Drainage Report

Avista Bronx Substation

Ponderay, ID

January 19, 2025

Brian Parsons

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Prepared by:

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1.0 Introduction

A new substation is proposed for development by Avista Utilities along Bronx Road. This report serves to document the general drainage design and requirements for this project. The project is located in Ponderay, ID. This report provides drainage design and criteria for the newly construction substation and documents the stormwater design approach, including new drainage features to manage stormwater runoff from the contributing basin. Bronx Road will also be paved from the highway to Craig Ct as part of this project. A separate stormwater report for that scope will be completed by Parametrix.

2.0 Existing Conditions

Existing conditions of the site and surrounding area are detailed in the following sections.

2.1 Geotechnical Conditions

The site is characterized by topsoil overlying silt with interbedded layers of sand underlain by lean clay and a shallow water table. Further analysis of the soils encountered can be found in the geotechnical report.

The geotechnical investigation did not test for infiltration rates because the on-site soils do not support infiltration. The NRCS soils report shows the site consists of mission silt loam which is hydrologic soil group D.

Due to the geotechnical investigation encountering a shallow water table and soils that do not drain well, it will be assumed that there will be no infiltration, and excess stormwater will be controlled through an evaporative pond with an engineered outfall structure and ditch that discharges to the existing drainage path on site.

2.2 Critical Areas

The site is over 100 feet from any critical area buffer area as shown on DNR and County mapping. No known geologic hazards are identified within the project vicinity.

2.3 Jurisdictional Authority

The project is located within the City of Ponderay, ID. Any stormwater facilities addressing flow control and water quality fall under the jurisdictional authority of the City of Ponderay.

2.4 Regional Facilities

No regional facilities exist or are proposed as part of the project.

3.0 Hydrology

3.1 Pre-Construction Conditions

The existing site has two main basins: one to the north of the existing drainage path shown on the basin maps and one to the south. The runoff characteristics of the basin north of the existing drainage path are unaffected by this project and therefore not considered. The basin to the south is roughly 27 acres and is bounded by the existing natural drainage path to the north, a high point on Bronx Road just east of the proposed site, Bronx Road to the south, and Highway 95 to the west. The site primary drains to the west at a gradual slope (approximately 1%) where it eventually flows under the highway through a 24" concrete culvert where it ends up in a mapped freshwater pond adjacent to Sand Creek wetlands.

3.2 Post-Construction Conditions

The developed area within the affected basin with altered drainage characteristics is roughly 12 acres. The project will add approximately 3.4 acres of gravel surface and no more than 5000 sq ft of impervious surface consisting of a new building roof and substation equipment foundations. A rectangular shaped evaporative pond with a pond bottom area of 30,085 sq. ft. will be installed. The pond bottom was treated as impervious in the stormwater calculations.

The proposed pad does not have any significant effect on the natural drainage paths. Excess flow from the gravel substation pad and associated impervious area will be captured entirely by the evaporative pond. The pond will have a culvert outlet 1.5' above the pond bottom to meter the excess flow to a new drainage path that flows into the existing drainage path on site. A berm/ditch will be constructed heading north from the NW corner of the evaporation pond. This berm/ditch will act as a collector and will divert stormwater from Basin B and the evaporation pond discharge around the future service center location into the existing drainage path. All post developed flow is considered NPGIS and will continue to be discharged to the same location as the pre-developed conditions.

4.0 Design Criteria

The stormwater design was done in accordance with the City of Ponderay "Storm Water Management Ordinance". The water budget method was used to design the evaporative pond, and the outfall structure and culvert was sized using the NRCS Curve Number method. Post developed peak flow rates were kept below predeveloped values. More details can be found in the following sections and calculations can be found in appendix C.

4.1 Water Budget Method

The water budget method was used to size the evaporative pond. The corresponding curve numbers and land area for the pre-developed condition are shown in Table 1 below.

Table 1

Pre-Developed Surface Area Characteristics

Basin	Pasture/Field (pervious)	Gravel (pervious)	Roof/Foundations (impervious)	Pond (impervious)	Total Area	Total 1 Year Discharge (ft^3)
Soil Group	D	D	D	D	-	-
CN AMC II	84	91	98	98	-	-
CN AMC III	93	97	99	99	-	-
CN AMC III (Dec-Feb)	95	95	99	99	-	-
A	4.39	0	0	0	4.39	357,039

The curve number and land area data for the post-developed condition can be found in Table 2 below.

Table 2

Post-Developed Surface Area Characteristics

Basin	Pasture/Field (pervious)	Gravel (pervious)	Roof/Foundations (impervious)	Pond (impervious)	Total Area	Total 1 Year Discharge (ft^3)
Soil Group	D	D	D	D	-	-
CN AMC II	84	91	98	98	-	-
CN AMC III	93	97	99	99	-	-
CN AMC III (Dec-Feb)	95	95	99	99	-	-
A	0	3.28	.115	.69+.31	4.39	341,889

Based on this method, a pond with a 30,100 square foot pond bottom area with a 1.5-foot depth is adequate to capture excess stormwater over a 2-year period. The pond was sized to ensure the discharge for the post developed Basin A area does not exceed the predeveloped discharge of the same area. The total discharge for basins B, C and D is unchanged and therefore not included in the analysis. Further details are discussed in the next section on the NRCS methodology used for routing stormwater hydrographs.

4.2 NRCS Method

The NRCS method was used to determine the pre-developed peak flow rates for the basin. This method was also used to determine post developed peak flows for the basins to size the detention cell of the pond and size the outfall structure, and to determine bypass flow from the post developed condition to adjust the outfall structure flow rates to ensure the total bypass flow and flow from the outfall structure does not exceed the pre-developed peak flow rate. All stormwater elements were

sized using the 24-hour storm event with 25-year recurrence intervals. Hydraflow was used to perform these calculations. Output files from Hydraflow that show the peak post developed flowrate does not exceed the predeveloped conditions can be found in Appendix C.

4.3 Down Gradient Analysis

The project has no identified drainage problems nearby and no features that rely on groundwater recharge in the vicinity. The project proposes minimal impervious surfaces and the developed conditions were considered during design. Excess flow and volume will be mitigated by the proposed evaporative pond. There are no anticipated downstream impacts. The water discharged from the evaporative pond and runoff from undeveloped areas of the site will follow a natural wetland path to a freshwater pond on an adjacent, downstream property similar to pre-developed conditions.

4.4 Water Quality Treatment

Water quality evaluation is not required for Non-Pollutant Generating Impervious Surfaces (NPGIS). Although the project proposes a paved approach and gravel pad, the on-site traffic will be limited to only a few vehicle trips per month by Avista crews for routine maintenance and inspection activities. Therefore, the project does not meet the regular use criteria and is considered NPGIS. Water quality treatment is not being proposed for this project. Water discharged from the site will flow to a downstream freshwater pond west of the highway similar to the pre-developed condition.

5.0 Operations and Maintenance

An O&M plan will be developed prior to occupancy that will outline routine maintenance measures required for on-going operation of the proposed pond, culverts and outflow structures.

6.0 Construction Stormwater

The site exceeds 1 acre and construction stormwater has the potential to discharge into Sand Creek wetlands to the west of the site. Therefore, an Idaho Pollutant Discharge Elimination System (IPDES) storm water permit is required.

7.0 Summary

The project stormwater facilities are designed in accordance with the standards set forth by the City of Ponderay, Idaho. Stormwater from the proposed site will be managed using an evaporative pond and an outfall structure. Runoff generated from the developed area will drain to the evaporative pond located directly west of the substation. The outfall structure is designed to release post-developed flow from the 25-year storm event toward its natural drainage path. Ditches and culverts installed for conveyance are also designed for the 25-year storm event. The new graded pad is NPGIS, so there is no treatment requirement for this project. The post developed peak runoff rate for the 25-year storm event is less than the predeveloped peak runoff rates.

APPENDIX A

GEOTECHNICAL REPORT

August 29, 2025

Avista Corporation
1411 East Mission Avenue, MSC-024
Spokane, Washington 99202

Attention: Ms. Adorah Lester (O'Brien)

RE: Geotechnical Evaluation Report
Ponderay Avista Substation
West of 237 East Bronx Road
Ponderay, Idaho
ALLWEST Project No. 225-181G

Ms. Lester (O'Brien)

ALLWEST has completed the authorized Geotechnical Evaluation Report for the Ponderay Avista Substation project located at West of 237 East Bronx Road in Ponderay, Idaho. The purpose of this evaluation was to characterize the soil and geologic conditions on the property and prepare the attached report with the results of the field evaluation and our geotechnical recommendations to assist with design and construction of the proposed project. Based on our evaluation, the site is suitable for the planned development.

We appreciate the opportunity to work with you on this project. If you have any questions or need additional information, please call us at 509.534.4411.

Sincerely,
ALLWEST

Kenneth Rukavina, G.I.T.
Project Geologist

Scott M. Fraser, P.E. (WA, ID, OR)
Spokane Area Manager

GEOTECHNICAL EVALUATION REPORT

PONDERAY AVISTA SUBSTATION
WEST OF 237 EAST BRONX ROAD
PONDERAY, IDAHO
PROJECT NO. 225-181G

August 29, 2025

Prepared for:
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1411 EAST MISSION AVENUE, MSC-024
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1.0 EXECUTIVE SUMMARY

ALLWEST has completed the authorized geotechnical evaluation for the Ponderay Avista Substation project located at West of 237 East Bronx Road in Ponderay, Idaho. The purpose of this evaluation was to assess the subsurface conditions on the project site with respect to the planned development. Our services were provided in accordance with our proposal no. 225-181G dated June 13, 2025.

The site is suitable for the proposed construction provided the recommendations in this report are followed and the associated risks are acceptable to the owner. Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support and is required by the International Building Code. If we are not retained to provide required construction observation and materials testing services, we cannot be responsible for soil engineering related construction errors or omissions.

The following geotechnical considerations were identified:

- The topsoil and native soil encountered are unsuitable for use as structural fill.
- An allowable bearing pressure of 1,500 pounds per square foot (psf) can be used for shallow footings bearing on structural fill overlying properly prepared subgrade.
- If the owner decides to reduce the potential for liquefaction induced settlement, we recommend Stone Aggregate Columns (SAC) elements be installed to depths of 22 to 25 feet below shallow foundations.
- For Parking Stalls and Drive Lanes: A pavement section of 3-inches hot mix asphalt over a minimum of 8-inches crushed aggregate base is recommended. A gravel section of 14-inches of aggregate base is recommended for just gravel pavement and drive lanes.
- We recommend a permanent foundation drainage system be designed and constructed around the perimeter of structures where groundwater will be within 2 feet of bottom of foundations.
- Due to the shallow depth to limiting layers, high fines content of native soils at depth, and shallow groundwater, we do not recommend stormwater be disposed of in drywells or gravel galleries.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. Section *8.0 EVALUATION LIMITATIONS* should be read for an understanding of the report limitations.

2.0 PROJECT DOCUMENTS

ALLWEST was not provided with site plans or project documents prior to finalizing this report, however, description of the proposed construction was provided to ALLWEST by Avista Corporation.

3.0 PROJECT DESCRIPTION

We understand a new substation and a small storage building are planned at the above-referenced location. We assume the storage building and equipment for the substation will be bearing on concrete spread footings or reinforced concrete slabs. Associated asphalt parking lots, stormwater disposal facilities, and other associated infrastructure will also be constructed as part of the development. For purposes of preparing this report, we have assumed maximum continuous loads of 3 kips per lineal foot and equipment loads of 150 kips for reinforced concrete slabs. If the proposed design or loads vary from those stated, we should be notified to review our recommendations and provide additional or revised information, as necessary.

4.0 SITE CONDITIONS

The project site is comprised of an undeveloped lot, approximately 20.1 acres in total size. Topographically, the property does not contain geotechnically significant slopes. The ground coverage consists of mostly grass and soil. The project site is currently being utilized for cattle grazing. The general location of the project site is shown on Figure A-1 – Vicinity Map in Appendix A.

4.1 Subsurface Conditions

4.1.1 Published Subsurface Conditions

The geologic conditions in the vicinity of the subject property are mapped as glaciolacustrine deposits (Pleistocene to Holocene), which is described as massive to finely laminated clay, silt, and sand deposited in ice marginal and post glacial lakes in the Purcell Trench. This is described on the “Geologic Map of the Sandpoint Quadrangle, Bonner County, Idaho”, by Reed S. Lewis, Russel F. Burmester, Roy M. Breckenridge, Stephen E. Box, and Mark D. McFaddan, 2006.

The USDA Natural Resources Conservation Service (NRCS) has mapped the soils on and around the property as Mission silt loam, 0 to 2 percent slopes, which is described as poorly drained volcanic ash and loess over silty glaciolacustrine deposits. The typical soil profile is slightly decomposed plant material overlying silt loam overlying silt overlying silt loam overlying fine sand.

4.1.2 Subsurface Exploration Program

We observed the drilling of three borings and the excavation of five test pits at the site on July 16, 2025. The borings were drilled with a track mounted Acker Rebel drill rig equipped with hollow-

stem augers and an automatic hammer. The test pits were excavated with a Deere mini track-mounted excavator. The approximate locations of the borings and test pits are shown on Figure A-2, Exploration Location Map in Appendix A. The subsurface profiles and soil conditions observed in the borings and test pits were visually described and classified in general accordance with ASTM D 2487.

Split spoon samplers having an outside diameter of 2 inches (standard split spoon) were driven into the various subsurface materials from the bottom of a borehole using a 140-pound hammer falling 30 inches (ASTM International (ASTM) Method D 1586). The number of blows required for the sampler to penetrate each 6-inch increment to a total depth of up to 18 inches is recorded. The sum of the number of blows required for the second and third 6-inch increments of penetration is termed the "standard penetration resistance" or "N-value". In cases where 50 blows are insufficient to advance through a 6-inch interval, the penetration after 50 blows is recorded and the test concluded. The N-value provides an indication of the relative density or consistency of the subsurface materials.

Relatively undisturbed subsurface samples of fine-grained soils were obtained from select locations by hydraulically pushing 3-inch outside diameter thin-walled Shelby tube samplers in borings. Disturbed grab and bulk samples representative of soil conditions from select locations were obtained from hollow-stem auger cuttings returned to the surface.

4.1.3 Soil Characterization

Detailed descriptions of the soil observed within the explorations are presented on individual exploration logs in Appendix B of this report. The descriptive soil terms used on the exploration logs, and in this report, can be referenced from the Soil Classification Chart based on the *United Soil Classification System (USCS)* included in Appendix B. The subsurface conditions may vary between exploration locations; such changes in subsurface conditions may not be apparent until construction.

The near surface geologic profile appears to consist of topsoil overlying silt with interbedded layers of sand underlain by lean clay. General descriptions of the observed soil units follow:

Topsoil – Topsoil was observed in all our explorations. The topsoil on site is comprised of soft sandy silt. The topsoil layer was observed to be approximately 1.5 feet in thickness.

Silt – Underlying the topsoil we observed soft to medium stiff silt. The silt contained varying amounts of sand.

Sand – We observed interbedded layers of sand. The sand contained varying amounts of silt content.

Lean Clay – Underlying the silt and sand we observed very soft lean clay to depth.

4.1.4 Groundwater Conditions

Groundwater was observed at approximately 6 to 9 feet below the existing ground surface. We did not observe surface water on the property during our evaluation. Changes in precipitation, irrigation, construction, or other factors may impact depth to groundwater and the surface water flow on the property and therefore, conditions may be different during construction.

5.0 LABORATORY TESTING

We performed laboratory testing to supplement field classifications and to assess some of the soil engineering properties and parameters. The laboratory testing included are presented in *Table 1*. The laboratory test results, included in Appendix C of this report. Some results are also summarized on the exploration logs attached to this report in Appendix B.

Table 1 - Laboratory Tests Performed

Test Performed	Information Acquired
Particle-size Distribution (ASTM D 6913)	Size and distribution of soil particles (i.e., gravel, sand, and silt/clay) of a particular sample.
Atterberg Limits (ASTM D 4318)	Effects of varying water content on the consistency of fine-grained soils present in a particular sample.
pH (ASTM G 51)	This test method covers a procedure for determining the pH of a soil in corrosion testing.
Water Soluble Sulfates (EPA 300)	This test method covers the determination of inorganic anions by ion chromatography.
#200 Wash (ASTM C117)	Determines the amount of soil particles (silt/clay) that pass through the #200 sieve.
Moisture Content (ASTM D2216)	Determines moisture content of the in-situ soil.

Chemical Analysis

Factors which contribute to soil corrosion of buried metal structures include soil resistivity, pH, presence of water and oxygen, and soluble salts. Soil minimum resistivity and pH are typically regarded as the primary indicators of soil corrosion potential. In general, fine-grained soils (silt and clay) have lower resistivity and present a greater potential for corrosion. With an increase in soil moisture content, resistivity generally decreases, and corrosion potential generally increases. Soils with low pH and relatively high resistivity are also corrosive.

Generalized effects of soil resistivity and pH with respect to corrosion potential are summarized in *Table 2*, based on information available from the National Association of Corrosion Engineers (NACE).

Table 2 - Generalized Correlation Between Soil pH and Corrosivity

Soil pH	Soil Corrosivity
>7.5	Essentially non-corrosive (alkaline)
6.5 – 7.5	Neutral
5.5 – 6.5	Moderately corrosive
<5.5	Extremely corrosive

ALLWEST performed pH testing on soil obtained from test pit TP-1 at 2 feet below ground surface. Test results of the silt soil resulted in a pH of 6.56 which suggest the on-site soil has the potential to exhibit neutral corrosive behavior to buried metal in contact with them. A licensed engineer experienced with corrosion should be consulted to determine appropriate protection measures. Where possible, it is recommended that non-corrosive materials be used in lieu of metal conduits, and ductile iron pipe (if used) be encased with polyethylene tubing.

Durability requirements for concrete in contact with water or soil that contains sulfate ions which can solute in water are summarized in Table 3, based on information available from ACI 318. The degree of severity of concrete exposure to sulfate attack is characterized by the following four exposure classes.

Table 3 - Cement Restrictions Based on Water Soluble Sulfate Content in Soil

Exposure Class	Water Soluble Sulfate (SO_4^{2-}) in water, ppm	Maximum Water / Cement Ratio	ASTM C150 Cement Type
S0	$SO_4^{2-} < 150$	N/A	No type restriction
S1	$150 \leq SO_4^{2-} < 1,500$	0.50	II
S2	$1,500 \leq SO_4^{2-} < 10,000$	0.45	V
S3	$SO_4^{2-} > 10,000$	0.45	V plus pozzolan or slag

The test results indicate a sulfate content of 30.8 ppm. The test results indicate a low exposure to sulfate attack in normal strength concrete exposed to these materials. Based on the test results, Exposure Category S0 (ACI 318) may be specified for concrete in direct contact with on-site soils.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Our understanding of the proposed project and surface and subsurface site conditions were presented in the previous sections of this report. The following conclusions and recommendations are based on this understanding. If the proposed development changes or if unforeseen conditions are encountered, we must be given the opportunity to review the new information and, if necessary, update our recommendations. Additionally, we should be given the opportunity to

review the plans and specifications to determine whether the recommendations presented in this report were properly incorporated.

6.1 Site Preparation

Clearing and Stripping: Once temporary erosion and sediment control (TESC) measures are installed, we expect site preparation to continue with clearing and grubbing brush and stripping of organic-rich topsoil. Based on our explorations, the observed topsoil thickness is estimated to be approximately 18 inches. Clearing and stripping debris should be wasted off-site or used for topsoil within non-structural/landscape areas.

Test Pit Remediation: Test pit excavations were loosely backfilled with the excavated material following completion. To reduce the potential for future settlement or subsurface disturbance, we recommend that test pit backfill be over-excavated in its entirety below pavements and structures and backfilled in properly compacted lifts. The approximate test pit locations are indicated on Figure A-2 of this report, and the test pit depths are included on the test pit logs included in Appendix B of this report.

Subgrade Preparation: ALLWEST defines the subgrade as the native soil exposed at the base of excavation prior to placement of fill or concrete. The subgrade requires an evaluation by the geotechnical engineer of record or staff under their supervision to confirm the site conditions are consistent with those observed during our geotechnical evaluation. The subgrade should be moisture conditioned to within two percentage points of the optimum moisture content for compaction. The subgrade should then be compacted to a firm and unyielding condition.

In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, we recommend that the materials be removed to a sufficient depth to develop stable subgrade soil that can be compacted to the minimum recommended levels. The severity of construction problems will be dependent, in part, on the precautions that are taken by the contractor to protect the subgrade soil.

Subgrade Stabilization: In the event the exposed subgrade becomes unstable, yielding, or unable to be compacted due to high moisture conditions or construction traffic, we recommend that the materials be removed to a sufficient depth to develop stable subgrade soil. ALLWEST should be consulted to provide cost-effective recommendations to achieve a stable subgrade. The following paragraphs describe some of the typical methods used.

The subgrade may be stabilized using either fractured, angular cobble or with geosynthetics in conjunction with imported structural fill. The required thickness of crushed cobble or structural fill (used in conjunction with geosynthetic reinforcement) will depend on the construction traffic loads which are unknown at the time of this report. Therefore, a certain degree of trial and error may be needed to verify the recommended stabilization section thicknesses.

If fractured, angular cobble is selected to stabilize the subgrade, it should have a maximum particle size of 8 inches and should be relatively free of sand, silt, and clay. The first layer of cobble should be placed in a minimum 24-inch-thick loose lift and trafficked with tracked-construction and vibratory drum compaction equipment until it is observed to densify. If vibratory compaction destabilizes the subgrade, it should be discontinued. If the cobble is placed in a confined excavation, it should be mechanically densified from outside the excavation with vibratory compaction equipment.

If geosynthetic reinforcement is selected, it should consist of Tensar NX750, BX 1200, or Mirafi Rs380i, or approved equivalent. Alternatives should be approved by the geotechnical engineer prior to use on site. The following recommendations are provided for subgrade stabilization using geosynthetic reinforcement.

- Geosynthetic reinforcement materials should be placed on a properly prepared subgrade with a smooth surface. Loose and disturbed soil should be removed prior to placement of geosynthetic reinforcement materials.

- A non-woven geotextile filter fabric, such as Mirafi 140N, or approved equivalent, should be placed on the properly prepared subgrade. The geosynthetic reinforcement should be placed on the filter fabric. The filter fabric and geosynthetic reinforcement should be unrolled in the primary direction of fill placement and should be over-lapped at least 3 feet. The geosynthetic materials should be pulled taut to remove slack and pinned in place. If the material does not remain taut during fill placement, its effectiveness will be reduced.

- Construction equipment should not be operated directly on the geosynthetic materials. Fill should be placed from outside the excavation to create a pad on which equipment may be operated. We recommend a minimum of 12 inches of structural fill be placed over the geosynthetic reinforcement before operating construction equipment on the fill. Low pressure, track-mounted equipment should be used to place fill over the geosynthetic reinforcement.

- Fill placed directly over the geosynthetic reinforcement should be properly moisture conditioned prior to placement and should meet the following gradation presented in *Table 4*.

Table 4 - Structural Fill Recommendations for Use in Conjunction with Geosynthetic Reinforcement

Sieve Size	Percent Passing
1 ½ inch	100
¾ inch	50 – 100
#4	25 – 50
#40	10 – 20
#100	5 – 15
#200	≤ 10

- The fill material should be properly compacted. Care should be taken with the use of vibratory compaction equipment. Vibration should be discontinued if it reduces the subgrade stability.

6.2 Temporary Excavation and Trenching

Based on the conditions observed within our explorations, we anticipate excavation of the on-site soil can be achieved with typical excavation equipment. Temporary excavation slope stability is a function of many factors, including:

- The presence and abundance of groundwater.
- The type and density of the various soil strata.
- The depth of cut.
- Surcharge loadings adjacent to the excavation.
- The length of time the excavation remains open.

It is exceedingly difficult under the variable circumstances to pre-establish a safe and "maintenance-free" temporary cut slope angle. Therefore, it is the responsibility of the contractor to maintain safe temporary slope configurations since the contractor is continuously at the job site, able to observe the nature and condition of the cut slopes, and able to monitor the subsurface materials and groundwater conditions encountered. Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. The cuts should be adequately sloped, shored, or supported to prevent injury to personnel from local sloughing and spalling. The excavation should conform to applicable federal, state, and local regulations. Regarding trench wall support, the site soil is considered Type C soil according to OSHA guidelines and therefore should not exceed a 1.5H:1V (horizontal to vertical) temporary slope.

6.3 Materials

The topsoil and native soil encountered are unsuitable for use as structural fill.

Import materials should consist of granular soil, free of organics, debris, and other deleterious material and meet the following criteria. Import materials should be approved by the geotechnical

engineer prior to delivery to the site. Our recommended gradational requirements for imported soil are presented in *Table 5* .

Table 5 – Imported Soil and Aggregate Recommendations.

Fill Type	Criteria
Structural Fill	Maximum size ≤ 3 inches Retained on ¾-inch sieve <30% Passing No. 200 Sieve ≤ 10% Non-plastic
Utility-Trench Backfill	Maximum size ≤ 2 inches Passing No. 200 Sieve ≤ 15% Non-plastic
Top or Base Course	Idaho Transportation Department (ITD) ¾-inch Type B Base Course Standard Specification 703.04

6.4 Fill Placement and Compaction

Fill should be placed in lift thicknesses which are appropriate for the compaction equipment used. Typically, eight-inch loose lifts are appropriate for typical rubber tire and steel drum compaction equipment. Lift thickness should be reduced to four inches for hand operated compaction equipment. Fill should be moisture conditioned to within two percentage points of the optimum moisture content prior to placement to facilitate compaction. Structural fill and utility trench backfill should be compacted to a minimum of 95 percent of the maximum dry density determined by ASTM D1557 (modified Proctor).

Fill materials which are too coarse to establish a relevant moisture-density relationship curve (Proctor) and associated density test results with a nuclear densometer in accordance with ASTM methodology (greater than 30 percent retained on a ¾-inch sieve), a method-based compaction specification should be established in accordance with ASTM D1557. The compaction method should be established by making repeated passes with appropriately sized compaction equipment over the subgrade with appropriate soil moisture conditioning until a dense and unyielding surface is achieved. For areas where a large compactor cannot access, a walk-behind articulating trench roller or heavy plate compactor may be used if approved by the geotechnical engineer. Where appropriate, a Proctor should be performed to assist in evaluating appropriate moisture and density conditions of the method-based compaction procedures. Success in executing proper compaction control is highly dependent upon the quality and experience of the contractor and inspector.

6.5 Wet Weather Construction

Due to the climatic effects in this region during late fall, winter, and spring (generally wet conditions), we recommend construction (especially site grading) take place during the summer and early fall season, if possible. If construction occurs during or immediately after excessive precipitation, it may be necessary to over-excavate and replace wet subgrade soil which might otherwise be suitable. If construction is undertaken in wet periods of the year, it will be important to slope the ground surface to provide drainage away from construction.

6.6 Cold Weather Construction

Foundations should be embedded adequately to protect against frost action as recommended in section *6.7 Foundation Recommendations* of this report. We recommend removal of frost susceptible soil (soil with fines contents greater than 10 percent) within the frost-depth zone below concrete flatwork (sidewalks, patios, etc.) to reduce the potential detrimental effects of frost heave.

If site grading and construction are anticipated during cold weather, we recommend good winter construction practices be observed. Snow and ice should be removed from all fill placement surfaces prior to additional earthwork or construction. Footings, floor slabs or structural portions of the construction should not be placed on frozen ground; nor should the supporting soil for buildings be permitted to freeze during or after construction. Frozen soil should not be used as fill.

6.7 Foundation Recommendations

The following recommendations are provided for foundations based on the subsurface conditions observed, the stated assumptions and associated risks are acceptable:

- Shallow foundations and reinforced concrete equipment pads bearing on two feet of structural fill over undisturbed native silt may be designed for an allowable bearing pressure of 1,500 pounds per square foot (psf) if properly prepared. The allowable bearing pressure value may be increased by one-third to account for transient loads such as wind and seismic.

- Unless specified by project engineer or governing codes, continuous footings should be a minimum of 18 inches in width and column footings should be a minimum of 24 inches in width.

- An ultimate value for coefficient of friction between cast-in-place concrete and native silt of 0.30 may be used for design.

- Foundation bearing surfaces should be free of loose soil and debris.

- Footings should be embedded at least 24 inches below finished exterior ground surface to help protect against frost action.

- We recommend backfill placed adjacent to foundation walls be brought up uniformly on both sides of the foundation walls to reduce displacement of the foundation walls.

- If shallow foundations are constructed on native silt the anticipated total settlement will be less than one inch and differential settlement will be less than ½-inch in a 30-foot span. However, liquefaction induced settlement may induce up to 4.8-inches of additional settlement.

- Steel reinforcement for reinforced concrete equipment pads should be designed by the structural engineer using a modulus of subgrade reaction of 120 pounds per cubic inch (pci).

- We recommend a permanent foundation drainage system be designed and constructed around the perimeter of the structure. The drainage system should consist of a four-inch diameter, Schedule 40 or ADS, perforated pipe surrounded with a free draining aggregate. The pipe should be located at the lowest elevation of the footing trench excavation such that gravity drainage may be achieved. Water collected in the drains should be discharged down-gradient of the structure.

Shallow Foundations Supported on Stone Column Elements

If the owner chooses to mitigate the additional liquefaction induced settlement, we recommend supporting the proposed structure on shallow foundations underlain by soil improved with stone column elements.

Based on conversations with Geopier, we recommend that stone column systems be installed using a displacement method. Displacement methods are ideal for caving soils and/or environmentally impacted soils and are constructed by driving a 12-inch to 20-inch hollow mandrel into the ground and then feeding aggregate through the bottom of the mandrel to construct the pier. The displacement mandrel provides temporary casing during installation, which prevents the caving soils from contaminating the pier.

For the proposed substation, we anticipate the stone columns will extend to depths in the range of 22 to 25 feet below existing ground surface to reinforce the liquefiable soil observed at the project site. Based on preliminary discussions with the Geopier team, the footings can be designed for an allowable bearing pressure of 3,000 psf. This design bearing pressure can be increased by one-third for transient loading conditions such as wind or seismic loads. The final design for the stone aggregate columns solution should be performed by Geopier or other licensed professional engineer and reviewed by the project team to confirm the design meets the settlement criteria for the proposed substation.

6.8 Concrete Slabs-on-Grade

Concrete slabs-on-grade should be underlain by at least 12 inches of crushed base course. The crushed base course below the slabs should be compacted to at least 95 percent of the maximum dry density established by modified Proctor (ASTM D 1557). The slab subgrade should be

prepared as previously recommended. The above recommendations are intended for site walks and concrete aprons and should not be implemented for the reinforced concrete equipment pads.

6.9 Lateral Earth Pressures

Below-grade building walls should be designed to resist lateral earth pressures. Recommended equivalent fluid pressures for on-site soil and structural fill for calculation of lateral earth pressures are presented in *Table 6*. These pressures are only applicable for cases where the ground surface around the structure is relatively flat or sloping away and do not account for hydrostatic forces.

Table 6 – Equivalent Fluid Pressures for On-Site Soil and Structural fill.

Condition	Equivalent Fluid Pressure On-Site Soil (pcf)	Equivalent Fluid Pressure Structural Fill (pcf)
At-rest	54	55
Active	36	35
Passive	200	350

Walls should be provided with adequate drainage so hydrostatic forces do not adversely affect the walls. We recommend placement of gravel behind walls and/or weep holes to assist with drainage and reduce the potential for the buildup of hydrostatic pressures. Walls that are braced in a manner that does not allow any rotational movement (rigid) (e.g., basement walls) should be designed using the given “at-rest” equivalent fluid pressure. The active and at-rest pressures should be increased by an equivalent fluid weight of 16 pounds per cubic foot (pcf) and the passive pressure should be reduced by 16 pcf for seismic design. The dynamic component of the active pressure acts at a height of approximately 0.6 times the height of the wall.

6.10 Permanent Slopes

We recommend that all permanent cut or fill slopes constructed in native soil be designed at a 2H:1V inclination or flatter. All permanent cut and fill slopes should be adequately protected from erosion both temporarily and permanently. Prior to construction ALLWEST should be provided a copy of the final grading plan to determine whether the proposed site grading will affect the recommendations provided in this report.

6.11 Liquefaction Analysis

Liquefaction Potential

Liquefaction is a failure that occurs when cyclic shaking or vibrations—typically from seismic events—generate excess pore-water pressures, leading to a loss of shear strength in susceptible soil layers. This hazard is most common in loose, saturated sandy soils at or near the groundwater table.

Subsurface conditions observed at the project site included saturated sand layers at depths of approximately 7.5 to 10 feet, and between 20 to 25 feet below the existing ground surface. Groundwater was observed across the project site, at 6-to 9-feet below the existing ground surface. Liquefaction potential is typically evaluated based on either SPT $N_{1(60)}$ or Cone Penetrometer Testing (CPT). ALLWEST evaluated the liquefaction potential using $N_{1(60)}$ which is the SPT blow count after accounting for overburden pressure and hammer efficiency. We do not have a record of the hammer efficiency calibration data for the SPT hammer used for the original evaluation. Based on the soil conditions encountered in our borings, laboratory testing, and subsequent engineering analyses, we estimate that seismically induced liquefaction settlement potential is moderate.

ALLWEST performed liquefaction analyses using Settle3D 4.0 and data obtained during subsurface exploration. Based on a bearing capacity of 1,500 pounds per square foot (psf), our analysis indicates that total seismic induced settlement could reach upwards of 4.84-inches under the expected loads. The following table contains the statistics for deaggregation

Table 7 – Deaggregation Statistical Analysis

Condition	Total Settlement (in)
2% in 50 years (Typical Design Period)	4.84
5% in 50 years	3.81
10% in 50 years	2.35

6.12 Retaining Walls

At the time this report was prepared we have no knowledge of planned retaining walls for this project. If retaining walls are to be implemented as part of this project ALLWEST should be provided the opportunity to review the plans to determine if further geotechnical evaluation is required. We may need to develop wall specific lateral earth pressures depending on location and height of proposed retaining walls. Our scope of services did not include segmental block design, boulder faced slope design, or global stability analyses; we can provide these services for an additional fee, if requested.

6.13 Seismicity

We anticipate the *2018 International Building Code* (IBC) will be used as the basis for design of the proposed structures. The soil at the site can be characterized as Site Class E for seismic design. *Table 8* contains seismic parameters that were calculated using USGS U.S. Seismic Design Maps for use with the 2018 IBC. The latitude and longitude for the site were used to specify the location of the subject property.

Table 8 - Seismic design parameters.

Parameter	Value	Description
Latitude	48.32893°	Project site geographic position
Longitude	-116.54303°	Project site geographic position
Seismic Site Class	E	Seismic Design Site Classification
Risk Category	IV	Seismic design risk category
S_S	0.33	MCE_R ground motion (period = 0.2s)
S_1	0.112	MCE_R ground motion (period = 1.0s)
S_{DS}	0.479	Numeric seismic design value at 0.2s SA
S_{D1}	0.312	Numeric seismic design value at 1.0s SA
F_a	2.176	Site amplification factor at 0.2s
F_v	4.2	Site amplification factor at 1.0s
PGA	0.148	MCE_G peak ground acceleration
F_{PGA}	2.16	Site amplification factor at PGA
PGA_M	0.32	Site modified peak ground acceleration

6.14 Pavement

We understand new asphalt pavement will be constructed on the site for parking and drive areas. Prior to placing site grading fill or base course, the subgrade should be prepared as recommended in section *6.1 Site Preparation*. Key design parameters used in the development of this pavement design are presented in *Table* 9. These values were either measured, estimated, or assumed. If actual traffic loading varies from that stated in the following table, we should be notified so we may reevaluate our recommendations.

Table 9 - Pavement design parameters.

Design Parameter	Value
Estimated: Subgrade California Bearing Ratio (CBR)	7%
Estimated: Equivalent Single-Axle Loads (ESALs) Parking Lot / Truck Lanes	19,000
Assumed: Pavement Reliability	85%
Assumed: Pavement Design Life	20-year
Assumed: Initial Serviceability	4.2
Assumed: Terminal Serviceability	2.0

Our designed pavement sections are based on the parameters presented in *Table 9*.

Table 10 – Recommended Pavement Sections.

Pavement Area	Flexible Pavement		Gravel Roads
	Asphalt (in.)	Base Course (in.)	Base Course (in.)
Drive Lanes	3	8	14

We recommend specifying crushed aggregate base meeting the requirements of the ITD Standard Specification 703.04 for ¾-inch Type B untreated base course. We recommend the asphalt concrete pavement meet the requirements of ITD Standard Specifications 702 and 703 for plant mix asphalt concrete pavements. Portland cement concrete should have a minimum 28-day compressive strength of 4,000 psi. We recommend the crushed aggregate base be compacted to a minimum of 95 percent of the modified Proctor maximum dry density (ASTM D1557). We recommend the asphaltic concrete surface be compacted to minimum of 92 percent of the Rice density.

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the crushed aggregate base section.

The pavement sections provided in this report represent minimum recommended thicknesses. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g., crack, and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance should be the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements.

6.15 Stormwater and Drainage

Final stormwater management plans were not available at the time this report was prepared.

We recommend the grading plan include slopes such that stormwater run-off is directed away from buildings and pavement areas to a stormwater management system. We recommend the ground surface adjacent to foundations be sloped a minimum of five percent within ten feet of the building. If the adjoining ground surface consists of hardscapes, it may be sloped a minimum of two percent in the first ten feet. Water should not be allowed to infiltrate or pond adjacent to the foundations.

6.15.1 Drywell Recommendations.

Due to the shallow depth to limiting layers, high fines content of native soils at depth, and shallow groundwater, we do not recommend stormwater infiltration with drywells or gravel galleries. If stormwater treatment and disposal is required, we recommend evaporation ponds be used for stormwater management.

7.0 ADDITIONAL RECOMMENDED SERVICES

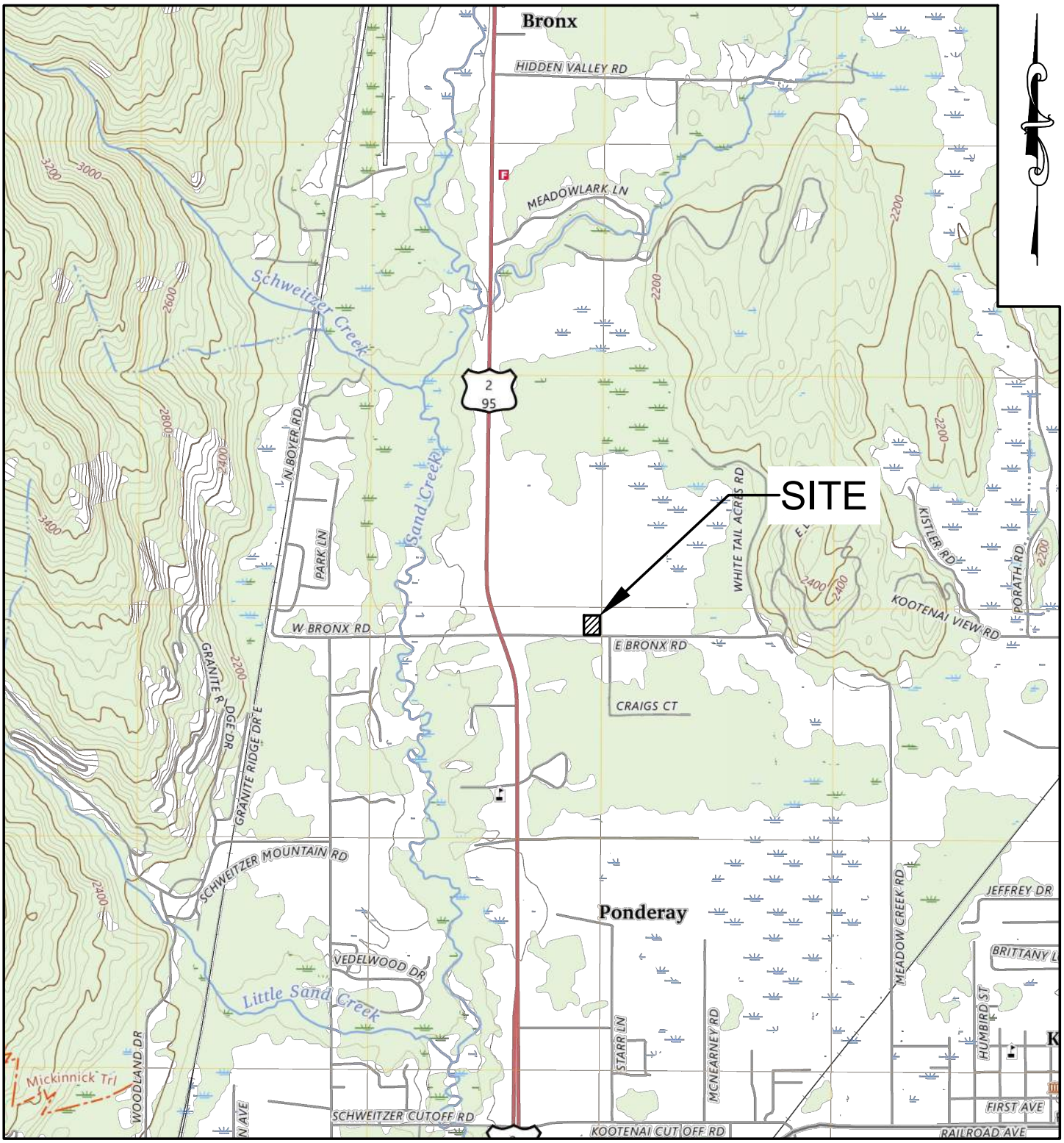
We recommend ALLWEST be retained to provide construction materials testing and observation to verify the soil and geologic conditions and the report recommendations are incorporated into the actual construction. The design engineer-of-record should determine applicable testing and special inspection requirements in accordance with the governing code documents. If we are not retained to provide required construction observation and materials testing services, we cannot be responsible for errors and omissions related to geotechnical aspects of the construction phase.

8.0 EVALUATION LIMITATIONS

This report has been prepared to assist the planning and design for the Ponderay Avista Substation project located at West of 237 East Bronx Road in Ponderay, Idaho. Reliance by any other party is prohibited without the written authorization of ALLWEST. Our services consist of professional opinions and conclusions made in accordance with generally accepted geotechnical engineering principles and practices in the local area at the time this report was prepared. This acknowledgement is in lieu of all warranties, express or implied.

Appendix A

Site Vicinity Map
Site and Exploration Map



BASEMAP SOURCE: USGS TOPOGRAPHIC MAP, SANDPOINT QUADRANGLE
IDAHO-BONNER COUNTY, 7.5-MINUTE SERIES, DATED 2024.

ALLWEST
16617 E. Euclid Ave., Bldg A
Spokane Valley, Washington
(509) 534-4411
www.allwesttesting.com

FIGURE A-1: VICINITY MAP

PROJECT:	225-181G PONDERAY AVISTA SUBSTATION		
LOCATION:	237 E BRONX RD, PONDERAY, IDAHO		
CLIENT:	AVISTA CORPORATION		
DATE:	AUGUST 2025	SCALE:	1-IN = 2,000 FT

BASEMAP SOURCES: GOOGLE EARTH IMAGERY ACCESSED ON AUGUST 1, 2025.

LEGEND:

TP-# TEST PIT NUMBER AND APPROXIMATE LOCATION

B-# BORING NUMBER AND APPROXIMATE LOCATION

ALLWEST
16617 E. Euclid Ave., Bldg A
Spokane Valley, Washington
(509) 534-4411
www.allwesttesting.com

FIGURE A-2: EXPLORATION LOCATION MAP			
PROJECT:	225-181G PONDERAY AVISTA SUBSTATION		
LOCATION:	237 E BRONX RD, PONDERAY, IDAHO		
CLIENT:	AVISTA CORPORATION		
DATE:	AUGUST 2025	SCALE:	NOT TO SCALE

Appendix B

Exploration Logs
Soil Classification Chart

Soil Boring

Ponderay Avista Substation

48.32917, -116.54394

B-01

Project No.:	225-181G	Date Completed:	07/16/2025	Notes:	-
Logged By:	Kenny Rukavina	Depth:	21.5'		
Drilling Co.:	GeoWest Drilling	Method:	Auger		
Driller:	Andy	Hammer Type:	Auto		
Rig Type:	Acker Rebel	Coordinates:	,		
Location Accuracy:	Not Surveyed	Surface Elevation	N/A	GW depth at time of drilling:	6'
		Elevation Datum	-	Static GW depth:	N/A

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Number	Sample Type	Recovery Length (")	Blow Counts (N-Value)	N-Value Plot	Lab: % Gravel	% Sand	% Fines	Atterberg Limits (LL-PL-PI)	Moisture Content (%)
	SILT with SAND (ML), soft, moist, fine-grained, brown											
	Silty SAND (SM), loose, moist, fine-grained, brown		1-1	ST								
5	Sandy SILT (ML), medium stiff, moist to wet, fine-grained, brown		1-2	Grab		3-3-3						
			1-3	Grab		1-2-4						
10	Silty CLAY (CL), very soft, wet, gray		1-4	Grab		1-1-1	H		4	96	25-20-5	
15	Sandy SILT (ML), interbedded sand layers, very soft to soft, wet, fine- to coarse-grained, brown		1-5	Grab		x-x-2						
20			1-6	Grab		1-2-1			37	63		

Boring terminated. Groundwater observed at 6'.

Soil Boring

Ponderay Avista Substation

48.32917, -116.54394

B-02

Project No.:	225-181G	Date Completed:	07/16/2025	Notes:	-
Logged By:	Kenny Rukavina	Depth:	51.5		
Drilling Co.:	GeoWest Drilling	Method:	Auger		
Driller:	Andy	Hammer Type:	Auto		
Rig Type:	Acker Rebel	Coordinates:	,		
Location Accuracy:	Not Surveyed	Surface Elevation	N/A	GW depth at time of drilling:	6'
		Elevation Datum	-	Static GW depth:	N/A

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Number	Sample Type	Recovery Length (")	Blow Counts (N-Value)	N-Value Plot	Lab: % Gravel	% Sand	% Fines	Atterberg Limits (LL-PL-PI)	Moisture Content (%)
0	Silty SAND (SM), medium dense, moist, fine-grained, brown		2-1	Grab		3-4-4						
5 ▽	Sandy SILT (ML), very soft to soft, moist to wet, fine-grained, brown		2-2	Grab		1-1-3						
			2-3	Grab		1-1-1			49	51		
10	SILT with SAND (ML), very soft, wet, fine-grained, brown		2-4	Grab		x-x-2						
	Silty SAND (SM), very loose, wet, fine-grained, brown		2-5	Grab		x-x-1			83	17		
15	SILT with SAND (ML), stiff, wet, fine-grained, brown		2-6	Grab		2-3-6						
	Silty SAND (SP-SM), medium dense, wet, fine to coarse, brown		2-7	Grab		4-6-8						
20	Poorly graded SAND with silt (SP-SM), medium dense, wet, fine to coarse, gray brown		2-8	Grab		3-4-6			92	8		
			2-9	Grab		2-4-7						
25	Silty SAND (SM), interbedded poorly graded sand with silt lenses, medium dense, wet, fine-grained, brown		2-10	Grab		6-8-12						
			2-11	Grab		6-9-14			59	41		
30			2-12	Grab		6-11-13			68	32		
	LEAN CLAY (CL), very soft to medium stiff, wet, gray		2-13	Grab		x-3-3						
35			2-14	Grab		x-1-2						
			2-15	Grab		x-1-3						
40			2-16	Grab		x-x-1				97	34-22-12	
			2-17	Grab		x-1-3						
45			2-18	Grab		x-x-x						
			2-19	Grab		x-x-x						
50	Boring terminated. Groundwater observed at 7'.											

N-Value Plot: ■ Raw N-Value Blows; 0 10 20 30 40 50; PL-MC-LL; 0 25 50 75 100

Soil Boring

Ponderay Avista Substation

48.32917, -116.54394

B-03

Project No.:	225-181G	Date Completed:	07/16/2025	Notes:	-
Logged By:	Kenny Rukavina	Depth:	21.5'		
Drilling Co.:	GeoWest Drilling	Method:	Auger		
Driller:	Andy	Hammer Type:	Auto		
Rig Type:	Acker Rebel	Coordinates:	,		
Location Accuracy:	Not Surveyed	Surface Elevation	N/A	GW depth at time of drilling:	8'
		Elevation Datum	-	Static GW depth:	N/A

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Number	Samples: Sample Type	Samples: Recovery Length (")	Samples: Blow Counts (N-Value)	N-Value Plot	Lab: % Gravel	Lab: % Sand	Lab: % Fines	Lab: Moisture Content (%)
	SILT with SAND (ML), stiff, moist, fine-grained, brown		1-1	Grab		4-4-5					
5	Silty SAND (SM), loose, moist, fine-grained, brown No recovery in shelby		1-2	ST							
	Poorly graded SAND with silt (ML), medium dense, moist to wet, fine to coarse, brown		1-3	Grab		1-3-2					
10	SILT with SAND (ML), medium stiff, wet, gray		1-4	Grab		x-2-2					
15			1-5	Grab		x-2-4					
20	Poorly graded SAND with silt (SP-SM), interbedded sand layers, medium dense, wet, fine to coarse, brown		1-6	Grab		4-6-8					

N-Value Plot: ■ Raw N-Value Blows; 0 10 20 30 40 50; PL-MC-LL; 0 25 50 75 100

Boring terminated. Groundwater observed at 6'.

Test Pit

Ponderay Avista Substation

48.32917, -116.54394

TP-01

Project No.:	225-181G	Date:	07/16/2025	Groundwater Observations: Water encountered @ 9.5'
Contractor:	GeoWest Drilling	Hole Depth:	-	
Equipment:	Mini-Excavator	V. Datum:	-	
Operator:	Kevin	Elevation:	N/A	
Logged By:	Chad Peterson	Coordinates:	,	

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: Lab Sample ID	Lab: % Gravel	Lab: % Sand	Lab: % Fines	Lab: pH
0	TOPSOIL, Sandy SILT (ML), loose, moist, fine-grained, brown							
1	1.5		Grab					
2	Sandy SILT (ML), stiff, moist, fine-grained, brown							
3			Grab	X5G0391-01				6.56
4	4.5							
5	SILT (ML), stiff, moist, brown		Grab					
6	6.0							
7	Silty SAND (SM), loose to medium dense, moist, fine-grained, brown							
8	7.0		Grab					
9	Poorly graded SAND with silt (SP-SM), medium dense, moist, fine to coarse, gray brown							
▽	8.5							
10	Sandy SILT (ML), soft to medium stiff, moist to wet, fine-grained, brown		Grab					
	10.0							

Test pit terminated. Groundwater observed at 9.5'. Minor caving observed from 7' to 8.5'.

Notes: -

Test Pit

Ponderay Avista Substation

48.32917, -116.54394

TP-02

Project No.:	225-181G	Date:	07/16/2025	Groundwater Observations: Water encountered @ 9.5'
Contractor:	GeoWest Drilling	Hole Depth:	-	
Equipment:	Mini-Excavator	V. Datum:	-	
Operator:	Kevin	Elevation:	N/A	
Logged By:	Chad Peterson	Coordinates:	,	

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples	Lab		
			Sample Type	% Gravel	% Sand	% Fines
0	TOPSOIL, Sandy SILT (ML), loose, moist, fine-grained, brown					
1.5	Sandy SILT (ML), medium stiff to stiff, moist, fine-grained, brown					
4.5	Silty SAND (SM), less fines with depth, loose to medium dense, moist to wet, brown					
9.0	Sandy SILT (ML), soft to medium stiff, wet, fine-grained, brown					
10.0	Test pit terminated. Groundwater observed at 9.5'. Minor caving observed from 9' to 10'.					

Notes: -

Test Pit

Ponderay Avista Substation

48.32917, -116.54394

TP-03

Project No.:	225-181G	Date:	07/16/2025	Groundwater Observations: Water encountered @ 8'
Contractor:	GeoWest Drilling	Hole Depth:	-	
Equipment:	Mini-Excavator	V. Datum:	-	
Operator:	Kevin	Elevation:	N/A	
Logged By:	Chad Peterson	Coordinates:	,	

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
1	TOPSOIL, Sandy SILT (ML), loose, moist, fine-grained, brown							
	1.5							
2	SILT (ML), soft to medium stiff, moist, fine-grained, brown							
3			Grab	S225-0258	18		11	89
4								
	4.5							
5	Silty SAND (SM), less fines with depth, loose to medium dense, moist to wet, brown		Grab					
6								
			Grab					
7								
▽ 8								
9								
	9.0							
	SILT (ML), soft to medium stiff, wet, fine-grained, brown							
10	10.0		Grab					

Test pit terminated. Groundwater observed at 8'. Minor caving observed from 9' to 10'.

Notes: -

Test Pit

Ponderay Avista Substation

48.32917, -116.54394

TP-04

Project No.:	225-181G	Date:	07/16/2025	Groundwater Observations: Water encountered @ 9.5'
Contractor:	GeoWest Drilling	Hole Depth:	-	
Equipment:	Mini-Excavator	V. Datum:	-	
Operator:	Kevin	Elevation:	N/A	
Logged By:	Chad Peterson	Coordinates:	,	

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples: Sample Type	Lab: % Gravel	Lab: % Sand	Lab: % Fines
1	TOPSOIL, Sandy SILT (ML), loose, moist, fine-grained, brown					
	1.5					
2	Sandy SILT (ML), medium stiff to stiff, moist, fine-grained, brown					
3						
4						
	4.5					
5	Silty SAND (SM), less fines with depth, loose to medium dense, moist to wet, brown					
6						
7						
8						
9						
▽	9.5					
	SILT (ML), medium stiff to stiff, wet, fine-grained, brown					
10	10.0					

Test pit terminated. Groundwater observed at 9.5'. Minor caving observed from 9' to 10'.

Notes: -

Test Pit

Ponderay Avista Substation

48.32917, -116.54394

TP-05

Project No.:	225-181G	Date:	07/16/2025	Groundwater Observations: Water encountered @ 9'
Contractor:	GeoWest Drilling	Hole Depth:	-	
Equipment:	Mini-Excavator	V. Datum:	-	
Operator:	Kevin	Elevation:	N/A	
Logged By:	Chad Peterson	Coordinates:	,	

Depth (ft)	Soil Description and Remarks	Graphic Log	Samples	Lab				
			Sample Type	Lab Sample ID	Moisture Content (%)	% Gravel	% Sand	% Fines
1	TOPSOIL, Sandy SILT (ML), loose, moist, fine-grained, brown							
	1.5							
2	SILT (ML), soft to medium stiff, moist to wet, fine-grained, brown							
3				S225-0259	23		6	94
4								
5								
6								
7								
8								
▽ 9								
10	10.0							

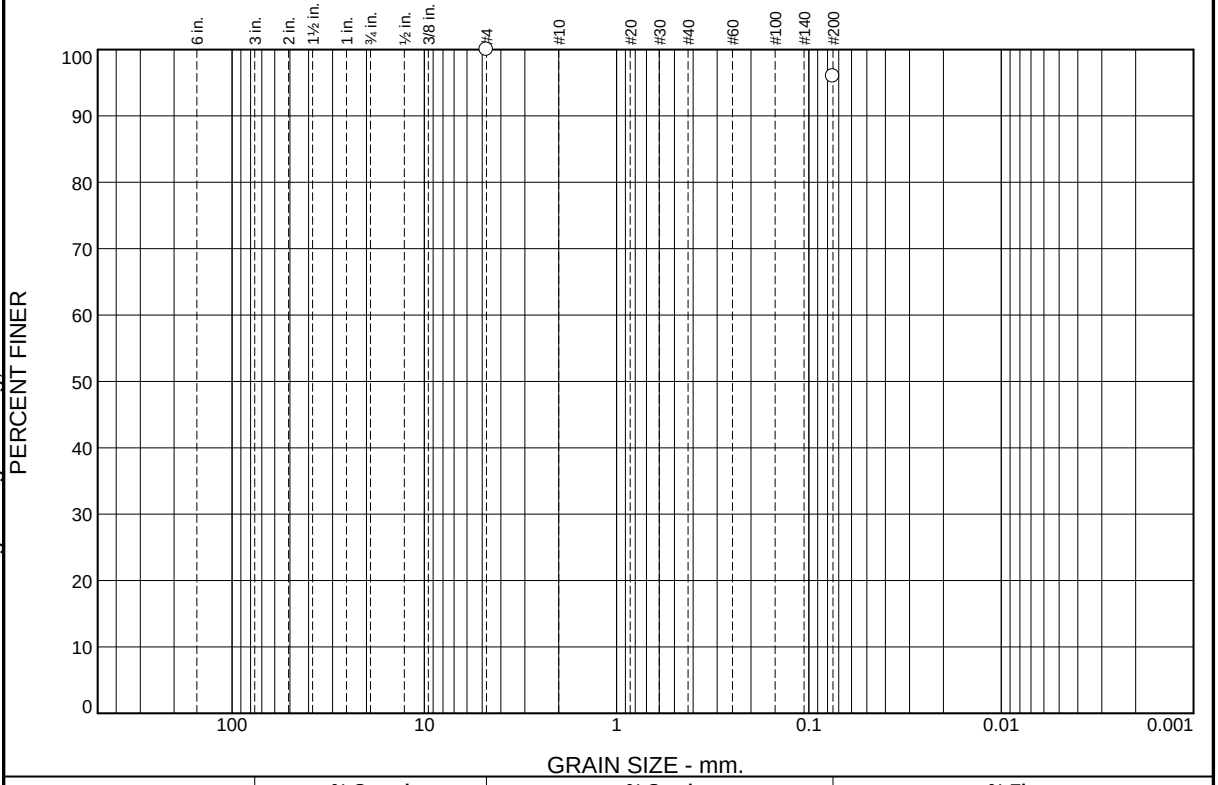
Test pit terminated. Groundwater observed at 9'. Minor caving observed from 9' to 10'.

Notes: -

Appendix C

Laboratory Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	1	2	96	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#200	96		

* (no specification provided)

Soil Description

Silty clay

Atterberg Limits

PL= 20 LL= 25 PI= 5

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL-ML AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

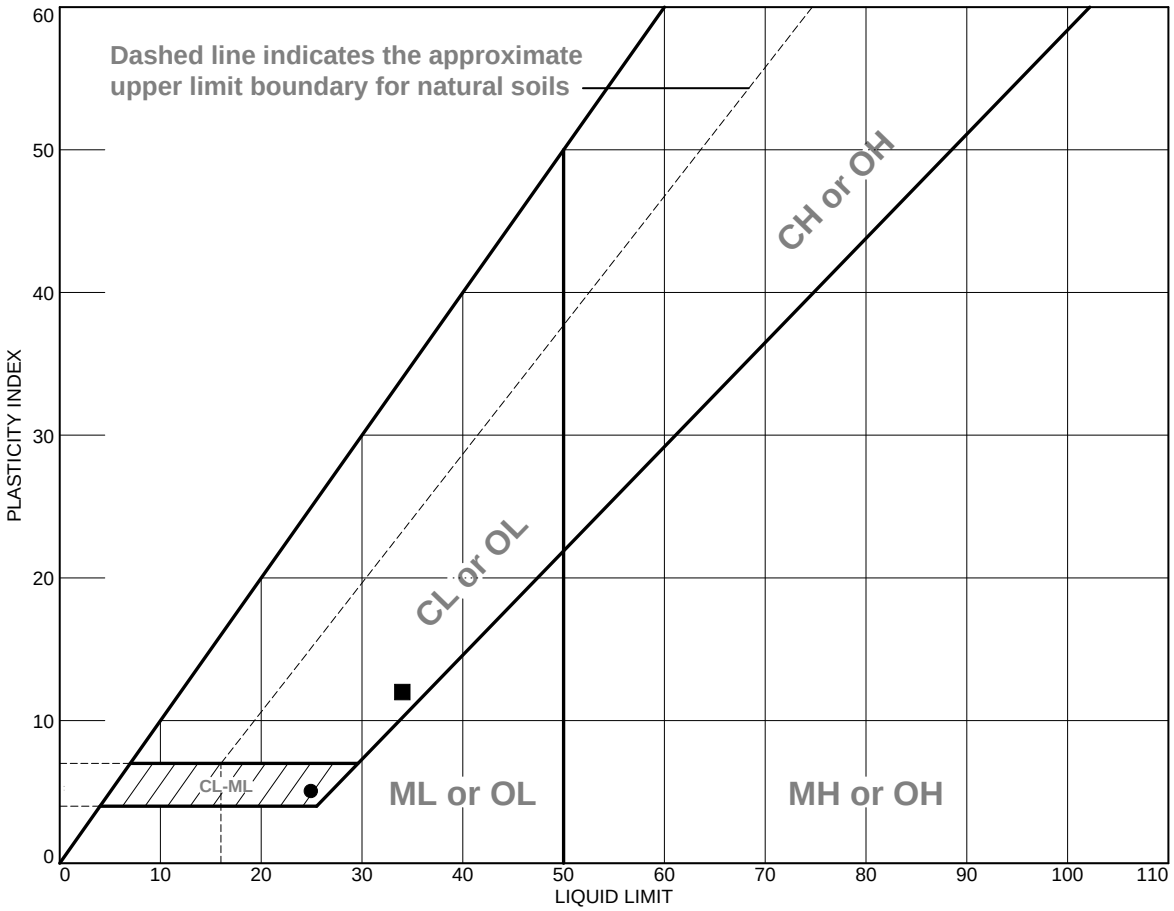
Location: B1
Sample Number: S225-0250 **Depth:** 10' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-1

Tested By: K. Semanko **Checked By:** D. Schmitz

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty clay	25	20	5	100	96	CL-ML
■	Lean clay	34	22	12	100	96.7	CL

Project No. 225-181G **Client:** Avista Corporation - Spokane

Project: Ponderay Avista Substation

●**Location:** B1 **Depth:** 10' **Sample Number:** S225-0250

■**Location:** B2 **Depth:** 40' **Sample Number:** S225-0256

Remarks:

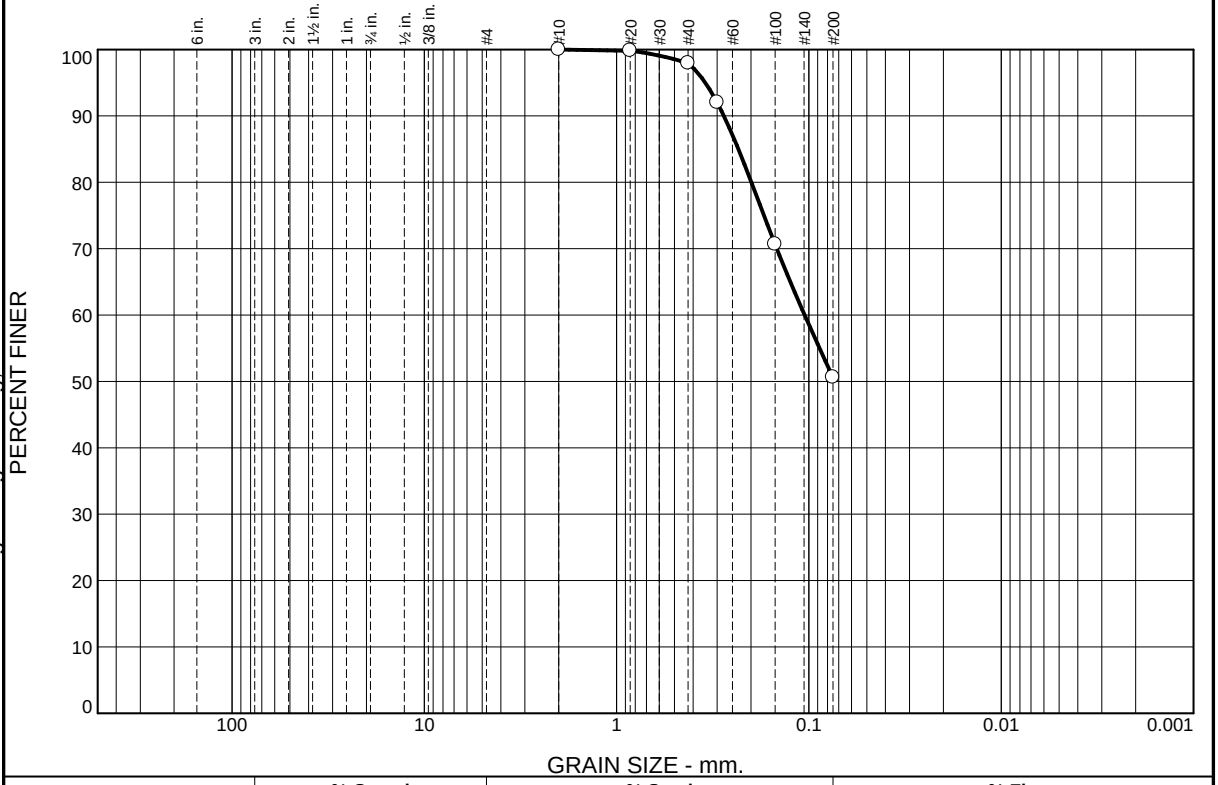
●Sampled by: K. Rukavina
Sample date: 7/22/25

ALLWEST

Figure C-1, C-7

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	2	47	51	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100		
#20	100		
#40	98		
#50	92		
#100	71		
#200	51		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.2768 D_{85}= 0.2327 D_{60}= 0.1053
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

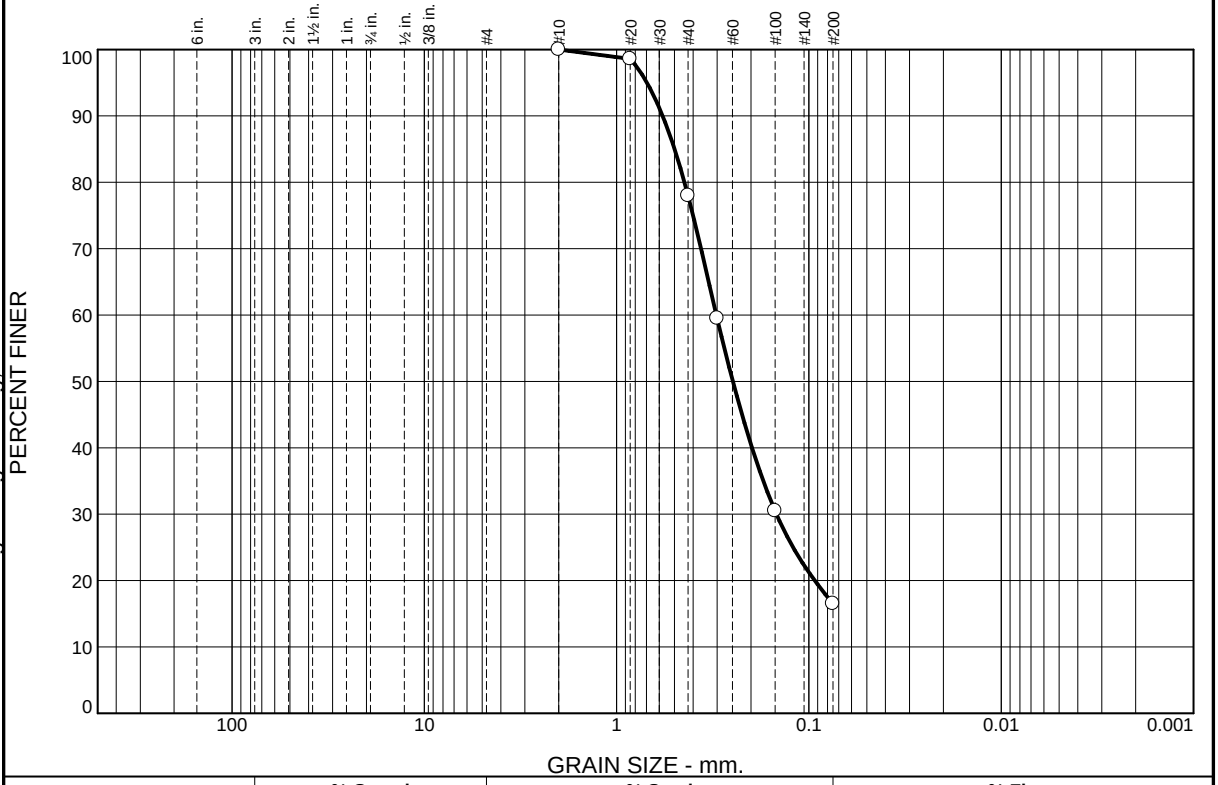
Location: B2
Sample Number: S225-0251 **Depth:** 7.5' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-2

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	22	61	17	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100		
#20	99		
#40	78		
#50	59		
#100	30		
#200	17		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.5763 D_{85}= 0.4997 D_{60}= 0.3030
D_{50}= 0.2485 D_{30}= 0.1475 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

Location: B2
Sample Number: S225-0252 **Depth:** 12.5' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-3

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	29	63	8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	100		
#20	99		
#40	71		
#50	36		
#100	14		
#200	8.4		

* (no specification provided)

Soil Description

Poorly graded sand with silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.5712 D_{85}= 0.5158 D_{60}= 0.3814
D_{50}= 0.3475 D_{30}= 0.2791 D_{15}= 0.1735
D_{10}= 0.0890 C_u= 4.29 C_c= 2.29

Classification

USCS= SP-SM AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

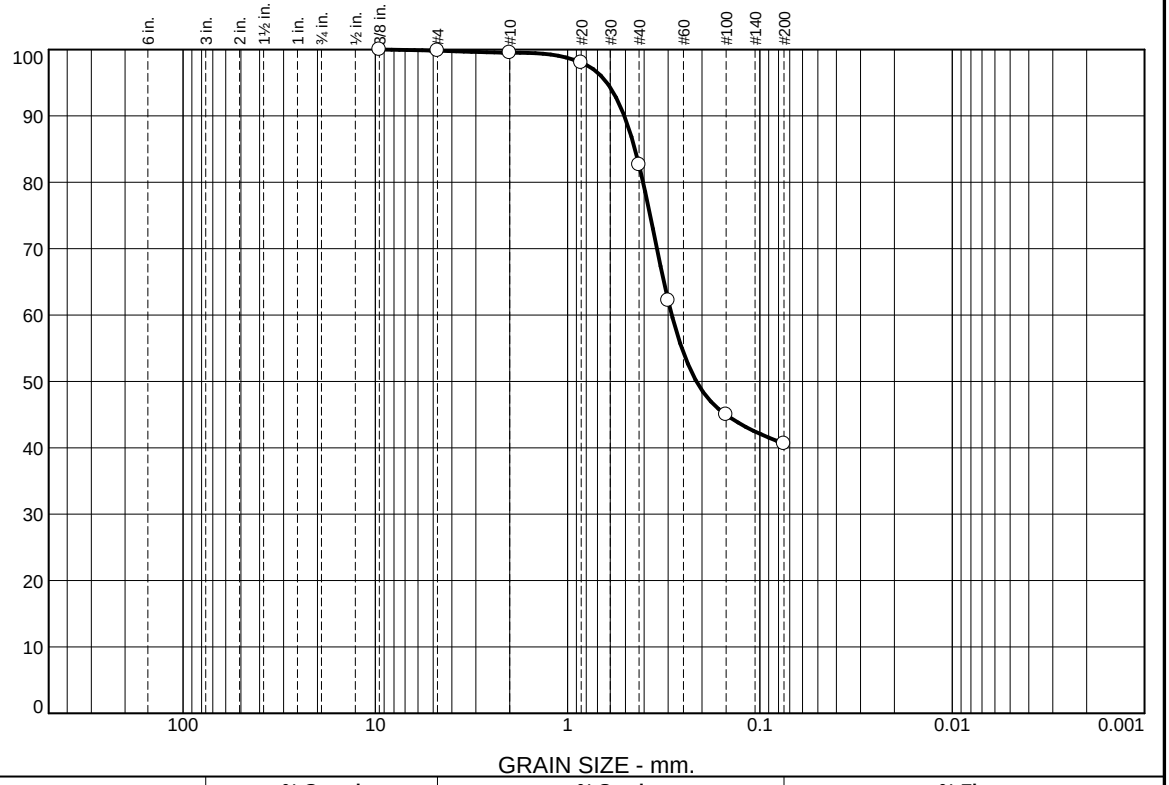
Location: B2
Sample Number: S225-0253 **Depth:** 20' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-4

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	17	42	41	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#10	100		
#20	98		
#40	83		
#50	62		
#100	45		
#200	41		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.5075 D_{85}= 0.4464 D_{60}= 0.2872
D_{50}= 0.2139 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

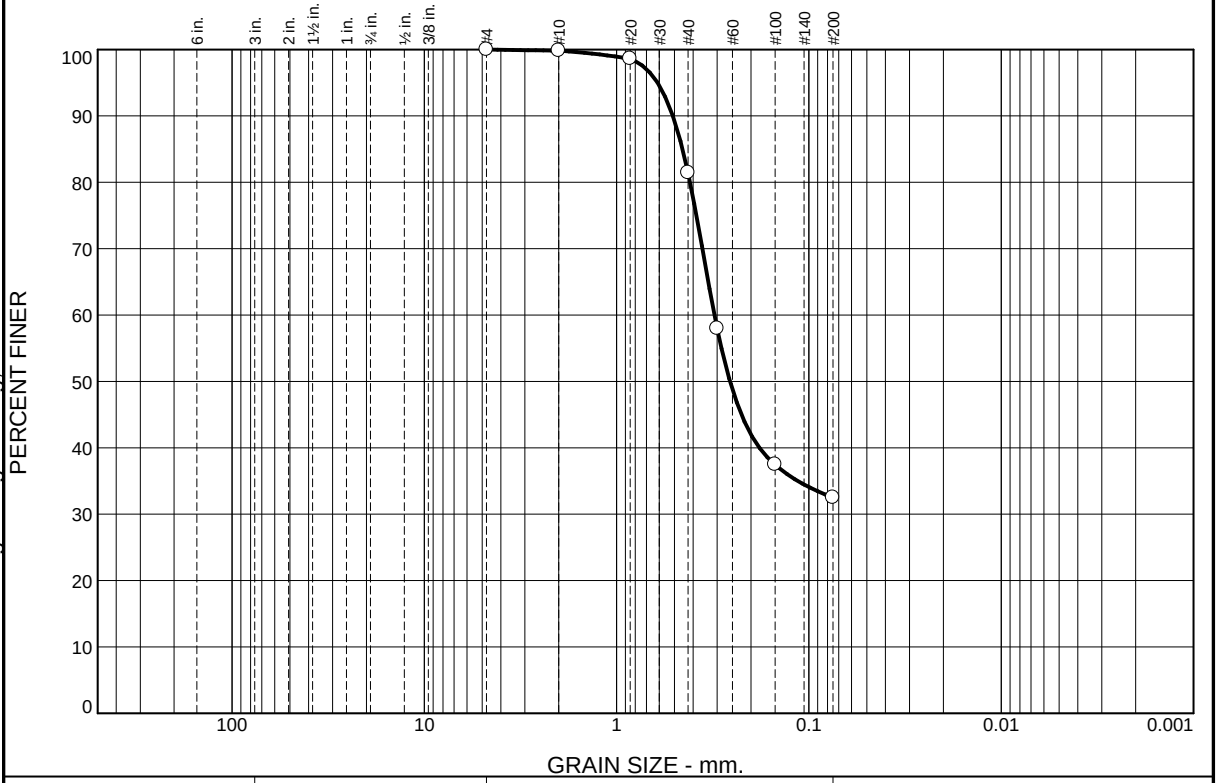
Location: B2
Sample Number: S225-0254 **Depth:** 27.5' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-5

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	19	49	32	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#10	100		
#20	99		
#40	81		
#50	58		
#100	37		
#200	32		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.5105 D_{85}= 0.4541 D_{60}= 0.3099
D_{50}= 0.2571 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

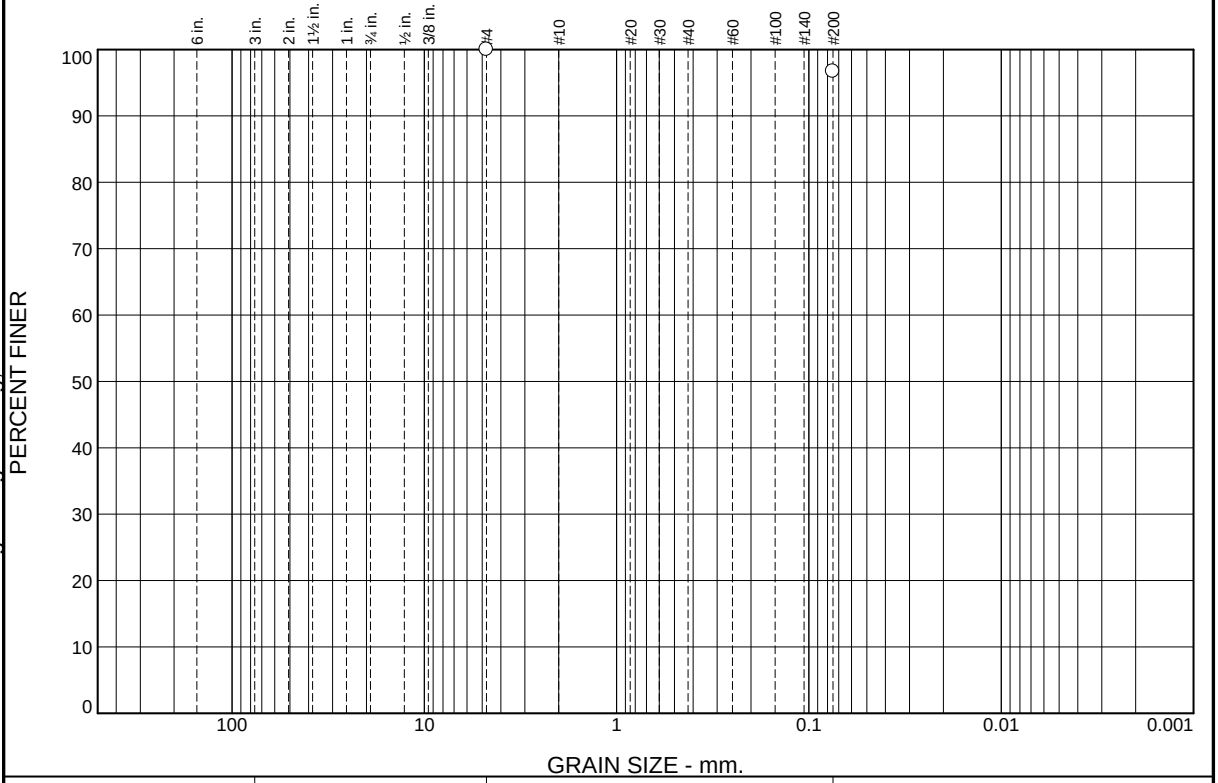
Location: B2
Sample Number: S225-0255 **Depth:** 30' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-6

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	1	1	97	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#200	97		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 22 LL= 34 PI= 12

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

Location: B2
Sample Number: S225-0256 **Depth:** 40' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-7

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	0	6	31	63	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100		
#20	100		
#40	94		
#50	88		
#100	79		
#200	63		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.3290 D_{85}= 0.2383 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25

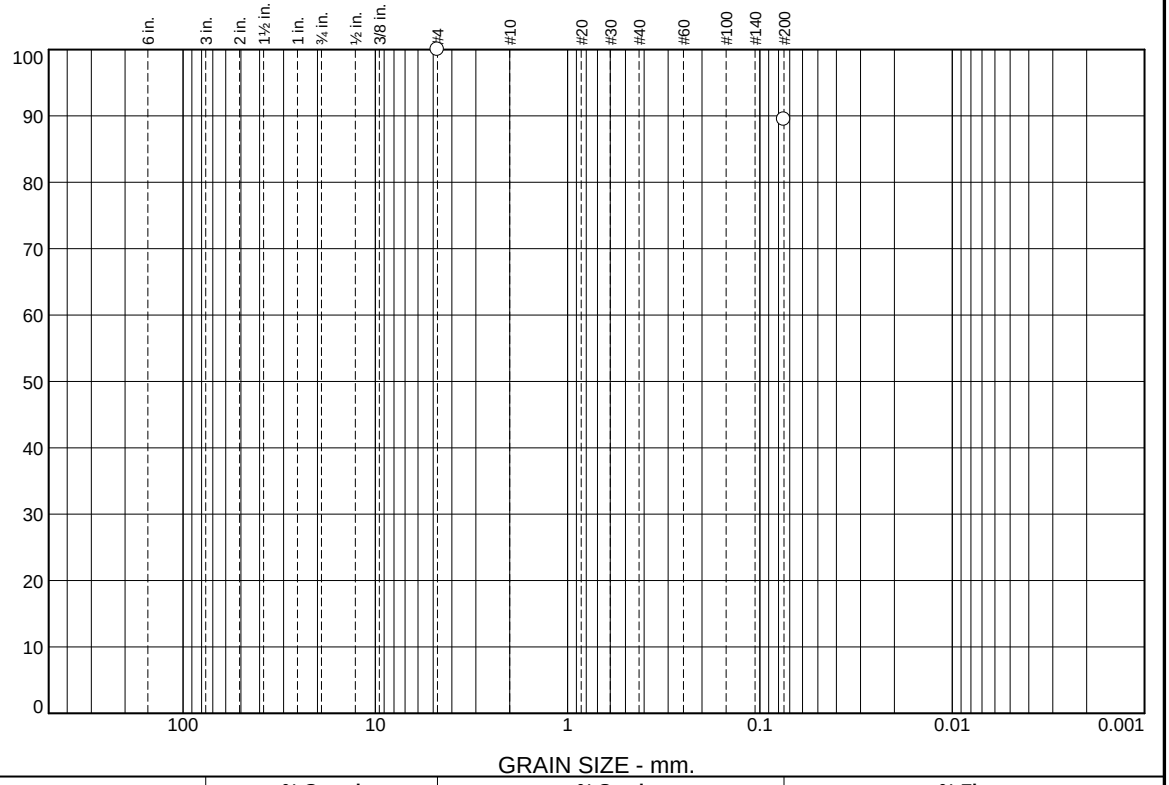
Location: B1
Sample Number: S225-0257 **Depth:** 20' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-8

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	2	4	5	89	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#200	89		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{90}= 0.0922 D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25
Percent Moisture Content: 18

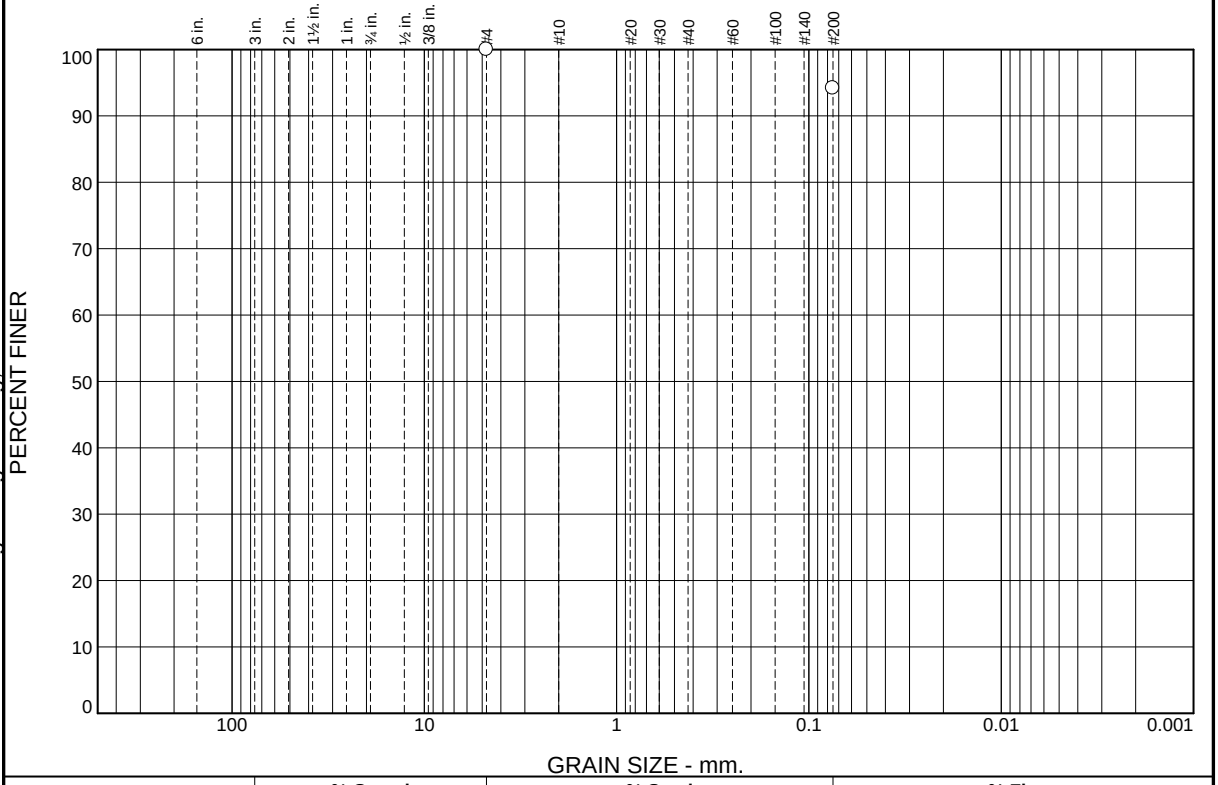
Location: TP3
Sample Number: S225-0258 **Depth:** 3' **Date:** 7/28/25

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-9

Tested By: K. Semanko **Checked By:** D. Schmitz

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	2	3	94	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100		
#200	94		

* (no specification provided)

Soil Description

Silt

Atterberg Limits

PL= - LL= -- PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= -

Remarks

Sampled by: K. Rukavina
Sample date: 7/22/25
Percent Moisture Content: 23

Location: TP5
Sample Number: S225-0259 **Depth:** 3' **Date:** 7/28/22

Client: Avista Corporation - Spokane
Project: Ponderay Avista Substation

Project No: 225-181G **Figure** C-10

Tested By: K. Semanko **Checked By:** D. Schmitz

One Government Gulch - PO Box 929
Kellogg, ID 83837-0929
(208) 784-1258
www.svl.net

Allwest
690 W Capstone Ct
Hayden, ID 83835

Work Order: **X5G0391**
Reported: 28-Jul-25 15:14

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Sampled By	Date Received	Notes
TP-1 @ 2'	X5G0391-01	Solid	23-Jul-25 14:18	KR	23-Jul-2025	

Solid samples are analyzed on an as-received, wet-weight basis, unless otherwise requested.
Sample preparation is defined by the client as per their Data Quality Objectives.
This report supercedes any previous reports for this Work Order. The complete report includes pages for each sample, a full QC report, and a notes section.
Analyses were performed in accordance with SVL standard operating procedures and calibrations were performed and met SVL internal QC criteria.
The results presented in this report relate only to the samples, and meet all requirements of the NELAC Standards unless otherwise noted.

One Government Gulch - PO Box 929
Kellogg, ID 83837-0929
(208) 784-1258
www.svl.net

Allwest
690 W Capstone Ct
Hayden, ID 83835

Work Order: **X5G0391**
Reported: 28-Jul-25 15:14

Client Sample ID: **TP-1 @ 2'**
SVL Sample ID: **X5G0391-01 (Solid)**

Sampled: 23-Jul-25 14:18
Received: 23-Jul-25
Sampled By: KR

Method	Analyte	Result	Units	RL	MDL	Dilution	Batch	Analyst	Analyzed	Notes
Classical Chemistry Parameters										
EPA 9045D	**pH @22.3°C**	6.56	pH Units				X530048	MLP	07/25/25 17:15	
Anions by Ion Chromatography										
EPA 300.0	Sulfate as SO4	< 3.0	mg/kg	3.0	2.5		X530209	GMD	07/25/25 06:15	
Percent Solids / Percent Moisture										
Percent Solids	**% Solids**	83.6	%	0.1			X530192	PB	07/28/25 08:58	

This data has been reviewed for accuracy and has been authorized for release.

Kristi A. Groth

Kristi A. Groth
Project Manager

One Government Gulch - PO Box 929
Kellogg, ID 83837-0929
(208) 784-1258
www.svl.net

Allwest
690 W Capstone Ct
Hayden, ID 83835

Work Order: **X5G0391**
Reported: 28-Jul-25 15:14

Quality Control - BLANK Data

Method	Analyte	Units	Result	MDL	MRL	Batch ID	Analyzed	Notes
Anions by Ion Chromatography								
EPA 300.0	Sulfate as SO4	mg/kg	<3.0	2.5	3.0	X530209	25-Jul-25	

Quality Control - LABORATORY CONTROL SAMPLE Data

Method	Analyte	Units	LCS Result	LCS True	% Rec.	Acceptance Limits	Batch ID	Analyzed	Notes
Classical Chemistry Parameters									
EPA 9045D	pH @22.5°C	pH Units	7.79	7.97	97.7	94 - 106	X530048	25-Jul-25	
Anions by Ion Chromatography									
EPA 300.0	Sulfate as SO4	mg/kg	99.0	100	99.0	80 - 120	X530209	25-Jul-25	

Quality Control - DUPLICATE Data

Method	Analyte	Units	Duplicate Result	Sample Result	RPD	RPD Limit	Batch and Source ID	Analyzed	Notes
Classical Chemistry Parameters									
EPA 9045D	pH @21.9°C	pH Units	4.60	4.60	0.0	20	X530048 - X5G0276-01	25-Jul-25	
Percent Solids / Percent Moisture									
Percent Solids	% Solids	%	94.0	94.2	0.2	20	X530192 - X5G0386-01	28-Jul-25	

Quality Control - MATRIX SPIKE Data

Method	Analyte	Units	Spike Result	Sample Result (R)	Spike Level (S)	% Rec.	Acceptance Limits	Batch and Source ID	Analyzed	Notes
Anions by Ion Chromatography										
EPA 300.0	Sulfate as SO4	mg/kg	112	<3.0	100	112	75 - 125	X530209 - X5G0391-01	25-Jul-25	

Quality Control - MATRIX SPIKE DUPLICATE Data

Method	Analyte	Units	MSD Result	Spike Result	Spike Level	RPD	RPD Limit	% Recovery	Batch and Source ID	Notes
Anions by Ion Chromatography										
EPA 300.0	Sulfate as SO4	mg/kg	110	112	100	2.1	20	110	X530209 - X5G0391-01	

One Government Gulch - PO Box 929
Kellogg, ID 83837-0929
(208) 784-1258
www.svl.net

Allwest
690 W Capstone Ct
Hayden, ID 83835

Work Order: **X5G0391**
Reported: 28-Jul-25 15:14

Notes and Definitions

LCS	Laboratory Control Sample (Blank Spike)
RPD	Relative Percent Difference
UDL	A result is less than the detection limit
0.30R>S	% recovery not applicable; spike level is less than 30% of the sample concentration
<RL	A result is less than the reporting limit
MRL	Method Reporting Limit
MDL	Method Detection Limit
N/A	Not Applicable

APPENDIX B

NRCS WEB SOIL SURVEY

United States Department of Agriculture

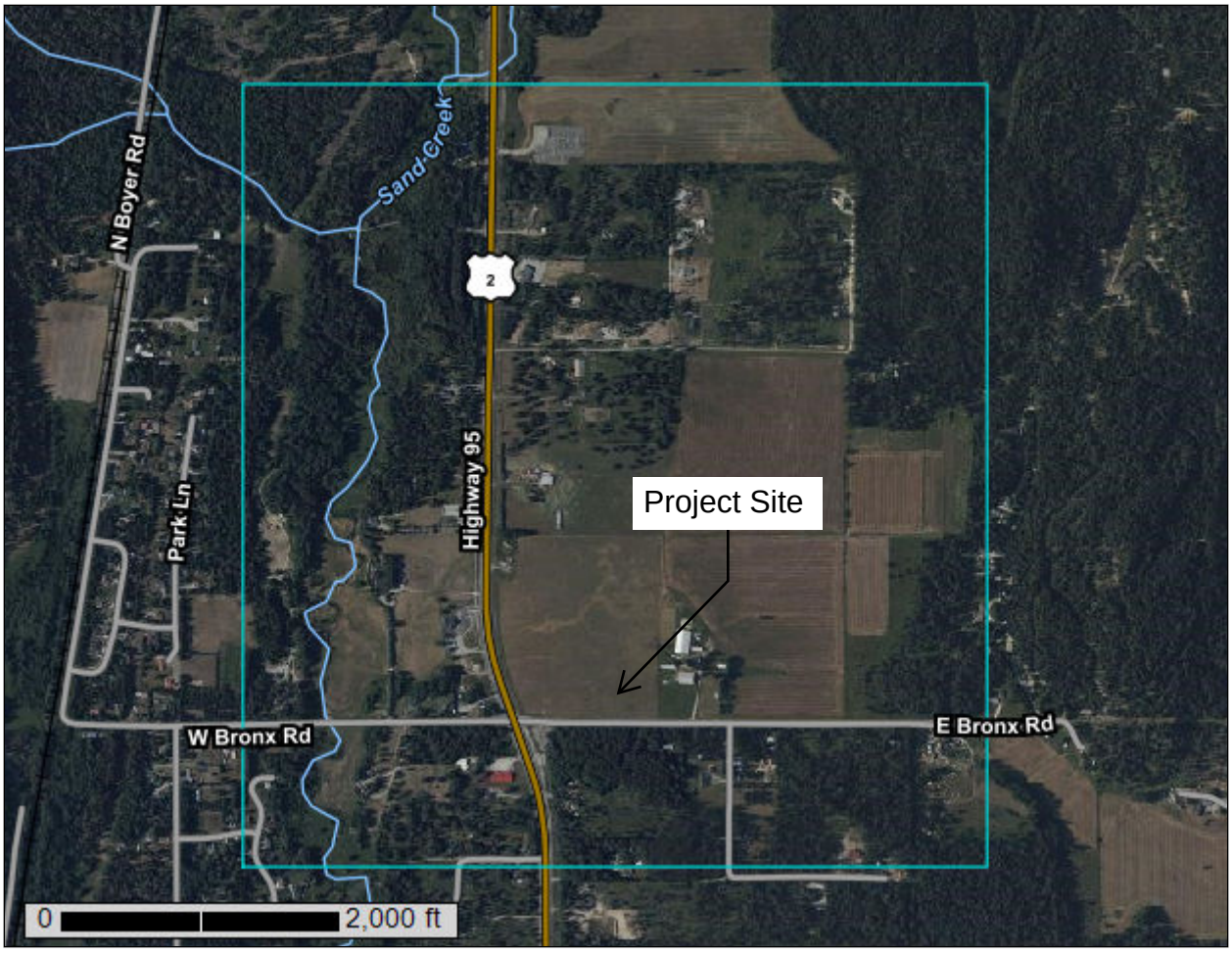
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

Avista Bronx Substation



November 13, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

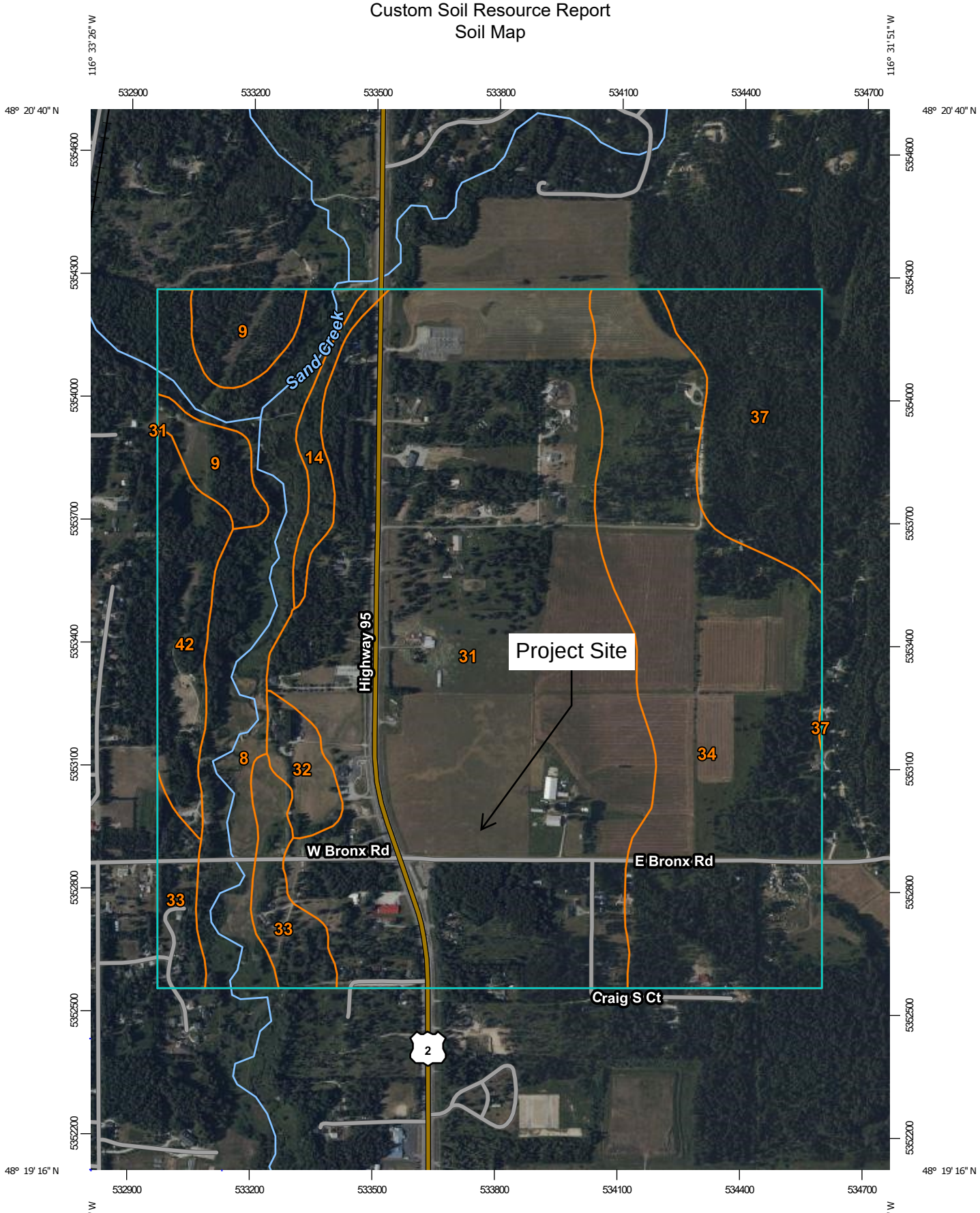
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:12,600 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Bonner County Area, Idaho, Parts of Bonner and Boundary Counties
Survey Area Data: Version 21, Aug 27, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 14, 2023—Aug 13, 2023

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Capehorn silt loam, 0 to 2 percent slopes	70.9	10.3%
9	Colburn very fine sandy loam, 0 to 4 percent slopes	23.2	3.4%
14	Haploxeralfs and Xerochrepts, 30 to 55 percent slopes	8.9	1.3%
31	Mission silt loam, 0 to 2 percent slopes	312.6	45.4%
32	Mission silt loam, 2 to 12 percent slopes	9.7	1.4%
33	Mission silt loam, 12 to 30 percent slopes	25.9	3.8%
34	Odenson silt loam, 0 to 2 percent slopes	159.7	23.2%
37	Pend Oreille-Rock outcrop complex, 5 to 45 percent slopes	50.1	7.3%
42	Pywell-Hoodoo complex, 0 to 1 percent slopes	27.3	4.0%
Totals for Area of Interest		**688.3**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different

management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Bonner County Area, Idaho, Parts of Bonner and Boundary Counties

8—Capehorn silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 547b
Elevation: 2,000 to 4,200 feet
Mean annual precipitation: 25 to 45 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 60 to 110 days
Farmland classification: Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Capehorn and similar soils: 80 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Capehorn

Setting

Landform: Drainageways, flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over outwash and/or alluvium derived from granite and/or gneiss and/or schist

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 8 inches: silt loam
Bs - 8 to 16 inches: gravelly silt loam
2Cg - 16 to 60 inches: very gravelly sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): 6c
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B/D
Ecological site: F044AY504WA - Frigid, Udic, Loamy Foothills and Drainageways, high water table (Western Hemlock/Moist Forbes) Tsuga heterophylla / Clintonia uniflora , Tsuga heterophylla / Asarum caudatum
Other vegetative classification: western redcedar/ladyfern (CN540)
Hydric soil rating: Yes

Minor Components

Hoodoo

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

9—Colburn very fine sandy loam, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 547c
Elevation: 2,000 to 4,200 feet
Mean annual precipitation: 25 to 45 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 60 to 120 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Colburn and similar soils: 70 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colburn

Setting

Landform: Alluvial fans, stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

A - 0 to 3 inches: very fine sandy loam
Bwc - 3 to 20 inches: very fine sandy loam
2Btg - 20 to 29 inches: very fine sandy loam
2Cg - 29 to 60 inches: fine sand

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 24 to 42 inches
Frequency of flooding: Rare
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F043AY526WA - Warm-Frigid, Udic, Loamy Foothills/ Mountainsides, ashy surface (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Hoodoo

Percent of map unit: 5 percent
Landform: Depressions, swales
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

Capehorn

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Other vegetative classification: western redcedar/ladyfern (CN540)
Hydric soil rating: Yes

Pywell

Percent of map unit: 5 percent
Landform: Swales, depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

14—Haploxeralfs and Xerochrepts, 30 to 55 percent slopes

Map Unit Setting

National map unit symbol: 545g
Elevation: 2,050 to 2,500 feet
Mean annual precipitation: 30 to 35 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 90 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Haploxeralfs and similar soils: 40 percent
Xerochrepts and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Haploxeralfs

Setting

Landform: Escarpments
Landform position (three-dimensional): Riser
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

A - 0 to 8 inches: silt loam
Bt - 8 to 36 inches: silty clay loam
C - 36 to 60 inches: stratified fine sand to silty clay

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 11.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F043AY526WA - Warm-Frigid, Udic, Loamy Foothills/ Mountainsides, ashy surface (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Description of Xerochrepts

Setting

Landform: Escarpments
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over sandy glaciolacustrine deposits and/or outwash and/or till

Typical profile

A - 0 to 4 inches: gravelly sandy loam
Bw - 4 to 25 inches: gravelly sandy loam
2C - 25 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 30 to 55 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: F043AY522WA - Warm-Frigid, Moist- Xeric Loamy Foothills/ Mountainsides, mixed ash surface (Grand Fir Warm Dry Shrub) Abies grandis - Pseudotsuga menziesii / Physocarpus malvaceus - Symphoricarpos albus
Other vegetative classification: grand fir/twinflower (CN590)
Hydric soil rating: No

31—Mission silt loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 5462
Elevation: 2,000 to 2,800 feet
Mean annual precipitation: 25 to 38 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Mission and similar soils: 75 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mission

Setting

Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
Bw - 3 to 12 inches: silt loam
2Btx - 12 to 21 inches: silt loam
2E - 21 to 33 inches: silt
2Bt - 33 to 48 inches: silt loam
3C - 48 to 67 inches: fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: 10 to 20 inches to fragipan
Drainage class: Somewhat poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F043AY527WA - Warm-Frigid, Udic, Loamy Foothills/Valleys, high water table (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Hoodoo

Percent of map unit: 3 percent
Landform: Drainageways, flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: Yes

Odenson

Percent of map unit: 2 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

32—Mission silt loam, 2 to 12 percent slopes

Map Unit Setting

National map unit symbol: 5463
Elevation: 2,000 to 2,800 feet
Mean annual precipitation: 25 to 38 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Farmland of statewide importance, if drained

Map Unit Composition

Mission and similar soils: 70 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mission

Setting

Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
Bw - 3 to 12 inches: silt loam
2Btx - 12 to 21 inches: silt loam
2E - 21 to 33 inches: silt
2Bt - 33 to 48 inches: silt loam
3C - 48 to 67 inches: fine sand

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: 10 to 20 inches to fragipan
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: F043AY527WA - Warm-Frigid, Udic, Loamy Foothills/Valleys, high water table (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Wrencoe

Percent of map unit: 5 percent
Landform: Flood plains
Microfeatures of landform position: Shorelines
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R043AY512ID - Loamy High Water Table Floodplains 19-24" PZ Frigid Western Bitterroot Foothills
Hydric soil rating: Yes

Hoodoo

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

33—Mission silt loam, 12 to 30 percent slopes

Map Unit Setting

National map unit symbol: 5464
Elevation: 2,050 to 2,500 feet
Mean annual precipitation: 28 to 35 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Mission and similar soils: 75 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mission

Setting

Landform: Lake terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 3 inches: silt loam
Bw - 3 to 12 inches: silt loam
2Btx - 12 to 21 inches: silt loam
2E - 21 to 33 inches: silt
2Bt - 33 to 48 inches: silt loam
3C - 48 to 67 inches: fine sand

Properties and qualities

Slope: 12 to 30 percent
Depth to restrictive feature: 10 to 20 inches to fragipan
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 6 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D

Ecological site: F043AY527WA - Warm-Frigid, Udic, Loamy Foothills/Valleys, high water table (western redcedar, moist herb) Thuja plicata / Clintonia uniflora
Other vegetative classification: western redcedar/queencup beadlily (CN530)
Hydric soil rating: No

Minor Components

Odenson
Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

34—Odenson silt loam, 0 to 2 percent slopes

Map Unit Setting
National map unit symbol: 5465
Elevation: 2,000 to 3,000 feet
Mean annual precipitation: 25 to 38 inches
Mean annual air temperature: 43 to 46 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Prime farmland if drained

Map Unit Composition
Odenson and similar soils: 70 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Odenson

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and loess over silty glaciolacustrine deposits

Typical profile
A - 0 to 9 inches: silt loam
2Bg - 9 to 18 inches: silty clay loam
2Bgk - 18 to 35 inches: silty clay loam
3Cg - 35 to 46 inches: silt loam
4Cgk - 46 to 57 inches: silty clay
5Cg - 57 to 60 inches: very fine sandy loam
6Cgk - 60 to 62 inches: silty clay
7Cg - 62 to 65 inches: silt loam

Properties and qualities
Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches

Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: High (about 11.0 inches)

Interpretive groups
Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: R043AY512ID - Loamy High Water Table Floodplains 19-24" PZ Frigid Western Bitterroot Foothills
Hydric soil rating: Yes

Minor Components

Pywell
Percent of map unit: 5 percent
Landform: Basin floors
Hydric soil rating: Yes

Wrencoe
Percent of map unit: 5 percent
Landform: Depressions
Ecological site: R043AY512ID - Loamy High Water Table Floodplains 19-24" PZ Frigid Western Bitterroot Foothills
Hydric soil rating: Yes

Hoodoo
Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

37—Pend Oreille-Rock outcrop complex, 5 to 45 percent slopes

Map Unit Setting
National map unit symbol: 5468
Elevation: 2,000 to 3,600 feet
Mean annual precipitation: 25 to 38 inches
Mean annual air temperature: 43 to 45 degrees F
Frost-free period: 70 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition
Pend oreille and similar soils: 45 percent
Rock outcrop: 25 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pend Oreille

Setting

Landform: Mountain slopes, hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Mountainflank, side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Volcanic ash and/or loess over till derived from granite and/or metamorphic rock

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 6 inches: ashy silt loam
Bw - 6 to 19 inches: gravelly loam
2Bt - 19 to 43 inches: gravelly sandy loam
2C - 43 to 60 inches: very cobbly sandy loam

Properties and qualities

Slope: 5 to 45 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: F043AY524WA - Frigid, Udic, Loamy, Foothills/Mountainsides, ashy surface (Western Hemlock/Moist Forbes) Tsuga heterophylla / Clintonia uniflora , Tsuga heterophylla / Asarum caudatum
Other vegetative classification: western hemlock/queencup beadlily (CN570)
Hydric soil rating: No

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: bedrock

Properties and qualities

Slope: 5 to 45 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Minor Components

Hoodoo

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

42—Pywell-Hoodoo complex, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 546g
Elevation: 2,000 to 4,200 feet
Mean annual precipitation: 25 to 45 inches
Mean annual air temperature: 41 to 46 degrees F
Frost-free period: 60 to 120 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Pywell and similar soils: 40 percent
Hoodoo and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pywell

Setting

Landform: Depressions, flood plains
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Herbaceous and/or woody organic material

Typical profile

Oa1 - 0 to 15 inches: muck
Oa2 - 15 to 42 inches: muck
Oe - 42 to 60 inches: mucky peat

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 0 to 48 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 26.9 inches)

Interpretive groups

Land capability classification (irrigated): 5w
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C
Ecological site: R043AY511ID - Organic Depressions 19-24" PZ Frigid Clearwater Mountains
Other vegetative classification: sedge plant associations (meadow series) - wetland (MW)
Hydric soil rating: Yes

Description of Hoodoo

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Volcanic ash and/or mixed alluvium

Typical profile

A - 0 to 15 inches: ashy silt loam
Cg1 - 15 to 52 inches: silt loam
2Cg2 - 52 to 60 inches: very cobbly silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 40 to 60 inches to abrupt textural change
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.7 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Ecological site: R043AY512ID - Loamy High Water Table Floodplains 19-24" PZ Frigid Western Bitterroot Foothills
Hydric soil rating: Yes

Minor Components

Wrencoe

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R043AY512ID - Loamy High Water Table Floodplains 19-24" PZ Frigid Western Bitterroot Foothills
Hydric soil rating: Yes

Capehorn

Percent of map unit: 5 percent
Landform: Flood plains
Down-slope shape: Linear

Across-slope shape: Concave
Other vegetative classification: western redcedar/ladyfern (CN540)
Hydric soil rating: Yes

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Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the following National Soil Survey Handbook link: “National Soil Survey Handbook.”

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology)

from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left

behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2
Low: 0.2 to 0.4
Moderately low: 0.4 to 0.75
Moderate: 0.75 to 1.25
Moderately high: 1.25 to 1.75
High: 1.75 to 2.5
Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth’s crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can

occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or “washed out” from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and

promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
   A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
   B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
   C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
   A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
   B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where “Rock outcrop” is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which “severely eroded,” “very severely eroded,” or “gullied” is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1
Moderate: 13-30:1
Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0
Coarse sand: 1.0 to 0.5
Medium sand: 0.5 to 0.25
Fine sand: 0.25 to 0.10
Very fine sand: 0.10 to 0.05
Silt: 0.05 to 0.002
Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated

Prismatic: Vertically elongated and having flat tops

Columnar: Vertically elongated and having rounded tops

Angular blocky: Having faces that intersect at sharp angles (planes)

Subangular blocky: Having subrounded and planar faces (no sharp angles)

Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand

Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field

generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

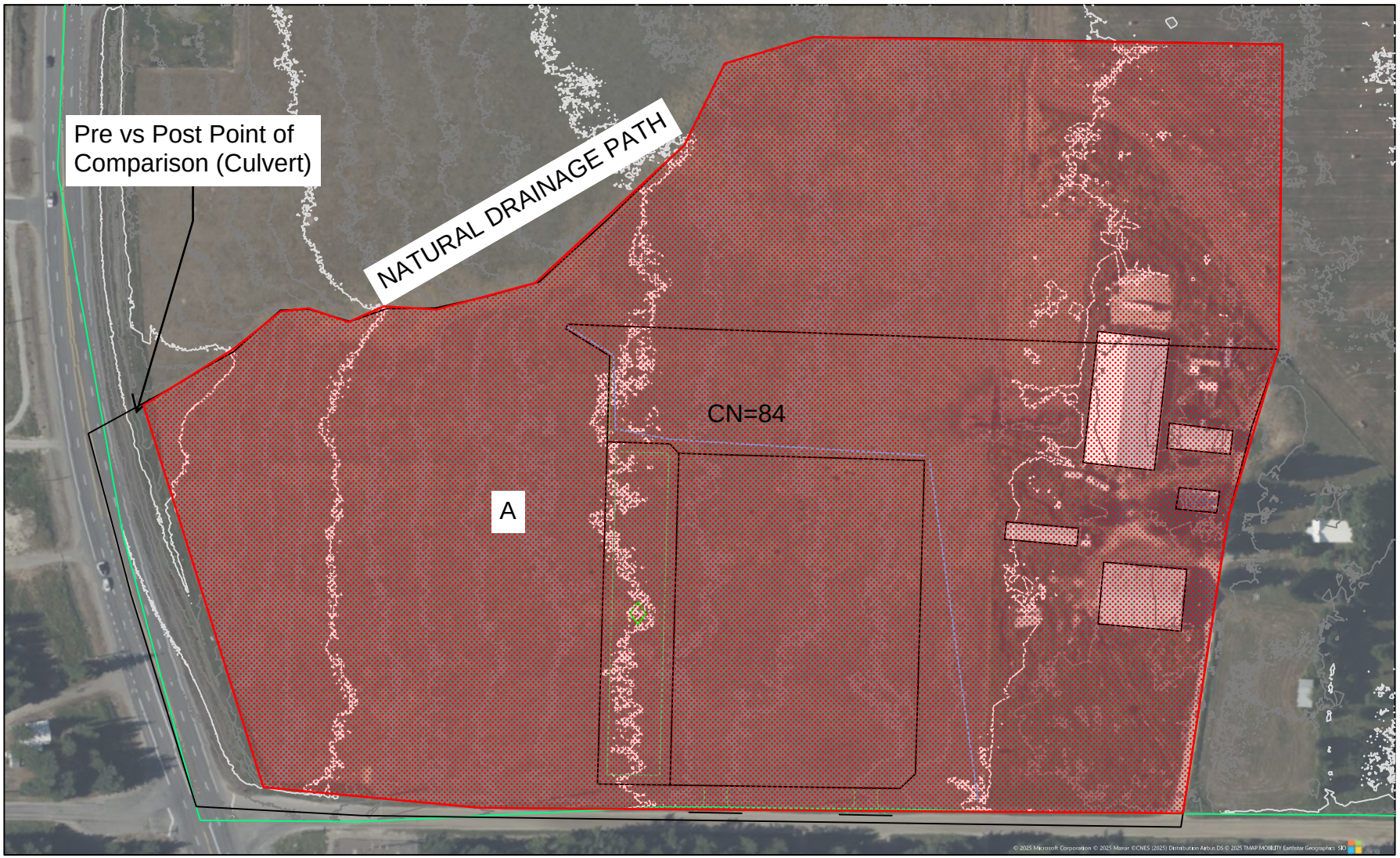
Windthrow

The uprooting and tipping over of trees by the wind.

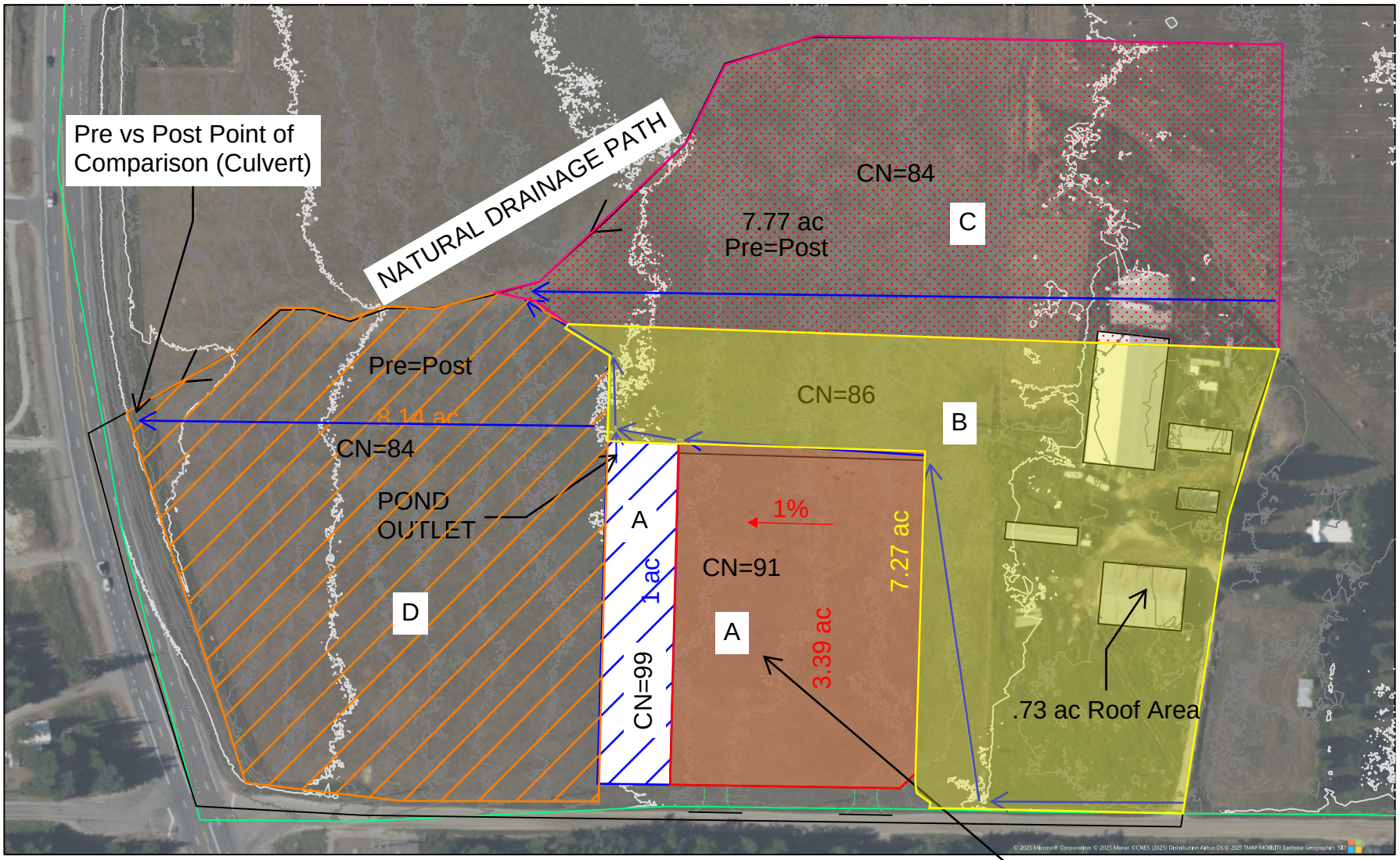
APPENDIX C

DRAINAGE CALCULATIONS/BASIN MAP

BASIN MAP (PRE)



BASIN MAP (POST)



LOCAL DESIGN STORMS (NOAA)

Time series type: Partial duration
Project area: Interior Northwest
Location nan Idaho USA
Station Name: -
Latitude: 48.3292 Degree
Longitude: -116.5441 Degree
Elevation (USGS): 2142 ft

PRECIPITATION FREQUENCY ESTIMATES

by duration f	1	2	5	10	25	50	100	200	500
5-min:	0.136	0.184	0.26	0.319	0.395	0.45	0.5	0.548	0.605
10-min:	0.188	0.256	0.36	0.443	0.548	0.624	0.694	0.76	0.84
15-min:	0.219	0.297	0.419	0.514	0.637	0.724	0.806	0.883	0.975
30-min:	0.267	0.362	0.511	0.627	0.776	0.883	0.983	1.08	1.19
60-min:	0.32	0.433	0.61	0.748	0.925	1.05	1.17	1.28	1.42
2-hr:	0.457	0.578	0.768	0.919	1.11	1.26	1.39	1.52	1.68
3-hr:	0.58	0.702	0.894	1.05	1.25	1.4	1.54	1.68	1.86
6-hr:	0.841	0.968	1.17	1.34	1.56	1.73	1.89	2.06	2.27
12-hr:	1.21	1.37	1.62	1.83	2.11	2.32	2.54	2.75	3.03
24-hr:	1.67	1.88	2.21	2.48	2.86	3.14	3.42	3.7	4.06
2-day:	2.15	2.42	2.85	3.2	3.68	4.04	4.39	4.74	5.18
3-day:	2.47	2.78	3.29	3.69	4.24	4.65	5.05	5.44	5.95
4-day:	2.74	3.09	3.65	4.1	4.7	5.15	5.59	6.02	6.57
7-day:	3.44	3.86	4.53	5.07	5.8	6.34	6.88	7.4	8.07
10-day:	4.05	4.53	5.29	5.91	6.73	7.34	7.94	8.53	9.27
20-day:	5.84	6.49	7.5	8.3	9.33	10.1	10.8	11.5	12.3
30-day:	7.3	8.07	9.26	10.2	11.4	12.2	13	13.7	14.5
45-day:	9.27	10.2	11.6	12.7	14	15	15.8	16.6	17.4
60-day:	11	12	13.6	14.8	16.3	17.3	18.2	19	19.9

MEAN ANNUAL PRECIPITATION

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Summary of Monthly Normals
1991-2020
Generated on 12/16/2025

Current Location: Elev: 2126 ft. Lat: 48.2942° N Lon: 116.5628° W
Station: **SANDPOINT EXP STN, ID US USC00108137**

Precipitation (in.)								
	Totals	**Mean Number of Days**				**Precipitation Probabilities Probability that precipitation will be equal to or less than the indicated amount**		
	Means	**Daily Precipitation**				**Monthly Precipitation vs. Probability Levels**		
Month	**Mean**	**>= 0.01**	**>= 0.10**	**>= 0.50**	**>= 1.00**	**0.25**	**0.50**	**0.75**
01	4.33	15.8	10.7	2.7	0.5	3.52	4.14	4.82
02	2.91	12.3	7.4	1.9	0.4	2.04	2.53	3.21
03	3.58	13.6	7.9	1.6	0.4	1.97	3.18	5.12
04	2.37	11.6	6.7	0.9	0.2	1.45	2.33	3.45
05	2.72	11.3	6.4	1.2	0.2	1.76	2.57	3.45
06	2.44	10.8	6.5	1.3	0.3	1.56	2.09	2.93
07	1.17	5.5	2.9	0.5	0.1	0.43	0.73	1.67
08	0.80	4.7	2.4	0.4	0.1	0.09	0.45	1.07
09	1.41	7.3	3.7	0.8	0.1	0.49	1.30	1.81
10	2.95	11.3	7.1	1.9	0.4	1.40	2.90	3.90
11	4.72	14.2	9.6	2.7	0.8	3.33	4.89	5.33
12	4.61	15.2	10.6	3.4	0.8	3.48	4.44	5.62
Summary	34.01	133.6	81.9	19.3	4.3	21.52	31.55	42.38

Empty or blank cells indicate data is missing or insufficient occurrences to compute value

*Data used for evaporation pond calculations

EVAPORATION POND CALCULATIONS

Project :	Avista Bronx Road Substation
Job No.:	n/a
Date:	1/16/26
Designer:	Brian Parsons
Pond Bottom Area:	30,100 sq. ft.
Pond Bottom Perimeter:	1,000 ft
Pond Side Slopes:	3 : 1
Assumed Pond Depth:	1.5 ft
Assumed Pond Volume:	45,150 c.ft.

Mean Annual Precipitation

Project Site 34.01

Evaporative / Detention
Combination Pond

CONDITION B - with Discharge Point

	AMC II Normal	AMC III Nov., Mar.	- - Dec.-Feb.
Pre-Dev. (Impervious) CN:	98	99	99
Pre-Dev. (Permeable) CN:	84	93	95
Post-Dev. (Impervious) CN:	98	99	99
Post-Dev. (Permeable) CN:	91	97	95
Pre-Dev.(Impervious) S:	0.20	0.10	0.10
Pre-Dev.(Permeable) S:	1.90	0.75	0.53
Post-Dev.(Impervious) S:	0.20	0.10	0.10
Post-Dev.(Permeable) S:	0.99	0.31	0.53

	Pre-dev	Post-dev		
Impervious Basin Size:	0.00	0.42	acres	
Impervious Pond Size:	0.00	0.69	acres	
Pervious Basin Size:	4.39	3.28	acres	
	4.39	4.39	acres	4.39

Month	Precip. "P" (in.)	Adj. "P" (in)	Imp pre-dev (P-0.2S)	Perm. pre-dev (P-0.2S)	Imp post-dev (P-0.2S)	Perm post-dev (P-0.2S)	Imp pre-dev Runoff Depth (in)	Perm pre-dev Runoff Depth (in)	Imp post-dev Runoff Depth (in)	Perm post-dev Runoff Depth (in)	Imp pre-dev runoff volume (cft)	Perm pre-dev runoff volume (cft)	TOTAL PRE VOL (cft)	Imp post-dev runoff volume (cft)	Perm post-dev runoff volume (cft)	TOTAL POST VOL (cft)	NET Increase in Volume (cft)	Pan Evap. (in.)	Evap Volume Out (cft) 28% Adj.	Total Volume to Handle (cft)	Current Volume in Pond (cft)	Spill Volume to Detention or Disposal < PRE (cft)
Oct.		2.95	2.91	2.57	2.91	2.75	2.72	1.48	2.72	2.02	0	23,509	23,509	10,963	24,099	35,062	11,553	2.58	4,659	30,403	30,403	0
Nov.		4.72	4.70	4.57	4.70	4.66	4.60	3.92	4.60	4.37	0	62,519	62,519	18,555	51,993	70,548	8,029	0.92	1,662	99,289	45,150	54,139
Dec.		4.61	4.59	4.50	4.59	4.50	4.49	4.03	4.49	4.03	0	64,276	64,276	18,112	48,010	66,121	1,845	0.51	921	110,350	45,150	65,200
Jan.		4.33	4.31	4.22	4.31	4.22	4.21	3.76	4.21	3.76	0	59,866	59,866	16,983	44,715	61,699	1,832	0.61	1,102	105,747	45,150	60,597
Feb.		2.91	2.89	2.80	2.89	2.80	2.79	2.36	2.79	2.36	0	37,633	37,633	11,261	28,109	39,370	1,737	1.11	2,005	82,515	45,150	37,365
Mar.		3.58	3.56	3.43	3.56	3.52	3.46	2.81	3.46	3.23	0	44,815	44,815	13,960	38,492	52,452	7,637	2.28	4,118	93,484	45,150	48,334
Apr.		2.37	2.33	1.99	2.33	2.17	2.14	1.02	2.14	1.49	0	16,191	16,191	8,637	17,766	26,403	10,211	4.45	8,037	63,516	45,150	18,366
May		2.72	2.68	2.34	2.68	2.52	2.49	1.29	2.49	1.81	0	20,544	20,544	10,040	21,565	31,605	11,061	6.69	12,082	64,673	45,150	19,523
June		2.44	2.40	2.06	2.40	2.24	2.21	1.07	2.21	1.56	0	17,045	17,045	8,917	18,520	27,437	10,392	8.14	14,701	57,886	45,150	12,736
July		1.17	1.13	0.79	1.13	0.97	0.96	0.23	0.96	0.48	0	3,683	3,683	3,857	5,736	9,593	5,910	10.7	19,324	35,419	35,419	0
Aug.		0.80	0.76	0.42	0.76	0.60	0.60	0.08	0.60	0.23	0	1,204	1,204	2,413	2,713	5,126	3,922	9.42	17,013	23,532	23,532	0
Sept.		1.41	1.37	1.03	1.37	1.21	1.19	0.36	1.19	0.67	0	5,752	5,752	4,806	7,946	12,751	6,999	5.9	10,655	25,628	25,628	0
Oct.		2.95	2.91	2.57	2.91	2.75	2.72	1.48	2.72	2.02	0	23,509	23,509	10,963	24,099	35,062	11,553	2.58	4,659	56,031	45,150	10,881
Nov.		4.72	4.70	4.57	4.70	4.66	4.60	3.92	4.60	4.37	0	62,519	62,519	18,555	51,993	70,548	8,029	0.92	1,662	114,036	45,150	68,886
Dec.		4.61	4.59	4.50	4.59	4.50	4.49	4.03	4.49	4.03	0	64,276	64,276	18,112	48,010	66,121	1,845	0.51	921	110,350	45,150	65,200
Jan.		4.33	4.31	4.22	4.31	4.22	4.21	3.76	4.21	3.76	0	59,866	59,866	16,983	44,715	61,699	1,832	0.61	1,102	105,747	45,150	60,597
Feb.		2.91	2.89	2.80	2.89	2.80	2.79	2.36	2.79	2.36	0	37,633	37,633	11,261	28,109	39,370	1,737	1.11	2,005	82,515	45,150	37,365
Mar.		3.58	3.56	3.43	3.56	3.52	3.46	2.81	3.46	3.23	0	44,815	44,815	13,960	38,492	52,452	7,637	2.28	4,118	93,484	45,150	48,334
Apr.		2.37	2.33	1.99	2.33	2.17	2.14	1.02	2.14	1.49	0	16,191	16,191	8,637	17,766	26,403	10,211	4.45	8,037	63,516	45,150	18,366
May		2.72	2.68	2.34	2.68	2.52	2.49	1.29	2.49	1.81	0	20,544	20,544	10,040	21,565	31,605	11,061	6.69	12,082	64,673	45,150	19,523
June		2.44	2.40	2.06	2.40	2.24	2.21	1.07	2.21	1.56	0	17,045	17,045	8,917	18,520	27,437	10,392	8.14	14,701	57,886	45,150	12,736
July		1.17	1.13	0.79	1.13	0.97	0.96	0.23	0.96	0.48	0	3,683	3,683	3,857	5,736	9,593	5,910	10.7	19,324	35,419	35,419	0
Aug.		0.80	0.76	0.42	0.76	0.60	0.60	0.08	0.60	0.23	0	1,204	1,204	2,413	2,713	5,126	3,922	9.42	17,013	23,532	23,532	0
Sept.		1.41	1.37	1.03	1.37	1.21	1.19	0.36	1.19	0.67	0	5,752	5,752	4,806	7,946	12,751	6,999	5.9	10,655	25,628	25,628	0
Oct.		2.95	2.91	2.57	2.91	2.75	2.72	1.48	2.72	2.02	0	23,509	23,509	10,963	24,099	35,062	11,553	2.58	4,659	56,031	45,150	10,881
																			96277.86			
											total annual pre		357,039	total annual post		438,167	81,128	Net Increase			Amount spilled	341,889

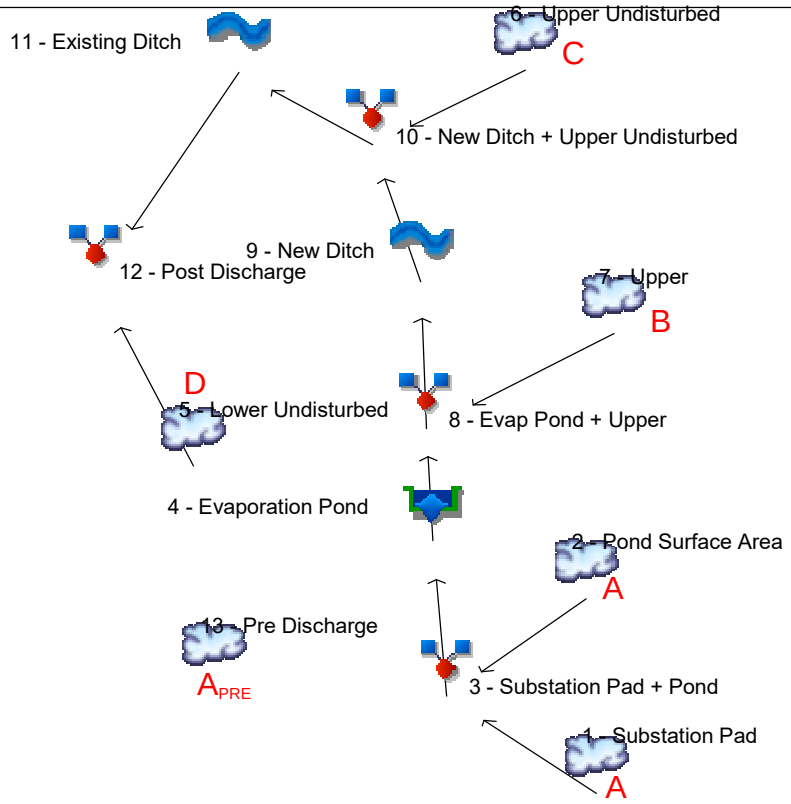
34.01 Mean Annual Precipitation for Project Site

Notes:

1. Initial 100 year storm volume was determined by utilizing Quick TR-55 and Pond2 software
2. Run-off curve numbers for normal conditions (AMC II) were established from Table 9.1A (210-VI-NEH-4, Amend. 7, November 1988) of the U.S. Dept. of Agriculture Soil Conservation Service manu
3. Run-off curve numbers for wet conditions (AMC III) were established from Table 10.1 of the U.S. Dept. of Agriculture Soil Conservation Service manu
4. Run-off curve numbers for snowpack/snowmelt conditions were taken from the Policy Memorandum on Minimum Standards for Evaporative Pond Drainage System*Interim* (March 7, 1997).
5. Precipitation values were obtained from the National Oceanic and Atmospheric Administration, December 1997
6. Pan evaporation values were obtained from the National Oceanic and Atmospheric Administration, December 1997
7. Seasonal Run-off depth percentage = (Run-off Depth / Precipitation)(100
8. Run-off Depth = (P-0.2S)2 / (P+0.8S
9. Total volume = (basin size)(43,560)(run-off depth / 12
10. NET Total Volume = (Post-Dev. Total VolumeBasin A + Post-Dev. Total VolumeBasin B) - (Pre-Dev. Total Volume
11. Total Evaporative Volume Out = ((Pan Evap. / 12)(Pond Bottom Area + (Pond Depth*Slope*Pond Bottom Perimeter)))*0.7
12. Total Stored Volume in Pond = (Previous Total Stored Volume in Pond + NET Total Volume) - (Total Evaporative Volume Ou
13. Pond Depth = Total Volume / Pond Bottom Area
14. Total Basin Size refers to developed area only
15. Mean Annual Precipitation adjusted from 16.11 to insert adjusted Mean Annual Precipitation (reference attached U.S. Weather Bureau Map)

Hydraflow Table of Contents

Watershed Model Schematic

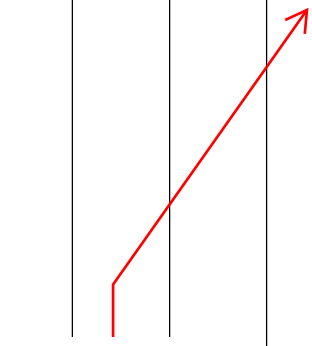


Legend

Hyd.	Origin	Description
1	SCS Runoff	Substation Pad
2	SCS Runoff	Pond Surface Area
3	Combine	Substation Pad + Pond
4	Reservoir	Evaporation Pond
5	SCS Runoff	Lower Undisturbed
6	SCS Runoff	Upper Undisturbed
7	SCS Runoff	Upper
8	Combine	Evap Pond + Upper
9	Reach	New Ditch
10	Combine	New Ditch + Upper Undisturbed
11	Reach	Existing Ditch
12	Combine	Post Discharge
13	SCS Runoff	Pre Discharge

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	------	-------	-------	-------	-------	-------	7.267	-------	-------	Substation Pad
2	SCS Runoff	------	-------	-------	-------	-------	-------	7.196	-------	-------	Pond Surface Area
3	Combine	1, 2	-------	-------	-------	-------	-------	10.15	-------	-------	Substation Pad + Pond
4	Reservoir	3	-------	-------	-------	-------	-------	0.786	-------	-------	Evaporation Pond
5	SCS Runoff	------	-------	-------	-------	-------	-------	4.584	-------	-------	Lower Undisturbed
6	SCS Runoff	------	-------	-------	-------	-------	-------	4.237	-------	-------	Upper Undisturbed
7	SCS Runoff	------	-------	-------	-------	-------	-------	3.393	-------	-------	Upper
8	Combine	4, 7	-------	-------	-------	-------	-------	4.178	-------	-------	Evap Pond + Upper
9	Reach	8	-------	-------	-------	-------	-------	4.177	-------	-------	New Ditch
10	Combine	6, 9	-------	-------	-------	-------	-------	8.195	-------	-------	New Ditch + Upper Undisturbed
11	Reach	10	-------	-------	-------	-------	-------	8.163	-------	-------	Existing Ditch
12	Combine	5, 11	-------	-------	-------	-------	-------	12.38	-------	-------	Post Discharge
13	SCS Runoff	------	-------	-------	-------	-------	-------	12.46	-------	-------	Pre Discharge



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025

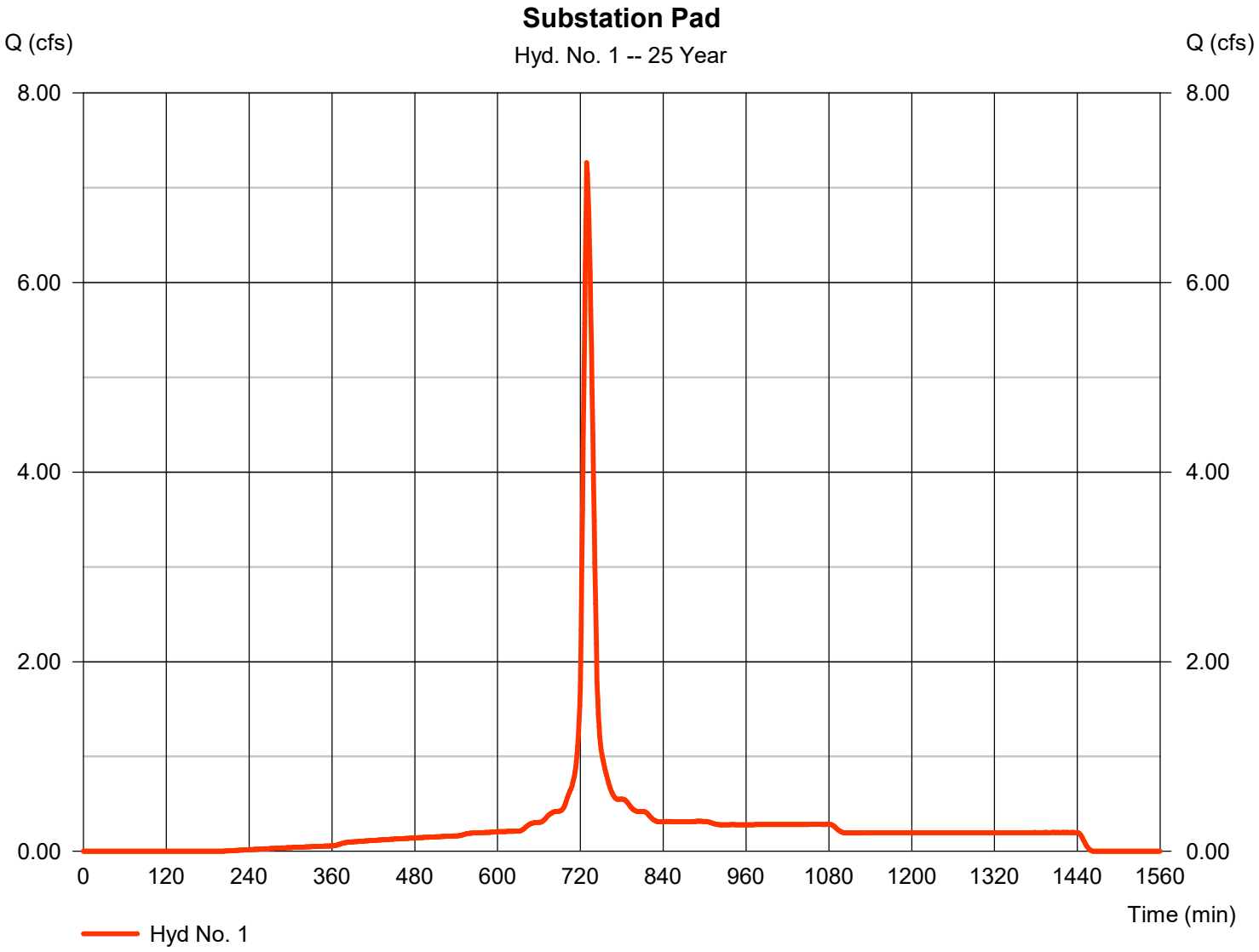
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	7.267	1	729	23,865	------	------	------	Substation Pad
2	SCS Runoff	7.196	1	722	9,332	------	------	------	Pond Surface Area
3	Combine	10.15	1	722	33,197	1, 2	------	------	Substation Pad + Pond
4	Reservoir	0.786	1	766	29,730	3	2141.65	64,612	Evaporation Pond
5	SCS Runoff	4.584	1	757	40,324	------	------	------	Lower Undisturbed
6	SCS Runoff	4.237	1	761	39,536	------	------	------	Upper Undisturbed
7	SCS Runoff	3.393	1	770	36,647	------	------	------	Upper
8	Combine	4.178	1	770	66,377	4, 7	------	------	Evap Pond + Upper
9	Reach	4.177	1	771	66,375	8	------	------	New Ditch
10	Combine	8.195	1	769	105,911	6, 9	------	------	New Ditch + Upper Undisturbed
11	Reach	8.163	1	771	105,907	10	------	------	Existing Ditch
12	Combine	12.38	1	766	146,231	5, 11	------	------	Post Discharge
13	SCS Runoff	12.46	1	770	135,467	------	------	------	Pre Discharge

Hydrograph Report

Hyd. No. 1

Substation Pad

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.267 cfs
Storm frequency	=	25 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	23,865 cuft
Drainage area	=	3.387 ac	Curve number	=	91
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	15.00 min
Total precip.	=	2.86 in	Distribution	=	Custom
Storm duration	=	C:\Users\bpp9189\OneDrive - Aviation Construction\Projects\Bronx\Stormwater\Bron	Shape factor	=	484

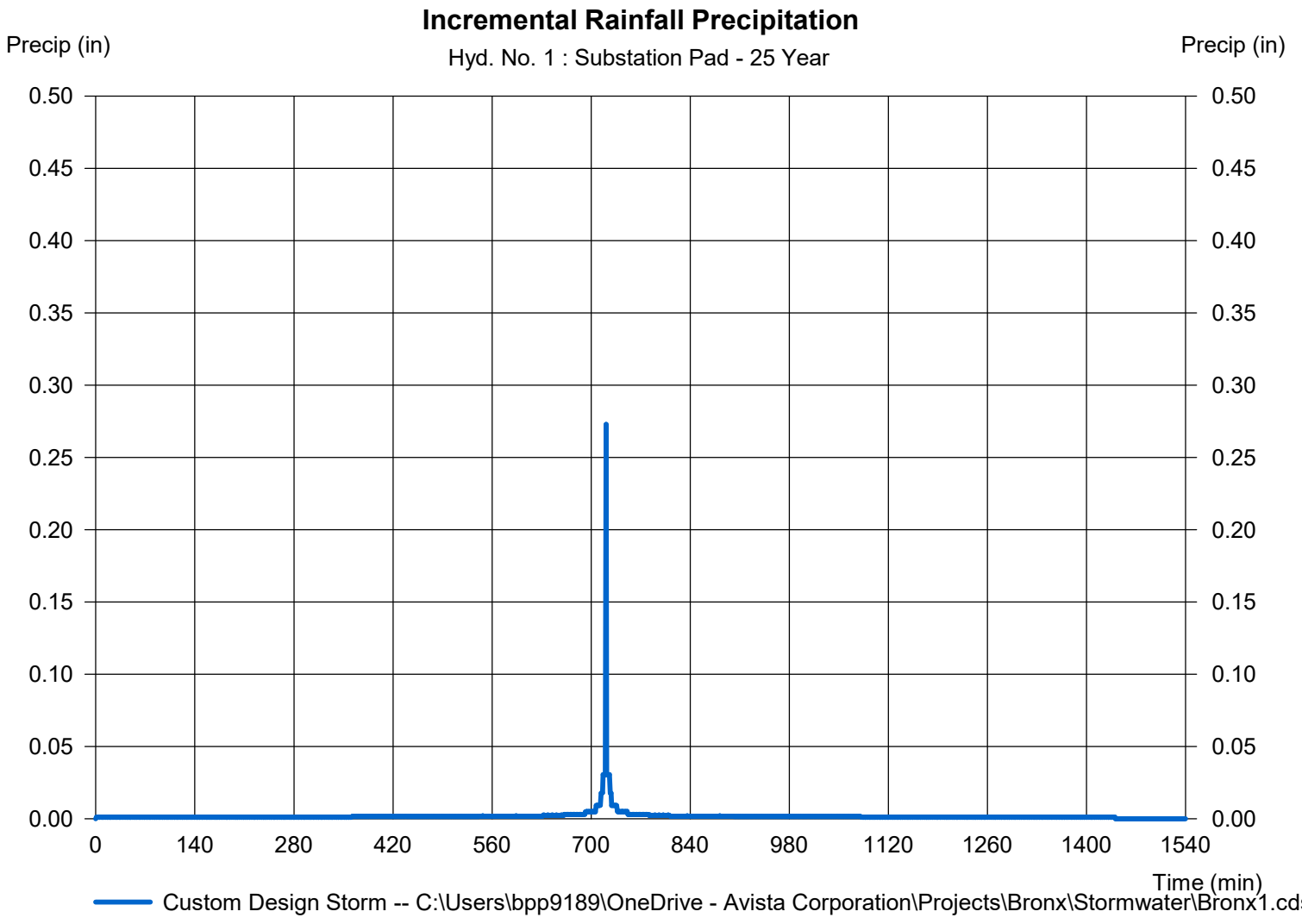


Precipitation Report

Hyd. No. 1

Substation Pad

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		

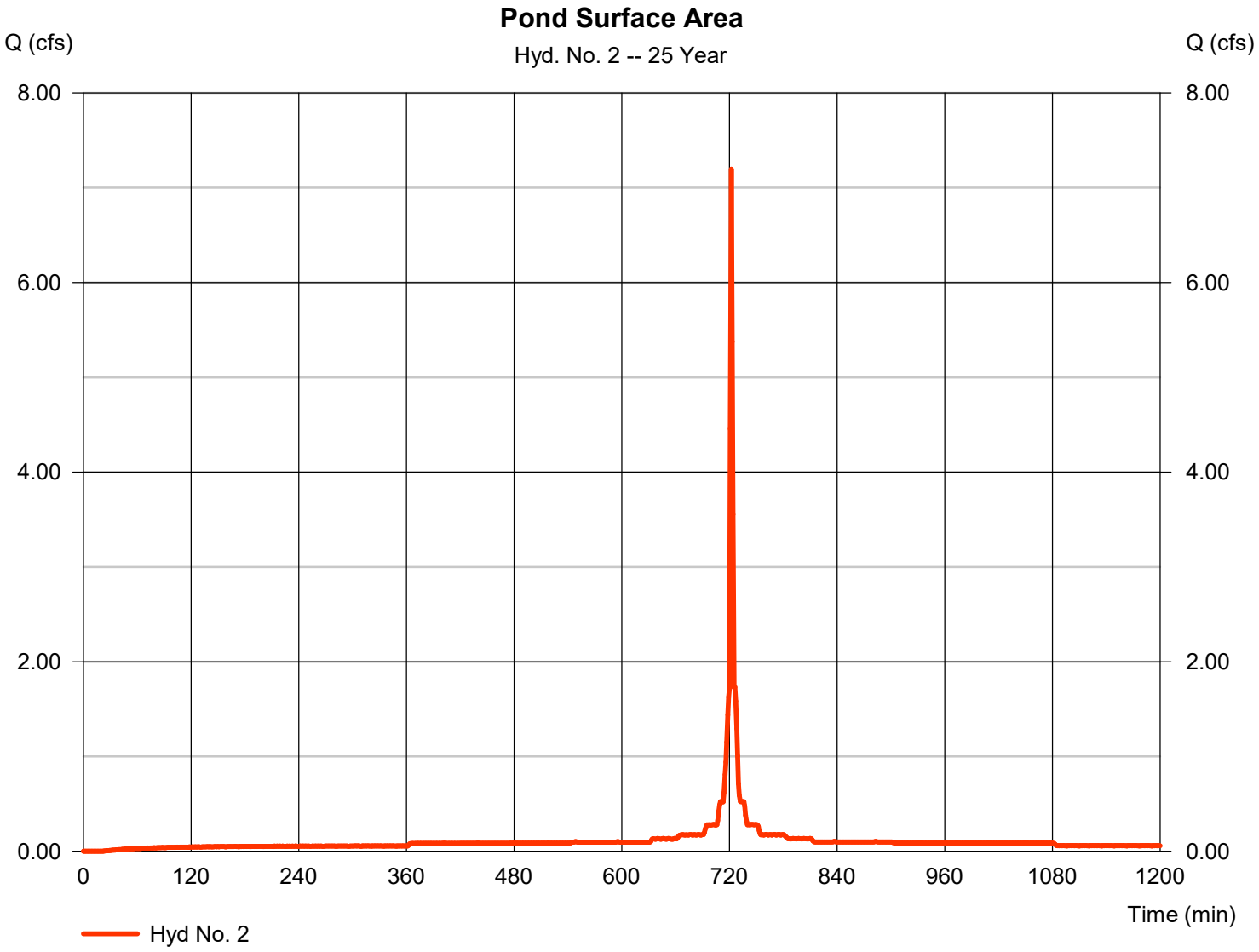


Hydrograph Report

Hyd. No. 2

Pond Surface Area

Hydrograph type	=	SCS Runoff	Peak discharge	=	7.196 cfs
Storm frequency	=	25 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	9,332 cuft
Drainage area	=	1.000 ac	Curve number	=	99
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	2.00 min
Total precip.	=	2.86 in	Distribution	=	Custom
Storm duration	=	C:\Users\bpp9189\OneDrive - AmerCor	Shape Factor	=	484

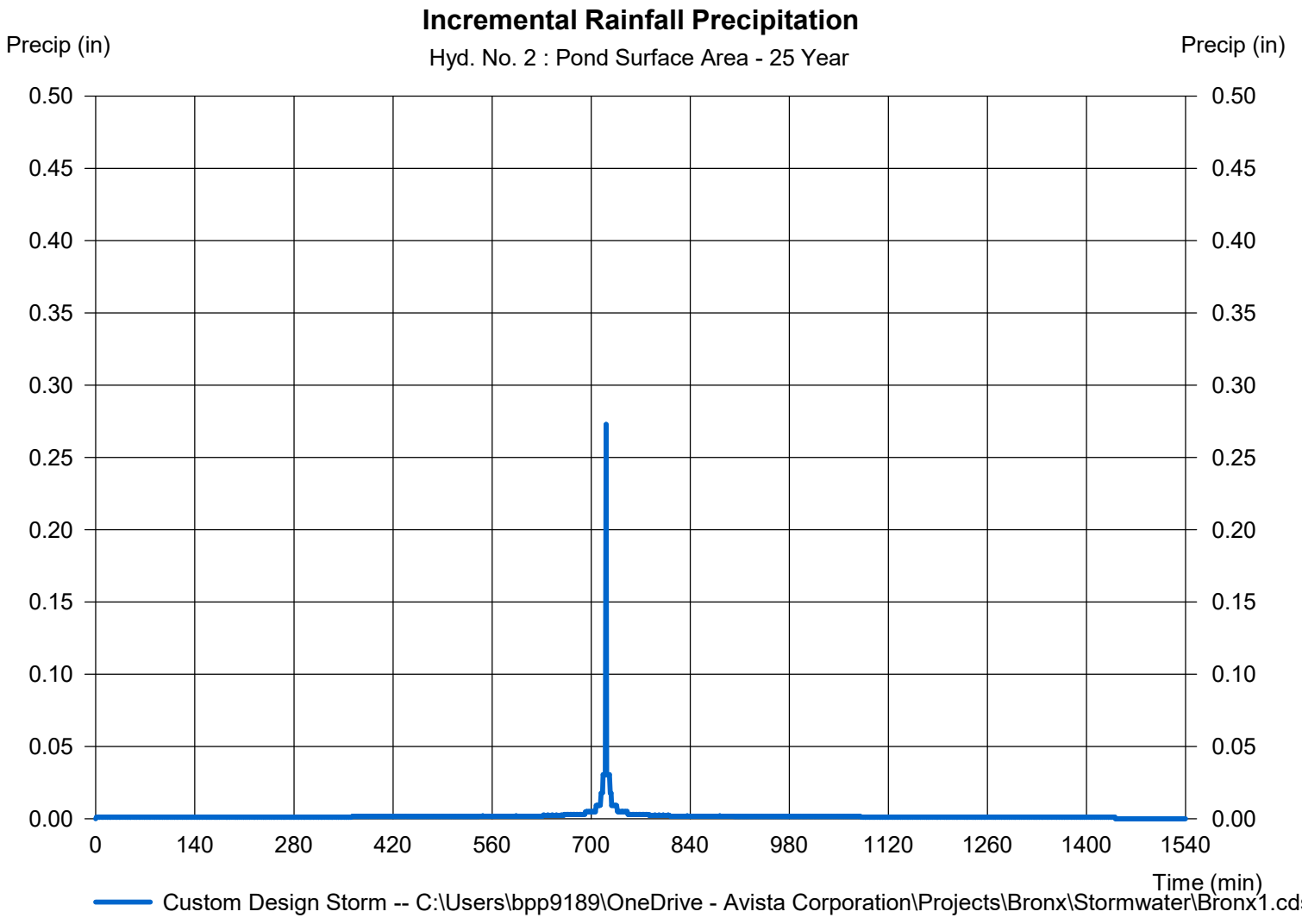


Precipitation Report

Hyd. No. 2

Pond Surface Area

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		

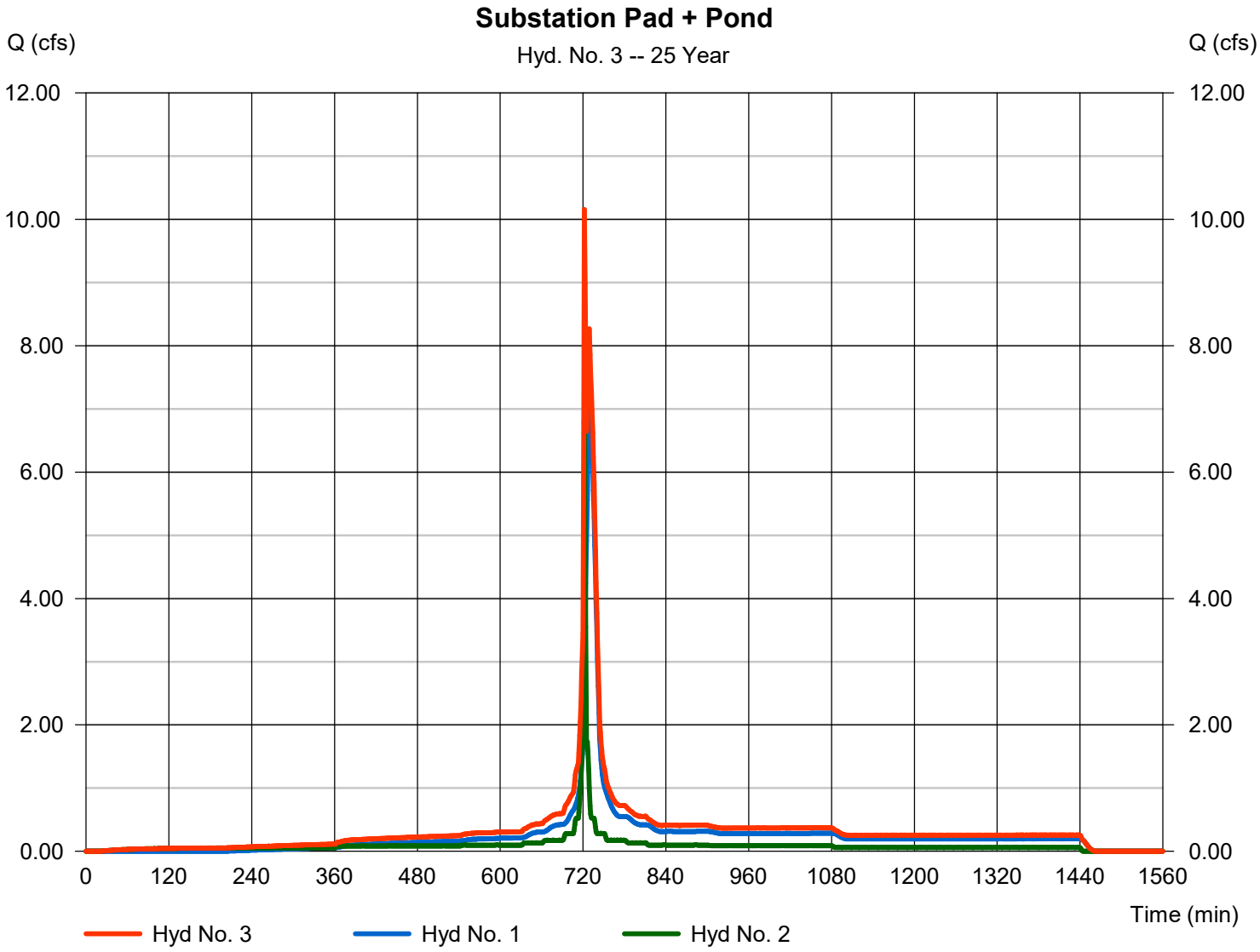


Hydrograph Report

Hyd. No. 3

Substation Pad + Pond

Hydrograph type	=	Combine	Peak discharge	=	10.15 cfs
Storm frequency	=	25 yrs	Time to peak	=	722 min
Time interval	=	1 min	Hyd. volume	=	33,197 cuft
Inflow hyds.	=	1, 2	Contrib. drain. area	=	4.387 ac



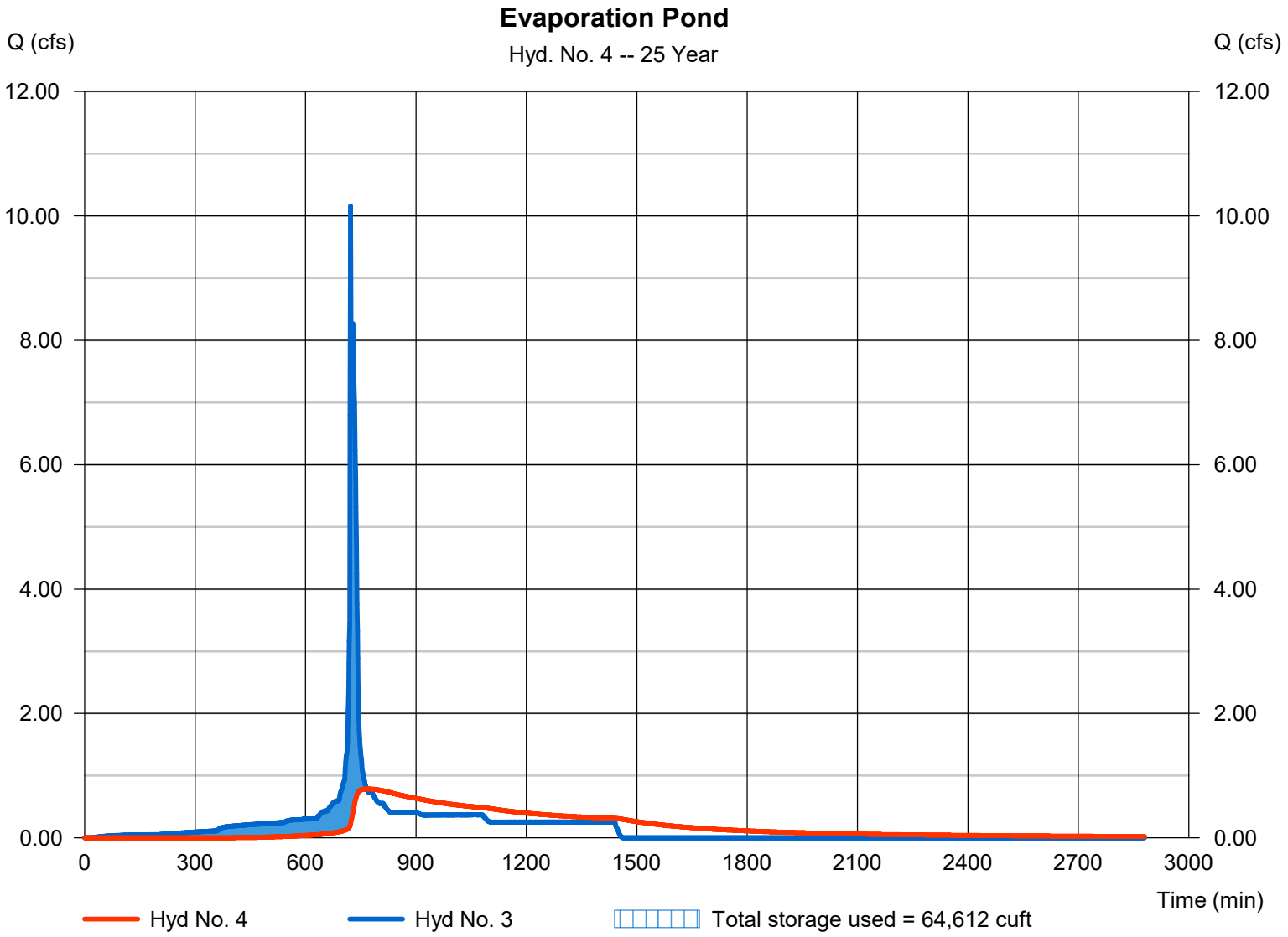
Hydrograph Report

Hyd. No. 4

Evaporation Pond

Hydrograph type	=	Reservoir	Peak discharge	=	0.786 cfs
Storm frequency	=	25 yrs	Time to peak	=	766 min
Time interval	=	1 min	Hyd. volume	=	29,730 cuft
Inflow hyd. No.	=	3 - Substation Pad + Pond	Max. Elevation	=	2141.65 ft
Reservoir name	=	Evaporation Pond	Max. Storage	=	64,612 cuft

Storage Indication method used. Wet pond routing start elevation = 2141.17 ft.



Pond No. 1 - Evaporation Pond

Pond Data

Trapezoid -Bottom L x W = 430.3 x 70.0 ft, Side slope = 3.00:1, Bottom elev. = 2139.70 ft, Depth = 3.50 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	2139.70	30,118	0	0
0.35	2140.05	31,173	10,726	10,726
0.70	2140.40	32,237	11,097	21,822
1.05	2140.75	33,310	11,470	33,293
1.40	2141.10	34,391	11,847	45,140
1.75	2141.45	35,481	12,227	57,367
2.10	2141.80	36,580	12,610	69,978
2.45	2142.15	37,688	12,997	82,974
2.80	2142.50	38,805	13,386	96,360
3.15	2142.85	39,930	13,778	110,139
3.50	2143.20	41,065	14,174	124,313

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 2141.20	0.00	0.00	0.00
Length (ft)	= 16.70	0.00	0.00	0.00
Slope (%)	= 7.80	0.00	0.00	n/a
N-Value	= .025	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	2139.70	0.00	---	---	---	---	---	---	---	---	---	0.000
0.04	1,073	2139.74	0.00	---	---	---	---	---	---	---	---	---	0.000
0.07	2,145	2139.77	0.00	---	---	---	---	---	---	---	---	---	0.000
0.10	3,218	2139.80	0.00	---	---	---	---	---	---	---	---	---	0.000
0.14	4,290	2139.84	0.00	---	---	---	---	---	---	---	---	---	0.000
0.17	5,363	2139.88	0.00	---	---	---	---	---	---	---	---	---	0.000
0.21	6,435	2139.91	0.00	---	---	---	---	---	---	---	---	---	0.000
0.25	7,508	2139.94	0.00	---	---	---	---	---	---	---	---	---	0.000
0.28	8,581	2139.98	0.00	---	---	---	---	---	---	---	---	---	0.000
0.31	9,653	2140.01	0.00	---	---	---	---	---	---	---	---	---	0.000
0.35	10,726	2140.05	0.00	---	---	---	---	---	---	---	---	---	0.000
0.38	11,835	2140.08	0.00	---	---	---	---	---	---	---	---	---	0.000
0.42	12,945	2140.12	0.00	---	---	---	---	---	---	---	---	---	0.000
0.46	14,055	2140.16	0.00	---	---	---	---	---	---	---	---	---	0.000
0.49	15,164	2140.19	0.00	---	---	---	---	---	---	---	---	---	0.000
0.52	16,274	2140.23	0.00	---	---	---	---	---	---	---	---	---	0.000
0.56	17,384	2140.26	0.00	---	---	---	---	---	---	---	---	---	0.000
0.60	18,493	2140.29	0.00	---	---	---	---	---	---	---	---	---	0.000
0.63	19,603	2140.33	0.00	---	---	---	---	---	---	---	---	---	0.000
0.67	20,713	2140.36	0.00	---	---	---	---	---	---	---	---	---	0.000
0.70	21,822	2140.40	0.00	---	---	---	---	---	---	---	---	---	0.000
0.74	22,969	2140.44	0.00	---	---	---	---	---	---	---	---	---	0.000
0.77	24,116	2140.47	0.00	---	---	---	---	---	---	---	---	---	0.000
0.80	25,263	2140.50	0.00	---	---	---	---	---	---	---	---	---	0.000
0.84	26,410	2140.54	0.00	---	---	---	---	---	---	---	---	---	0.000
0.87	27,557	2140.57	0.00	---	---	---	---	---	---	---	---	---	0.000
0.91	28,704	2140.61	0.00	---	---	---	---	---	---	---	---	---	0.000
0.94	29,852	2140.64	0.00	---	---	---	---	---	---	---	---	---	0.000
0.98	30,999	2140.68	0.00	---	---	---	---	---	---	---	---	---	0.000
1.01	32,146	2140.71	0.00	---	---	---	---	---	---	---	---	---	0.000
1.05	33,293	2140.75	0.00	---	---	---	---	---	---	---	---	---	0.000
1.09	34,477	2140.78	0.00	---	---	---	---	---	---	---	---	---	0.000

Continues on next page...

Evaporation Pond

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.12	35,662	2140.82	0.00	---	---	---	---	---	---	---	---	---	0.000
1.15	36,847	2140.85	0.00	---	---	---	---	---	---	---	---	---	0.000
1.19	38,032	2140.89	0.00	---	---	---	---	---	---	---	---	---	0.000
1.23	39,216	2140.93	0.00	---	---	---	---	---	---	---	---	---	0.000
1.26	40,401	2140.96	0.00	---	---	---	---	---	---	---	---	---	0.000
1.29	41,586	2140.99	0.00	---	---	---	---	---	---	---	---	---	0.000
1.33	42,770	2141.03	0.00	---	---	---	---	---	---	---	---	---	0.000
1.37	43,955	2141.06	0.00	---	---	---	---	---	---	---	---	---	0.000
1.40	45,140	2141.10	0.00	---	---	---	---	---	---	---	---	---	0.000
1.43	46,363	2141.14	0.00	---	---	---	---	---	---	---	---	---	0.000
1.47	47,585	2141.17	0.00	---	---	---	---	---	---	---	---	---	0.000
1.50	48,808	2141.21	0.00 ic	---	---	---	---	---	---	---	---	---	0.000
1.54	50,031	2141.24	0.01 ic	---	---	---	---	---	---	---	---	---	0.007
1.58	51,254	2141.27	0.02 ic	---	---	---	---	---	---	---	---	---	0.025
1.61	52,476	2141.31	0.05 ic	---	---	---	---	---	---	---	---	---	0.053
1.64	53,699	2141.34	0.09 ic	---	---	---	---	---	---	---	---	---	0.091
1.68	54,922	2141.38	0.14 ic	---	---	---	---	---	---	---	---	---	0.138
1.72	56,145	2141.41	0.19 ic	---	---	---	---	---	---	---	---	---	0.195
1.75	57,367	2141.45	0.26 ic	---	---	---	---	---	---	---	---	---	0.262
1.78	58,628	2141.49	0.34 ic	---	---	---	---	---	---	---	---	---	0.335
1.82	59,889	2141.52	0.42 ic	---	---	---	---	---	---	---	---	---	0.418
1.86	61,150	2141.55	0.51 ic	---	---	---	---	---	---	---	---	---	0.507
1.89	62,411	2141.59	0.60 ic	---	---	---	---	---	---	---	---	---	0.603
1.92	63,673	2141.63	0.71 ic	---	---	---	---	---	---	---	---	---	0.705
1.96	64,934	2141.66	0.81 ic	---	---	---	---	---	---	---	---	---	0.814
2.00	66,195	2141.69	0.93 ic	---	---	---	---	---	---	---	---	---	0.927
2.03	67,456	2141.73	1.05 ic	---	---	---	---	---	---	---	---	---	1.047
2.07	68,717	2141.76	1.17 ic	---	---	---	---	---	---	---	---	---	1.168
2.10	69,978	2141.80	1.30 ic	---	---	---	---	---	---	---	---	---	1.299
2.13	71,277	2141.83	1.43 ic	---	---	---	---	---	---	---	---	---	1.429
2.17	72,577	2141.87	1.56 ic	---	---	---	---	---	---	---	---	---	1.559
2.20	73,877	2141.91	1.69 ic	---	---	---	---	---	---	---	---	---	1.692
2.24	75,176	2141.94	1.83 ic	---	---	---	---	---	---	---	---	---	1.825
2.28	76,476	2141.98	1.96 ic	---	---	---	---	---	---	---	---	---	1.958
2.31	77,776	2142.01	2.09 ic	---	---	---	---	---	---	---	---	---	2.088
2.35	79,075	2142.04	2.21 ic	---	---	---	---	---	---	---	---	---	2.214
2.38	80,375	2142.08	2.34 ic	---	---	---	---	---	---	---	---	---	2.337
2.42	81,675	2142.11	2.45 ic	---	---	---	---	---	---	---	---	---	2.451
2.45	82,974	2142.15	2.56 ic	---	---	---	---	---	---	---	---	---	2.558
2.48	84,313	2142.19	2.65 ic	---	---	---	---	---	---	---	---	---	2.645
2.52	85,652	2142.22	2.73 ic	---	---	---	---	---	---	---	---	---	2.726
2.56	86,990	2142.25	2.82 ic	---	---	---	---	---	---	---	---	---	2.816
2.59	88,329	2142.29	2.90 ic	---	---	---	---	---	---	---	---	---	2.903
2.63	89,668	2142.32	2.99 ic	---	---	---	---	---	---	---	---	---	2.988
2.66	91,006	2142.36	3.07 ic	---	---	---	---	---	---	---	---	---	3.071
2.69	92,345	2142.39	3.15 ic	---	---	---	---	---	---	---	---	---	3.151
2.73	93,683	2142.43	3.23 ic	---	---	---	---	---	---	---	---	---	3.229
2.77	95,022	2142.46	3.31 ic	---	---	---	---	---	---	---	---	---	3.305
2.80	96,360	2142.50	3.38 ic	---	---	---	---	---	---	---	---	---	3.382
2.84	97,738	2142.53	3.46 ic	---	---	---	---	---	---	---	---	---	3.455
2.87	99,116	2142.57	3.53 ic	---	---	---	---	---	---	---	---	---	3.527
2.90	100,494	2142.60	3.60 ic	---	---	---	---	---	---	---	---	---	3.597
2.94	101,872	2142.64	3.67 ic	---	---	---	---	---	---	---	---	---	3.665
2.97	103,250	2142.68	3.73 ic	---	---	---	---	---	---	---	---	---	3.733
3.01	104,628	2142.71	3.80 ic	---	---	---	---	---	---	---	---	---	3.799
3.05	106,005	2142.74	3.86 ic	---	---	---	---	---	---	---	---	---	3.864
3.08	107,383	2142.78	3.93 ic	---	---	---	---	---	---	---	---	---	3.928
3.12	108,761	2142.81	3.99 ic	---	---	---	---	---	---	---	---	---	3.991
3.15	110,139	2142.85	4.05 ic	---	---	---	---	---	---	---	---	---	4.055
3.18	111,556	2142.89	4.12 ic	---	---	---	---	---	---	---	---	---	4.116
3.22	112,974	2142.92	4.18 ic	---	---	---	---	---	---	---	---	---	4.176
3.26	114,391	2142.96	4.24 ic	---	---	---	---	---	---	---	---	---	4.235
3.29	115,808	2142.99	4.29 ic	---	---	---	---	---	---	---	---	---	4.294
3.33	117,226	2143.02	4.35 ic	---	---	---	---	---	---	---	---	---	4.352
3.36	118,643	2143.06	4.41 ic	---	---	---	---	---	---	---	---	---	4.409
3.39	120,061	2143.09	4.46 ic	---	---	---	---	---	---	---	---	---	4.465
3.43	121,478	2143.13	4.52 ic	---	---	---	---	---	---	---	---	---	4.520
3.46	122,895	2143.16	4.58 ic	---	---	---	---	---	---	---	---	---	4.575
3.50	124,313	2143.20	4.63 ic	---	---	---	---	---	---	---	---	---	4.631

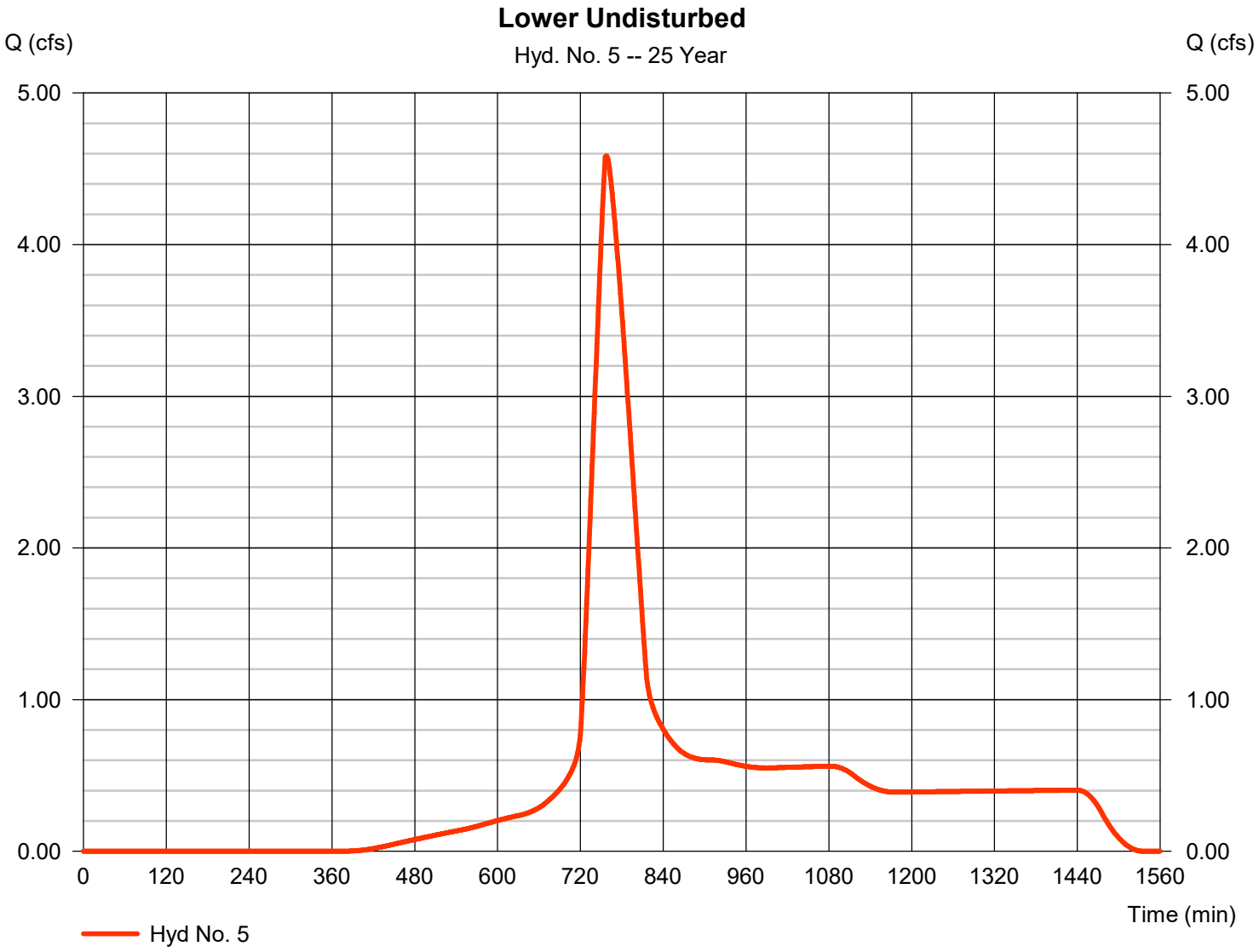
...End

Hydrograph Report

Hyd. No. 5

Lower Undisturbed

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.584 cfs
Storm frequency	=	25 yrs	Time to peak	=	757 min
Time interval	=	1 min	Hyd. volume	=	40,324 cuft
Drainage area	=	7.924 ac	Curve number	=	84
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	60.00 min
Total precip.	=	2.86 in	Distribution	=	Custom
Storm duration	=	C:\Users\bpp9189\OneDrive - AmerCor	Shape Factor	=	484

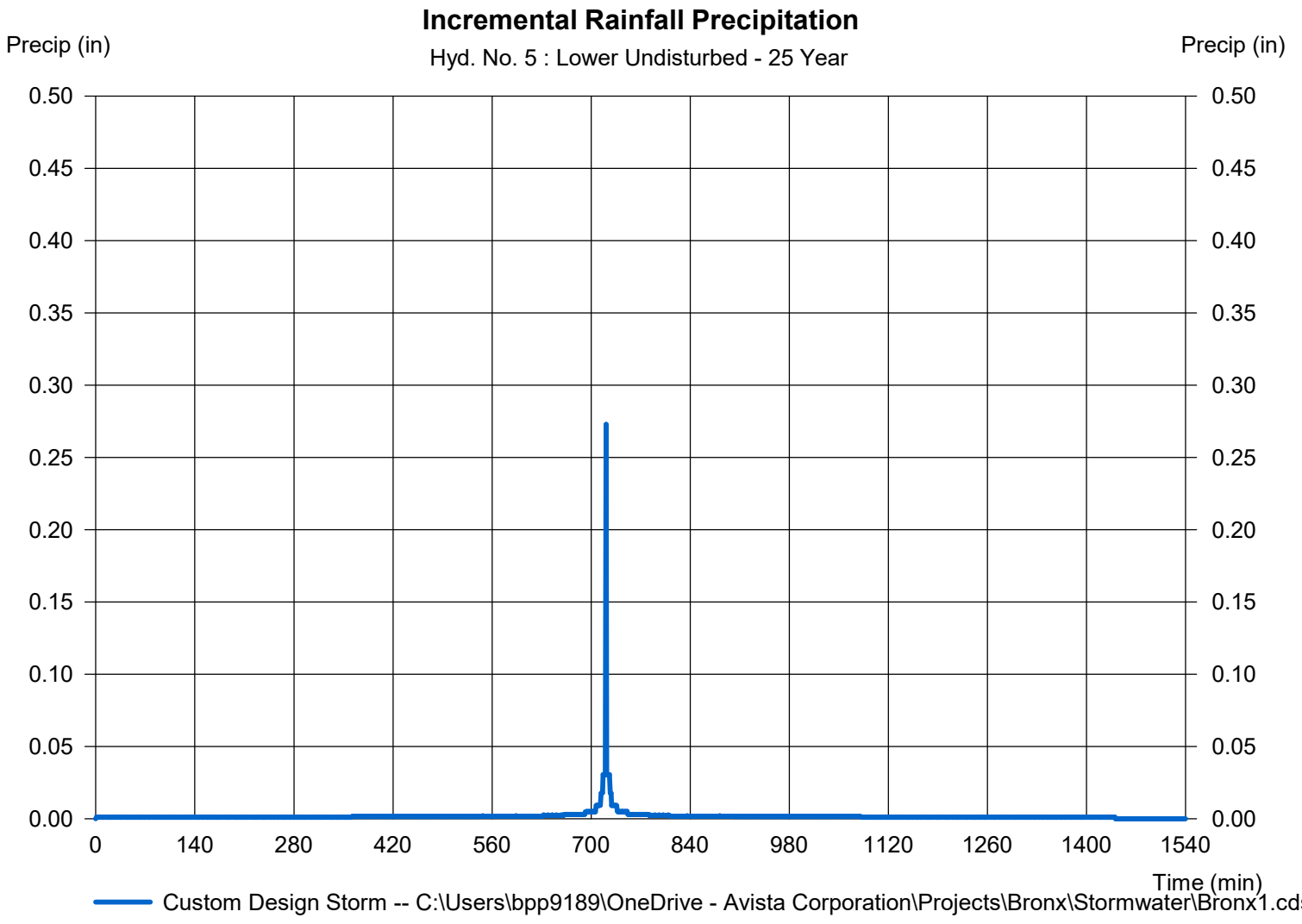


Precipitation Report

Hyd. No. 5

Lower Undisturbed

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		



Hydrograph Report

Hyd. No. 6

Upper Undisturbed

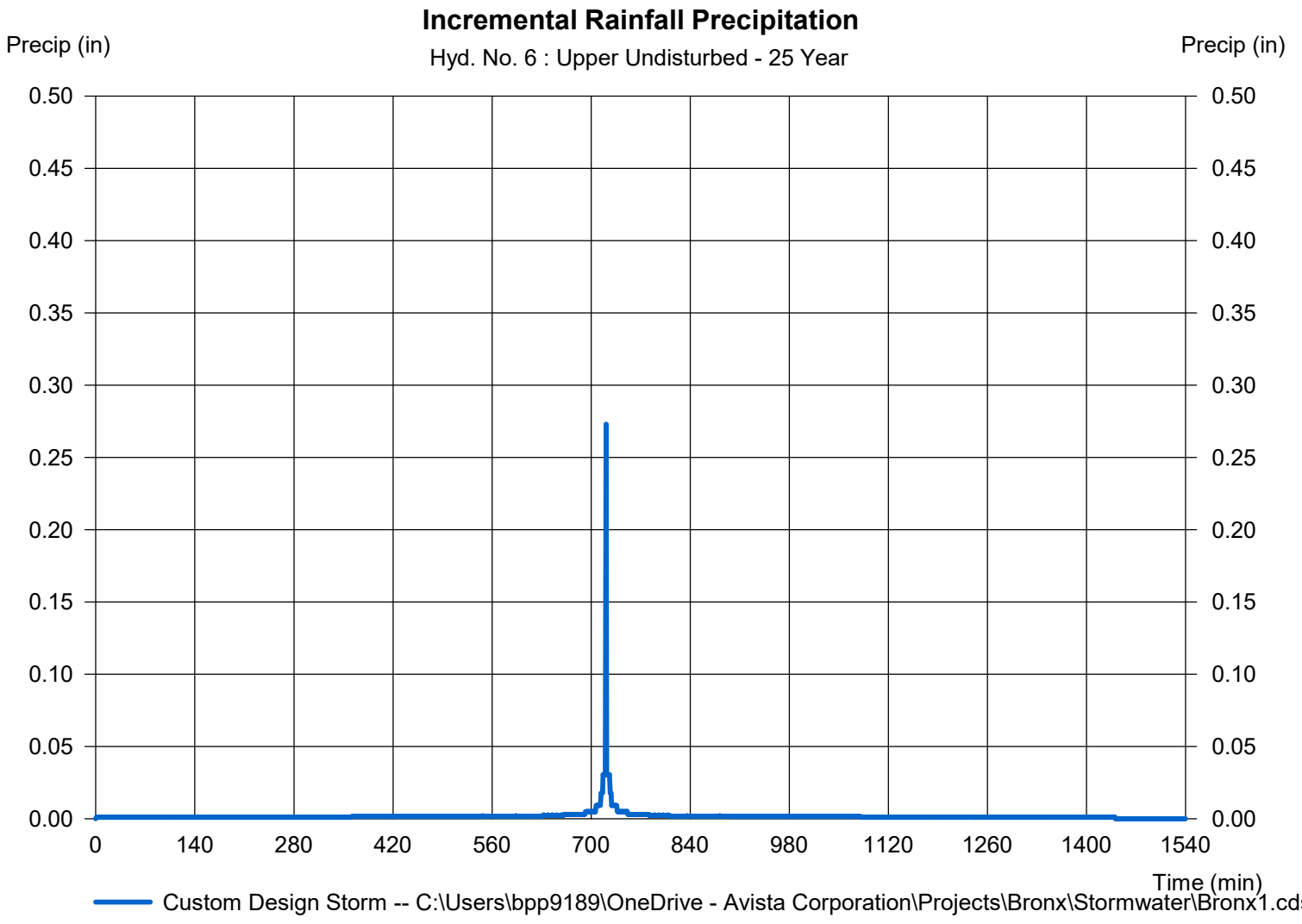
Hydrograph type	=	SCS Runoff	Peak discharge	=	4.237 cfs
Storm frequency	=	25 yrs	Time to peak	=	761 min
Time interval	=	1 min	Hyd. volume	=	39,536 cuft
Drainage area	=	7.769 ac	Curve number	=	84
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	65.00 min
Total precip.	=	2.86 in	Distribution	=	Custom
Storm duration	=	C:\Users\bpp9189\OneDrive - Aviation Factor	Shape Factor	=	484

Precipitation Report

Hyd. No. 6

Upper Undisturbed

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		

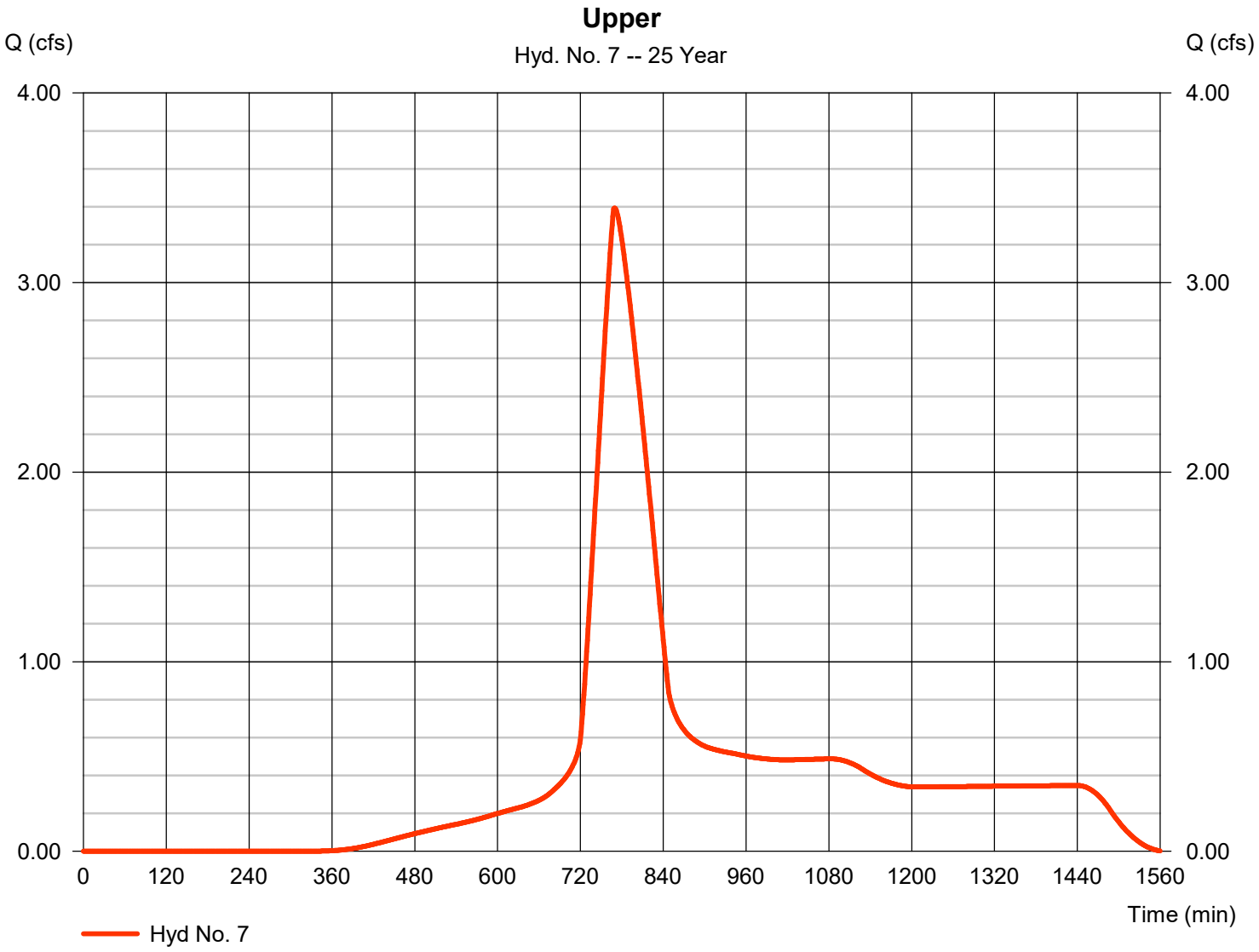


Hydrograph Report

Hyd. No. 7

Upper

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.393 cfs
Storm frequency	=	25 yrs	Time to peak	=	770 min
Time interval	=	1 min	Hyd. volume	=	36,647 cuft
Drainage area	=	6.542 ac	Curve number	=	86
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	User	Time of conc. (Tc)	=	80.00 min
Total precip.	=	2.86 in	Distribution	=	Custom
Storm duration	=	C:\Users\bpp9189\OneDrive - AmerCor	Shape Factor	=	484

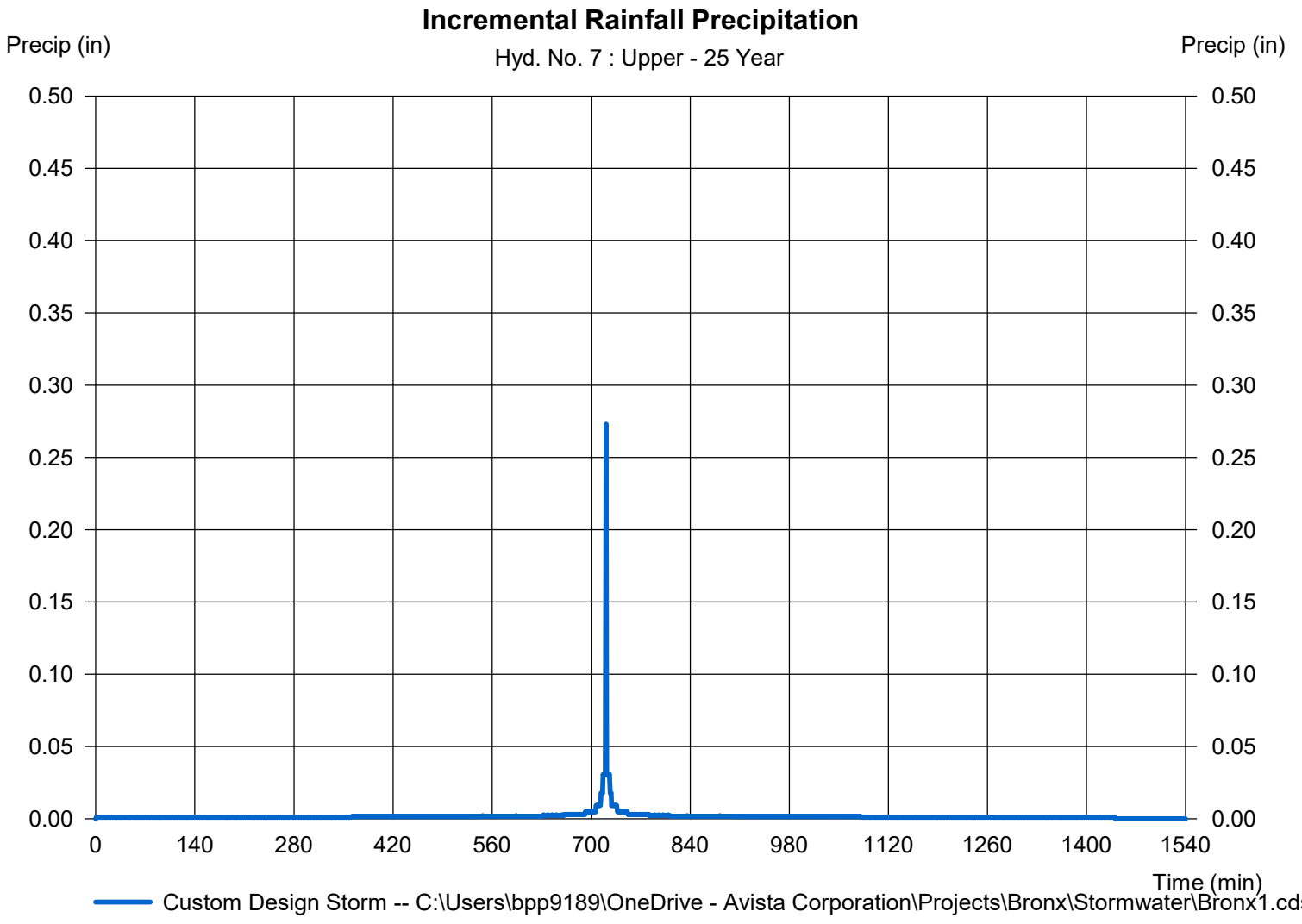


Precipitation Report

Hyd. No. 7

Upper

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		

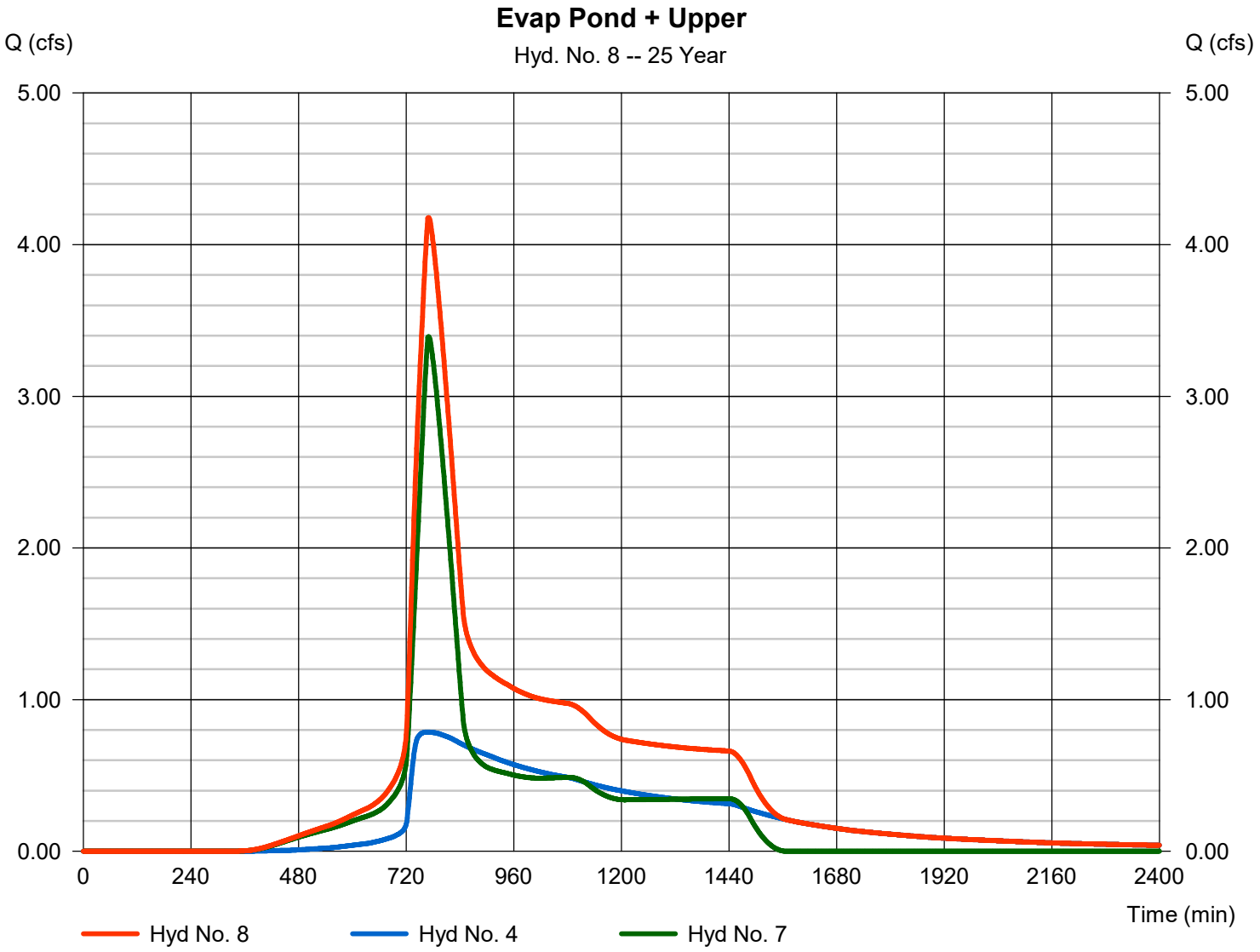


Hydrograph Report

Hyd. No. 8

Evap Pond + Upper

Hydrograph type	=	Combine	Peak discharge	=	4.178 cfs
Storm frequency	=	25 yrs	Time to peak	=	770 min
Time interval	=	1 min	Hyd. volume	=	66,377 cuft
Inflow hyds.	=	4, 7	Contrib. drain. area	=	6.542 ac



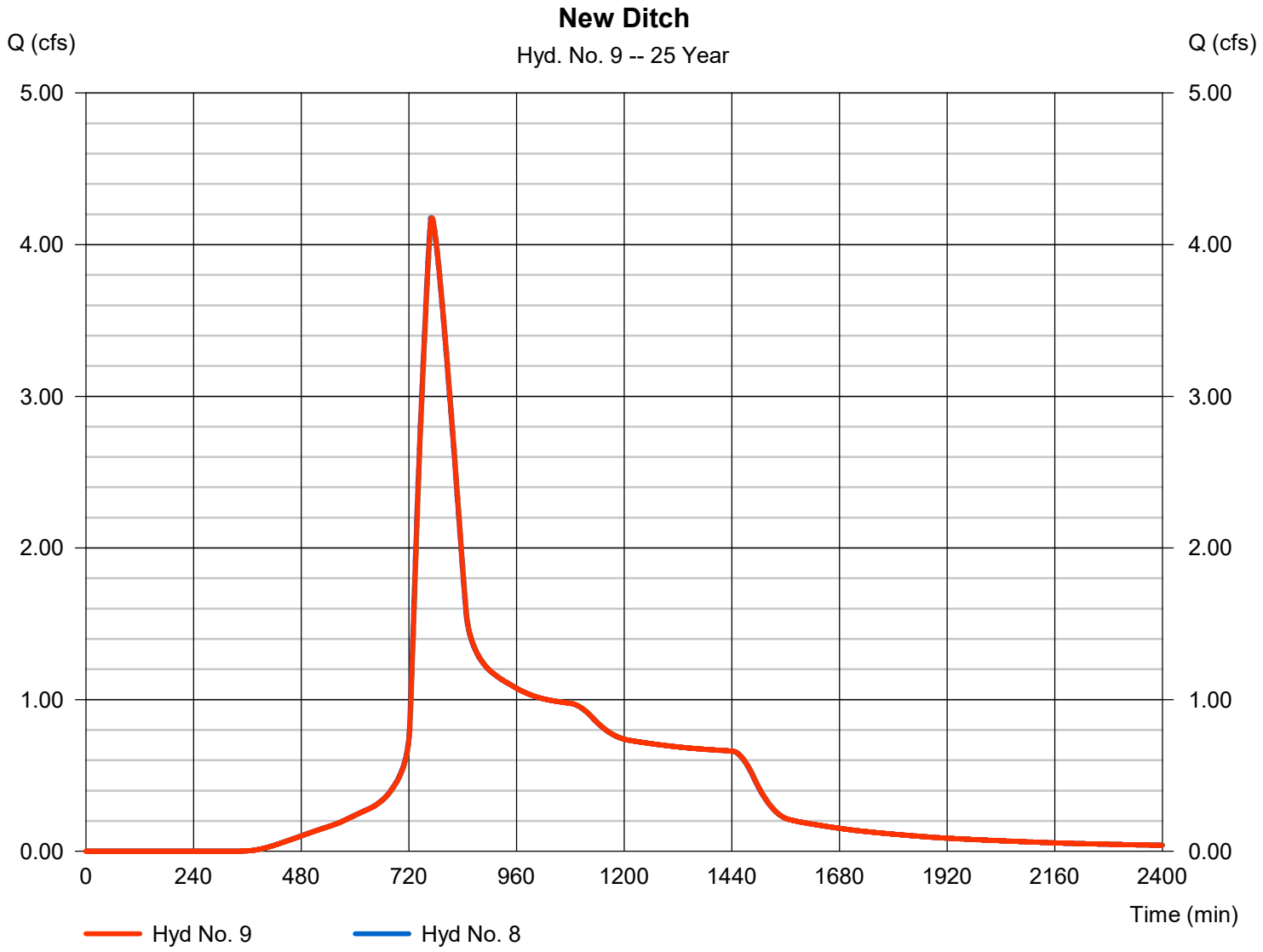
Hydrograph Report

Hyd. No. 9

New Ditch

Hydrograph type	=	Reach	Peak discharge	=	4.177 cfs
Storm frequency	=	25 yrs	Time to peak	=	771 min
Time interval	=	1 min	Hyd. volume	=	66,375 cuft
Inflow hyd. No.	=	8 - Evap Pond + Upper	Section type	=	Triangular
Reach length	=	183.0 ft	Channel slope	=	0.9 %
Manning's n	=	0.030	Bottom width	=	0.0 ft
Side slope	=	3.0:1	Max. depth	=	0.0 ft
Rating curve x	=	2.096	Rating curve m	=	1.333
Ave. velocity	=	2.49 ft/s	Routing coeff.	=	0.7050

Modified Att-Kin routing method used.

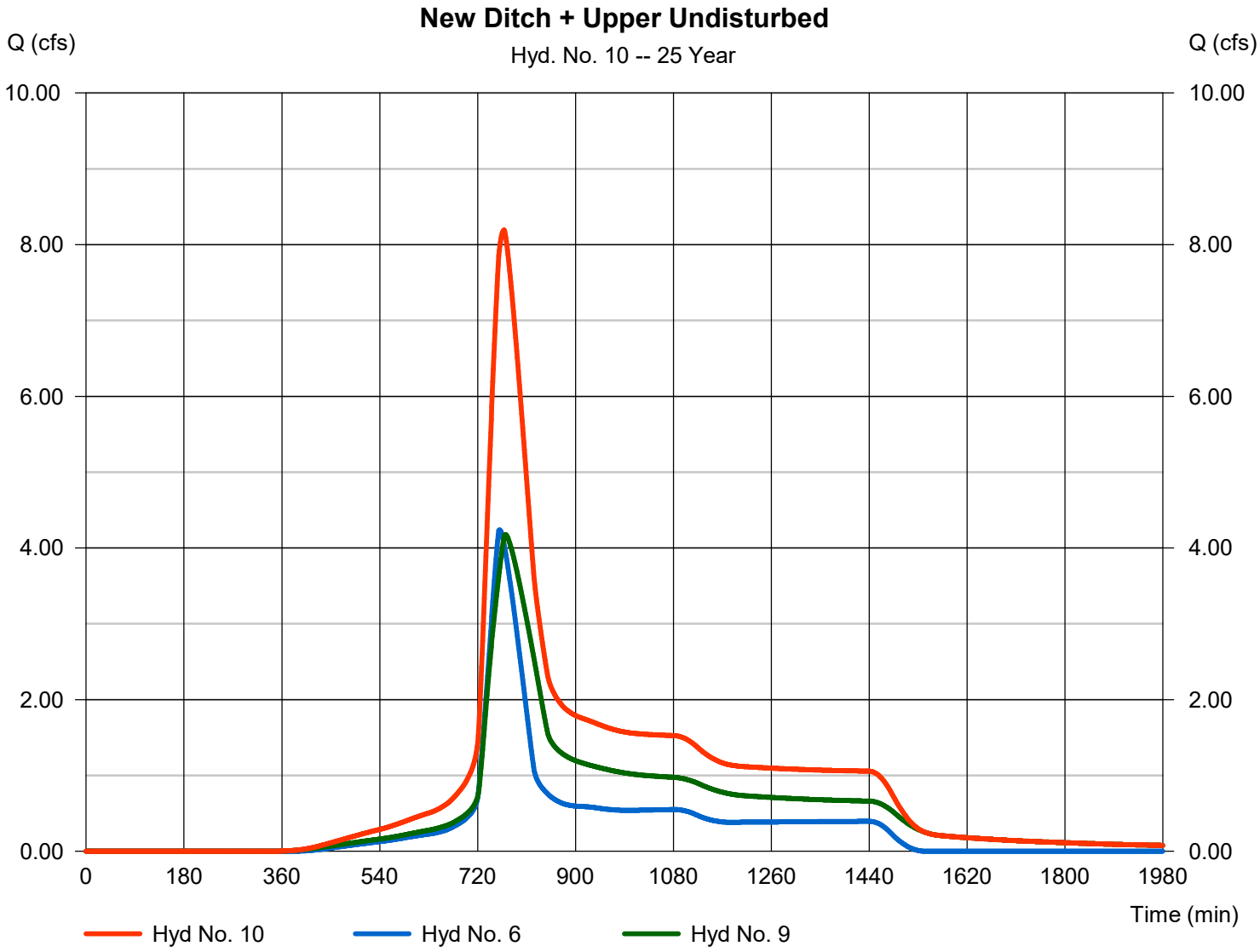


Hydrograph Report

Hyd. No. 10

New Ditch + Upper Undisturbed

Hydrograph type	= Combine	Peak discharge	= 8.195 cfs
Storm frequency	= 25 yrs	Time to peak	= 769 min
Time interval	= 1 min	Hyd. volume	= 105,911 cuft
Inflow hyds.	= 6, 9	Contrib. drain. area	= 7.769 ac



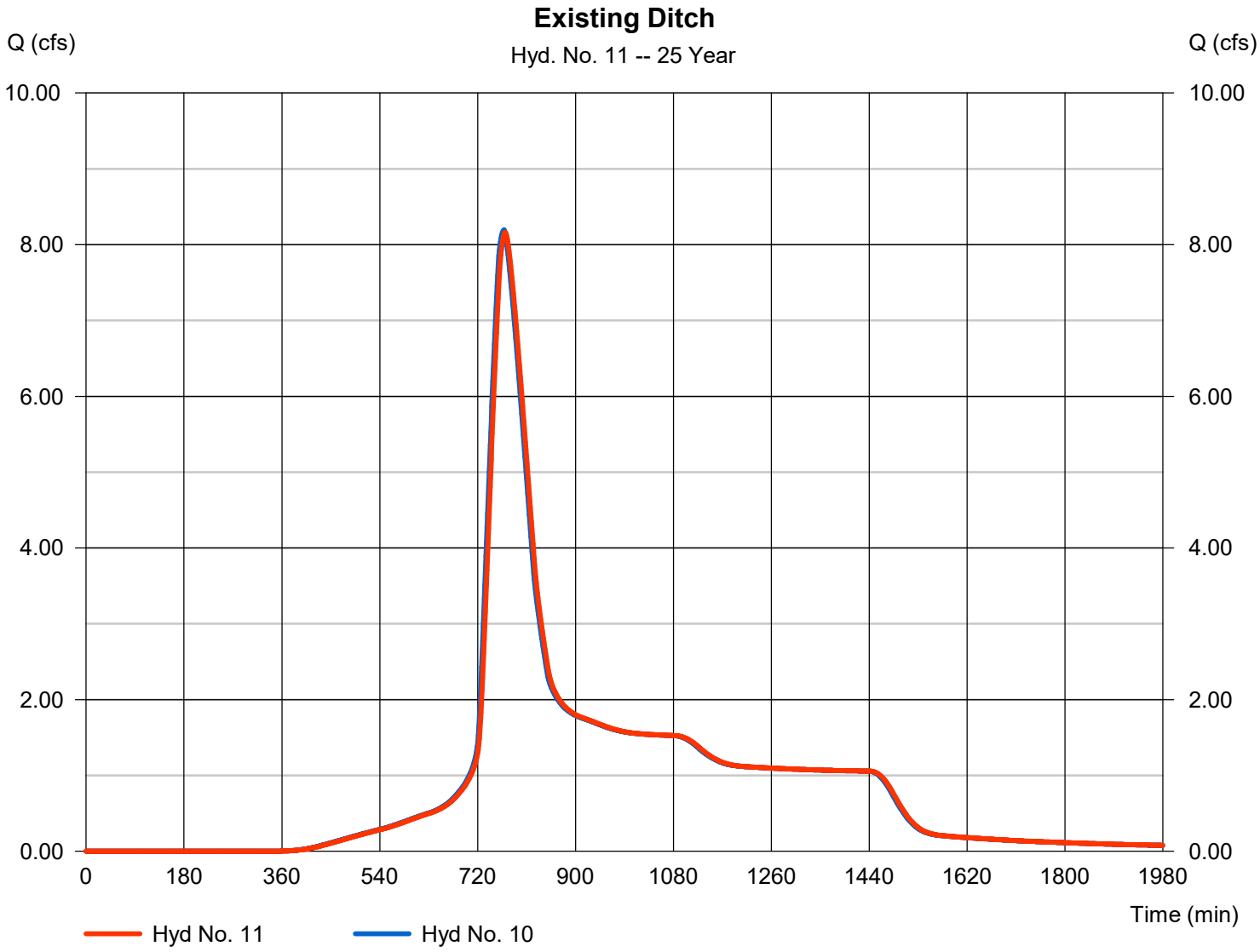
Hydrograph Report

Hyd. No. 11

Existing Ditch

Hydrograph type	=	Reach	Peak discharge	=	8.163 cfs
Storm frequency	=	25 yrs	Time to peak	=	771 min
Time interval	=	1 min	Hyd. volume	=	105,907 cuft
Inflow hyd. No.	=	10 - New Ditch + Upper Undisturbed	Section type	=	Trapezoidal
Reach length	=	550.0 ft	Channel slope	=	1.0 %
Manning's n	=	0.030	Bottom width	=	1.0 ft
Side slope	=	50.0:1	Max. depth	=	1.0 ft
Rating curve x	=	4.967	Rating curve m	=	0.817
Ave. velocity	=	4.44 ft/s	Routing coeff.	=	0.3303

Modified Att-Kin routing method used.

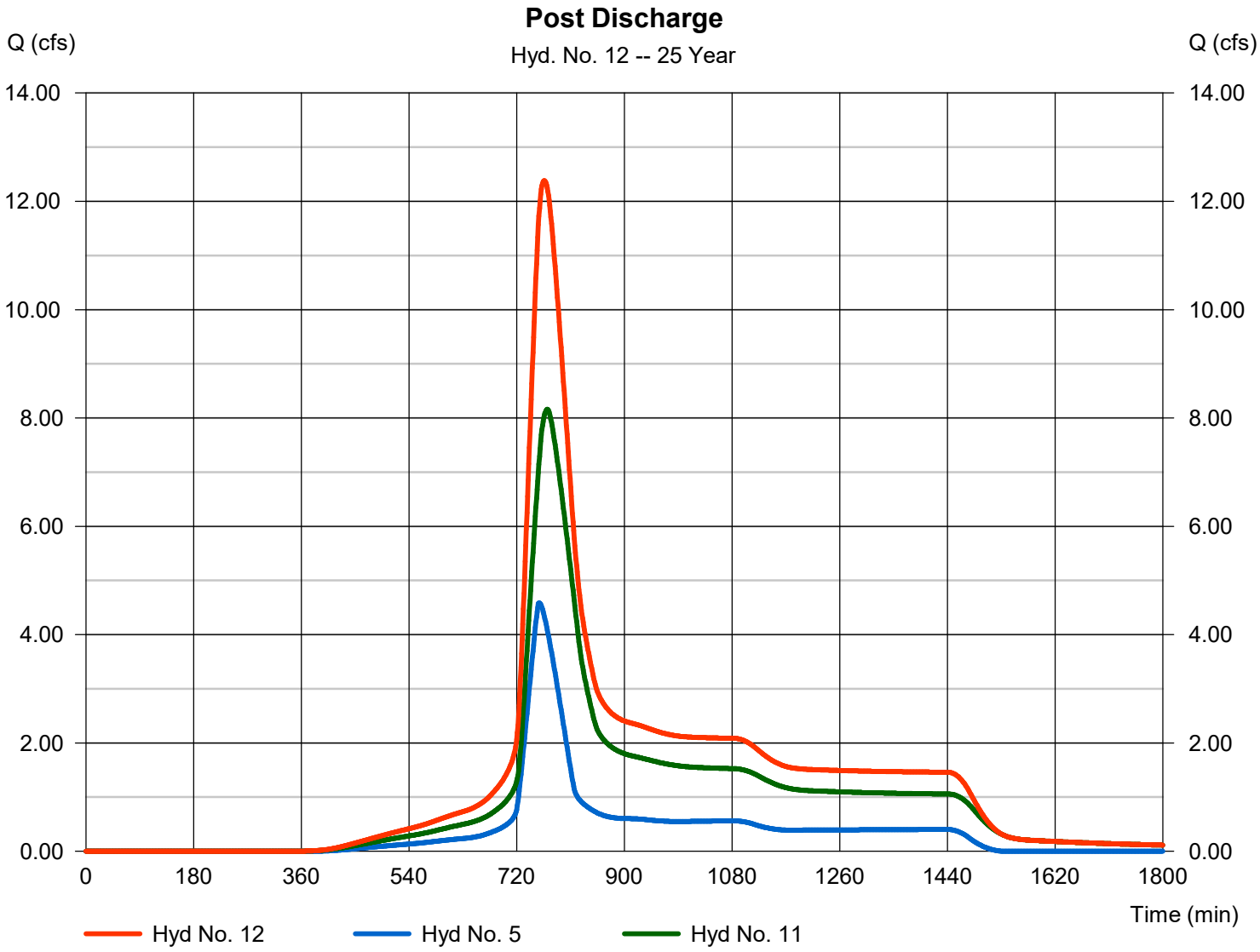


Hydrograph Report

Hyd. No. 12

Post Discharge

Hydrograph type	=	Combine	Peak discharge	=	12.38 cfs
Storm frequency	=	25 yrs	Time to peak	=	766 min
Time interval	=	1 min	Hyd. volume	=	146,231 cuft
Inflow hyds.	=	5, 11	Contrib. drain. area	=	7.924 ac



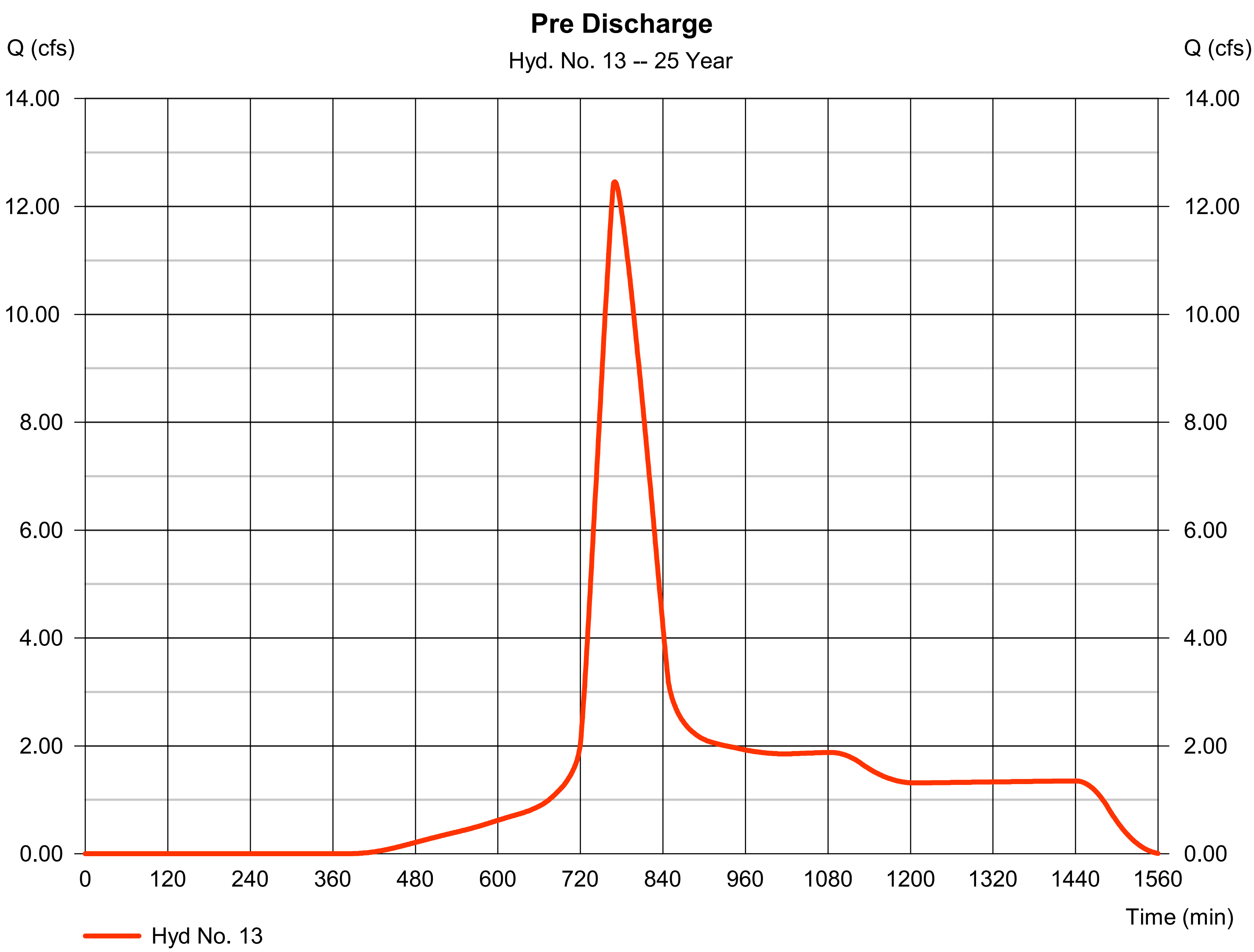
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2025 — Friday, 01 / 16 / 2026

Hyd. No. 13

Pre Discharge

Hydrograph type	= SCS Runoff	Peak discharge	= 12.46 cfs
Storm frequency	= 25 yrs	Time to peak	= 770 min
Time interval	= 1 min	Hyd. volume	= 135,467 cuft
Drainage area	= 26.620 ac	Curve number	= 84
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 80.00 min
Total precip.	= 2.86 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Bron	Shape factor	= 484

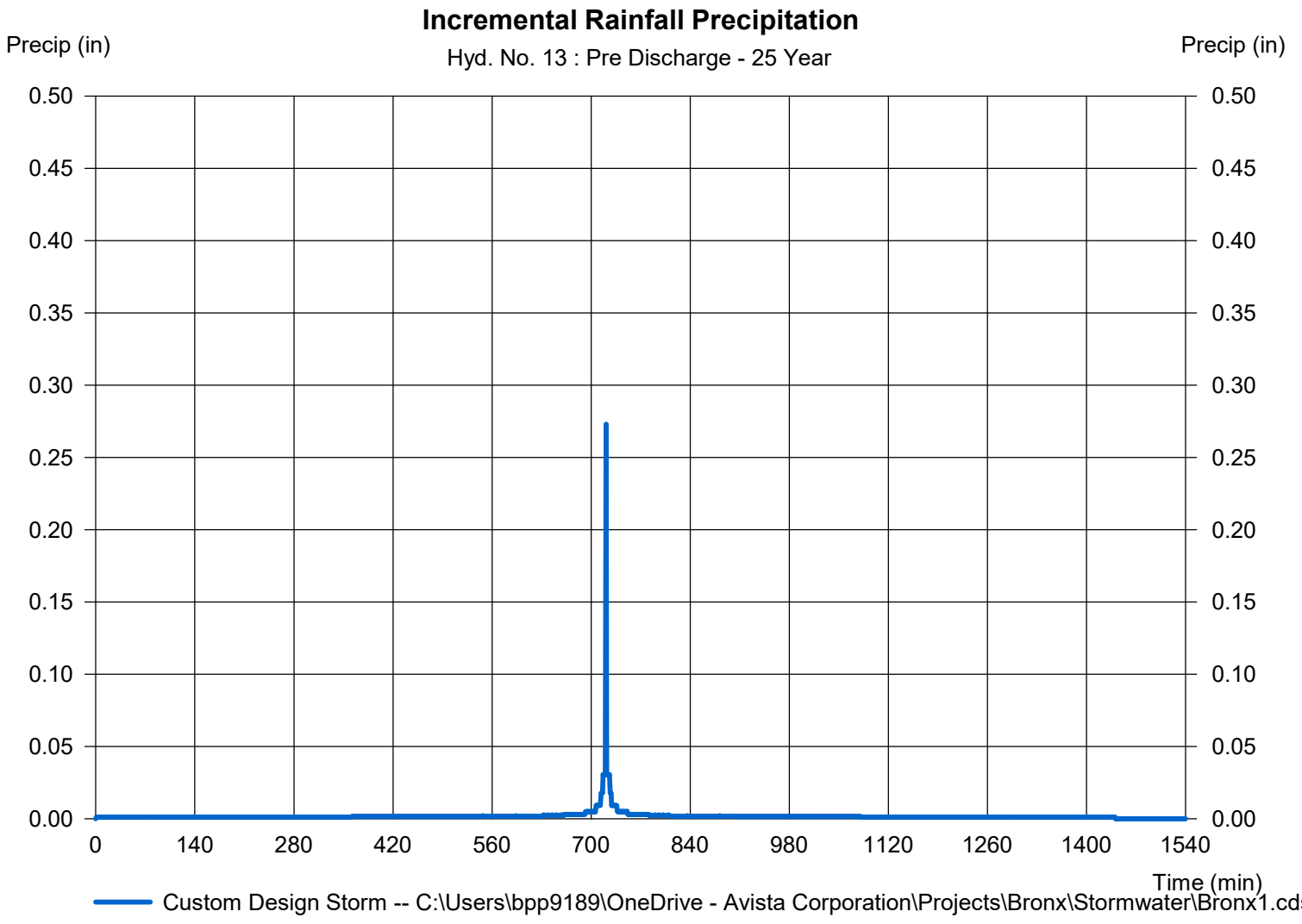


Precipitation Report

Hyd. No. 13

Pre Discharge

Storm Frequency	= 25 yrs	Time interval	= 1 min
Total precip.	= 2.8600 in	Distribution	= Custom
Storm duration	= C:\Users\bpp9189\OneDrive - Avista Corporation\Projects\Bronx\Stormwater\Br		



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	7.9095	2.7000	0.7751	--------
2	11.8942	3.2000	0.8007	--------
3	0.0000	0.0000	0.0000	--------
5	16.7253	3.2000	0.7986	--------
10	19.7931	3.0000	0.7900	--------
25	24.7544	3.1000	0.7917	--------
50	31.4107	3.6000	0.8184	--------
100	34.7374	3.6000	0.8165	--------

File name: Bronx.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	1.63	1.10	0.85	0.70	0.60	0.53	0.47	0.43	0.40	0.37	0.34	0.32
2	2.21	1.51	1.17	0.96	0.82	0.72	0.64	0.58	0.53	0.49	0.46	0.43
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	3.12	2.13	1.65	1.36	1.16	1.02	0.91	0.83	0.76	0.70	0.65	0.61
10	3.83	2.61	2.02	1.66	1.42	1.25	1.12	1.01	0.93	0.86	0.80	0.75
25	4.72	3.23	2.50	2.06	1.76	1.55	1.39	1.26	1.15	1.07	0.99	0.93
50	5.40	3.71	2.87	2.36	2.02	1.77	1.58	1.43	1.31	1.21	1.12	1.05
100	5.99	4.12	3.19	2.63	2.25	1.97	1.76	1.59	1.46	1.35	1.25	1.17

Tc = time in minutes. Values may exceed 60.

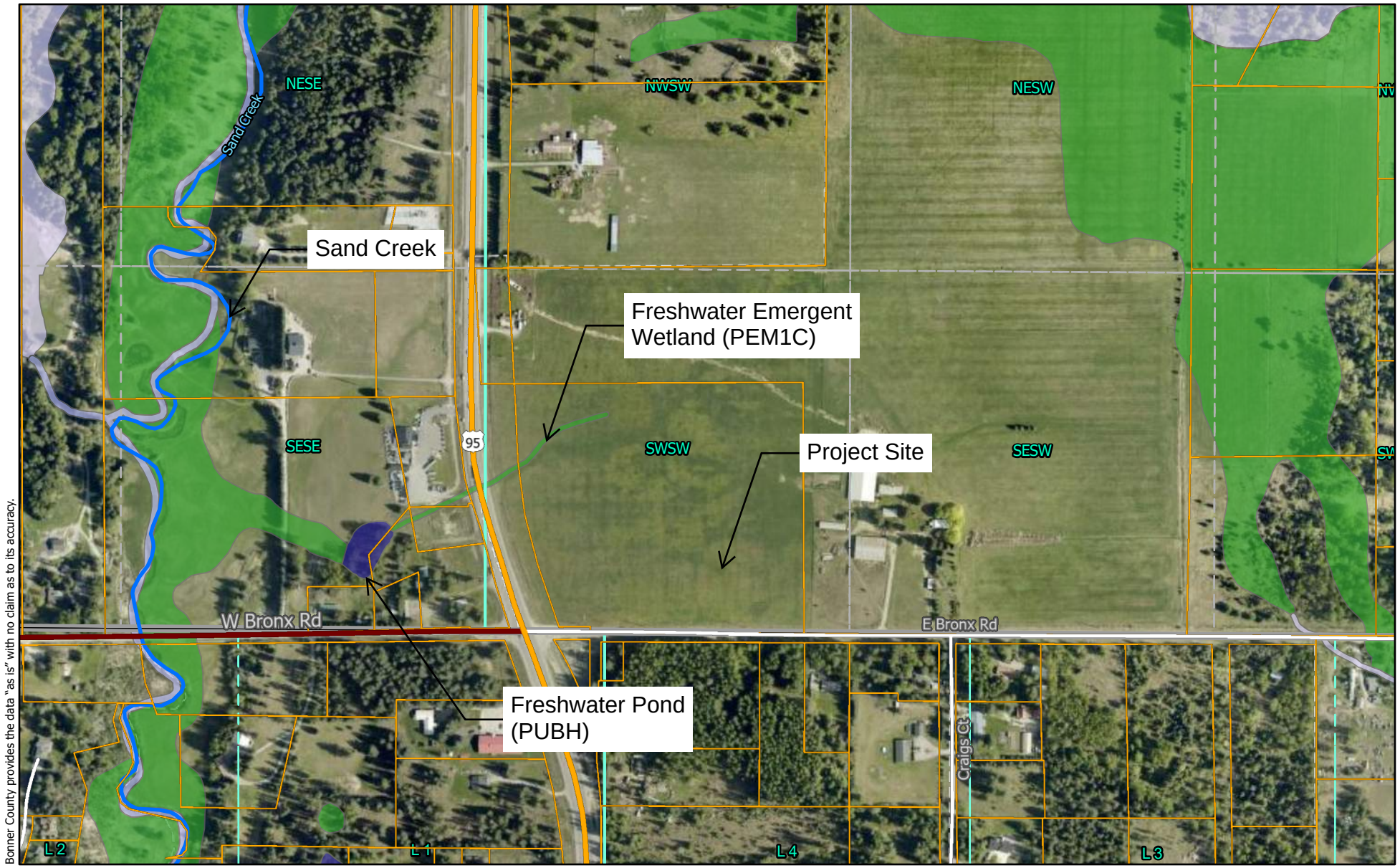
Precip. file name: \\c01u54\c01u54\bpp9189\My Documents\Bronx.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	1.87	0.00	3.30	4.25	2.86	6.80	7.95
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	1.56	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	0.00	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	2.86	6.00	7.10

APPENDIX D

COUNTY WETLAND MAP

Avista Bronx Substation



Bonner County provides the data "as is" with no claim as to its accuracy.

11/13/2025

1:8,990

Parcels

Streams and Rivers

Perennial

Wetlands

Freshwater Emergent Wetland

Freshwater Pond

Riverine

Freshwater Forested/Shrub Wetland

World_Boundaries_and_Places

World Imagery

Low Resolution 15m Imagery

High Resolution 60cm Imagery

High Resolution 30cm Imagery

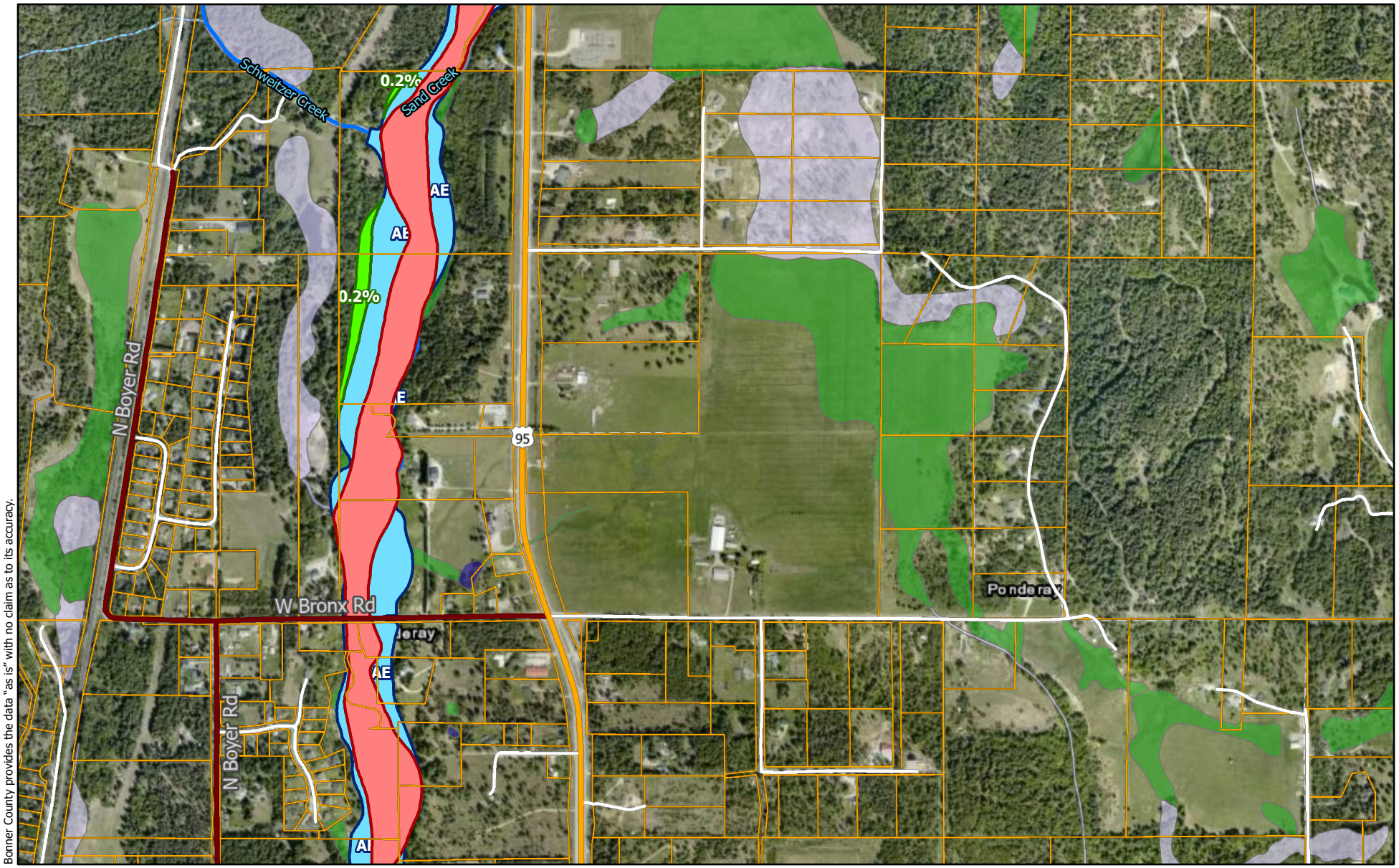
Citations

0 0.07 0.15 mi

0 0.13 0.25 km

N W E S

Avista Bronx Substation



Bonner County provides the data "as is" with no claim as to its accuracy.

10/9/2025

1:18,056

Parcels

Streams and Rivers
- Perennial
- Intermittent

Wetlands
- Freshwater Emergent Wetland
- Freshwater Pond
- Riverine
- Freshwater Forested/Shrub Wetland

World_Boundaries_and_Places

World Imagery

Low Resolution 15m Imagery

High Resolution 60cm Imagery

High Resolution 30cm Imagery

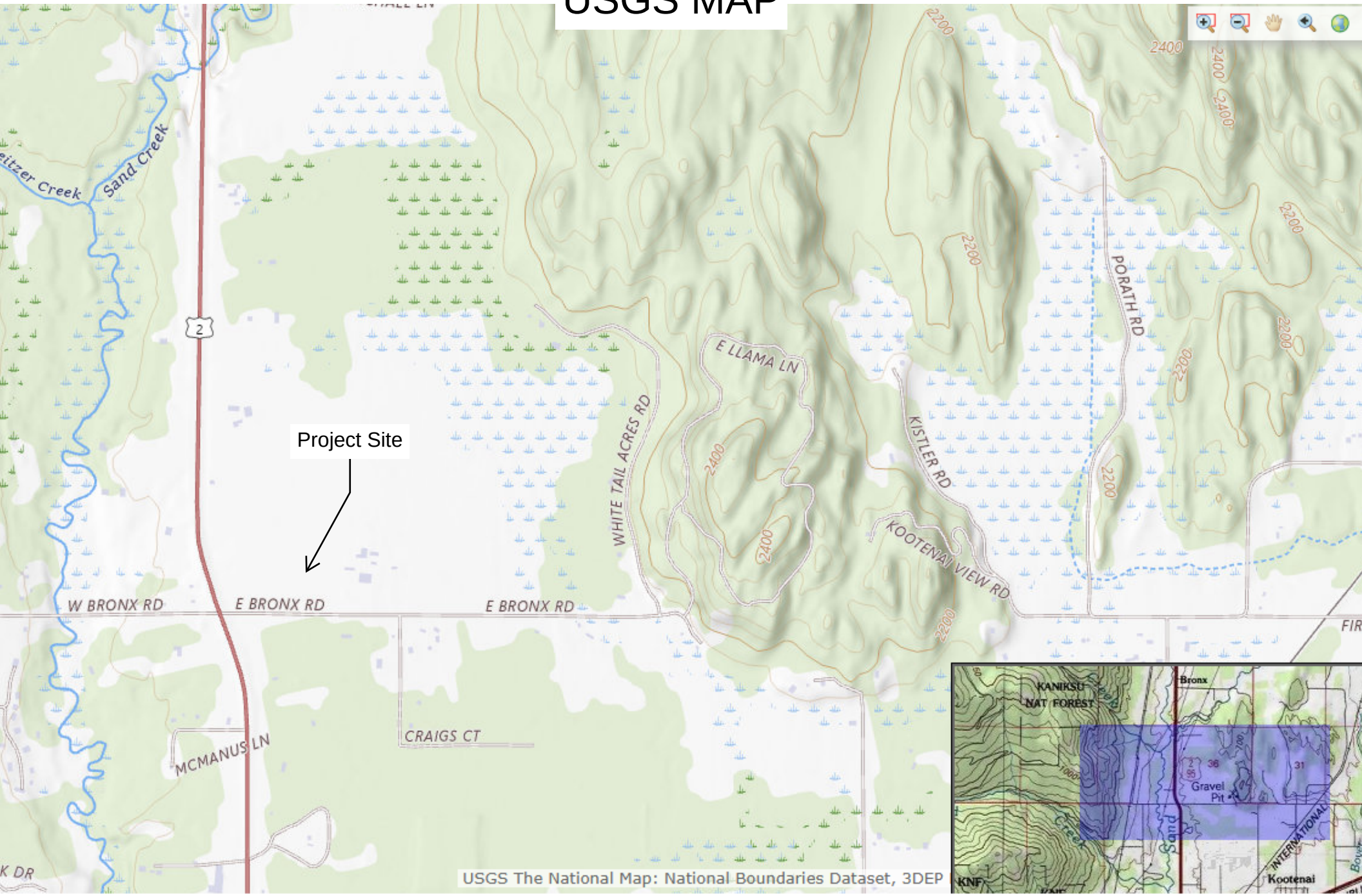
Citations

0 0.15 0.3 mi

0 0.25 0.5 km

N W E S

USGS MAP



N
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