11	S-4	POORLY GRADED SAND (SP), few angular to subangular gravel, (medium dense), moist, dark gray.	
	12		WELL-GRADED SAND (SW), (medium dense), wet, light brown.	
	13		POORLY GRADED SAND (SP), few angular to subangular gravel, (medium dense), moist, dark gray.	
	14		Bottom of Test Pit at 14.0 feet.	

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024	Date Completed: 03/07/2024	Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Rig Model/Type: CASE 580N / Backhoe	
Location: Lat: 45.584124 Long: -122.387982 (WGS 84)		Total Depth: 14.0 feet	Depth to Seepage: Not Encountered
Ground Surface Elevation: 36.99 feet (NAVD 88)			
Comments:			

Elevation (feet)	Depth (feet)	Sample Data: Type	Sample Data: Length (inches)	Sample Data: Number / Tests	Graphic Log	Material Description	WC ● / ✖ Fines Content (%) (10, 20, 30, 40)	Depth (feet)
	0					Root zone (6-inches thick).		0
35						POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), (dense), moist, gray, coarse angular gravel, trace debris. [FILL]		
						grades to very dense, with frequent cobbles up to 6-inch diameter, little boulders up to 2-ft diameter		
				S-1 / GS, WC			10	
	5							5
30				S-2		becomes wet		
						(minor caving from 1.5 to 14 ft)		
	10			S-3		grades to more sand		10
25								
				S-4				
						Bottom of Test Pit at 14.0 feet.		
	15							15
20								
	20							20
15								
	25							25
10								

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024 Date Completed: 03/07/2024 Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig

Logged by: T. Slothower/J. Hein Checked by: M. Hintz Rig Model/Type: CASE 580N / Backhoe

Location: Lat: 45.584133 Long: -122.387494 (WGS 84) Total Depth: 14.0 feet Depth to Seepage: Not Encountered

Ground Surface Elevation: 41.25 feet (NAVD 88)

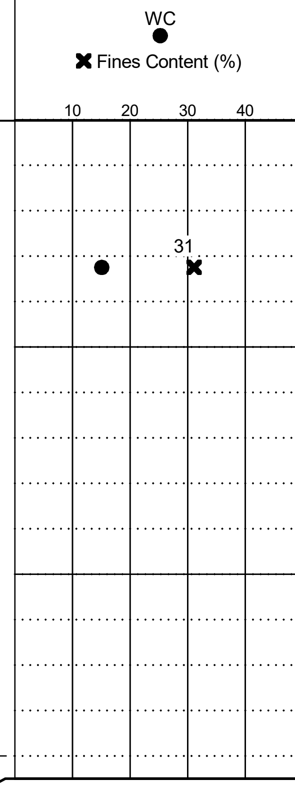
Comments:

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Graphic Log	Material Description	WC ● / ✖ Fines Content (%)	Depth (feet)
	0					SILTY SAND WITH GRAVEL (SM), (medium dense), moist, light brown-gray, rounded gravel pockets, construction debris including asphalt chunks up to 4-inches. [FILL]		0
40								
		☒		S-1 GS, WC			● ✖ 18	
35	5							5
						SILTY SAND WITH GRAVEL (SM), (dense), moist, light brown, angular gravel.		
		☒		S-2				
	10							10
30		☒		S-3		(minor caving from 8 to 14 ft)		
		☒		S-4				
						Bottom of Test Pit at 14.0 feet.		
25	15							15
20	20							20
15	25							25

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024	Date Completed: 03/07/2024	Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Rig Model/Type: CASE 580N / Backhoe	
Location: Lat: 45.583987 Long: -122.386897 (WGS 84)		Total Depth: 14.5 feet	Depth to Seepage: Not Encountered
Ground Surface Elevation: 41.42 feet (NAVD 88)			
Comments:			

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Graphic Log	Material Description
41.42	0					SILTY SAND WITH GRAVEL (SM), few cobbles up to 5-inch diameter, boulders up to 4-ft diameter, (medium dense), moist, light brown-gray, construction debris including concrete chunks up to 6-inches. [FILL]
	~3	X		S-1 / GS, WC		
	~7	X		S-2		
	~11	X		S-3		
	~14	X		S-4		WELL-GRADED SAND (SW), (dense), moist, gray, angular sand. [NATIVE]
	14.5					Bottom of Test Pit at 14.5 feet.



General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

HALEY ALDRICH	Project: Camas Well 6-14 Transmission Main Location: Camas, Washington Project No.: 0208144-000	Test Pit Log **TP-4**	Figure **A-8** Sheet **1 of 1**

Date Started: 03/07/2024	Date Completed: 03/07/2024	Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Rig Model/Type: CASE 580N / Backhoe	
Location: Lat: 45.583932 Long: -122.385784 (WGS 84)		Total Depth: 14.5 feet	Depth to Seepage: Not Encountered
Ground Surface Elevation: 41.06 feet (NAVD 88)			
Comments:			

Elevation (feet)	Depth (feet)	Sample Type	Length (inches)	Number / Tests	Graphic Log	Material Description	WC ● / ✖ Fines Content (%)
	0					SILTY SAND WITH GRAVEL (SM), few cobbles up to 5-inch diameter, boulders 4-ft diameter, (medium dense), moist, light brown-gray, construction debris including concrete chunks up to 6-inches. [FILL]	
40							
	~3.25	⊠		S-1 / GS, WC			22
	5						
35							
	~8.25	⊠		S-2			
30	10					POORLY GRADED SAND WITH SILT (SP-SM), (medium dense), moist, brown, coarse angular sand, fine gravel.	
	~11.25	⊠		S-3			
	12					SILTY SAND WITH GRAVEL (SM), boulders 4-ft diameter, (dense), moist, light brown-gray, wood debris.	
	~14.25	⊠		S-4			
	14.5					Bottom of Test Pit at 14.5 feet.	

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

Date Started: 03/07/2024	Date Completed: 03/07/2024	Contractor/Crew: Dan J. Fischer Excavating, Inc. / Craig	
Logged by: T. Slothower/J. Hein	Checked by: M. Hintz	Rig Model/Type: CASE 580N / Backhoe	
Location: Lat: 45.583961 Long: -122.384736 (WGS 84)		Total Depth: 14.5 feet	Depth to Seepage: Not Encountered
Ground Surface Elevation: 45.12 feet (NAVD 88)			
Comments:			

Elevation (feet)	Depth (feet)	Sample Data: Type	Length (inches)	Number / Tests	Graphic Log	Material Description	WC ● / ✖ Fines Content (%)
	0					POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), (medium dense), moist, light gray-brown. [FILL]	
						filter fabric	
						SILTY SAND WITH GRAVEL (SM), cobbles up to 5-inch diameter, boulders up to 3.5-ft diameter, (dense), moist, light brown, coarse rounded to subangular sand. [NATIVE]	
		☒		S-1 GS, WC			12
40	5						
		☒		S-2			
35	10						
						SILT WITH SAND (ML), (stiff), moist, gray, low plasticity.	
		☒		S-3		WELL-GRADED SAND (SW), (medium dense), moist, light brown, rounded to subrounded sand.	
		☒		S-4			
						Bottom of Test Pit at 14.5 feet.	
30	15						
25	20						
20	25						

General Notes:
1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Material stratum lines are interpretive and actual changes may be gradual. Solid lines indicate distinct contacts and dashed lines indicate gradual or approximate contacts.
3. USCS designations are based on visual-manual identification (ASTM D 2488), unless otherwise supported by laboratory testing (ASTM D 2487).
4. Groundwater level, if indicated, is at time of drilling/excavation (ATD) or for date specified. Level may vary with time.
5. Location and ground surface elevations are approximate.

APPENDIX B
Laboratory Test Results

APPENDIX B

Laboratory Testing

Soil samples obtained from the explorations were transported to our laboratory and evaluated to confirm or modify field classifications, as well as to assess engineering properties of the soils encountered. Representative samples were selected for laboratory testing and transported to our geotechnical laboratory in Portland, Oregon. The tests were performed in general accordance with the test methods of the ASTM International (ASTM) or other applicable procedures. One sample was submitted to CERCO Analytical, Inc., for corrosivity testing. A summary of the test results is included as Figure B-1.

VISUAL CLASSIFICATIONS

Soil samples obtained from the explorations were visually classified in the field and in our geotechnical laboratory based on the Unified Soil Classification System and ASTM classification methods. ASTM Test Method D 2488 was used to classify soils using visual and manual methods. ASTM Test Method D 2487 was used to classify soils based on laboratory test results.

LABORATORY TEST RESULTS

Moisture Content

Moisture contents of samples were obtained in general accordance with ASTM Test Method D 2216. The results of the moisture content tests completed on samples from the explorations are presented on the exploration logs included in Appendix A and on Figure B-1 in this appendix.

Particle Size Distribution

Sieve analysis tests were performed to determine the quantitative distribution of particle sizes in each sample. The tests were performed in general accordance with ASTM Test Method D 6913. The "percent fines" portions of the test results are indicated on the appropriate exploration logs included in Appendix A and on Figure B-1 in this appendix. The full test results are shown on Figure B-2 in this appendix.

Corrosivity Testing

One corrosivity test suite was performed on a sample collected from boring B-2. The test suite included testing for pH, redox, chloride, sulfate, and electrical resistivity. The results of the test are presented on the final sheet of this appendix.

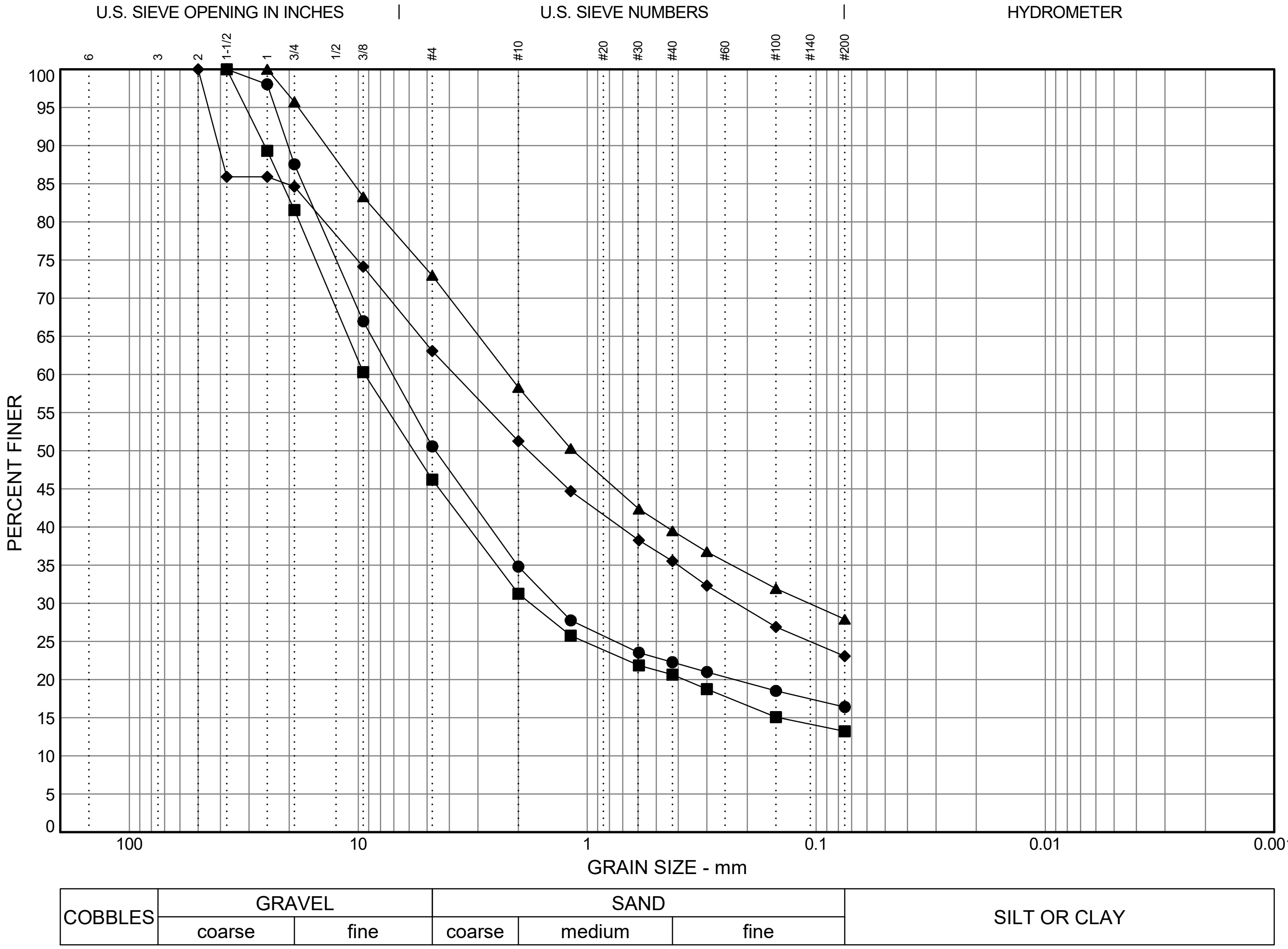
Exploration	Sample ID	Depth	Water Content (%)	Dry Density (pcf)	Fines (%)	Sand (%)	Gravel (%)	Liquid Limit	Plastic Limit	Plasticity Index	Organic Content (%)	Pocket Pen (tsf)	Torvane (tsf)	
B-1	GB-4	14.0	8.8		16	34	49							
B-1	GB-5	19.0	8.2		13	33	54							
B-1	GB-6	22.5	6.1		28	45	27							
B-2	GB-1	2.0	13.9		23	40	37							
B-2	GB-4	18.0	18.8		9	86	5							
TP-1	S-1	2.0	7.6		7	36	57							
TP-2	S-1	3.0	9.3		10	32	58							
TP-3	S-1	3.0	12.5		18	43	39							
TP-4	S-1	3.0	15.1		31	41	28							
TP-5	S-1	3.0	17.0		22	41	37							
TP-6	S-1	3.0	10.5		12	60	27							

HALEY ALDRICH

Project: Camas Well 6-14 Transmission Main
Location: Camas, Washington
Project No.: 0208144-000

Summary of Laboratory Results

Figure **B-1**
Sheet **1 of 1**



	Location and Description			% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
●	**Source:** B-1	**Sample No.:** GB-4	**Depth:** 14.0 to 14.5	0.0	49.4	34.2	16.4		9	GM
	SILTY GRAVEL WITH SAND									
■	**Source:** B-1	**Sample No.:** GB-5	**Depth:** 19.0 to 19.5	0.0	53.8	33.0	13.2		8	GM
	SILTY GRAVEL WITH SAND									
▲	**Source:** B-1	**Sample No.:** GB-6	**Depth:** 22.5 to 23.0	0.0	27.0	45.1	27.9		6	SM
	SILTY SAND WITH GRAVEL									
◆	**Source:** B-2	**Sample No.:** GB-1	**Depth:** 2.0 to 2.5	0.0	36.9	40.0	23.1		14	SM
	SILTY SAND WITH GRAVEL									

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			17.435	7.075	4.604	1.396				
■			21.470	9.361	5.725	1.775	0.146			
▲			10.455	2.213	1.153	0.108				
◆			20.579	3.793	1.808	0.223				

Remarks:

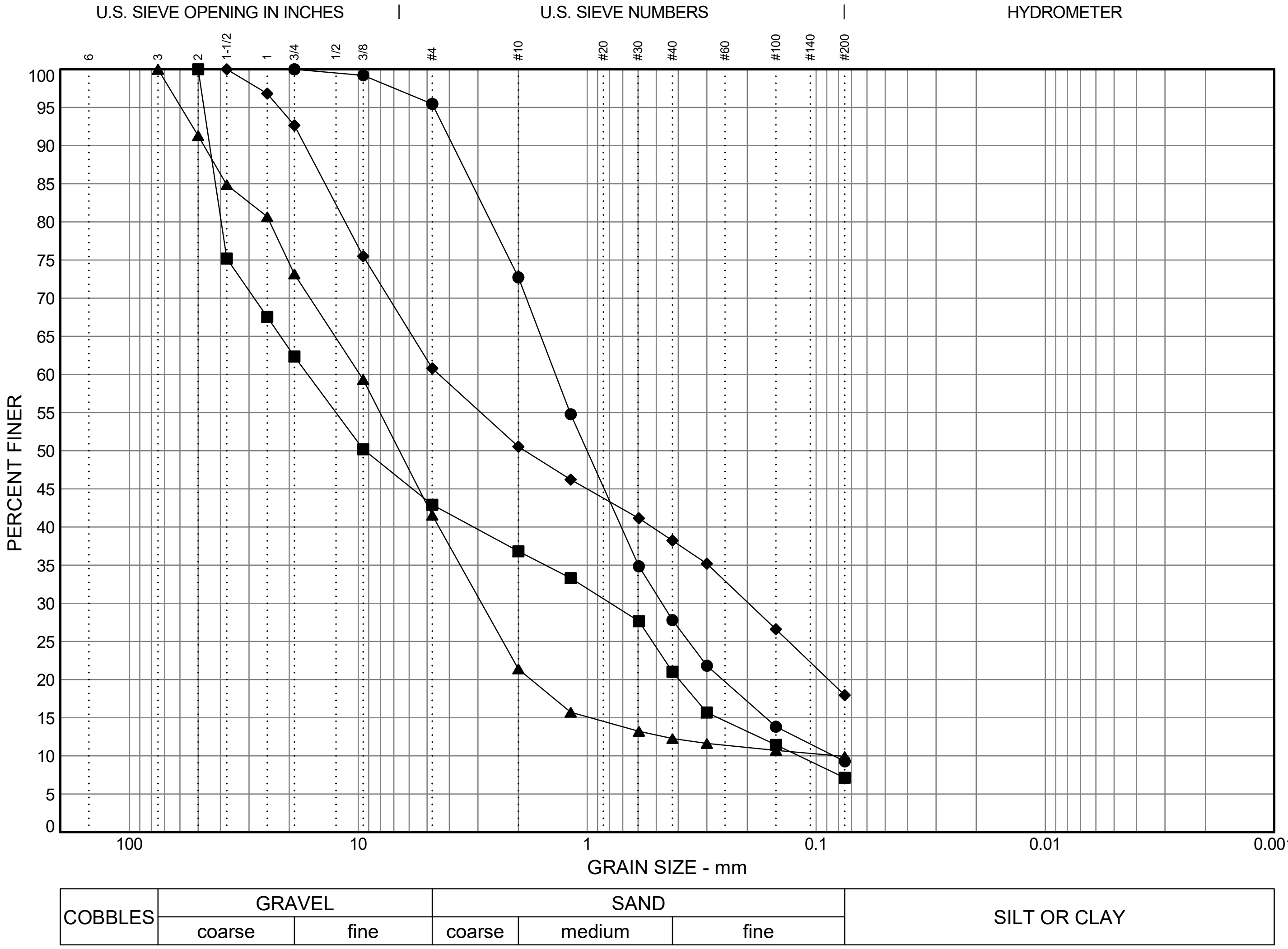
●

■

▲

◆

HALEY ALDRICH	Project: Camas Well 6-14 Transmission Main Location: Camas, Washington Project No.: 0208144-000	**Particle-Size Analysis**	Figure **B-3** Sheet **1 of 3**



Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** B-2 **Sample No.:** GB-4 **Depth:** 18.0 to 18.5 WELL-GRADED SAND WITH SILT	0.0	4.5	86.2	9.3		19	SW-SM
■ **Source:** TP-1 **Sample No.:** S-1 **Depth:** 2.0 to 2.5 POORLY GRADED GRAVEL WITH SILT AND SAND	0.0	57.1	35.8	7.1		8	GP-GM
▲ **Source:** TP-2 **Sample No.:** S-1 **Depth:** 3.0 to 3.5 POORLY GRADED GRAVEL WITH SILT AND SAND	0.0	58.5	31.6	9.9		9	GP-GM
◆ **Source:** TP-3 **Sample No.:** S-1 **Depth:** 3.0 to 3.5 SILTY SAND WITH GRAVEL	0.0	39.2	42.8	18.0		12	SM

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			3.190	1.376	1.001	0.472	0.166	0.084	1.94	16.45
■			42.021	16.633	9.335	0.791	0.268	0.119	0.32	139.59
▲			37.739	9.836	6.607	2.895	0.972	0.081	10.54	121.64
◆			13.954	4.439	1.876	0.198				

Remarks:

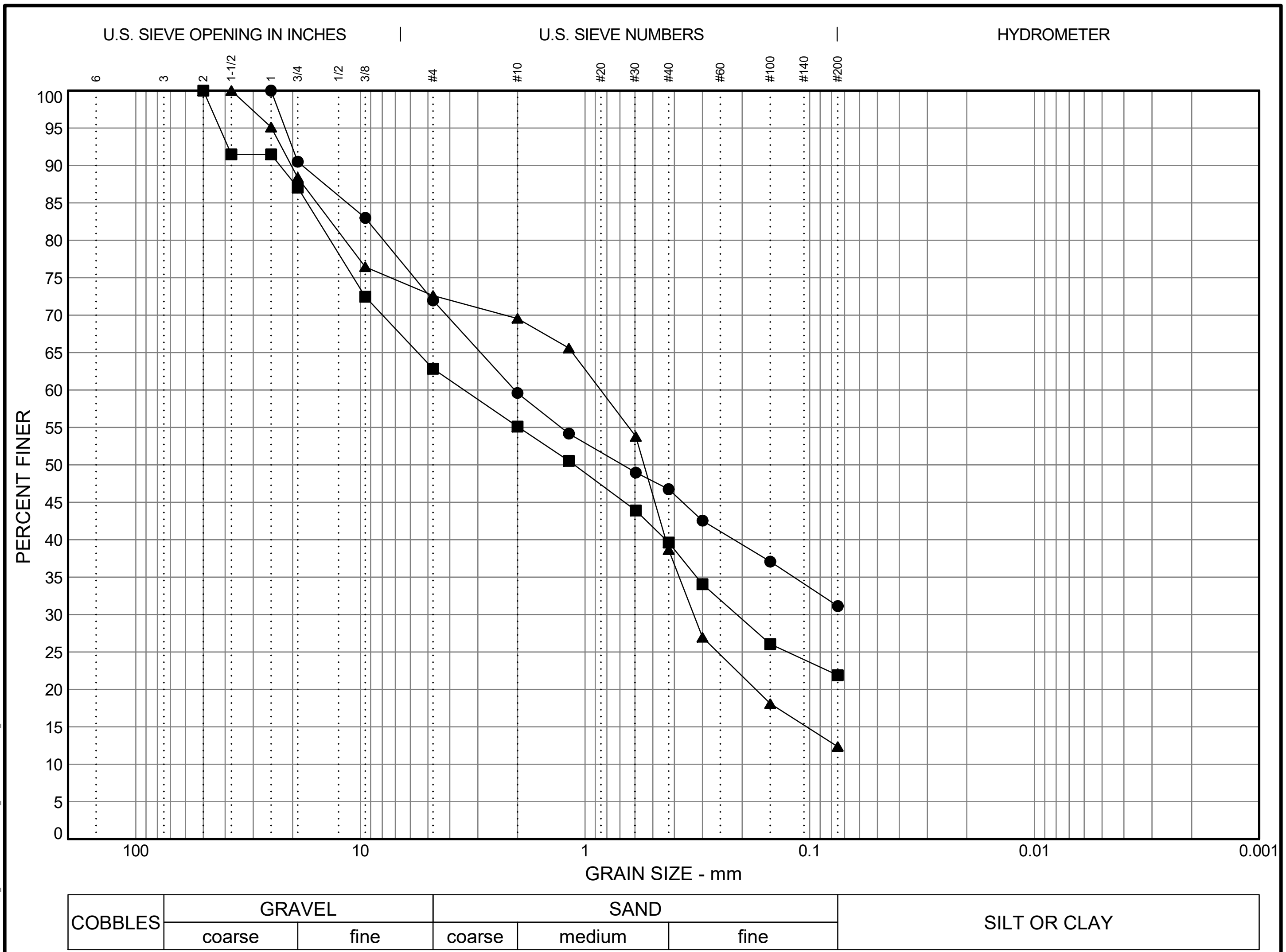
●
■
▲
◆

HALEY ALDRICH

Project: Camas Well 6-14 Transmission Main
Location: Camas, Washington
Project No.: 0208144-000

Particle-Size Analysis

Figure **B-3**
Sheet **2 of 3**



Location and Description	% Cobbles	% Gravel	% Sand	% Silt	% Clay	MC%	USCS
● **Source:** TP-4 **Sample No.:** S-1 **Depth:** 3.0 to 3.5 SILTY SAND WITH GRAVEL	0.0	28.0	40.8	31.1		15	SM
■ **Source:** TP-5 **Sample No.:** S-1 **Depth:** 3.0 to 3.5 SILTY SAND WITH GRAVEL	0.0	37.2	41.0	21.9		17	SM
▲ **Source:** TP-6 **Sample No.:** S-1 **Depth:** 3.0 to 3.5 SILTY SAND WITH GRAVEL	0.0	27.4	60.3	12.4		10	SM

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●			11.429	2.057	0.682					
■			17.249	3.457	1.116	0.211				
▲			15.609	0.853	0.547	0.328	0.103		2.24	15.12

Remarks:

●

■

▲

HALEY ALDRICH

Project: Camas Well 6-14 Transmission Main
Location: Camas, Washington
Project No.: 0208144-000

Particle-Size Analysis

Figure **B-3**
Sheet **3 of 3**

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

16 April, 2024

Job No. 2404025
Cust. No. 13349

Mr. Micah Hintz
Haley & Aldrich
6420 S. Macadam Avenue, Suite 100
Portland, OR 97239

Subject: Project No.: 0208144-000-002-01
Project Name: Camas Well 6-14 Transmission Main
Corrosivity Analysis –ASTM Test Methods

Dear Mr. Hintz:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on April 11, 2024. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

Based upon the resistivity measurement, this sample is classified as "moderately corrosive". All buried iron, steel, cast iron, ductile iron, galvanized steel and dielectric coated steel or iron should be properly protected against corrosion depending upon the critical nature of the structure. All buried metallic pressure piping such as ductile iron firewater pipelines should be protected against corrosion.

The chloride ion concentration reflects none detected with a reporting limit of 15 mg/kg.

The sulfate ion concentration is 37 mg/kg and is determined to be insufficient to damage reinforced concrete structures and cement mortar-coated steel at these locations.

The pH of the soil is 8.33, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potential is 150-mV and is indicative of potentially "moderately corrosive" soils resulting from anaerobic soil conditions.

This corrosivity evaluation is based on general corrosion engineering standards and is non-specific in nature. For specific long-term corrosion control design recommendations or consultation, please call *JDH Corrosion Consultants, Inc. at (925) 927-6630.*

We appreciate the opportunity of working with you on this project. If you have any questions, or if you require further information, please do not hesitate to contact us.

Very truly yours,
CERCO ANALYTICAL, INC.

for

J. Darby Howard, Jr., P.E.
President

JDH/jdl
Enclosure

CERCO analytical
1100 Willow Pass Court, Suite A
Concord, CA 94520-1006
925 462 2771 Fax. 925 462 2775
www.cercoanalytical.com

Client:	Haley & Aldrich, Inc.
Client's Project No.:	0208144-000-002-01
Client's Project Name:	Camas Well 6-14 Transmission Main
Date Sampled:	6-Mar-24
Date Received:	11-Apr-24
Matrix:	Soil
Authorization:	Signed Chain of Custody

Date of Report: 16-Apr-2024

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)*	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
2404025-001	0208144_B-2_GB-1	150	8.33	-	3,100	-	N.D.	37

Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:	-	-	10	-	50	15	15
Date Analyzed:	11-Apr-2024	12-Apr-2024		11-Apr-2024		15-Apr-2024	15-Apr-2024

* Results Reported on "As Received" Basis

N.D. - None Detected

Julia Clauson
Chemist

Quality Control Summary - All laboratory quality control parameters were found to be within established limits

Chain of Custody

1100 Willow Pass Court
Concord, CA 94520-1005
925 462-2771
Fax: 925 462-2775
www.cercoanalytical.com

CERCO analytical

Job No.	CU#	Client Project I.D.
2404025-	13349	0208144-000-002-01

Schedule
Analyte

Date Sampled | Date Due

Full Name Micah Hintz
Phone 503-310-3821 X
Fax

Company and/or Mailing Address Haley & Aldrich, Inc. OREGON
Cell 503-310-3821 ☒

Sample Source 0208144-000 Camas Well 6-14 Transmission Main

ANALYSIS — ASTM w/Brief Evaluation

Lab No.	Sample I.D.	Date	Time	Matrix	Contain.	Size	Preserv.	Qty.	Redox Potential	pH	Sulfate	Chloride	Resistivity-100% Saturated		Brief Evaluation							
1	0208144_B-2_GB-1	3/6/24		Soil	Bag				X	X	X	X	X		X							

MATRIX
DW - Drinking Water
GW - Ground Water
SW - Surface Water
WW - Waste Water
Water
SL - Sludge
S - Soil
Product

ABBREVIATIONS
HB - Hosebib
PV - Petcock Valve
PT - Pressure Tank
PH - Pump House
RR - Restroom
GL - Glass
PL - Plastic
ST - Sterile

SAMPLE RECEIPT
Total No. of Containers
Rec'd Good Cond/Cold
Conforms to Record
Temp. a t Lab -°C
Sampler

		Date	Time
Relinquished By:	Micah Hintz	4/9/24	1500
Received By:	UPS	4/11/24	1022
Relinquished By:			
Received By:			
Relinquished By:			
Received By:			

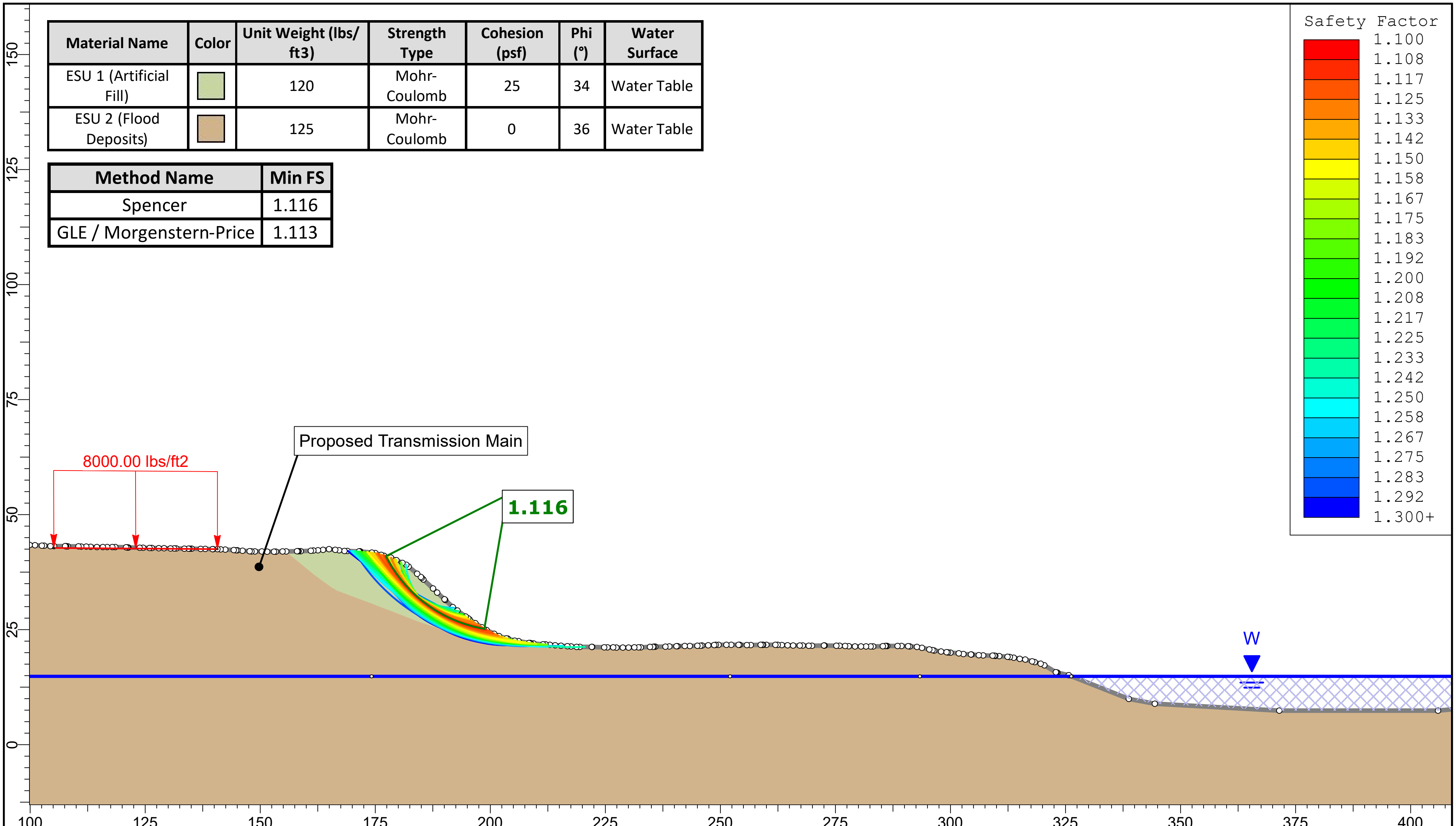
Comments:
THERE IS AN ADDITIONAL CHARGE FOR EXTRUDING SOIL FROM TUBES

Email Address: mhintz@haleyaldrich.com

APPENDIX C
Slope Stability Analyses

Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface
ESU 1 (Artificial Fill)		120	Mohr-Coulomb	25	34	Water Table
ESU 2 (Flood Deposits)		125	Mohr-Coulomb	0	36	Water Table

Method Name	Min FS
Spencer	1.116
GLE / Morgenstern-Price	1.113



HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

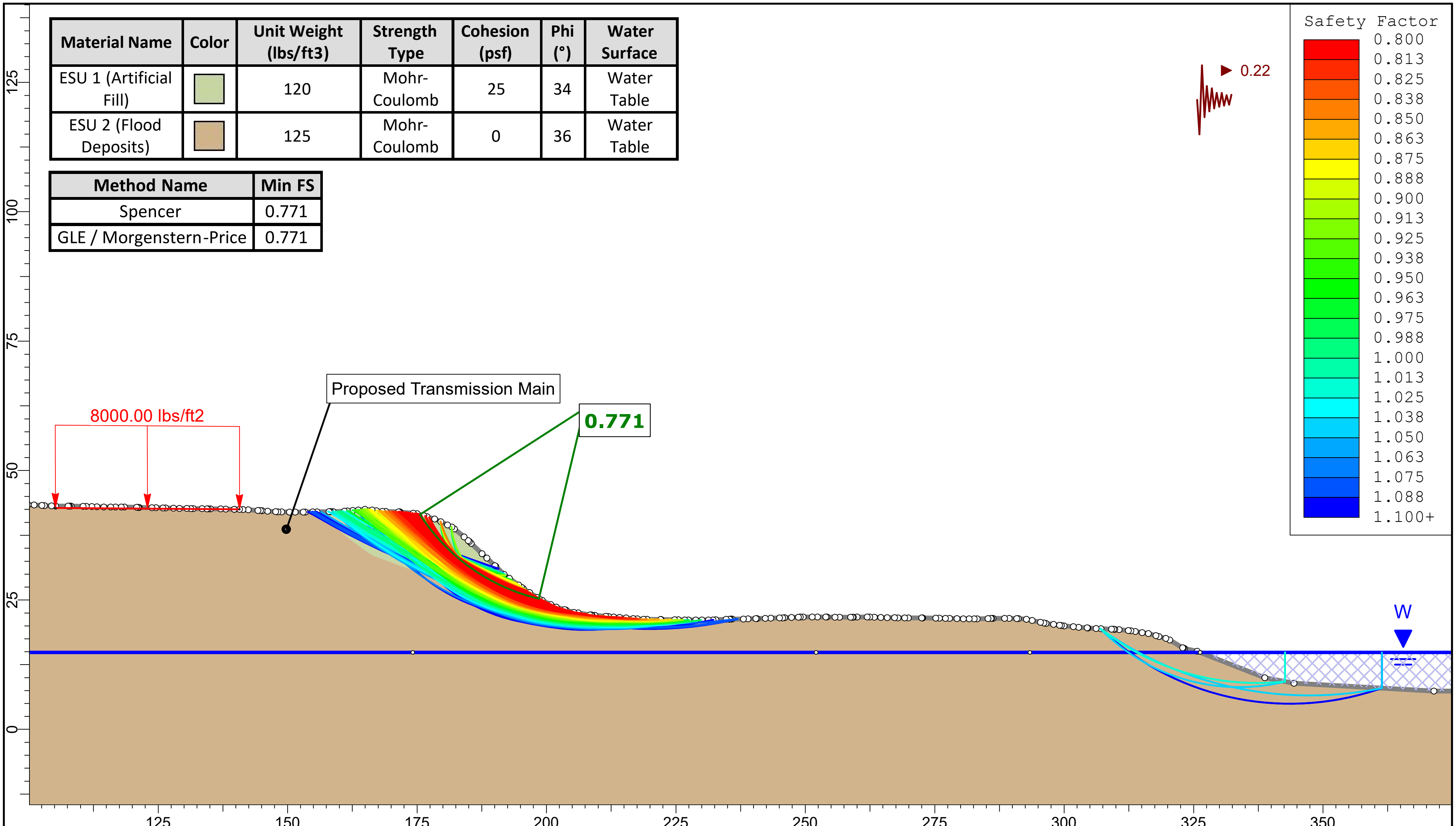
SLOPE STABILITY ANALYSIS
SECTION A-A'
STATIC CONDITION

SCALE: AS SHOWN
APRIL 2024

FIGURE C1

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface
ESU 1 (Artificial Fill)		120	Mohr-Coulomb	25	34	Water Table
ESU 2 (Flood Deposits)		125	Mohr-Coulomb	0	36	Water Table

Method Name	Min FS
Spencer	0.771
GLE / Morgenstern-Price	0.771



HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

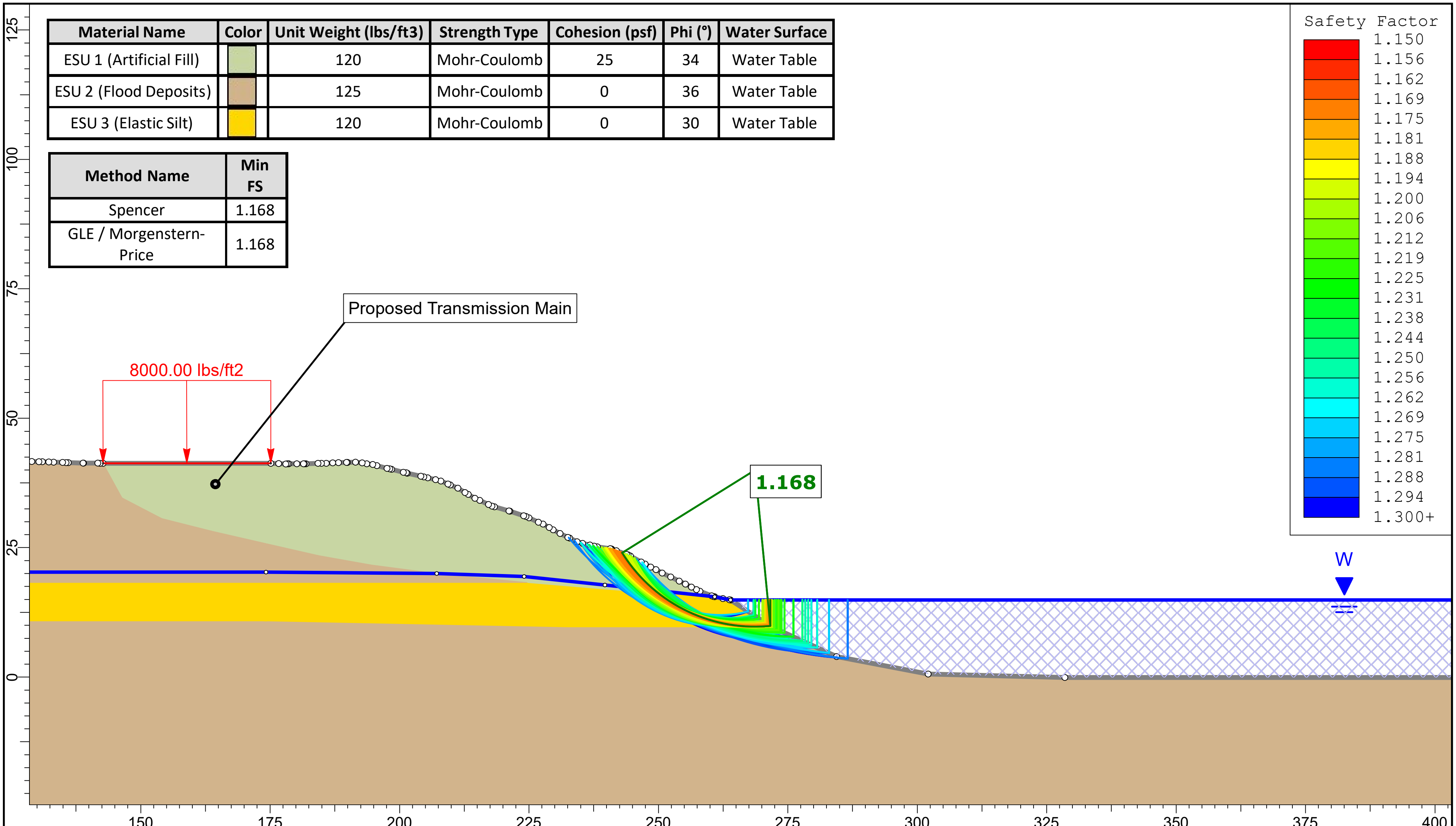
SLOPE STABILITY ANALYSIS
SECTION A-A'
SEISMIC CONDITION

SCALE: AS SHOWN
APRIL 2024

FIGURE C2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface
ESU 1 (Artificial Fill)		120	Mohr-Coulomb	25	34	Water Table
ESU 2 (Flood Deposits)		125	Mohr-Coulomb	0	36	Water Table
ESU 3 (Elastic Silt)		120	Mohr-Coulomb	0	30	Water Table

Method Name	Min FS
Spencer	1.168
GLE / Morgenstern-Price	1.168



HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

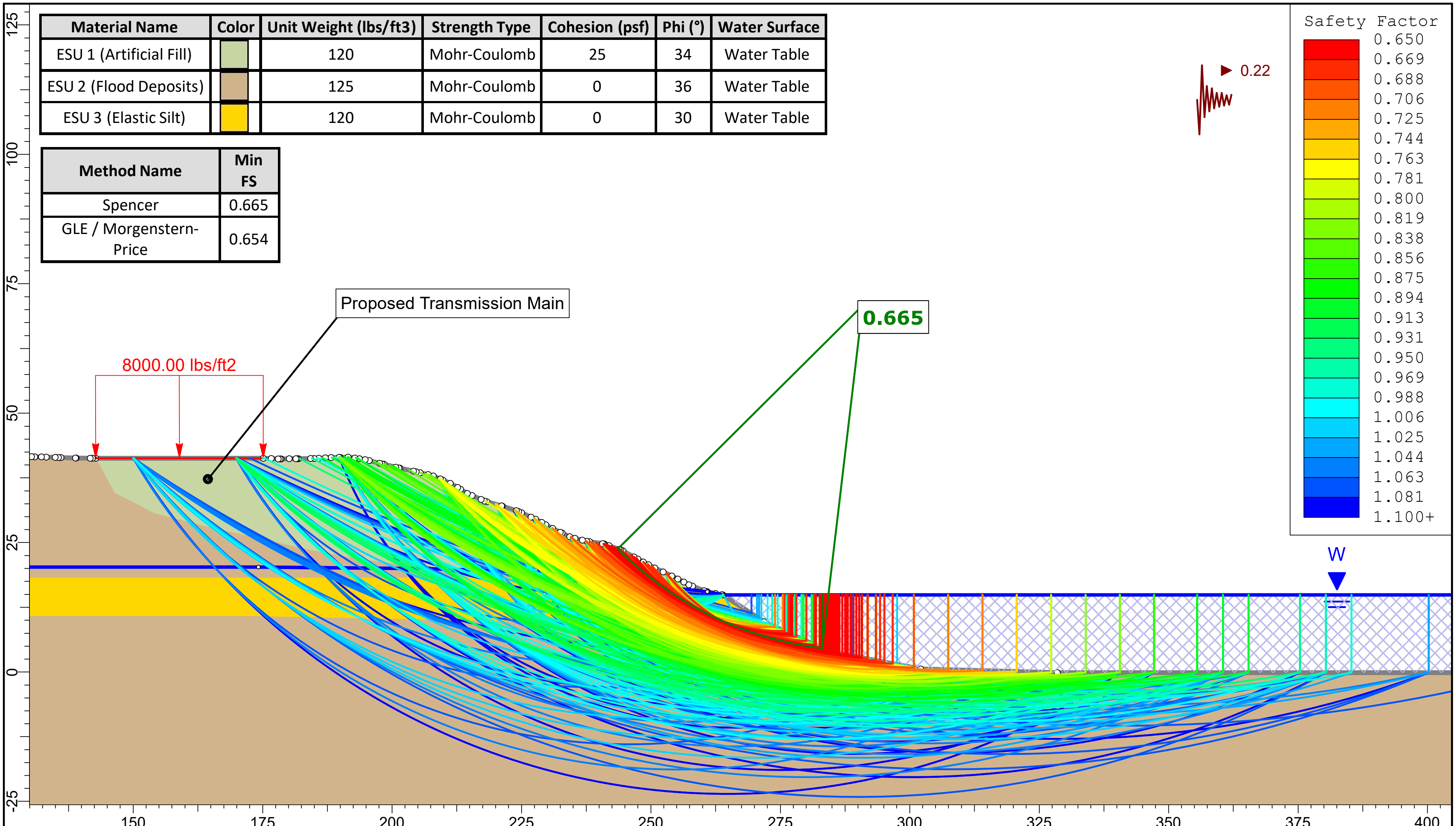
SLOPE STABILITY ANALYSIS
SECTION B-B'
STATIC CONDITION

SCALE: AS SHOWN
APRIL 2024

FIGURE C3

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (°)	Water Surface
ESU 1 (Artificial Fill)		120	Mohr-Coulomb	25	34	Water Table
ESU 2 (Flood Deposits)		125	Mohr-Coulomb	0	36	Water Table
ESU 3 (Elastic Silt)		120	Mohr-Coulomb	0	30	Water Table

Method Name	Min FS
Spencer	0.665
GLE / Morgenstern-Price	0.654



HALEY ALDRICH

CAMAS WELL 6-14 TRANSMISSION MAIN
1620 SE 6TH AVENUE
CAMAS, WASHINGTON

SLOPE STABILITY ANALYSIS
SECTION B-B'
STATIC CONDITION

SCALE: AS SHOWN
APRIL 2024

FIGURE C4

APPENDIX D
Historical Photos

1615 SE 6th Ave

1615 SE 6th Ave

Camas, WA 98607

Inquiry Number: 7479445.1

October 25, 2023

The EDR Aerial Photo Decade Package

EDR®

6 Armstrong Road, 4th floor
Shelton, CT 06484
Toll Free: 800.352.0050
www.edrnet.com

EDR Aerial Photo Decade Package

10/25/23

Site Name:

1615 SE 6th Ave
1615 SE 6th Ave
Camas, WA 98607
EDR Inquiry # 7479445.1

Client Name:

Haley & Aldrich, Inc
6420 S Macadam Avenue, Suite 100
Portland, OR 97239
Contact: Tyler Slothower

Environmental Data Resources, Inc. (EDR) Aerial Photo Decade Package is a screening tool designed to assist environmental professionals in evaluating potential liability on a target property resulting from past activities. EDR's professional researchers provide digitally reproduced historical aerial photographs, and when available, provide one photo per decade.

Search Results:

Year	*Scale*	*Details*	*Source*
2020	1"=500'	Flight Year: 2020	USDA/NAIP
2017	1"=500'	Flight Year: 2017	USDA/NAIP
2014	1"=500'	Flight Year: 2014	USDA/NAIP
2011	1"=500'	Flight Year: 2011	USDA/NAIP
2006	1"=500'	Flight Year: 2006	USDA/NAIP
2001	1"=500'	Acquisition Date: January 01, 2001	USGS/DOQQ
1998	1"=500'	Flight Date: May 31, 1998	USGS
1993	1"=500'	Flight Date: July 08, 1993	USGS
1990	1"=500'	Acquisition Date: January 01, 1990	USGS/DOQQ
1984	1"=500'	Flight Date: February 04, 1984	USDA
1981	1"=500'	Flight Date: August 06, 1981	USDA
1975	1"=500'	Flight Date: September 19, 1975	USGS
1970	1"=500'	Flight Date: July 08, 1970	USGS
1963	1"=500'	Flight Date: June 17, 1963	USDA
1960	1"=500'	Flight Date: July 18, 1960	USGS
1955	1"=500'	Flight Date: July 22, 1955	USDA
1951	1"=500'	Flight Date: July 27, 1951	USGS
1948	1"=500'	Flight Date: July 24, 1948	USDA
1935	1"=500'	Flight Date: January 01, 1935	ACOE

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INQUIRY #: 7479445.1

YEAR: 2020

= 500'

N

EDR


INQUIRY #: 7479445.1
YEAR: 2017
= 500'
N
EDR

INQUIRY #: 7479445.1

YEAR: 2014

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 2011

= 500'

N

EDR

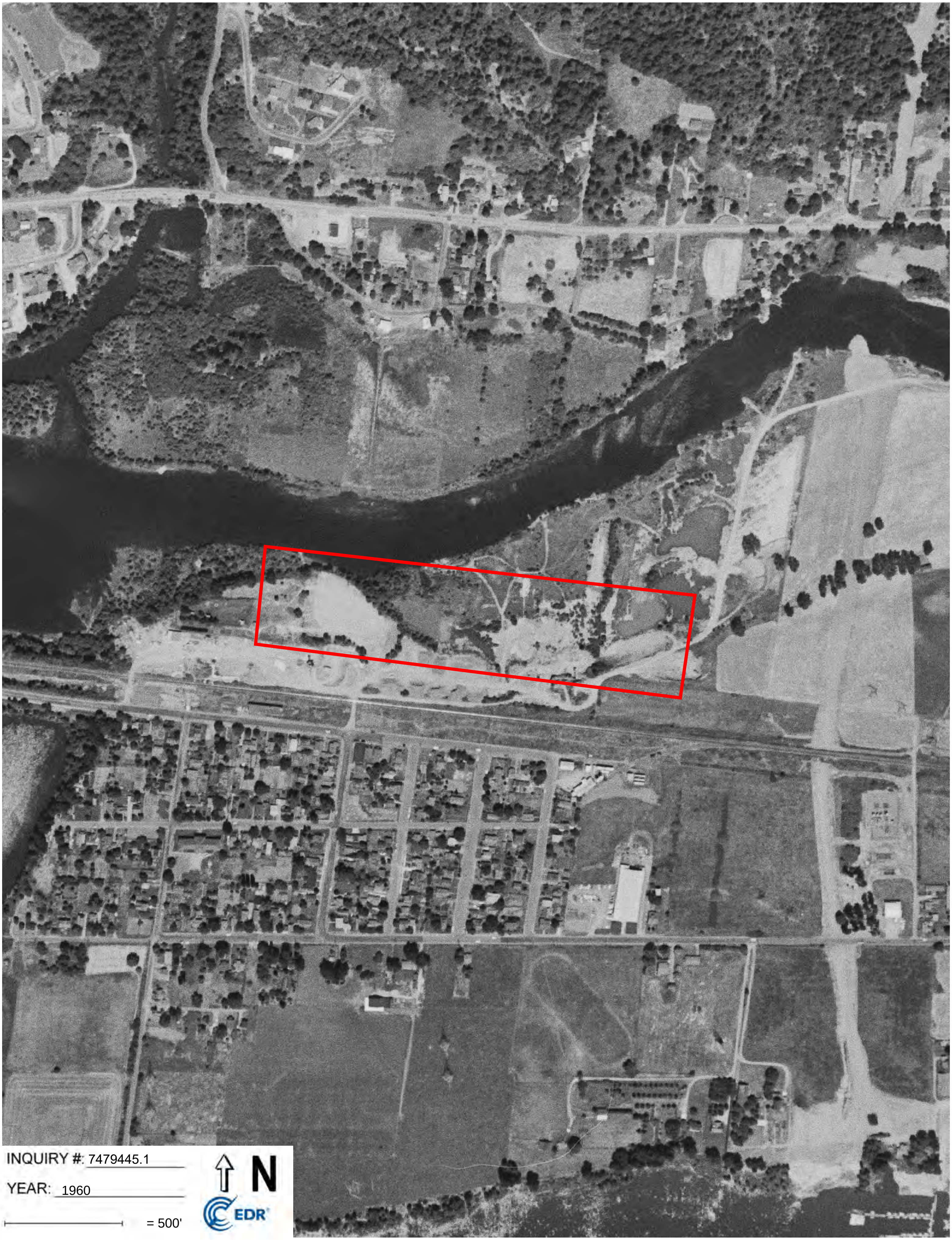
INQUIRY #: 7479445.1

YEAR: 2006

= 500'

N


INQUIRY #: 7479445.1
YEAR: 2001
= 500'
N
EDR



INQUIRY #: 7479445.1

YEAR: 1960

= 500'

N

EDR

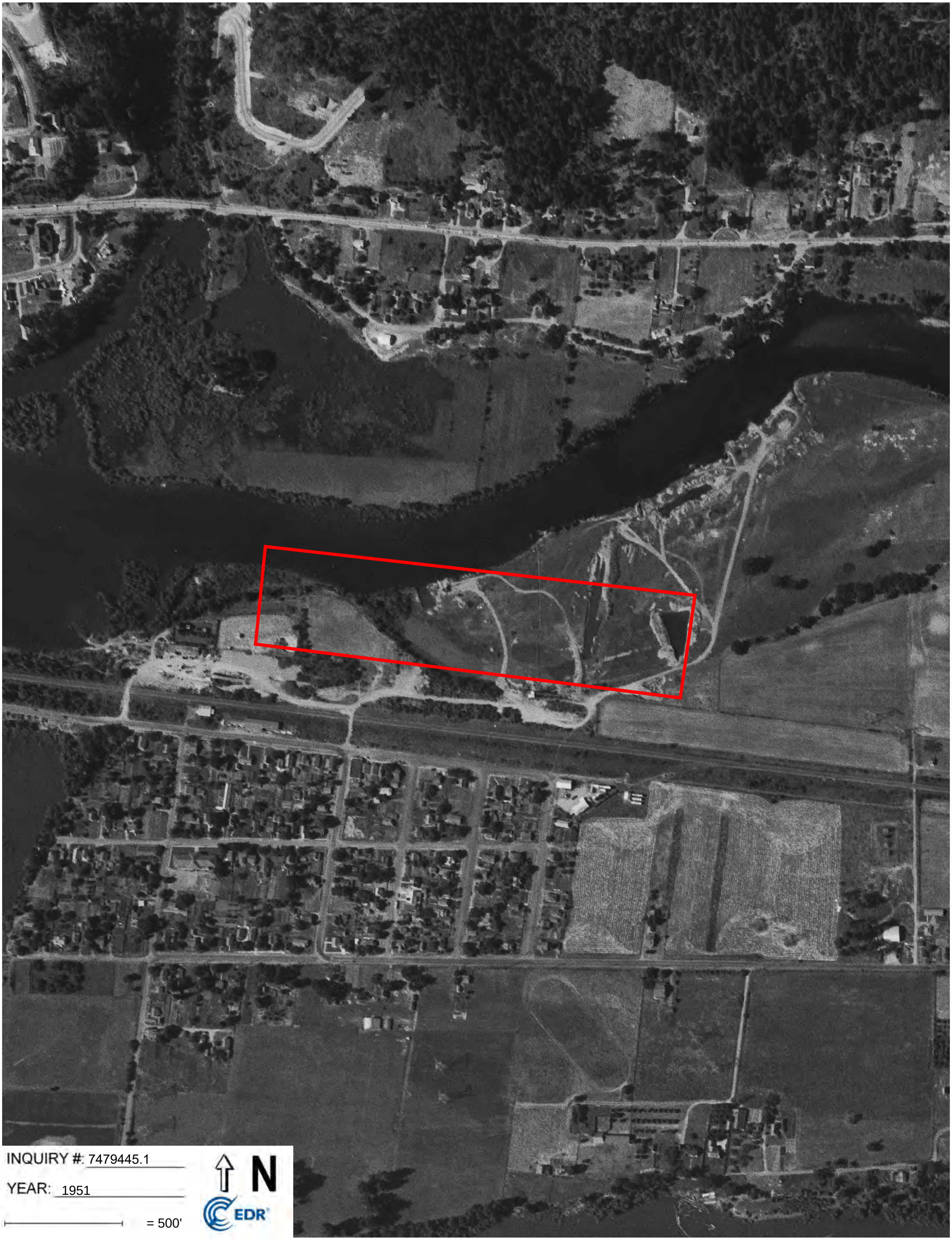
INQUIRY #: 7479445.1

YEAR: 1955

= 500'

N

EDR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YEAR: 1951
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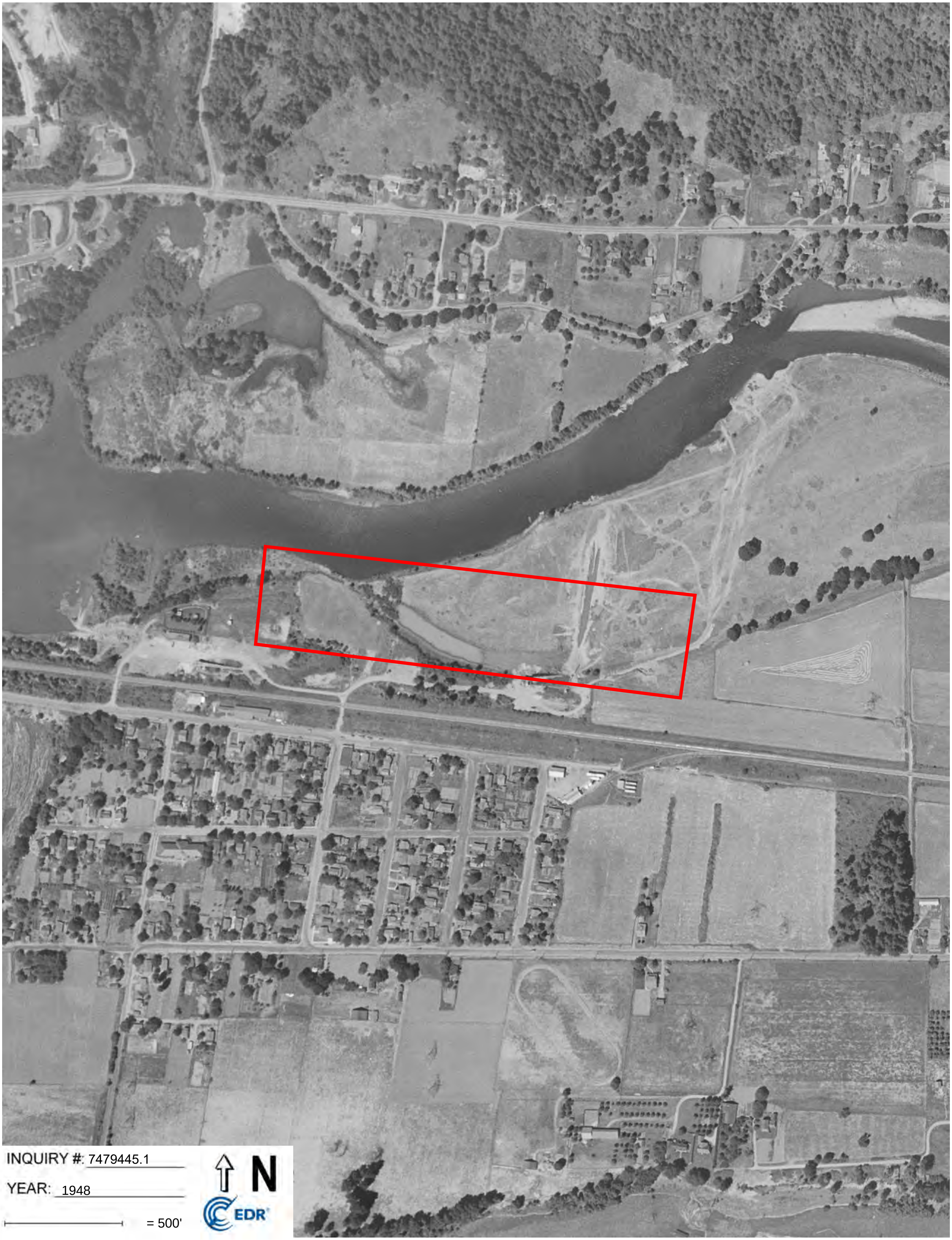
EDR



INQUIRY #: 7479445.1

YEAR: 1948

= 500'

N

INQUIRY #: 7479445.1

YEAR: 1935

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 1998

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 1993

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 1990

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 1984

= 500'

N

EDR

INQUIRY #: 7479445.1

YEAR: 1981

= 500'

N

INQUIRY #: 7479445.1

YEAR: 1975

= 500'

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EDR


INQUIRY #: 7479445.1
YEAR: 1970
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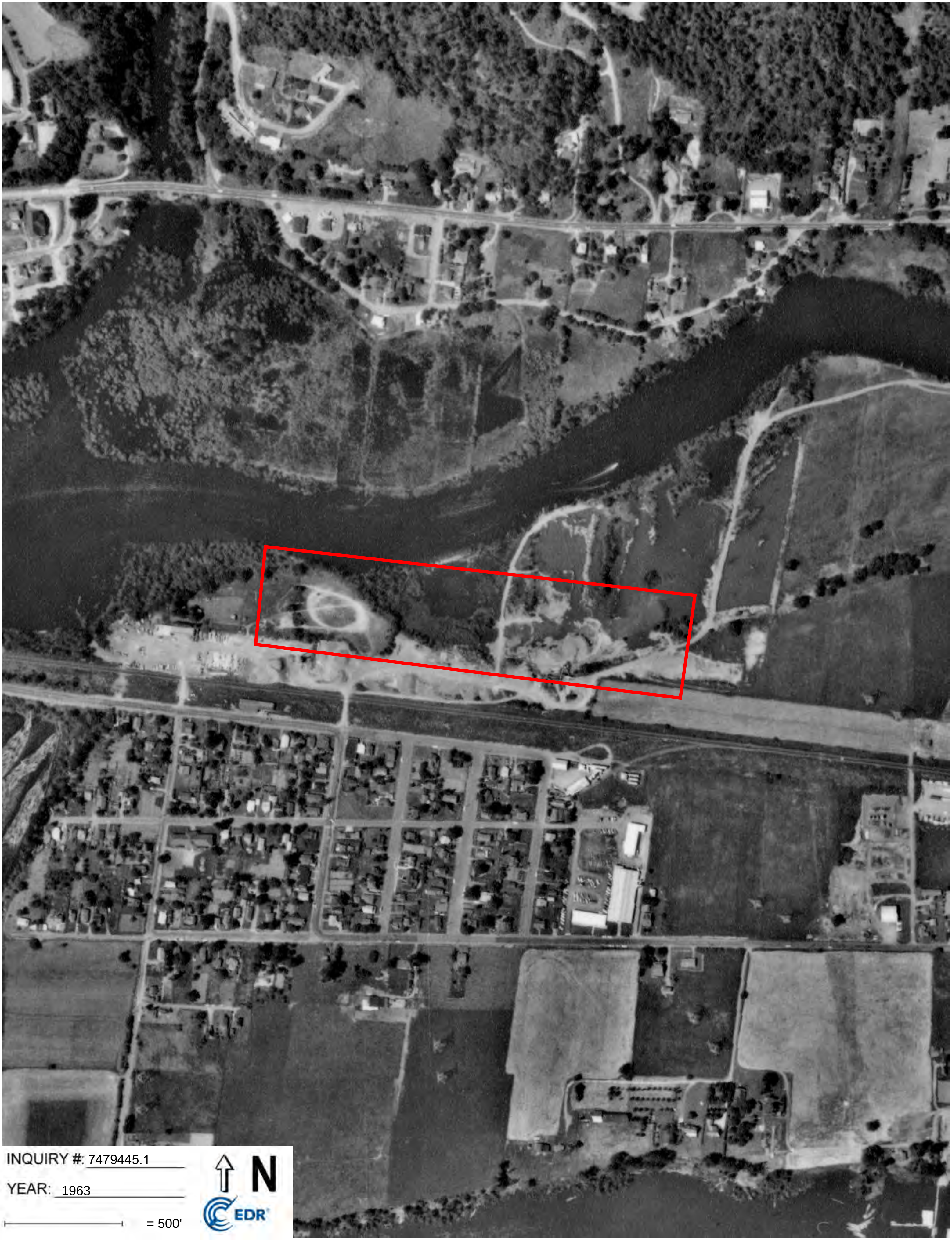

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YEAR: 1963

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EDR