REPORT OF GEOTECHNICAL ENGINEERING SERVICES

Delta Logistics Day Road Annex
SW Day Road
Wilsonville, Oregon

For
Delta Logistics, Inc.
June 30, 2021

Project: DeltaLog-1-01

NV5

City of Wilsonville
Exhibit B1 (Part 3) DB22-0007

June 30, 2021

Delta Logistics, Inc.
9835 Commerce Circle
Wilsonville, OR 97070

Attention: Igor Nichiporchik

Report of Geotechnical Engineering Services
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NV5 is pleased to present this report of geotechnical engineering services for the proposed Delta Logistics Day Road Annex project located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. Our services were provided in general conformance with our proposal dated May 17, 2021.

We appreciate the opportunity to be of continued service to you. Please call if you have questions regarding this report.

Sincerely,

NV5

Brett A. Shipton, P.E., G.E.
Principal Engineer

cc: Lee Leighton, Mackenzie (via email only)

BAS:kt
Attachments
One copy submitted (via email only)
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EXECUTIVE SUMMARY

- Shallow basalt bedrock was encountered in the explorations, which will be difficult to excavate. Specialized excavation techniques such as controlled blasting and ripping may be required to make the planned site cuts
- The proposed building can be supported on spread footings that bear on basalt or the native soil.
- The silt overburden soil will require moisture conditioning if it is to be used as structural fill.
- Measured infiltration rates are extremely low and on-site stormwater infiltration is not feasible.
- Seismic forces on the building can be computed assuming seismic Site Class B as described in the SOSSC.
- The excavated basalt bedrock can be crushed and processed and re-used as structural fill or aggregate base if it meets gradation requirements.

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APPENDIX

ACRONYMS AND ABBREVIATIONS

AC	asphalt concrete
ACP	asphalt concrete pavement
ASTM	American Society for Testing and Materials
BGS	below ground surface
CRB	Columbia River Basalt
FHWA	Federal Highway Administration
g	gravitational acceleration (32.2 feet/second^2)
H:V	horizontal to vertical
MCE	maximum considered earthquake
OSHA	Occupational Safety and Health Administration
OSSC	Oregon Standard Specifications for Construction (2021)
pcf	pounds per cubic foot
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
RQD	rock quality designation
SOSSC	State of Oregon Structural Specialty Code
SPT	standard penetration test
USGS	U.S. Geological Survey

1.0 INTRODUCTION

NV5 is pleased to submit this report of geotechnical engineering services for the proposed Delta Logistics Day Road Annex project. The site is located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. The subject property includes Tax Lots 600 and 601 of Washington County Tax Map 3S102B, which collectively encompass 9.13 acres.

The site location is shown relative to surrounding features on Figure 1. Existing conditions and the proposed site layout (overlay) are shown on Figure 2. Acronyms and abbreviations used herein are defined above, immediately following the Table of Contents.

2.0 PROJECT UNDERSTANDING

The proposed development includes construction of a new logistics center with a building footprint of 57,300 square feet on the eastern portion of the site. We understand the new building will be of concrete tilt-up construction. A concrete loading dock apron is planned along the western perimeter of the proposed building. The center portion of the site will be paved with AC for drive lanes and parking spaces. A detached parking lot located on the western portion of the site is also being considered at this time. A 125-foot-wide drainage easement runs north to south through the property with its centerline approximately 150 feet from the western property boundary.

Foundation loads of the proposed building were not provided at the time of this report. Based on our experience with similar structures, we anticipate maximum column and wall loads will be less than 200 kips and 5 kips per lineal foot, respectively. In addition, we have assumed maximum floor loads of 300 psf. Cuts and fills are expected to be 18 and 5 feet, respectively. An approximately 18-foot-tall retaining wall will support a cut along the site's eastern perimeter and an approximately 5-foot-tall retaining wall will support fill along a storm drainage easement in the western portion of the site.

3.0 PURPOSE AND SCOPE

The purpose of our services was to provide geotechnical engineering recommendations for use in design and construction of the proposed logistics center. Specifically, we completed the following scope of services:

- Reviewed readily available, published geologic data and our in-house files for existing information on subsurface conditions in the site vicinity.
- Coordinated and managed the field explorations, including private and public utility locates and scheduling subcontractors and NV5 staff.
- Conducted a geotechnical subsurface investigation at the site that included the following:
  - Three borings to depths between 15 and 22.5 feet BGS
  - Nine test pits to depths of between 3 and 12 feet BGS
- Conducted two infiltration tests in a test pit at depths of 2 and 3.5 feet BGS.
- Conducted two dynamic cone penetrometer tests in test pits for use in pavement design.

- Collected geotechnical soil samples from the explorations for laboratory testing and maintained a log of encountered soil, rock, and groundwater conditions in the explorations.
- Conducted a laboratory testing program, including the following tests:
    - Four moisture content determinations in general accordance with ASTM D2216
    - One particle-size analyses in general accordance with ASTM D1140
    - Three unconfined compression tests in general accordance with ASTM D2166
- Provided recommendations for site preparation, grading and drainage, stripping depths, fill type for imported material, compaction criteria, trench excavation and backfill, use of on-site soil, and wet weather earthwork.
- Provided recommendations for design and construction of shallow spread foundations, including allowable design bearing pressure, minimum footing depth and width, passive resistance capacity, and coefficient of friction.
- Provided recommendations for preparation of floor slab subgrade.
- Provided design criteria recommendations for retaining walls, including lateral earth pressures, backfill, compaction, and drainage.
- Evaluated the rippability of the basalt bedrock encountered in the explorations.
- Provided recommendations for managing groundwater conditions that may affect the performance of structures.
- Provided recommendations for the construction of AC pavement for on-site access roads and parking areas, including subbase, base course, and AC paving thickness.
- Provided recommendations for subsurface drainage of foundations and roadways, as necessary.
- Provided seismic coefficients in accordance with the SOSSC.
- Documented our findings, conclusions, and recommendations in this report.

4.0 SITE CONDITIONS

4.1 GEOLOGIC CONDITIONS

The site is located in the Tualatin Basin of the Puget Sound-Willamette Valley physiographic province, a tectonically active lowland located along the convergent Cascadia margin. The Tualatin Basin is formed between the uplifted Coast Ranges to the west, the Chehalem Mountains to the south, and the Tualatin Mountains to the north and east. The Tualatin Mountains have been uplifted along northwesterly oriented faults, including the steeply dipping Portland Hills fault located along the eastern flank of the mountains.

The near-surface geologic unit mapped at the site is the fine-grained facies of the Missoula flood deposits. The unit consists of unconsolidated silt and sand deposited by catastrophic floods associated with the sudden release of waters from glacial Lake Missoula during the late Pleistocene (15,500 and 12,500 years ago) (Madin, 1990).

Underlying the Quaternary flood deposits, we encountered basalt bedrock representing the Miocene CRBs, emplaced approximately 17 million to 6 million years ago in the Portland area (Madin, 1990). The CRBs consist of thick flows of basalt and are exposed in the Tualatin Mountains and in the mountains southwest of the site, including Cooper Mountain and Bull Mountain.

4.2 SURFACE CONDITIONS

The site is located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. The subject property includes Tax Lots 600 and 601 of Washington County Tax Map 3S102B, which collectively encompass 9.13 acres. The site is undeveloped, except for a residence located on the northeastern property corner. The site slopes down from east to west, with the eastern end of the site at an elevation of 285 feet and the western end at an elevation of approximately 240 feet. The slope is steeper toward the east with a gradient of between 10 and 15 percent. Vegetation at the site includes grass, shrubbery, and trees.

4.3 SUBSURFACE CONDITIONS

Subsurface conditions were explored by drilling three borings (B-1 through B-3) to depths between 15 and 22.5 feet BGS and excavating nine test pits (TP-1 through TP-9) to depths between 3 and 12 feet BGS. The locations of the explorations are shown on Figure 2. The exploration logs and laboratory test results are presented in the Appendix.

Subsurface conditions encountered in our explorations consists of a thin mantle of silt underlain by basalt bedrock to the maximum depth explored. The following sections provide a detailed description of the geologic units encountered.

4.3.1 Silt

In general, we observed a mantel of medium stiff to stiff silt with varying proportions of sand that extends to depths between approximately 1 foot and 7 feet BGS, except boring B-2 where silt was not observed. Laboratory testing indicates that the silt had moisture contents ranging from 21 to 26 percent at the time of our explorations.

4.3.2 Weathered Basalt

Weathered basalt that consists of clayey and silty gravel, cobbles, and boulders underlies the silt at depths between 1 foot and 7 feet BGS. All of the test pits were terminated in this unit where they encountered practical refusal. Laboratory testing indicates that the weathered basalt layer had a moisture content of 11 percent at the time of our explorations.

4.3.3 Basalt

Competent basalt was encountered to the maximum depths explored in borings B-2 and B-3. In general, the basalt consists of soft (R2) to hard (R4) basalt. The basalt exhibits varying degrees of weathering from fresh to decomposed. A siltstone interflow was encountered in boring B-3 between depths of 14.6 and 15.6 feet BGS. The siltstone interflow is very soft (R1) and moderately weathered.

4.3.4 Groundwater

Groundwater was not encountered during our explorations, except for moderate seepage in TP-8 at a depth of 8 feet BGS. Groundwater may perch on the basalt bedrock during the wet season or prolonged periods of wet weather. The depth to groundwater may fluctuate in response to seasonal changes, prolonged rainfall, changes in surface topography, and other factors not observed in this study.

4.4 INFILTRATION TESTING

We conducted two infiltration tests in test pit TP-5 at depths of 2 and 3.5 feet BGS. The infiltration testing procedures are described in the Appendix, and the results of the infiltration testing are presented in Table 1.

Table 1. Infiltration Testing Summary

Location	Depth (feet BGS)	Observed Infiltration Rate[1] (inches per hour)	Test Method	Soil Type at Test Depth
TP-5	2	1.5	Standpipe	Silt
TP-5	3.5	0	Open Pit	Weathered Basalt

1. Infiltration rate measured in the field

4.5 GEOLOGIC HAZARDS

4.5.1 Liquefaction

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Silty soil with low plasticity is moderately susceptible to liquefaction under relatively higher levels of ground shaking. Based on the subsurface conditions encountered in the explorations, liquefaction is not a hazard at the site.

4.5.2 Lateral Spreading

Lateral spreading is a liquefaction-related seismic hazard. Areas subject to lateral spreading are typically gently sloping or flat sites underlain by liquefiable sediment adjacent to an open face, such as a riverbank. Since liquefaction is not a hazard at the site, lateral spreading is also not considered a site hazard.

4.5.3 Fault Surface Rupture

There are no mapped faults reported beneath this site by the USGS Quaternary Fault and Fold Database of the United States. Consequently, it is our opinion that the probability of surface fault rupture beneath the site is low.

5.0 DESIGN RECOMMENDATIONS

5.1 GENERAL

The following sections provide our design recommendations for the project. All site preparation and structural fill should be prepared as recommended in the "Construction" section.

5.2 SHALLOW FOUNDATIONS

In our opinion, the proposed building can be supported on conventional spread footings founded on the basalt bedrock or native silt.

5.2.1 Bearing Capacity

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the lowest adjacent exterior grade. The bottom of interior footings should be established at least 12 inches below the base of the slab.

Footings bearing on basalt bedrock can be sized assuming an allowable bearing pressure of 15,000 psf. Footings bearing on the overburden fine-grained soil should be sized assuming an allowable bearing pressure equal to 3,000 psf. These are net values; the weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and may be increased by one-third for short-term loads such as those resulting from wind or seismic forces.

5.2.2 Resistance to Sliding

Lateral loads on footings can be resisted by passive earth pressure on the sides of structures and by friction on the base of footings. Our analysis indicates the available passive earth pressure for footings confined by native soil or structural fill is 350 pcf modeled as an equivalent fluid pressure. If the footings are confined by basalt bedrock, this value can be increase to 750 pcf. Adjacent floor slabs, pavement, or the upper 12-inch depth of adjacent, unpaved areas should not be considered when calculating passive resistance. To rely on passive resistance, a minimum of 10 feet of horizontal clearance must exist between the face of the footings and any adjacent down slopes. For footings that bear on granular pads as described above, a coefficient of friction equal to 0.5 may be used when calculating resistance to sliding for footings bearing on basalt or crushed rock; this should be reduced to 0.35 for footings bearing on the native silt.

5.2.3 Settlement

Total foundation settlement should be less than 0.25 inch; a differential settlement of 0.25 inch should be assumed between similarly loaded footings. A total settlement of 1 inch should be assumed for footings that bear on silt, with a differential of 0.5 inch between similarly loaded footings.

5.2.4 Subgrade Observation

All footing and floor slab subgrade should be observed by a representative of NV5 to evaluate the bearing conditions. Observations should also confirm that all loose or soft material, organic material, unsuitable fill, prior topsoil zones, and softened subgrades (if present) have been removed. Localized over-excavation of footing subgrade may be required to remove deleterious material.

5.3 SEISMIC DESIGN CONSIDERATIONS

5.3.1 Seismic Design Parameters

Based on the results of our subsurface explorations, the seismic design coefficients consistent with Site Class B can be used for design. These coefficients are presented in Table 2.

Table 2. Seismic Design Parameters

Seismic Design Parameter	Short Period (T_s = 0.2 second)	1 Second Period (T_1 = 1.0 second)
MCE Spectral Acceleration	S_s = 0.827 g	S_1 = 0.385 g
Site Class	B	
Site Coefficient	F_a = 0.9	F_v = 0.8
Adjusted Spectral Acceleration	S_{MS} = 0.744 g	S_{M1} = 0.308 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.496 g	S_{D1} = 0.205 g

5.4 FLOOR SLABS

Slabs should be reinforced according to their proposed use and per the structural engineer's recommendations. Slabs on grade may be designed assuming a modulus of subgrade reaction, k, of 600 psi per inch, if they bear on basalt. This value should be decreased 150 psi per inch if the floor slab bears on the overburden silty soil. To aid as a capillary break, we recommend a 6-inch-thick layer of floor slab base rock be placed and compacted over the prepared subgrade. The floor slab base rock should meet the requirements in the "Structural Fill" section and be compacted to at least 95 percent of ASTM D1557.

The near-surface native soil is primarily fine grained and will tend to maintain a high moisture content. In areas where moisture-sensitive floor slab and flooring will be installed, installation of a vapor barrier is warranted in order to reduce the potential for moisture transmission through and efflorescence growth on the slab and flooring. In addition, flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives and will warrant their product only if a vapor barrier is installed according to their recommendations. Selection and design of an appropriate vapor barrier should be a collaborative effort with members of the design team.

5.5 RETAINING WALLS

We have provided recommendations for retaining walls that retain soil and basalt bedrock. Our recommendations are based on the following assumptions: (1) the walls are less than 20 feet in height, (2) adequate drainage is provided behind the retaining wall to prevent lateral earth pressures from developing, and (3) the ground surface behind the retaining wall is flatter than 4H:1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

Lateral earth pressures can be computed using Figure 3. Seismic earth pressures can be calculated assuming a uniformly distributed load equal to force equal to 7H pounds per linear foot of wall where the wall retains soil, where H is the wall height. The seismic force should be applied as a distributed load with the centroid located at 0.6H from the wall base. Footings for retaining walls should be designed as recommended for shallow foundations.

If other surcharges are located within a horizontal distance of twice the height of the wall from the back of the wall, additional pressures will need to be incorporated in the wall design. Figure 4 can be used to compute surcharge induced lateral earth pressures.

5.6 DRAINAGE

5.6.1 Temporary

During mass grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface. During rough and finished grading of the site, the contractor should keep all pads and subgrade free of ponding water.

5.6.2 Surface

Where possible, the finished ground surface around the building should be sloped away from the structure at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an appropriate stormwater system. Trapped planter areas should not be created adjacent to the building without providing means for positive drainage (e.g., swales or catch basins).

5.6.3 Subsurface

Assuming the site grades around the building will be sloped as discussed previously, it is our opinion that perimeter footing drains will not be required around the proposed building.

5.6.4 Infiltration

In our opinion, infiltration of stormwater is not feasible due the shallow impermeable bedrock.

5.7 PAVEMENT

5.7.1 Pavement Design

Pavement should be installed on competent subgrade or new engineered fills prepared in conformance with the recommendation in this report. Our pavement recommendations are based on the following assumptions:

- Reliability of 80 percent and standard deviation of 0.45
- Pavement design life of 20 years
- Initial and terminal serviceability indices of 4.2 and 2.5, respectively
- Structural coefficients of 0.42 and 0.10 for new AC and new base rock, respectively
- Subgrade resilient modulus of 3,500 psi for silt and 45,000 psi for basalt
- New base rock resilient modulus of 20,000 psi
- New base rock drainage coefficient of 1.0
- The subgrade below pavement areas is evaluated by proof rolling and prepared as recommended in this report

We do not have specific information on the frequency of vehicles expected at the site; however, we have assumed a breakdown on the type of vehicles likely to be used. We have assumed traffic will consist of passenger cars in light traffic areas and a mixture of cars and trucks elsewhere. The truck traffic is assumed to be single tractor-trailers evenly distributed between FHWA Classes 8, 9, and 10.

If any of these assumptions are incorrect, our office should be contacted with the appropriate information so that the pavement designs can be revised.

Our pavement design recommendations assuming between 0 and 50 trucks per day are presented in Tables 3 and 4. If projected truck traffic exceeds 50 or truck axle weights are projected to exceed street legal values, our office should be contacted to provide revised pavement design thicknesses.

Table 3. Recommended Pavement Sections on Bedrock

Traffic Levels	Trucks per Day	ESALs	AC (inches)	Base Rock (inches)
Car Traffic Only	0	10,000	2.5	4.0
Truck Area	10	100,000	3.0	4.0
Truck Area	25	240,000	3.5	4.0
Truck Area	50	475,000	4.0	4.0

Table 4. Recommended Pavement Sections on Soil Subgrade

Traffic Levels	Trucks per Day	ESALs	AC (inches)	Base Rock (inches)
Car Traffic Only	0	10,000	2.5	8.0
Truck Area	10	100,000	4.0	13.5
Truck Area	25	240,000	4.5	16.0
Truck Area	50	475,000	5.0	18.0

All thicknesses in Tables 3 and 4 are intended to be the minimum acceptable. Design of the recommended pavement section is based on the assumption that construction will be completed during an extended period of dry weather. Wet weather construction could require an increased thickness of base rock where the pavement is constructed on soil subgrade.

Construction traffic should be limited to non-building, unpaved portions of the site or haul roads. Construction traffic should not be allowed on new pavement. If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

6.0 CONSTRUCTION

6.1 SITE PREPARATION

6.1.1 Demolition

Demolition includes complete removal of the existing buildings, retaining walls, pavement, concrete curbs, abandoned utilities, and any subsurface elements within 5 feet of areas to receive new pavement, buildings, retaining walls, or engineered fills. Demolished material should be transported off site for disposal. In general, this material will not be suitable for re-use as engineered fill. However, concrete, pavement, and base rock material may be recycled in accordance with the requirements set forth by the project jurisdiction and the recommendations provided in the “Structural Fill” section.

Excavations remaining from removing basements, foundations, utilities, and other subsurface elements should be backfilled with structural fill where these are below planned site grades. The base of the excavations should be excavated to expose firm subgrade before filling. The sides of the excavations should be cut into firm material and sloped a minimum of 1½H:1V. Utility lines abandoned under new structural components should be completely removed and backfilled with structural fill or grouted full if left in place. Soft or disturbed soil encountered during demolition should be removed and replaced with structural fill.

Considerable subgrade damage can occur during demolition activities and we recommend that the subgrade protection measures discussed in the “Construction Considerations” section be implemented.

6.1.2 Grubbing and Stripping

Trees and shrubs should be removed from fill areas. In addition, root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used to remove root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

The existing root zone in landscaped areas should be stripped and removed from all fill areas. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or used in landscaped areas.

6.1.3 Subgrade Evaluation

Upon completion of stripping and subgrade stabilization, and prior to the placement of fill or pavement, the exposed subgrade should be evaluated by proof rolling. The subgrade should be proof rolled with a fully loaded dump truck or similarly heavy, rubber tire construction equipment to identify soft, loose, or unsuitable areas. A member of our geotechnical staff should observe proof rolling to evaluate yielding of the ground surface. During wet weather, subgrade evaluation should be performed by probing with a foundation probe rather than proof rolling. Areas that appear soft or loose should be improved in accordance with subsequent sections.

6.2 CONSTRUCTION CONSIDERATIONS

The fine-grained soil present on this site is easily disturbed, but the bedrock is less sensitive to disturbance. Where the subgrade consists of soil, site preparation, utility trench work, and excavation can create extensive soft areas and significant repair costs can result. Earthwork planning, regardless of the time of year, should include considerations for minimizing subgrade disturbance.

6.3 PERMANENT SLOPES

Permanent cut and fill slopes should not exceed 2H:1V in soil and ¾H:1H in competent bedrock. The face of bedrock slopes should be scaled to remove loose rock fragments from the face. Access roads and pavement should be located at least 5 feet from the top of cut and fill slopes. The setback should be increased to 10 feet for buildings. The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

6.4 EXCAVATION

6.4.1 Excavation and Shoring

The site soil should be readily excavatable with conventional grading equipment. Bedrock may require ripping and or blasting. Temporary excavation sidewalls should stand vertical to a depth of approximately 4 feet, provided groundwater seepage does not occur. Deeper excavations will require shoring or need to be sloped. Shoring will still be required in bedrock to protect worker safety from rockfall. Temporary soil slopes should be no steeper than 1.5H:1V and rock slopes no steeper than ¾H:1V. All loose rock fragments should be removed from the excavation sidewalls before workers are allowed to enter the excavation.

6.4.2 Trench Dewatering

Based on the results of our explorations, major dewatering is not anticipated for the project. If perched groundwater is present, dewatering may be required to maintain dry working conditions. Pumping from sumps located within the trench will likely be effective in removing water resulting from seepage.

6.4.3 Safety

All excavations should be made in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes certain approaches to excavation and dewatering, the contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety, and providing shoring (as required) to protect personnel and adjacent structural elements.

6.5 MATERIALS

6.5.1 Structural Fill

6.5.1.1 General

Fill should be placed on subgrade that has been prepared in conformance with the “Site Preparation” section. A variety of material may be used as structural fill at the site. However, all material used as structural fill should be free of organic material or other unsuitable material. A brief characterization of some of the acceptable materials and our recommendations for their use as structural fill are provided below.

6.5.1.2 On-Site Material

Basalt excavated from the site can be processed and re-used as structural fill. The gradation and compaction requirements will depend on its and intended use. The soil at the site should be suitable for use as general structural fill, provided it is properly moisture conditioned and free of debris, organic material, and particles over 6 inches in diameter. Moisture conditioning (drying) will likely be required to use on-site fine-grained soil for structural fill. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill and, given the site constraints, will possibly not be feasible. It will be difficult, if not impossible, to adequately compact on-site soil during the rainy season or during prolonged periods of rainfall. When used as structural fill, native soil should be placed in lifts with a maximum uncompacted thickness of 8 inches and compacted to not less than 92 percent of the maximum dry density, as determined by ASTM D1557.

6.5.1.3 Processed Native and Imported Granular Material

Processed native basalt and imported granular material used as structural fill should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand. The imported granular material should also be angular and fairly well graded between coarse and fine material, should have less than 5 percent fines by dry weight passing the U.S. Standard No. 200 sieve, and should have at least two mechanically fractured faces. Imported granular material should be placed in lifts with a maximum uncompacted thickness of 12 inches and compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557. During the wet season or when wet subgrade conditions exists, the initial lift should be approximately 18 inches in uncompacted thickness and should be compacted by rolling with a smooth-drum roller without using vibratory action.

6.5.1.4 Stabilization Material

Stabilization material used in staging or haul road areas or in trenches should consist of 4- or 6-inch-minus pit- or quarry-run rock, crushed rock, or crushed gravel and sand. The material should have a maximum particle size of 6 inches, should have less than 5 percent by dry weight passing the U.S. Standard No. 4 sieve, and should have at least two mechanically fractured faces. The material should be free of organic material and other deleterious material. Stabilization material should be placed in lifts between 12 and 24 inches thick and compacted to a firm condition.

6.5.1.5 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 12 inches above utility lines (i.e., the pipe zone) should consist of durable, well-graded granular material with a maximum particle size of 1½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. The pipe zone backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

Within roadway alignments, the remainder of the trench backfill up to the subgrade elevation should consist of durable, well-graded granular material with a maximum particle size of 2½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department. The upper 3 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone may consist of general fill material that is free of organic material and material over 6 inches in diameter. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

6.5.1.6 Drain Rock

Drain rock should consist of angular, granular material with a maximum particle size of 2 inches. The material should be free of roots, organic material, and other unsuitable material; should have less than 2 percent by dry weight passing the U.S. Standard No. 200 sieve (washed analysis); and should have at least two mechanically fractured faces. Drain rock should be compacted to a well-keyed, firm condition.

6.5.1.7 Aggregate Base Rock

Imported granular material used as base rock for building floor slabs and pavement should consist of ¾- or 1½-inch-minus material (depending on the application). In addition, the aggregate should have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve and have at least two mechanically fractured faces. The aggregate base should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.1.8 Retaining Wall Select Backfill

Backfill material placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of imported granular material as described above and should have less than 7 percent fines by dry weight and have at least two mechanically fractured faces. We recommend the wall backfill be separated from general fill, native soil, and/or topsoil using a geotextile fabric that meets the specifications provided below for drainage geotextiles.

The wall backfill should be compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D1557. However, backfill located within a horizontal distance of 3 feet from a retaining wall should only be compacted to approximately 90 percent of the maximum dry density, as determined by ASTM D1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (such as a jumping jack or vibratory plate compactor). If flatwork (sidewalks or pavement) will be placed atop the wall backfill, we recommend the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.2 Geotextile Fabric

6.5.2.1 Subgrade Geotextile

Subgrade geotextile should conform to OSSC Table 02320-4 and OSSC 00350 (Geosynthetic Installation). A minimum initial aggregate base lift of 6 inches is required over geotextiles. All drainage aggregate and stabilization material should be underlain by a subgrade geotextile.

6.5.2.2 Drainage Geotextile

Drainage geotextile should conform to Type 2 material of OSSC Table 02320-1 and OSSC 00350 (Geosynthetic Installation). A minimum initial aggregate base lift of 6 inches is required over geotextiles.

6.5.3 Conventional Pavement Material Requirements

The AC should be Level 3, ½-inch, dense ACP as described in OSSC 00744 (Asphalt Concrete Pavement) and compacted to 91 percent of the specific gravity of the mix, as determined by ASTM D2041. Minimum and maximum lift thicknesses for ½-inch, dense ACP are 2 and 3 inches, respectively. ACP should be placed at the minimum ground surface temperatures described in OSSC 00744.40 (Season and Temperature Limitations). Asphalt binder should be performance graded and conform to PG 64-22.

The crushed base rock should consist of ¾- or 1½-inch-minus material meeting the requirements in OSSC 00641 (Aggregate Subbase, Base, and Shoulders), with the exception that the crushed base rock should have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve. The crushed base rock should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.3.1 Cold Weather Paving Considerations

In general, AC paving is not recommended during the cold weather (temperatures less than 40 degrees Fahrenheit). Compacting under these conditions can result in low compaction and premature pavement distress.

Each AC mix design has a recommended compaction temperature range that is specific for the particular AC binder used. In colder temperatures, it is more difficult to maintain the temperature of the AC mix as it can lose heat while stored in the delivery truck, as it is placed, and in the time between placement and compaction. In Oregon, the AC surface temperature during paving should be at least 40 degrees Fahrenheit for lift thickness greater than 2.5 inches and at least 50 degrees Fahrenheit for lift thickness between 2 and 2.5 inches.

If paving activities must take place during cold-weather construction as defined above, the project team should be consulted and a site meeting should be held to discuss ways to lessen low compaction risks.

6.6 EROSION CONTROL

The site soil is susceptible to erosion; therefore, erosion control measures should be carefully planned and in place before construction begins. Surface water runoff should be collected and directed away from slopes to prevent water from running down the slope face. Erosion control measures (such as straw bales, sediment fences, and temporary detention and settling basins) should be used in accordance with local and state ordinances.

7.0 OBSERVATION OF CONSTRUCTION

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the subsurface exploration. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect if subsurface conditions change significantly from those anticipated.

We recommend NV5 be retained to observe earthwork activities, including stripping, proof rolling of the subgrade and repair of soft areas, footing subgrade and granular pad preparation, final proof rolling of the pavement subgrade and base rock, and AC placement and compaction, and performing laboratory compaction and field moisture-density tests.

8.0 LIMITATIONS

We have prepared this report for use by Delta Logistics, Inc. and members of the design and construction team for the proposed development. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions and are not applicable to other sites.

Soil explorations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

The site development plans and design details were conceptual at the time this report was prepared. When the design has been finalized and if there are changes in the site grades or location, configuration, design loads, or type of construction, the conclusions and recommendations presented may not be applicable. If design changes are made, we should be retained to review our conclusions and recommendations and to provide a written evaluation or modification.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in this report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

◆ ◆ ◆

We appreciate the opportunity to be of continued service to you. Please call if you have questions concerning this report or if we can provide additional services.

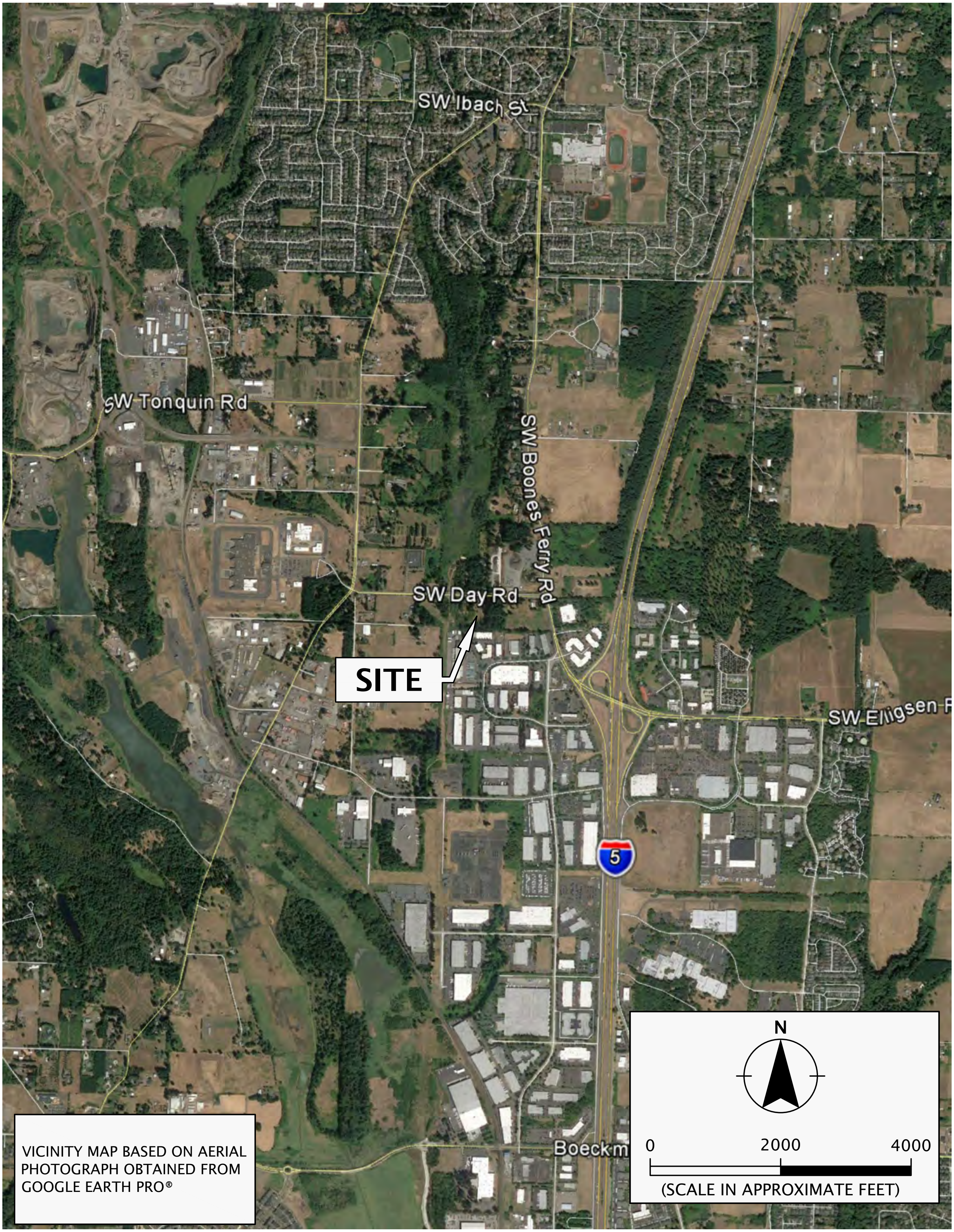
Sincerely,

NV5

Brett A. Shipton, P.E., G.E.
Principal Engineer

REGISTERED PROFESSIONAL
ENGINEER
56207
OREGON
July 11, 2000
BRETT A. SHIPTON
EXPIRES: 6/30/22

FIGURES



VICINITY MAP BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®

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VICINITY MAP

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE 1

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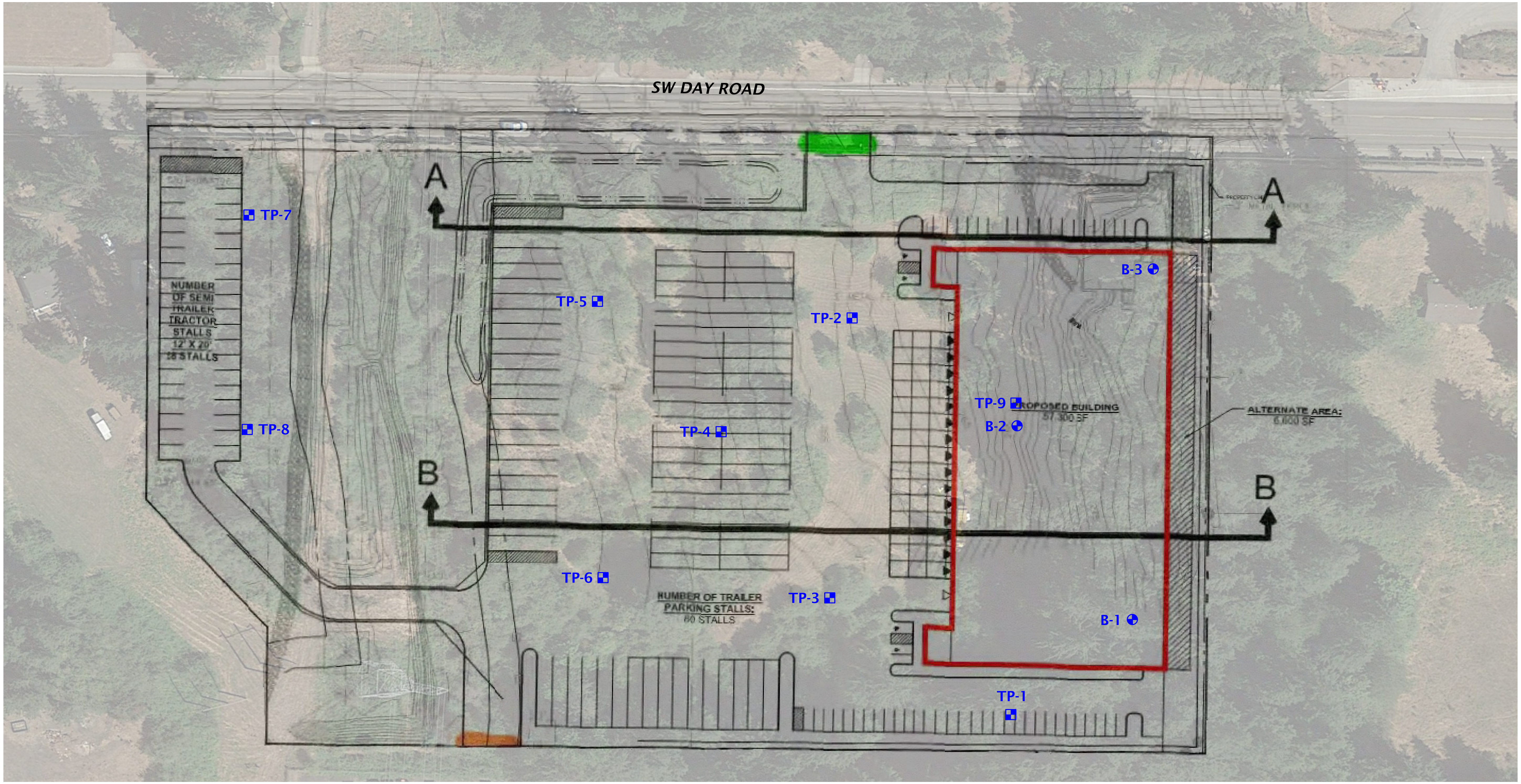
File Name: J:\A-D\DeltaLog\DeltaLog-1\DeltaLog-1-01\Figures\CAD\DeltaLog-1-01-VM01.dwg | Layout: FIGURE 1



LEGEND:

B-1 ◕ BORING

TP-1 ▣ TEST PIT

N

0 80 160

(SCALE IN FEET)

NOTES:

1. SITE PLAN BASED ON IMAGE OF SHEET SITE PLAN - OPTION 3B DATED MARCH 15, 2021 PREPARED BY MACKENZIE.
2. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO JUNE 21, 2021.

Printed By: mmiller | Print Date: 6/29/2021 9:47:30 AM
File Name: J:\A-D\DeltaLog\DeltaLog-1\DeltaLog-1-01\Figures\CAD\DeltaLog-1-01-SP01.dwg | Layout: FIGURE 2

NV5

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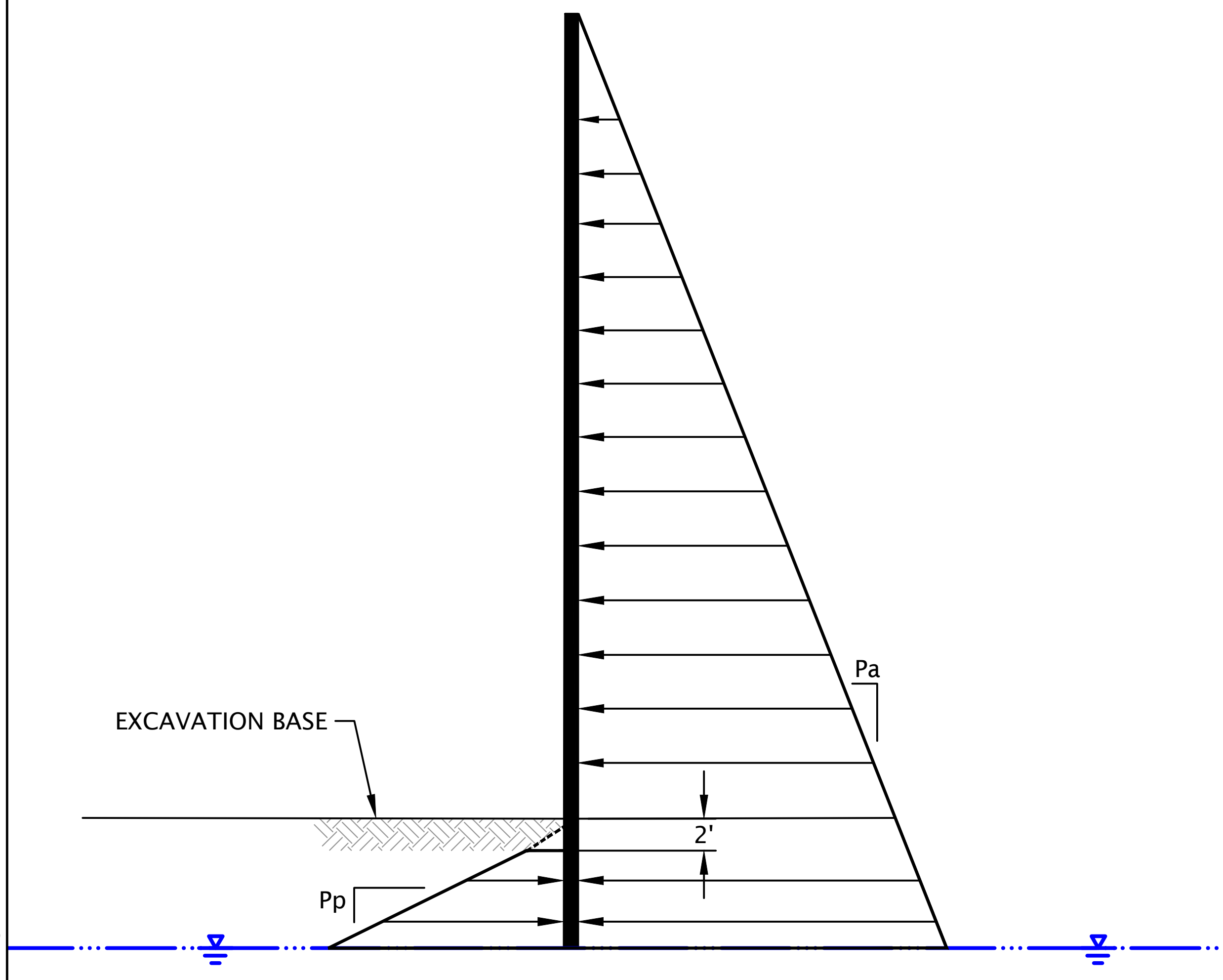
JUNE 2021

SITE PLAN

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE 2

RECOMMENDED DESIGN PARAMETERS FOR CANTILEVERED WALL



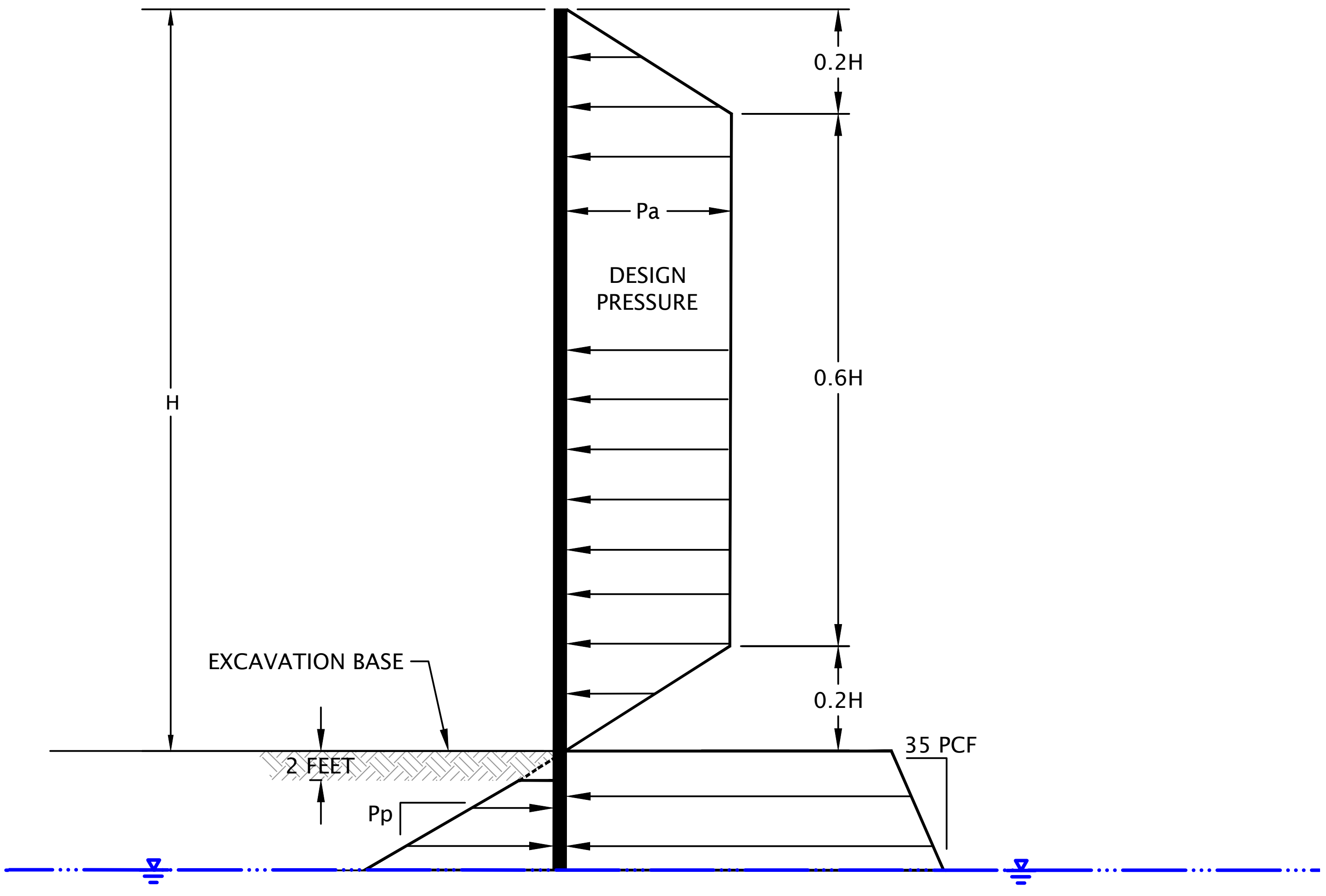
EXPLANATION:

Pa = 35 PCF FOR SOIL OR STRUCTURAL FILL ABOVE WATER TABLE
Pa = 15 PCF FOR BASALT ABOVE WATER TABLE
Pp = 350 PCF FOR SOIL ABOVE WATER TABLE
Pp = 850 PCF FOR BASALT ABOVE WATER TABLE

NOTES:

1. FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
2. LATERAL EARTH PRESSURE ASSUMES WATER WILL BE MAINTAINED BELOW THE BASE OF THE EXCAVATION.
3. THE LATERAL EARTH PRESSURES ARE UNFACTORED.
4. PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
5. REFER TO THE GEOTECHNICAL REPORT FOR APPROPRIATE GROUNDWATER ELEVATION.
6. ACTIVE EARTH PRESSURE ASSUMES RETAINING WALL IS FREE TO ROTATE SLIGHTLY AROUND THE BASE.

RECOMMENDED DESIGN PARAMETERS FOR BRACED WALL



EXPLANATION:

Pa = 25 PCF FOR SOIL OR STRUCTURAL FILL ABOVE WATER TABLE
Pa = 12 PCF FOR BASALT ABOVE WATER TABLE
Pp = 350 PCF FOR SOIL ABOVE WATER TABLE
Pp = 850 PCF FOR BASALT ABOVE WATER TABLE

NOTES:

1. FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
2. TIEBACKS SHOULD BE LOCKED OFF AT 100 PERCENT OF DESIGN LOAD.
3. THE LATERAL EARTH PRESSURES ARE UNFACTORED.
4. PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
5. REFER TO THE GEOTECHNICAL REPORT FOR APPROPRIATE GROUNDWATER ELEVATION.
6. ASSUMES RETAINING WALL IS BRACED AT MORE THAN ONE LOCATION.

CANTILEVERED AND BRACED WALLS DESIGN CRITERIA

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE 3

DELTALOG-1-01

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File Name: J:\A-D\DeltaLog\DeltaLog-1\DeltaLog-1-01\Figures\CAD\DeltaLog-1-01-DET01.dwg | Layout: FIGURE 3

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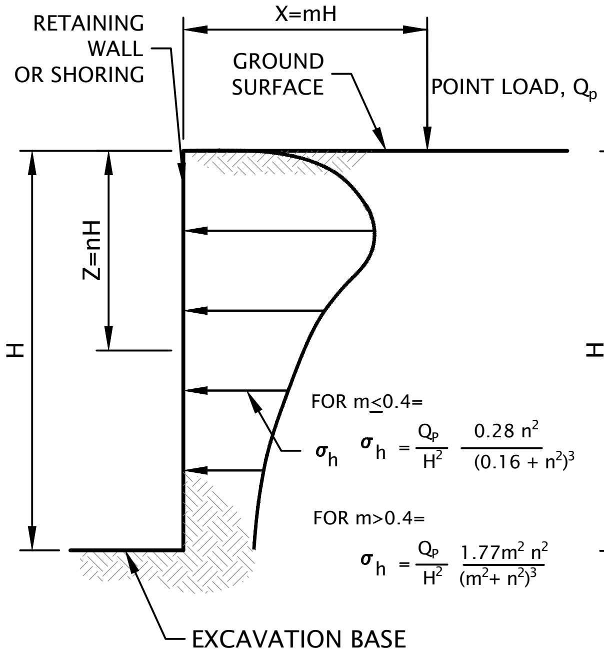
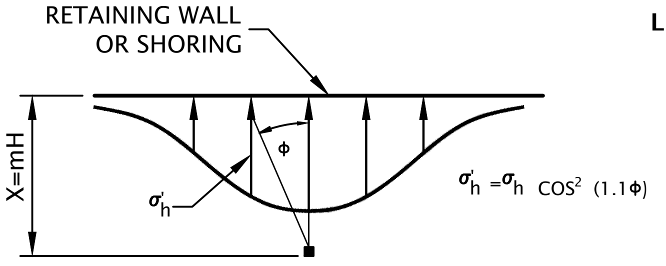
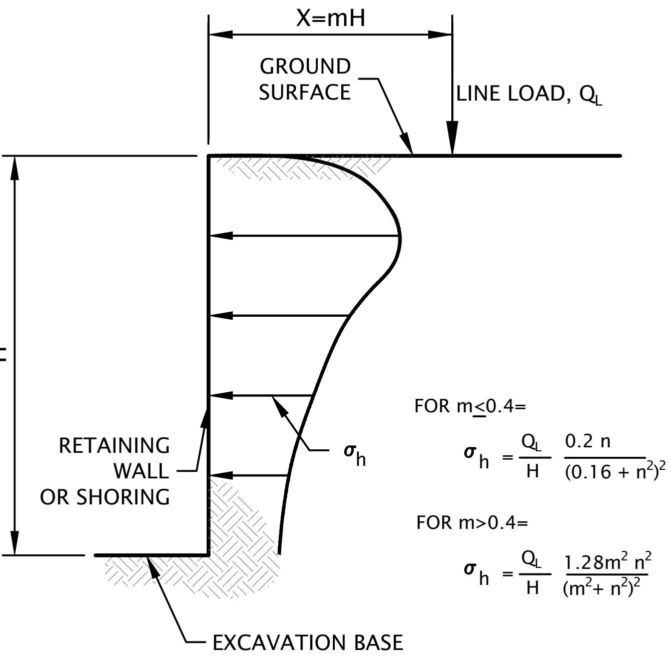
File Name: J:\A-D\DeltaLog\DeltaLog-1\DeltaLog-1-01\Figures\CAD\DeltaLog-1-01-DET02.dwg | Layout: FIGURE 4



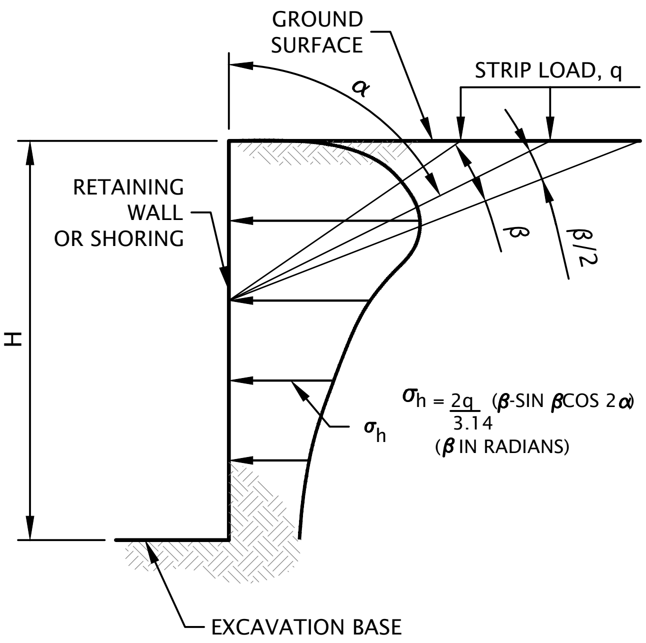


DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD



LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL

NOT TO SCALE

NOTES:

1. FIGURE SHOULD BE USED IN CONJUNCTION WITH REPORT TEXT.
2. THESE GUIDELINES APPLY TO RIGID WALLS WITH POISSON'S RATIO ASSUMED TO BE 0.5 FOR BACKFILL MATERIALS.
3. LATERAL PRESSURES FROM ANY COMBINATION OF ABOVE LOADS MAY BE DETERMINED BY THE PRINCIPLE OF SUPERPOSITION.

DELTALOG-1-01

JUNE 2021

SURCHARGE-INDUCED LATERAL EARTH PRESSURES

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE 4

APPENDIX

APPENDIX

FIELD EXPLORATIONS

GENERAL

Subsurface conditions were explored by drilling three borings (B-1 through B-3) to depths between 15 and 22.5 feet BGS and excavating nine test pits (TP-1 through TP-9). Drilling services were provided by Western States Soil Conservation, Inc. of Hubbard, Oregon, using mud rotary drilling methods and HQ core drilling techniques. Excavation services were provided by Dan J. Fischer Excavating, Inc. of Forest Grove, Oregon. All explorations were observed by a qualified member of NV5's staff. The approximate exploration locations are shown on Figure 2.

The exploration locations were determined by pacing from existing site features and should be considered accurate to the degree implied by the methods used.

SOIL AND ROCK SAMPLING

We collected representative samples of the various soils encountered during drilling for geotechnical laboratory testing. Samples were collected from the borings using 1½-inch-inside-diameter, split-spoon SPT samplers in general accordance with ASTM D1586. The samplers were driven into the soil with a 140-pound automatic trip hammer free-falling 30 inches. The samplers were driven a total distance of 18 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the exploration logs, unless otherwise noted. The average efficiency of the automatic SPT hammer used by Western States Soil Conservation, Inc. was 82.2 percent. The calibration testing results are presented at the end of this appendix.

Rock was cored continuously using HQ core drilling methods in general accordance with ASTM D2113-99. Percent core recovery and RQD are noted on the exploration logs. The RQD is defined as the total length of all the intact core sections over 4 inches in length divided by the total length of the core run.

Representative grab samples of the soil observed in the test pits were collected from the walls or base of the test pits using the excavator bucket.

Sampling methods and intervals are shown on the exploration logs.

SOIL AND ROCK CLASSIFICATION

The soil and rock samples were classified in the field in accordance with the "Exploration Key" (Table A-1), "Soil Classification System" (Table A-2), and "Rock Classification System" (Table A-3), which are presented in this appendix. The exploration logs indicate the depths at which the soil characteristics change, although the change could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

INFILTRATION TESTING

Infiltration testing was conducted test pit TP-5 at depths of 2 and 3.5 feet BGS. The infiltration test at a depth of 2 feet BGS was conducted using the falling head method in a 6-inch-diameter standpipe under a head of approximately 14 inches. An open pit technique was used to conduct the test at a depth of 3.5 feet BGS under a head of 14 inches.

LABORATORY TESTING

We visually examined soil samples collected from the explorations to confirm field classifications. We also performed the following laboratory tests to evaluate the engineering properties of the soil.

MOISTURE CONTENT

We tested the natural moisture content of select soil samples in general accordance with ASTM D2216. The test results are presented in this appendix.

PARTICLE-SIZE ANALYSIS

We determined the fines content of a select soil sample in general accordance with ASTM D1140. The test results are presented in this appendix.

UNCONFINED COMPRESSION TESTS

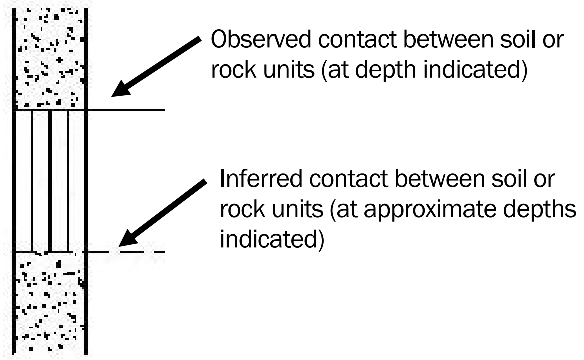
Unconfined compressive strength testing was conducted on several samples from the rock cores. The testing was completed in accordance with ASTM D2938 The test results are summarized in the table below.

Unconfined Compression Test Results

Boring	Depth (feet BGS)	Unconfined Compressive Strength (psi)
B-2	9.6	12,722
B-3	6.3	11,818
B-3	21	7,898

SYMBOL	SAMPLING DESCRIPTION
◨	Location of sample collected in general accordance with ASTM D1586 using Standard Penetration Test (SPT) with recovery
◧	Location of sample collected using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D1587 with recovery
▥	Location of sample collected using Dames & Moore sampler and 300-pound hammer or pushed with recovery
▥	Location of sample collected using Dames & Moore sampler and 140-pound hammer or pushed with recovery
⊠	Location of sample collected using 3-inch-outside diameter California split-spoon sampler and 140-pound hammer with recovery
⊠	Location of grab sample
▮	Rock coring interval
▽	Water level during drilling
▼	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density		
DS	Direct Shear	RES	Resilient Modulus
HYD	Hydrometer Gradation	SIEV	Sieve Gradation
MC	Moisture Content	TOR	Torvane
MD	Moisture-Density Relationship	UC	Unconfined Compressive Strength
NP	Non-Plastic	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen

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EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOIL

Relative Density	Standard Penetration Test (SPT) Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very loose	0 – 4	0 – 11	0 – 4
Loose	4 – 10	11 – 26	4 – 10
Medium dense	10 – 30	26 – 74	10 – 30
Dense	30 – 50	74 – 120	30 – 47
Very dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOIL

Consistency	Standard Penetration Test (SPT) Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 – 4	3 – 6	2 – 5	0.25 – 0.50
Medium stiff	4 – 8	6 – 12	5 – 9	0.50 – 1.0
Stiff	8 – 15	12 – 25	9 – 19	1.0 – 2.0
Very stiff	15 – 30	25 – 65	19 – 31	2.0 – 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOIL (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVEL WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SAND (<5% fines)	SW or SP	SAND
		SAND WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SAND WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOIL (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOIL			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.					
Percent	Silt and Clay In:		Percent	Sand and Gravel In:	
	Fine-Grained Soil	Coarse-Grained Soil		Fine-Grained Soil	Coarse-Grained Soil
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
▨	▨	▨	> 30	sandy/gravelly	Indicate %

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SOIL CLASSIFICATION SYSTEM

TABLE A-2

HARDNESS	DESCRIPTION
Extremely soft (R0)	Indented by thumbnail
Very soft (R1)	Can be peeled by pocket knife or scratched with finger nail
Soft (R2)	Can be peeled by a pocket knife with difficulty
Medium hard (R3)	Can be scratched by knife or pick
Hard (R4)	Can be scratched with knife or pick only with difficulty
Very hard (R5)	Cannot be scratched with knife or sharp pick
WEATHERING	**DESCRIPTION**
Decomposed	Rock mass is completely decomposed
Predominantly decomposed	Rock mass is more than 50% decomposed
Moderately weathered	Rock mass is decomposed locally
Slightly weathered	Rock mass is generally fresh
Fresh	No discoloration in rock fabric
JOINT SPACING	**DESCRIPTION**
Very close	Less than 2 inches
Close	2 inches to 1 foot
Moderate close	1 foot to 3 feet
Wide	3 feet to 10 feet
Very wide	Greater than 10 feet
FRACTURING	**FRACTURE SPACING**
Very intensely fractured	Chips and fragments with a few scattered short core lengths
Intensely fractured	0.1 foot to 0.3 foot with scattered fragments intervals
Moderately fractured	0.3 foot to 1 foot with most lengths 0.6 foot
Slightly fractured	1 foot to 3 feet
Very slightly fractured	Greater than 3 feet
Unfractured	No fractures
HEALING	**DESCRIPTION**
Not healed	Discontinuity surface, fractured zone, sheared material or filling not re-cemented
Partly healed	Less than 50% of fractured or sheared material
Moderately healed	Greater than 50% of fractured or sheared material
Totally healed	All fragments bonded

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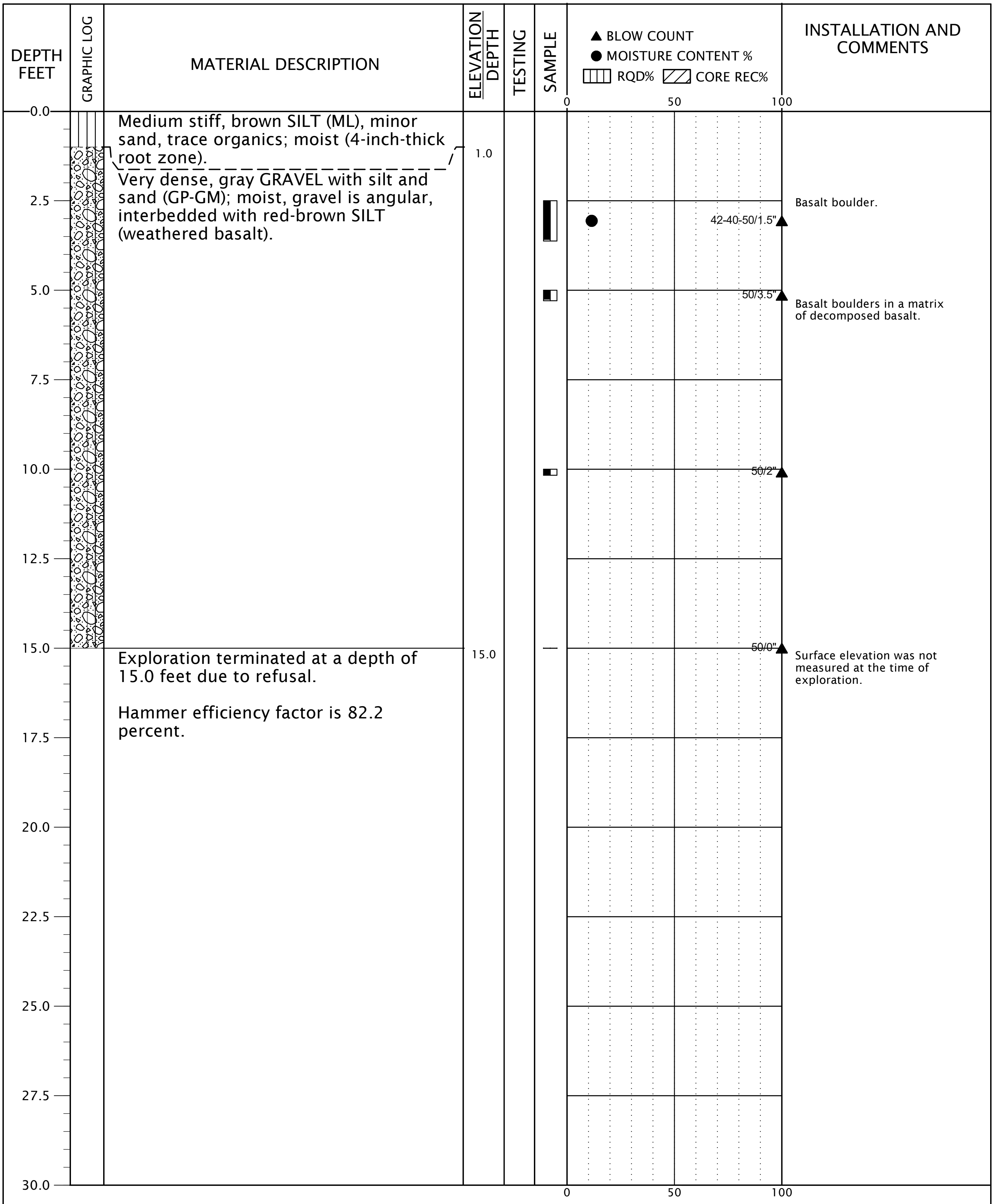
ROCK CLASSIFICATION SYSTEM

TABLE A-3



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	BLOW COUNT	INSTALLATION AND COMMENTS
0.0	Medium stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).	1.0		
	Very dense, gray GRAVEL with silt and sand (GP-GM); moist, gravel is angular, interbedded with red-brown SILT (weathered basalt).			
2.5			42-40-50/1.5"	Basalt boulder.
5.0			50/3.5"	Basalt boulders in a matrix of decomposed basalt.
10.0			50/2"	
15.0	Exploration terminated at a depth of 15.0 feet due to refusal. Hammer efficiency factor is 82.2 percent.	15.0	50/0"	Surface elevation was not measured at the time of exploration.

DRILLED BY: Western States Soil Conservation, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/08/21

BORING METHOD: mud rotary (see document text)

BORING BIT DIAMETER: 4 7/8 inches

DELTALOG-1-01

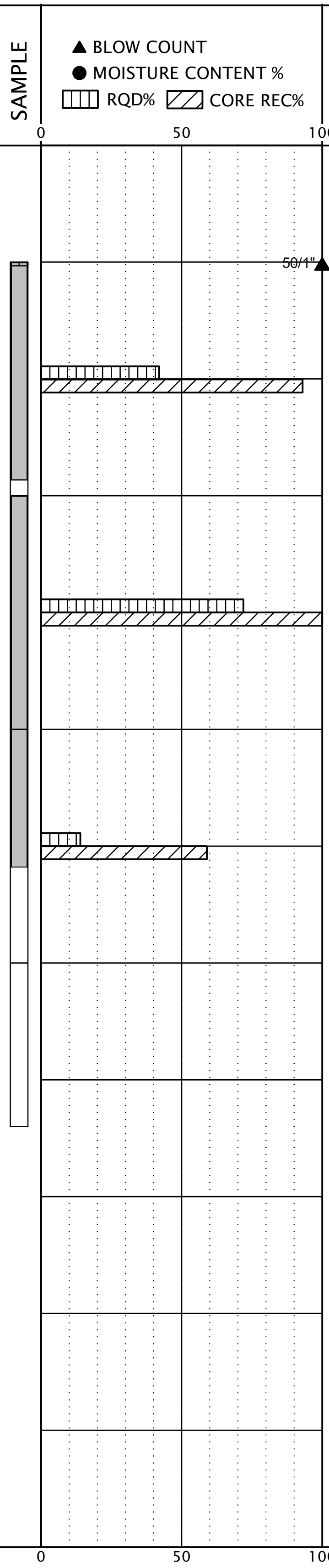
JUNE 2021

BORING B-1

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-1

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0.0	Very dense, gray GRAVEL with sand (GP); moist, gravel is angular.			
2.5	Medium hard (R3), light orange-gray BASALT; moderately weathered, intensely fractured [joint, 5-30˚, 70-90˚, narrow, decomposed rock infill (clay), planar, smooth to rough, partly healed], aphanitic, moist. hard (R4), light gray; [joint, 0-20˚, extremely narrow, surface staining/decomposed, not healed] at 5.5 feet	2.5		Switch to HQ rock drilling at 2.5 feet.
10.0			UC	UC = 12,722 psi
10.8	medium hard (R3); [joint, 0-80˚, very narrow] at 10.8 feet			
14.0	soft (R2); slightly weathered [fracture zone] at 14.0 feet			
21.0	Exploration completed at a depth of 21.0 feet. Hammer efficiency factor is 82.2 percent.	21.0		Surface elevation was not measured at the time of exploration.



DRILLED BY: Western States Soil Conservation, Inc.

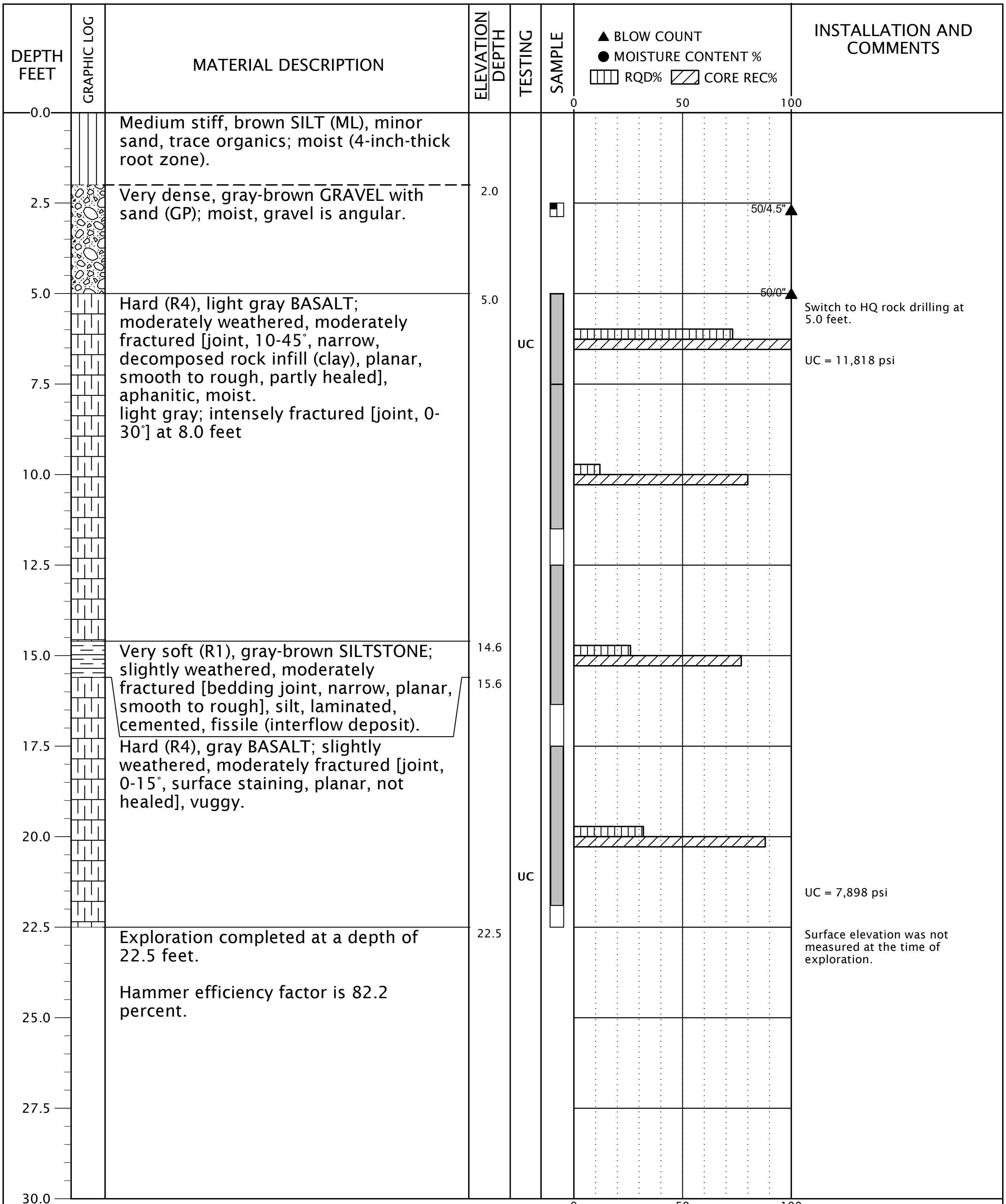
LOGGED BY: J. Pence

COMPLETED: 06/08/21

BORING METHOD: mud rotary and HQ core drilling (see document text)

BORING BIT DIAMETER: 4 7/8 inches

NV5	DELTALOG-1-01	**BORING B-2**
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR
		FIGURE A-2



MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
Medium stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).			
Very dense, gray-brown GRAVEL with sand (GP); moist, gravel is angular.	2.0		
Hard (R4), light gray BASALT; moderately weathered, moderately fractured [joint, 10-45°, narrow, decomposed rock infill (clay), planar, smooth to rough, partly healed], aphanitic, moist. light gray; intensely fractured [joint, 0-30°] at 8.0 feet	5.0	UC	Switch to HQ rock drilling at 5.0 feet. UC = 11,818 psi
Very soft (R1), gray-brown SILTSTONE; slightly weathered, moderately fractured [bedding joint, narrow, planar, smooth to rough], silt, laminated, cemented, fissile (interflow deposit).	14.6		
Hard (R4), gray BASALT; slightly weathered, moderately fractured [joint, 0-15°, surface staining, planar, not healed], vuggy.	15.6	UC	UC = 7,898 psi
Exploration completed at a depth of 22.5 feet. Hammer efficiency factor is 82.2 percent.	22.5		Surface elevation was not measured at the time of exploration.

DRILLED BY: Western States Soil Conservation, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/08/21

BORING METHOD: mud rotary and HQ core drilling (see document text)

BORING BIT DIAMETER: 4 7/8 inches

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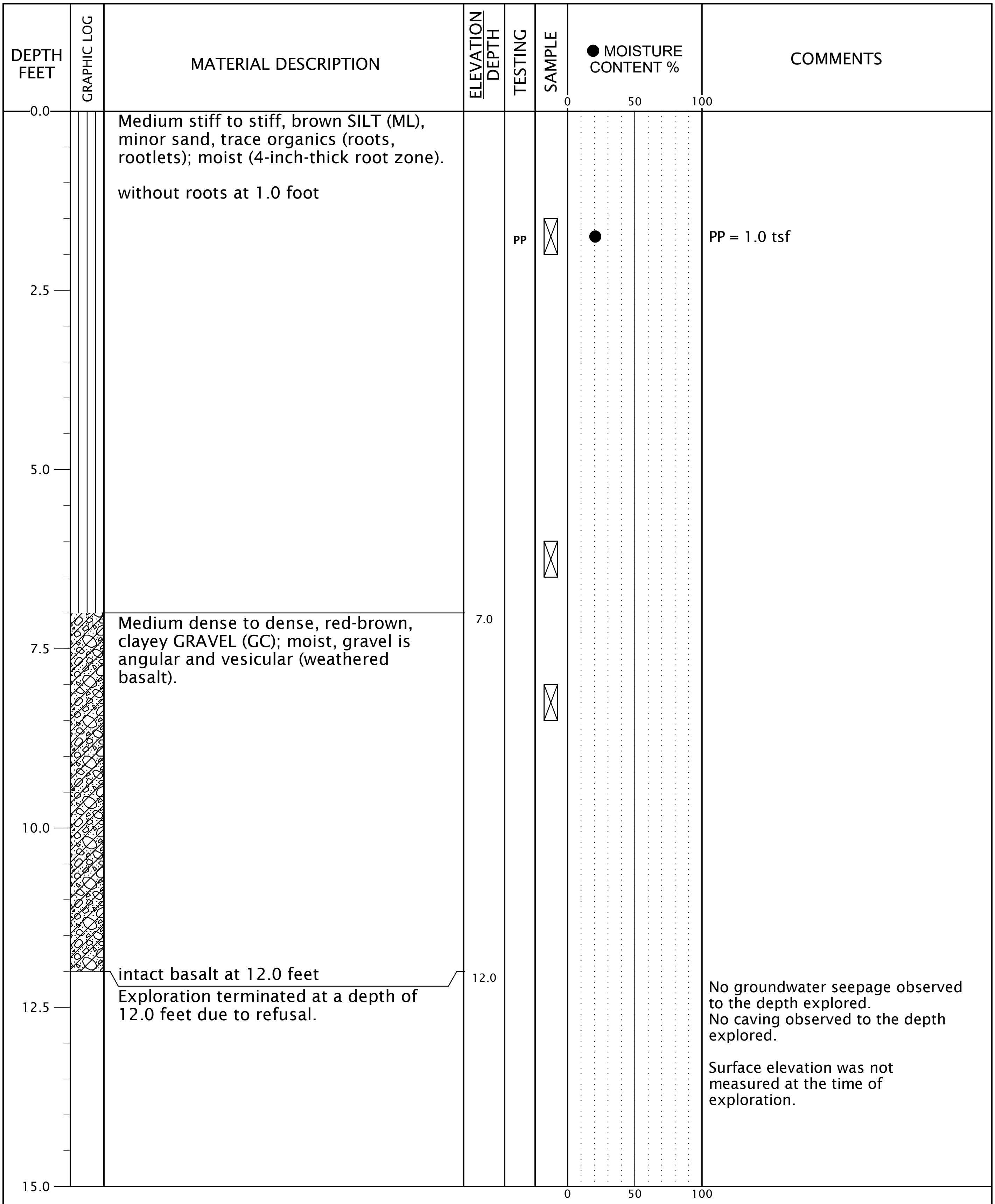
DELTALOG-1-01

JUNE 2021

BORING B-3

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-3



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION / DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT %	COMMENTS
0.0	Medium stiff to stiff, brown SILT (ML), minor sand, trace organics (roots, rootlets); moist (4-inch-thick root zone). without roots at 1.0 foot					
			PP	☒	●	PP = 1.0 tsf
				☒		
7.0	Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	7.0				
				☒		
12.0	intact basalt at 12.0 feet Exploration terminated at a depth of 12.0 feet due to refusal.	12.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.

EXCAVATED BY: Dan J. Fischer Excavating, Inc.   LOGGED BY: J. Pence   COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-1

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-4

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % (0 50 100)	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics; moist, sand is fine (4-inch-thick root zone).					
2.5							
				PP	☒		PP = 1.5 tsf
5.0		intact gray basalt at 5.0 feet Exploration terminated at a depth of 5.0 feet due to refusal.	5.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-2

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-5

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics; moist (3-inch-thick root zone).					
				PP	☒		PP = 13.5 tsf
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular (weathered basalt).	2.0				
2.5							
					☒		
		intact gray basalt at 4.0 feet Exploration terminated at a depth of 4.0 feet due to refusal.	4.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

DELTALOG-1-01

TEST PIT TP-3

JUNE 2021

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-6

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).					
				PP	☒		PP = 1.0 tsf
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	2.0				Basalt becomes more intact with depth.
2.5							
5.0		Exploration terminated at a depth of 5.0 feet due to refusal.	5.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

DELTALOG-1-01

JUNE 2021

TEST PIT TP-4

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-7

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).					
2.5				P200 PP	☒	●	Infiltration test at 2.0 feet. P200 = 86% PP = 1.0 tsf
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	3.0		☒		
		Exploration terminated at a depth of 3.5 feet due to refusal.	3.5				Infiltration test at 3.5 feet. No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-5

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-8

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION / DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		GRAVEL - **FILL**.					
		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics (roots); moist. without roots at 1.0 foot	0.5	PP	☒		PP = 1.0 tsf
2.5							
		Medium dense to dense, gray GRAVEL with sand (GP); dry to moist, gravel is angular (weathered basalt). intact gray basalt at 4.0 feet	3.0		☒		
		Exploration terminated at a depth of 3.5 feet due to refusal.	3.5				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

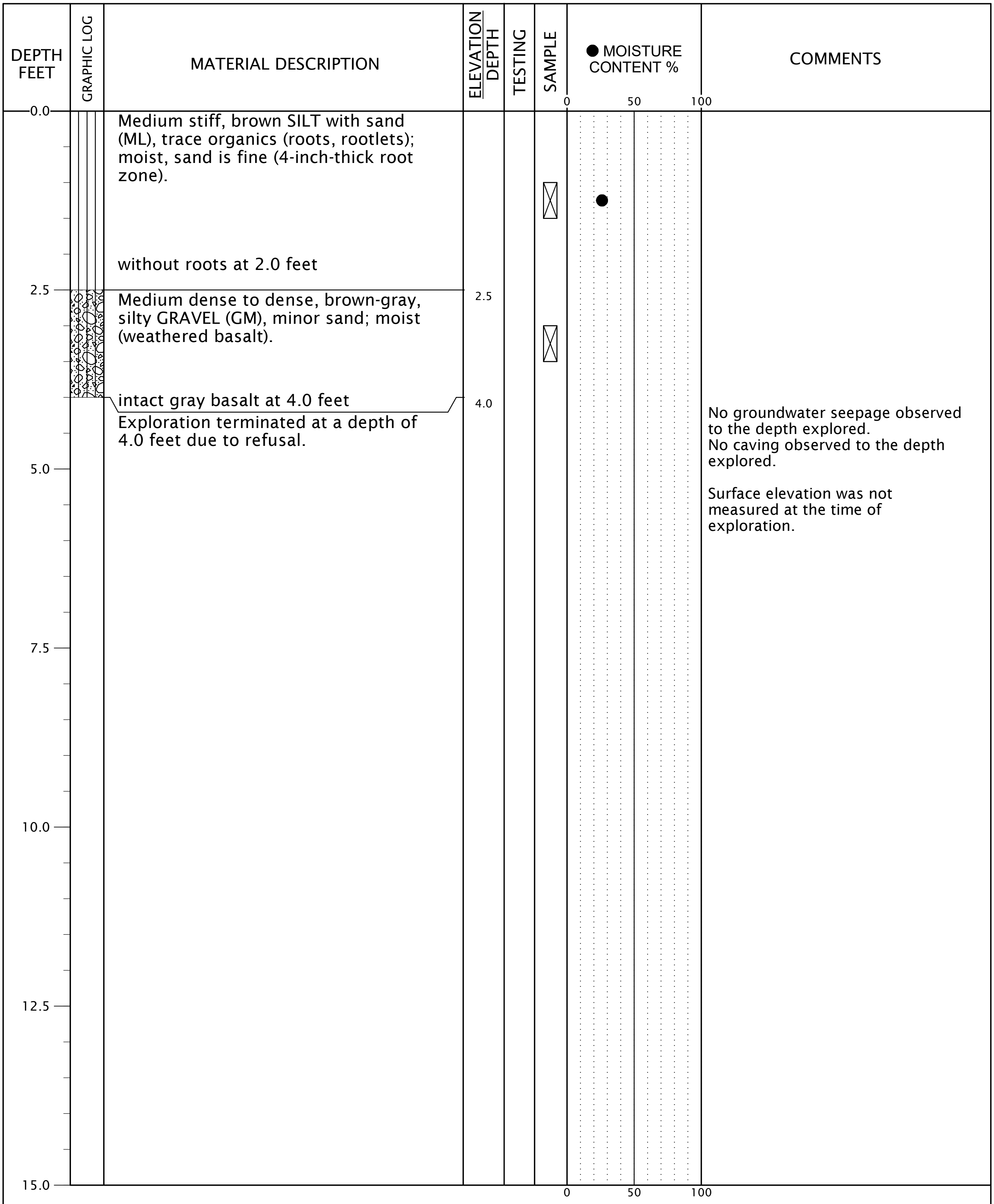
DELTALOG-1-01

JUNE 2021

TEST PIT TP-6

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-9



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	COMMENTS
0.0	Medium stiff, brown SILT with sand (ML), trace organics (roots, rootlets); moist, sand is fine (4-inch-thick root zone). without roots at 2.0 feet		
2.5	Medium dense to dense, brown-gray, silty GRAVEL (GM), minor sand; moist (weathered basalt). intact gray basalt at 4.0 feet	2.5	
	Exploration terminated at a depth of 4.0 feet due to refusal.	4.0	No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-7

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-10

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

TEST PIT TP-8

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0	Medium stiff, brown SILT (ML), minor sand, trace organics (roots); moist (4-inch-thick root zone).					
			PP	☒		PP = 0.75 tsf
	without roots at 2.0 feet					
2.5						
			PP	☒		PP = 1.5 tsf
	Dense, red-brown, silty GRAVEL (GM), minor sand; moist, gravel is angular (weathered basalt).	4.0				
5.0						
	Dense, gray GRAVEL (GP), minor sand, trace silt; moist, gravel is angular (weathered basalt).	6.0				
7.5						
						Moderate groundwater seepage observed at 8.0 feet.
	intact gray basalt at 8.5 feet Exploration terminated at a depth of 8.5 feet due to refusal.	8.5				No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
10.0						
12.5						
15.0					0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-11

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics (roots, rootlets); moist (4-inch-thick root zone).					
2.5							
		basalt at 3.0 feet Exploration terminated at a depth of 3.0 feet due to refusal.	3.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-9

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-12

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	2.5		11							
TP-1	1.5		21							
TP-5	2.0		21				86			
TP-7	1.0		26							

LAB SUMMARY - GDI-NV5 DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/23/21:SN

NV5

DELTALOG-1-01

JUNE 2021

SUMMARY OF LABORATORY DATA

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-13

BORING B-2, CORE RUN 1, 2.5 TO 7.5 FEET BGS.

BORING B-2, CORE RUN 2, 7.5 TO 12.5 FEET BGS.

NV5

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JUNE 2021

ROCK CORE PHOTOGRAPHS

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-14

BORING B-2, CORE RUN 3, 12.5 TO 17.5 FEET BGS.

BORING B-3, CORE RUN 1, 5 TO 7.5 FEET BGS.

NV5	DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-15**

BORING B-3, CORE RUN 2, 7.5 TO 12.5 FEET BGS.

BORING B-3, CORE RUN 3, 12.5 TO 17.5 FEET BGS.

DeltaLog-1-01-FA14_A17-CPH.docx Print Date: 6/29/21

DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-16**

BORING B-3, CORE RUN 4, 17.5 TO 22.5 FEET BGS.

DeltaLog-1-01-FA14_A17-CPH.docx Print Date: 6/29/21

DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-17**

Summary of SPT Test Results

Project: WSSC-8-05, Test Date: 4/13/2020

EMX: Maximum Energy

ETR: Energy Transfer Ratio - Rated

Start Depth ft	Final Depth ft	**N Value**	**N60 Value**	Average EMX ft-lb	Average ETR %
15.00	16.50	**8**	**10**	291.65	83.3
17.50	19.00	**15**	**20**	278.80	79.7
20.00	21.50	**18**	**24**	290.63	83.0
22.50	24.00	**15**	**20**	304.84	87.1
25.00	26.50	**11**	**15**	269.66	77.0
			Overall Average Values:	287.84	82.2
			Standard Deviation:	38.44	11.0
			Overall Maximum Value:	327.58	93.6
			Overall Minimum Value:	0.10	0.0

NV5

Delivering Solutions
Improving Lives

ADDENDUM TRANSMITTAL

To:	Igor Nichiporchik	From:	Jeff Tucker and Brett Shipton
Company:	Delta Logistics, Inc.	Date:	November 19, 2021
Address:	9835 Commerce Circle Wilsonville, OR 97070		

cc:	Lee Leighton, Mackenzie (via email only)

Project No.:	DeltaLog-1-01
RE:	Delta Logistics Day Road Annex

Original File Name	Date	Document Title
DeltaLog-1-01-063021-geor	6/30/21	Report of Geotechnical Engineering Services; Delta Logistics Day Road Annex; SW Day Road; Wilsonville, Oregon

Addendum Number	Date	Description
1	11/19/21	Preliminary Soil Nail Wall Design (attached)

sn
Attachment
One copy submitted (via email only)
Document ID: DeltaLog-1-01-111921-geoat-1.docx

November 19, 2021

Delta Logistics, Inc.
9835 Commerce Circle
Wilsonville, OR 97070

Attention: Igor Nichiporchik

Addendum 1
Preliminary Soil Nail Wall Design
Delta Logistics Day Road Annex
SW Day Road
Wilsonville, Oregon
Project: DeltaLog-1-01

INTRODUCTION

NV5 is pleased to provide this addendum to our geotechnical report for the Delta Logistics Day Road Annex project located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon.[1]

SOIL NAIL WALL

A soil nail wall is proposed to support the cut along the eastern property line for the project. The soil in this area will include overburden silt underlain by variably weathered and decomposed basalt rock. The proposed soil nail wall is 18 feet tall. We expect that the shotcrete will be approximately 9 inches thick.

Our analysis of the wall in this area primarily focused on global stability but also evaluated the preliminary nail spacing for the wall. The soil nail wall design parameters used in our analysis are summarized in Table 1. The soil parameters were based on our prior services at the site.

---

[1] NV5, 2021. *Report of Geotechnical Engineering Services; Delta Logistics Day Road Annex; SW Day Road; Wilsonville, Oregon,* dated June 30, 2021. Project: DeltaLog-1-01

Table 1. Soil Nail Wall Design Parameters

Material	Soil Unit Weight (pcf)	Soil Cohesion Static (psf)	Soil Cohesion Seismic (psf)	Soil Friction Static (degrees)	Soil Friction Seismic (degrees)	Ultimate Bond Strength (psf)
Silt	110	0	0	29	29	1,300
Soft to Hard Basalt	150	0	0	45	45	7,500

pcf: pounds per cubic foot
psf: pounds per square foot

We used the computer program SnailPlus 2021 to perform AASHTO load and resistance factor design analyses for the soil nail wall using the soil parameters summarized in Table 1. Our analysis assumes the wall is battered at an inclination of 1H:10V with horizontal and vertical soil nail spacings of 4 feet and soil nail lengths of 8 feet. The results of our analysis are presented in the Attachment. We recommend that final design be included in a bidder-design submittal.

The ultimate pullout resistance used in design is based on published values by Federal Highway Administration (FHWA) and AASHTO and should be considered preliminary. We recommend that verification pullout tests on sacrificial anchors be performed to establish that anchor lengths and capacities are consistent with the contractor's chosen method of installation. We recommend a minimum of two verification tests be performed in each anticipated soil type. Performance tests should be performed to 200 percent of the design load and in accordance with the guidelines provided in Publication No. FHWA-NHI-14-007, and the minimum length of soil or rock nails should be 8 feet to assure grouting of the entire bonded length and to provide sufficient ground cover above the anchorage zone.

In addition to verification pullout tests, proof testing should be performed on a minimum of 5 percent of the production nails in each nail row or a minimum of one nail per row. The locations shall be designated by the engineer. Proof testing should be performed in accordance with the guidelines provided in Publication No. FHWA-NHI-14-007.

We recommend that soil nail walls be constructed with sheet drains behind the walls to attain minimum drainage coverage of 30 to 50 percent. If water seepage is encountered during wall construction, we recommend 100 percent drainage coverage of the water seepage zone. The drainage pipe should be sloped and routed to drain toward a suitable discharge.

We recommend that all soil nails include the appropriate corrosion protection for permanent walls as required by county and city agencies. During installation, centralizers must be used to ensure a minimum thickness of grout completely covers the nail. Centralizers should be installed at a maximum spacing of 8 feet and a minimum distance of 1.5 feet from both ends of the nails.

LIMITATIONS

We have prepared this addendum for use by Delta Logistics, Inc. and members of the design and construction teams for the proposed soil nail wall. The data and addendum can be used for bidding or estimating purposes, but our addendum, conclusions, and interpretations should not be construed as warranty of the subsurface conditions and are not applicable to other nearby building sites.

Explorations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

If there are changes in the site grades or location, configuration, design loads, or type of construction, the conclusions and recommendations presented may not be applicable. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

The scope does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in this addendum for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time this addendum was prepared. No warranty, express or implied, should be understood.

◆ ◆ ◆

We appreciate the opportunity to be of service to you. Please call if you have questions concerning this addendum or if we can provide additional services.

Sincerely,

NV5

REGISTERED PROFESSIONAL ENGINEER
74942PE
OREGON
July 13, 2004
JEFFERY D. TUCKER
EXPIRES: 6/30/22

Jeffery D. Tucker, P.E., G.E.
Principal Engineer

Brett A. Shipton, P.E., G.E.
Principal Engineer

cc: Lee Leighton, Mackenzie (via email only)

JDT:BAS:sn
Attachments
One copy submitted (via email only)
Document ID: DeltaLog-1-01-111921-geoa-1.docx

ATTACHMENT

ATTACHMENT

PRELIMINARY SOIL NAIL WALL ANALYSIS

This attachment provides the output of our preliminary soil nail wall analysis.

SnailPlus 2021: Report Output

A program for the evaluation of soil nail walls. Deep Excavation LLC, Astoria, New York, www.deepexcavation.com

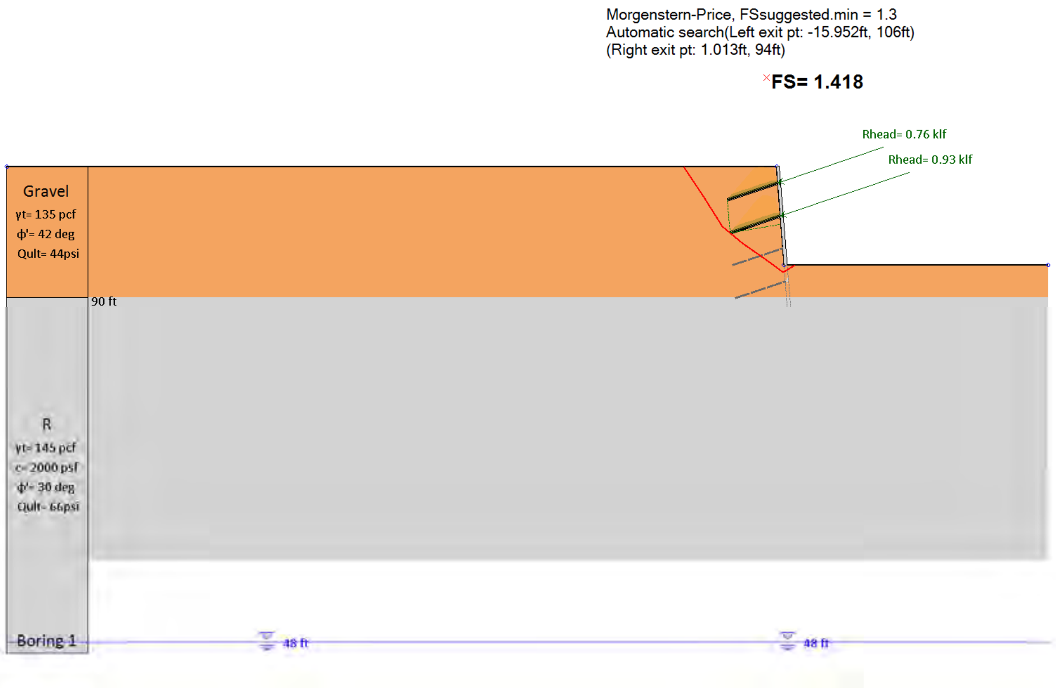
Project: Delta Logistics - Soil Nail Wall

Company: NV5
Prepared by engineer: JDT
File number: 1
Time: 10/28/2021 5:09:04 PM

File: C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP

Quick analysis summary for design section: Base model

Base model



Stage	Calculation	FS	Fmax.Nails	Fmax.Nails	Fmax.Mob	STR Check	STR Check	STR Chec	Max.	Min.
Section	Status	Slope	(k)	Head (k)	(k)	Nails	Plates	Facing	Reinf.	Reinf.
Exc. 98ft	Calculated	1.561	3.58	2.52	2.84	0.109	0.105	0.054	No	Yes
Exc. 94ft	Calculated	1.418	5.29	3.73	4.87	0.161	0.153	0.078	No	Yes
Exc. 90ft	Calculated	1.766	6.76	4.77	6.27	0.205	0.195	0.099	No	Yes
Final stage	Calculated	1.921	6.76	4.77	6.27	0.205	0.195	0.099	No	Yes

Fmax Nails = Maximum axial nail force in analysis.
Fmax Nail@head = Maximum axial nail force at facing (To).
Fmax.Mob = Maximum mob axial nail force from To/Tmax ratio Clouterre (Tmax)

STR Nails= Stress check for nails, Design load/Design Capacity (maintain below 1 for good design).
STR Plates= Stress check for nail plates (punching and bending).
STR Facing= Stress check for facing, Design load/Design Capacity.

Table: Analysis summary for all stages, Part 1

Stage	Analyzed	FS min	FS req. code	Type	Xc (ft)	Zc (ft)	R (ft)	Active (deg)	Passive (deg)
Exc. 98ft	Yes	1.561	1.3	Automatic	Auto	Auto	N/A	N/A	N/A
Exc. 94ft	Yes	1.418	1.3	Automatic	Auto	Auto	N/A	N/A	N/A
Exc. 90ft	Yes	1.766	1.3	Automatic	Auto	Auto	N/A	N/A	N/A
Final stage	Yes	1.921	1.5	Automatic	Auto	Auto	N/A	N/A	N/A

Table: Analysis summary for all stages, Part 2

Point 1	Point 2	Crack (ft)	Design Appro	Design Case	Nail force (k)	Nail check	Support Mre	Wall Mres(k-	MEQ seismic(
xL (-17.8 to -	xR (-1 to 1.5)	N/A		Service Facto	30.16	0.109	N/A	N/A	N/A
xL (-25.8 to -	xR (-0.6 to 1.	N/A		Service Facto	28.79	0.161	N/A	N/A	N/A
xL (-33.8 to -	xR (-0.2 to 2.	N/A		Service Facto	27.72	0.205	N/A	N/A	N/A
xL (-37.8 to -	xR (0 to 2.5)	N/A		Service Facto	32.92	0.172	N/A	N/A	N/A

Table: Basic analysis assumptions last stage

Stage conditions	Permanent structure long term
Min required FS	1.5
Method	Morgenstern-Price
Nail methods	Available shear
Surface search	Automatic
Left limits	-37.8ft to -2ft
Right limits	0ft to 2.5ft
Number of points	5
Min. slice width	3ft
Tolerance	1%
Force Tolerance	10%
Initial FS0	1
MP interslice factor m	1
MP interslice factor v	1
MP initial Lamda.0	0
Soil nail analysis	Same settings on all nails
Nail stability	External-Internal
Nail shear	Ignored
FS on nail STR strength	1.8
FS on nail pullout	2
FS on facing bending	1.5
FS on facing punching	1.5
FS on bolts	1.7
FS on bearing	3

Table: Nails & max mobilized head forces

Name	Nail	α	x	El.	Lfix	Lfree	Space	Fhead	Fhead
-	Section	deg	(ft)	(ft)	(ft)	(ft)	(ft)	(k/ft)	(k)
N0	0: N1	15	-1.6	104	8	0	4	1.0089	4.04
N1	0: N1	15	-1.2	100	8	0	4	1.0089	4.04
N2	0: N1	15	-0.8	96	8	0	4	1.192	4.77
N3	0: N1	15	-0.4	92	8	0	4	0.753	3.01

Fhead= Mobilized force at nail head (facing), determined from pressures at facing.

Table: Surface point coordinates for last stage

Point	x (ft)	El. (ft)
1	-120	106
2	-1.8	106
3	0	88
4	40	88

Soil type property data

Name	γtot	γdry	Φ'	c'	Su	qBond	Color
	(pcf)	(pcf)	(deg)	(psf)	(psf)	(psi)	
Gravel	135	125	42	0	N/A	44	🟧
R	145	140	30	2000	N/A	66	⬜

γtot = Total unit weight below water table
γdry = Bulk unit weight above water table
c' = Effective cohesion (in drained state for clays)
Φ' = Effective friction (in drained state for clays)
Su = Undrained shear strength (for clays in undrained condition)
qBond = Ultimate bond resistance for soil nails

Name: Boring 1, pos: (50, 0)

Top elev.	Soil type	OCR	Ko
106	Gravel	1	0.33
90	R	1	0.5

Slope stability assumptions: Exc. 98ft

Table: Basic analysis assumptions last stage

Stage conditions	Permanent structure long term
Min required FS	1.5
Method	Morgenstern-Price
Nail methods	Available shear
Surface search	Automatic
Left limits	-37.8ft to -2ft
Right limits	0ft to 2.5ft
Number of points	5
Min. slice width	3ft
Tolerance	1%
Force Tolerance	10%
Initial FS0	1
MP interslice factor m	1
MP interslice factor v	1
MP initial Lamda.0	0
Soil nail analysis	Same settings on all nails
Nail stability	External-Internal
Nail shear	Ignored
FS on nail STR strength	1.8
FS on nail pullout	2
FS on facing bending	1.5
FS on facing punching	1.5
FS on bolts	1.7
FS on bearing	3

Maximum number of Iterations = 100, Tolerance = 0.01%
Maximum slice width = 3 ft
Analysis performed with automatic search, with 5 points.
Left search limits: xLmin= -17.8ft, xLmax= -3.8ft
Right search limits: xRmin= -1ft, xRmax= 1.5ft
Initial search grid: DXi= 0.5ft, DYi= 0.5ft
Force tolerance: 10%
Mobilized soil nail axial force distribution calculated with back analysis for FS=1.0
Soil nail mobilization interaction factor Imob= 0.25
Imob= 0 means that FX.mobilized = FX.nail for FS=1.0, Imob= 1 means that FX.mobilized = FX.nail ultimate
Minimum soil nail mobilization factor SNmin.mob = 0
Fx.mob = Fx(FS=1.0) + Imob x (Fx.ULT -Fx(FS=1.0)) >= SNmin.mob x Fx.ULT
Global mode parameters applied for slope stability analysis.
Soil nail stability considers both external and internal stability (punching through facing).
Soil nail shear is ignored in the analysis.

Slope stability assumptions: Exc. 94ft

Table: Basic analysis assumptions last stage

Stage conditions	Permanent structure long term
Min required FS	1.5
Method	Morgenstern-Price
Nail methods	Available shear
Surface search	Automatic
Left limits	-37.8ft to -2ft
Right limits	0ft to 2.5ft
Number of points	5
Min. slice width	3ft
Tolerance	1%
Force Tolerance	10%
Initial FS0	1
MP interslice factor m	1
MP interslice factor v	1
MP initial Lamda.0	0
Soil nail analysis	Same settings on all nails
Nail stability	External-Internal
Nail shear	Ignored
FS on nail STR strength	1.8
FS on nail pullout	2
FS on facing bending	1.5
FS on facing punching	1.5
FS on bolts	1.7
FS on bearing	3

Maximum number of Iterations = 100, Tolerance = 0.01%
Maximum slice width = 3 ft
Analysis performed with automatic search, with 5 points.
Left search limits: xLmin= -25.8ft, xLmax= -4.8ft
Right search limits: xRmin= -0.6ft, xRmax= 1.9ft
Initial search grid: DXi= 0.5ft, DYi= 0.5ft
Force tolerance: 10%
Mobilized soil nail axial force distribution calculated with back analysis for FS=1.0
  Soil nail mobilization interaction factor Imob= 0.25
  Imob= 0 means that FX.mobilized = FX.nail for FS=1.0, Imob= 1 means that FX.mobilized = FX.nail ultimate
  Minimum soil nail mobilization factor SNmin.mob = 0
  Fx.mob = Fx(FS=1.0) + Imob x (Fx.ULT -Fx(FS=1.0)) >= SNmin.mob x Fx.ULT
Global mode parameters applied for slope stability analysis.
  Soil nail stability considers both external and internal stability (punching through facing).
  Soil nail shear is ignored in the analysis.

Slope stability assumptions: Exc. 90ft

Table: Basic analysis assumptions last stage

Stage conditions	Permanent structure long term
Min required FS	1.5
Method	Morgenstern-Price
Nail methods	Available shear
Surface search	Automatic
Left limits	-37.8ft to -2ft
Right limits	0ft to 2.5ft
Number of points	5
Min. slice width	3ft
Tolerance	1%
Force Tolerance	10%
Initial FS0	1
MP interslice factor m	1
MP interslice factor v	1
MP initial Lamda.0	0
Soil nail analysis	Same settings on all nails
Nail stability	External-Internal
Nail shear	Ignored
FS on nail STR strength	1.8
FS on nail pullout	2
FS on facing bending	1.5
FS on facing punching	1.5
FS on bolts	1.7
FS on bearing	3

Maximum number of Iterations = 100, Tolerance = 0.01%
Maximum slice width = 3 ft
Analysis performed with automatic search, with 5 points.
Left search limits: xLmin= -33.8ft, xLmax= -5.8ft
Right search limits: xRmin= -0.2ft, xRmax= 2.3ft
Initial search grid: DXi= 0.5ft, DYi= 0.5ft
Force tolerance: 10%
Mobilized soil nail axial force distribution calculated with back analysis for FS=1.0
Soil nail mobilization interaction factor Imob= 0.25
Imob= 0 means that FX.mobilized = FX.nail for FS=1.0, Imob= 1 means that FX.mobilized = FX.nail ultimate
Minimum soil nail mobilization factor SNmin.mob = 0
Fx.mob = Fx(FS=1.0) + Imob x (Fx.ULT -Fx(FS=1.0)) >= SNmin.mob x Fx.ULT
Global mode parameters applied for slope stability analysis.
Soil nail stability considers both external and internal stability (punching through facing).
Soil nail shear is ignored in the analysis.

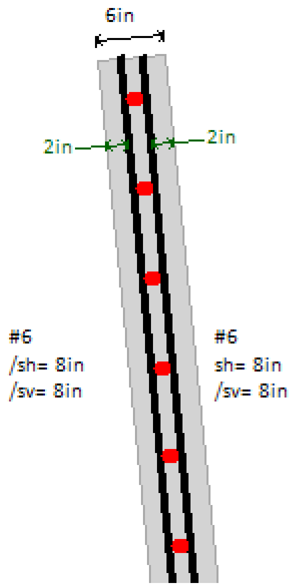
Slope stability assumptions: Final stage

Table: Basic analysis assumptions last stage

Stage conditions	Permanent structure long term
Min required FS	1.5
Method	Morgenstern-Price
Nail methods	Available shear
Surface search	Automatic
Left limits	-37.8ft to -2ft
Right limits	0ft to 2.5ft
Number of points	5
Min. slice width	3ft
Tolerance	1%
Force Tolerance	10%
Initial FS0	1
MP interslice factor m	1
MP interslice factor v	1
MP initial Lamda.0	0
Soil nail analysis	Same settings on all nails
Nail stability	External-Internal
Nail shear	Ignored
FS on nail STR strength	1.8
FS on nail pullout	2
FS on facing bending	1.5
FS on facing punching	1.5
FS on bolts	1.7
FS on bearing	3

Maximum number of Iterations = 100, Tolerance = 0.01%
Maximum slice width = 3 ft
Analysis performed with automatic search, with 5 points.
Left search limits: xLmin= -37.8ft, xLmax= -2ft
Right search limits: xRmin= 0ft, xRmax= 2.5ft
Initial search grid: DXi= 0.5ft, DYi= 0.5ft
Force tolerance: 10%
Mobilized soil nail axial force distribution calculated with back analysis for FS=1.0
Soil nail mobilization interaction factor Imob= 0.25
Imob= 0 means that FX.mobilized = FX.nail for FS=1.0, Imob= 1 means that FX.mobilized = FX.nail ultimate
Minimum soil nail mobilization factor SNmin.mob = 0
Fx.mob = Fx(FS=1.0) + Imob x (Fx.ULT -Fx(FS=1.0)) >= SNmin.mob x Fx.ULT
Global mode parameters applied for slope stability analysis.
Soil nail stability considers both external and internal stability (punching through facing).
Soil nail shear is ignored in the analysis.

Shotcrete facing data design section Base model



Facing Thickness D= 6in

Concrete strength Fc'= 3ksi

Rebar and mesh yield strength Fy= 60ksi

Back face hor. reinforcement (or mesh) #6@8in area a.bh=0.66 in^2/ft

Back face vertical reinforcement (or mesh) #6@8in area a.bv=0.66 in^2/ft

Front face reinforcement (if used in permanent section)

Front face hor. reinforcement (or mesh) #6@8in area a.fh=0.66 in^2/ft

Front face vertical reinforcement (or mesh) #6@8in area a.fv=0.66 in^2/ft

Stage	Active	Top El.	Bottom El.	Two stage facing	Thickness
Name	Yes/No	(ft)	(ft)	-	(in)
Exc. 98ft	Yes	106	98	N/A	6
Exc. 94ft	Yes	106	94	N/A	6
Exc. 90ft	Yes	106	90	N/A	6
Final stage	Yes	106	88	N/A	6

Soil nail input data for design section Base model

Name	Nail	α	x	El.	Lfix	Lfree	Space	Asteel	Dfix	Fy
-	Section	deg	(ft)	(ft)	(ft)	(ft)	(ft)	(in^2)	(in)	(ksi)
N0	0: N1	15	-1.6	104	8	0	4	0.79	6	75
N1	0: N1	15	-1.2	100	8	0	4	0.79	6	75
N2	0: N1	15	-0.8	96	8	0	4	0.79	6	75
N3	0: N1	15	-0.4	92	8	0	4	0.79	6	75

Header plate data

Nail	El.	Width	Thick	Fy	D open.	Studs	c studs	Waler
Number	(ft)	(in)	(in)	(ksi)	(in)	Studs	c studs	Bars
N0	104	8	1.25	36	1	N/A	N/A	N/A
N1	100	8	1.25	36	1	N/A	N/A	N/A
N2	96	8	1.25	36	1	N/A	N/A	N/A
N3	92	8	1.25	36	1	N/A	N/A	N/A

SLOPE STABILITY ANALYSIS: SOIL NAIL RESULTS ALL STAGES

Soil nail results for design section: Base model

Soil nail results Stage: 0

Soil nail results available for this stage.

Critical point at x= -3.16 z= 116.8 FS= 1.561

	F	Fmax	CAP S	CAP G	Tcap G	TC1 ST	TC2	TC3	TC4	TC4 C4	ks	Po	Pu	lo	IxxCalc	SxxCal	t. loss	% STR	Mode
Nail/Uni	k	k	k	k	k	k	k	k	k	k	ksf	ksf	ksf	ft	in4	in3	in	%	Crit
0: N0	0	30.16	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
1: N1	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2: N2	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3: N3	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Soil nail results Stage: 1

Soil nail results available for this stage.

Critical point at x= -3.228 z= 116.8 FS= 1.418

	F	Fmax	CAP S	CAP G	Tcap G	TC1 ST	TC2	TC3	TC4	TC4 C4	ks	Po	Pu	lo	IxxCalc	SxxCal	t. loss	% STR	Mode
Nail/Uni	k	k	k	k	k	k	k	k	k	k	ksf	ksf	ksf	ft	in4	in3	in	%	Crit
0: N0	0	25.34	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
1: N1	0	28.79	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
2: N2	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3: N3	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Soil nail results Stage: 2

Soil nail results available for this stage.

Critical point at x= -2.751 z= 116.8 FS= 1.766

	F	Fmax	CAP S	CAP G	Tcap G	TC1 ST	TC2	TC3	TC4	TC4 C4	ks	Po	Pu	lo	IxxCalc	SxxCal	t. loss	% STR	Mode
Nail/Uni	k	k	k	k	k	k	k	k	k	k	ksf	ksf	ksf	ft	in4	in3	in	%	Crit
0: N0	0	20.4	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
1: N1	3.82	22.55	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
2: N2	13.98	27.72	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
3: N3	Not ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Soil nail results Stage: 3

Soil nail results available for this stage.

Critical point at x= -5.054 z= 116.8 FS= 1.921

	F	Fmax	CAP S	CAP G	Tcap G	TC1 ST	TC2	TC3	TC4	TC4 C4	ks	Po	Pu	lo	IxxCalc	SxxCal	t. loss	% STR	Mode
Nail/Uni	k	k	k	k	k	k	k	k	k	k	ksf	ksf	ksf	ft	in4	in3	in	%	Crit
0: N0	0	32.39	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
1: N1	0	32.92	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
2: N2	0	32.92	53.32	39.81	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO
3: N3	17.6	32.74	53.32	40.92	0	26.66	Not in	Not in	Not in	Not in	N/A	N/A	N/A	N/A	0.05	0.1	N/A	N/A	GEO

GENERAL SOIL NAIL DATA

Soil nails are concidered only when a slope stability analysis is performed.

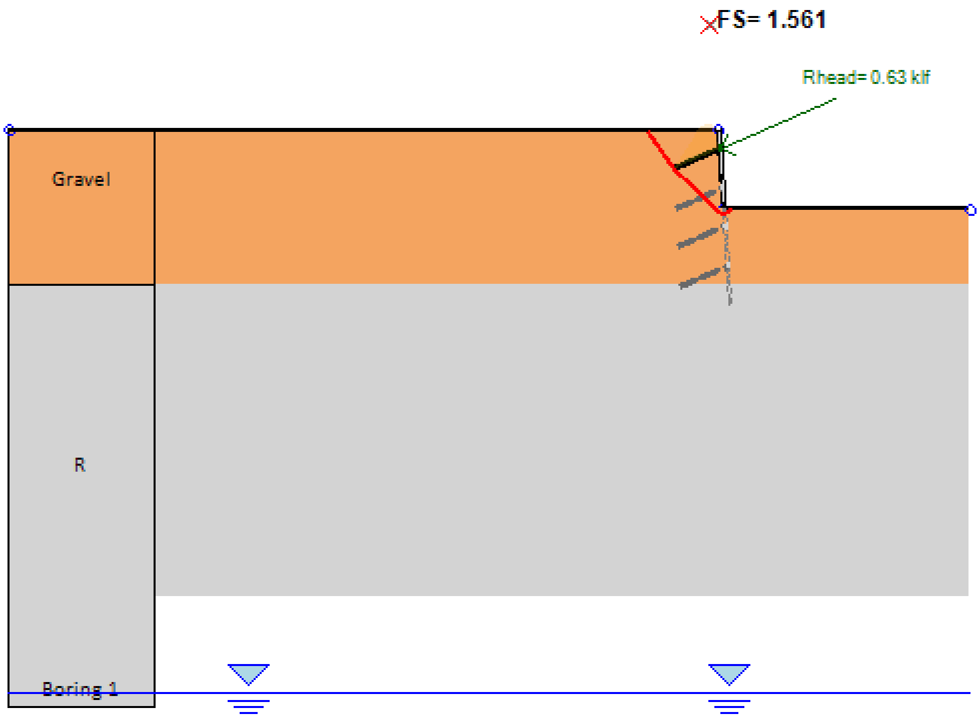
TABLE DATA (major parameters)

F = Soil nail axial tension force for critical failure surface (may not be the greatest)
Fmax = Maximum soil nail tension from all analyzed critical failure surfaces
CAP STR = Tensile structural design capacity for soil nail
CAP GEO = Tensile geotechnical pull out resistance for soil nail
TcapGEO = Critical shear resistance for soil nail (min TC1, TC2, TC3, TC4)
TC1 = Structural soil nail shear resistance
TC2 = Shear resistance according to Clouterre TC2 criterion
TC3 = Shear resistance according to Clouterre TC3 criterion
TC4 = Shear resistance according to Clouterre TC4 criterion
TC4 C4 = Shear resistance according to Clouterre TC4 criterion for limit equilibrium approach

kS = Soil subgrade modulus reaction at failure surface-soil nail intersection point
Po = Soil lateral pressure at failure surface-soil nail intersection point
Pu = Ultimate lateral pressure at failure surface-soil nail intersection point
Lo = Flexure length for shear calculations
IxxCalc = Nail moment of inertia (adjusted for corrosion loss if assumed etc)
SxxCalc = Nail section modulus (adjusted for corrosion loss if assumed)
t.loss = Structural thickness loss (if assumed by the user)
%STR = Structural capacity loss as a percentage (if assumed by the user)

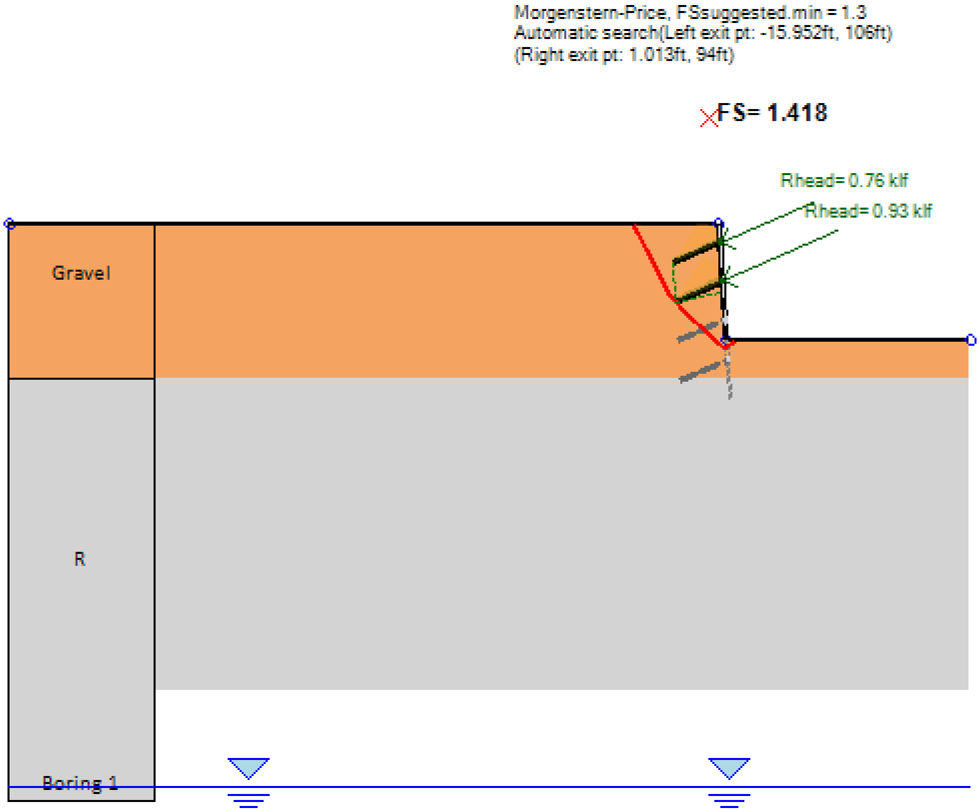
Base model

Morgenstern-Price, FSsuggested.min = 1.3
Automatic search(Left exit pt: -13.572ft, 106ft)
(Right exit pt: 0.311ft, 98ft)



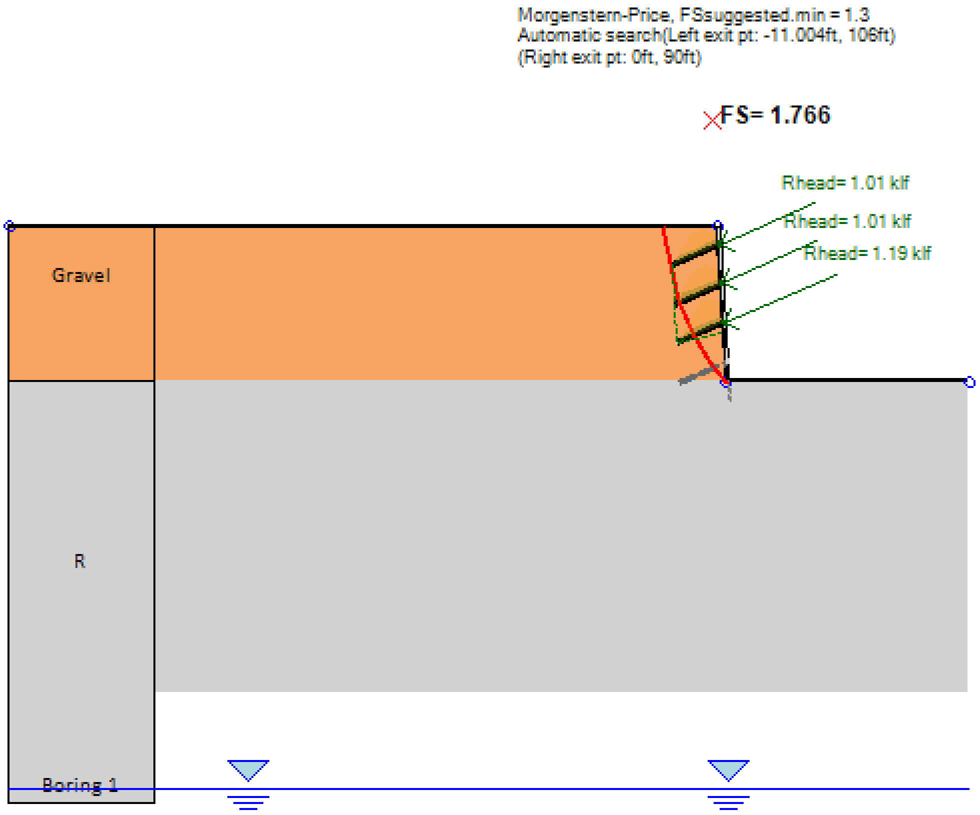
Company: My Company	DS: 0, Exc. 98ft	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

Base model



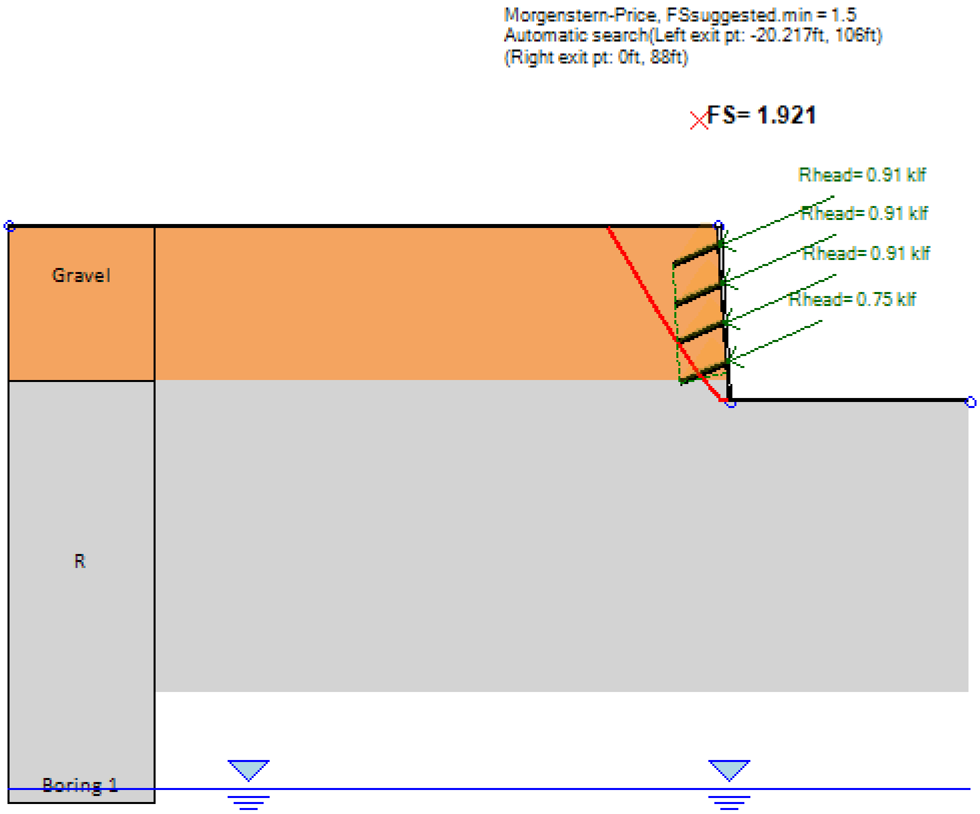
Company: My Company	DS: 0, Exc. 94ft	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

Base model


Morgenstern-Price, FSsuggested.min = 1.3
Automatic search(Left exit pt: -11.004ft, 106ft)
(Right exit pt: 0ft, 90ft)

Company: My Company Engineer: Engineer	DS: 0, Exc. 90ft	Deep Excavation LCC SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

Base model


Morgenstern-Price, FSsuggested.min = 1.5
Automatic search(Left exit pt: -20.217ft, 106ft)
(Right exit pt: 0ft, 88ft)

Company: My Company Engineer: Engineer	DS: 0, Final stage	Deep Excavation LCC SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

SOIL NAIL RESULTS FOR CRITICAL STAGES

Soil nail results for design section: Base model

Soil nail results (all stages) for nail: 0, N0

Soil nail at x= -1.6 ft, z= 104 ft, angle= 15 deg

Soil nail Lfree= 0 ft, Lfix= 8 ft

Nail uses structural section from tieback 0, name: N1

Nail diameter for fixed body: 6 in

Nail uses 1, strands or bars

Nail strands outer diam= 1 in

	Units	0: Exc. 98ft	1: Exc. 94ft	2: Exc. 90ft	3: Final stage
Tension	k	0	0	0	0
Max. tension stab. analysis	k	30.16	25.34	20.4	32.39
Force at head Po	k	2.52	3.03	4.04	3.64
Max. mob. force Pmax.mob	k	3.58	4.7	6.27	5.66
Tension stress check	-	0.109	0.143	0.19	0.172
Shear stress check	-	0	0	0	0
Critical stress check	-	0.109	0.143	0.19	0.172
Tension capacity STR	k	53.32	53.32	53.32	53.32
Design Tension cap GEO	k	39.81	39.81	39.81	39.81
Crit. shear GEO	k	0	0	0	0
Shear C2	k	Not included	Not included	Not included	Not included
Shear C3	k	Not included	Not included	Not included	Not included
Shear C4	k	Not included	Not included	Not included	Not included
Shear C4 LE	k	Not included	Not included	Not included	Not included
Modulus ks	ksf	N/A	N/A	N/A	N/A
Lateral pressure Po	ksf	N/A	N/A	N/A	N/A
Ult. lateral pressure Pu	ksf	N/A	N/A	N/A	N/A
Length lo	ft	N/A	N/A	N/A	N/A
IxxCalc	in4	0.05	0.05	0.05	0.05
SxxCalc	in3	0.1	0.1	0.1	0.1
Thickness loss	in	N/A	N/A	N/A	N/A
% STR loss	%	N/A	N/A	N/A	N/A
Moment on plate M	k-ft	0.434491	0.521389	0.695185	0.697331
Plate Mres	k-ft	5.46875	5.46875	5.46875	5.46875
Punching perimeter	in	47.79	47.79	47.79	47.79
Punching depth Dp	in	3.948	3.948	3.948	3.948
Punching area Ap	ft2	0.99	0.99	0.99	0.99
Ultimate punching cap PLv	k	31	31	31	31
Required factored load PLde	k	2.41	2.75	3.67	3.31
Geotechnical plate cap PLge	k	N/A	N/A	N/A	N/A
Punching ratio chek RAT.Pv		0.105	0.12	0.16	0.16
Critical	Mode	GEO	GEO	GEO	GEO

Soil nail results (all stages) for nail: 1, N1

Soil nail at x= -1.2 ft, z= 100 ft, angle= 15 deg

Soil nail Lfree= 0 ft, Lfix= 8 ft

Nail uses structural section from tieback 0, name: N1

Nail diameter for fixed body: 6 in

Nail uses 1, strands or bars

Nail strands outer diam= 1 in

	Units	1: Exc. 94ft	2: Exc. 90ft	3: Final stage
Tension	k	0	3.82	0
Max. tension stab. analysis	k	28.79	22.55	32.92
Force at head Po	k	3.73	4.04	3.64
Max. mob. force Pmax.mob	k	5.29	6.27	5.66
Tension stress check	-	0.161	0.19	0.172
Shear stress check	-	0	0	0
Critical stress check	-	0.161	0.19	0.172
Tension capacity STR	k	53.32	53.32	53.32
Design Tension cap GEO	k	39.81	39.81	39.81
Crit. shear GEO	k	0	0	0
Shear C2	k	Not included	Not included	Not included
Shear C3	k	Not included	Not included	Not included
Shear C4	k	Not included	Not included	Not included
Shear C4 LE	k	Not included	Not included	Not included
Modulus ks	ksf	N/A	N/A	N/A
Lateral pressure Po	ksf	N/A	N/A	N/A
Ult. lateral pressure Pu	ksf	N/A	N/A	N/A
Length lo	ft	N/A	N/A	N/A
IxxCalc	in4	0.05	0.05	0.05
SxxCalc	in3	0.1	0.1	0.1
Thickness loss	in	N/A	N/A	N/A
% STR loss	%	N/A	N/A	N/A
Moment on plate M	k-ft	0.642312	0.695185	0.697331
Plate Mres	k-ft	5.46875	5.46875	5.46875
Punching perimeter	in	47.79	47.79	47.79
Punching depth Dp	in	3.948	3.948	3.948
Punching area Ap	ft2	0.99	0.99	0.99
Ultimate punching cap PLv	k	31	31	31
Required factored load PLde	k	3.5	3.67	3.31
Geotechnical plate cap PLge	k	N/A	N/A	N/A
Punching ratio chek RAT.Pv		0.153	0.16	0.16
Critical	Mode	GEO	GEO	GEO

Soil nail results (all stages) for nail: 2, N2

Soil nail at x= -0.8 ft, z= 96 ft, angle= 15 deg

Soil nail Lfree= 0 ft, Lfix= 8 ft

Nail uses structural section from tieback 0, name: N1

Nail diameter for fixed body: 6 in

Nail uses 1, strands or bars

Nail strands outer diam= 1 in

	Units	2: Exc. 90ft	3: Final stage
Tension	k	13.98	0
Max. tension stab. analysis	k	27.72	32.92
Force at head Po	k	4.77	3.64
Max. mob. force Pmax.mob	k	6.76	5.66
Tension stress check	-	0.205	0.172
Shear stress check	-	0	0

Critical stress check	-	0.205	0.172
Tension capacity STR	k	53.32	53.32
Design Tension cap GEO	k	39.81	39.81
Crit. shear GEO	k	0	0
Shear C2	k	Not included	Not included
Shear C3	k	Not included	Not included
Shear C4	k	Not included	Not included
Shear C4 LE	k	Not included	Not included
Modulus ks	ksf	N/A	N/A
Lateral pressure Po	ksf	N/A	N/A
Ult. lateral pressure Pu	ksf	N/A	N/A
Length lo	ft	N/A	N/A
IxxCalc	in4	0.05	0.05
SxxCalc	in3	0.1	0.1
Thickness loss	in	N/A	N/A
% STR loss	%	N/A	N/A
Moment on plate M	k-ft	0.82134	0.697117
Plate Mres	k-ft	5.46875	5.46875
Punching perimeter	in	47.79	47.79
Punching depth Dp	in	3.948	3.948
Punching area Ap	ft2	0.99	0.99
Ultimate punching cap PLv	k	31	31
Required factored load PLde	k	4.48	3.31
Geotechnical plate cap PLge	k	N/A	N/A
Punching ratio chek RAT.Pv		0.195	0.16
Critical	Mode	GEO	GEO

Soil nail results (all stages) for nail: 3, N3

Soil nail at x= -0.4 ft, z= 92 ft, angle= 15 deg

Soil nail Lfree= 0 ft, Lfix= 8 ft

Nail uses structural section from tieback 0, name: N1

Nail diameter for fixed body: 6 in

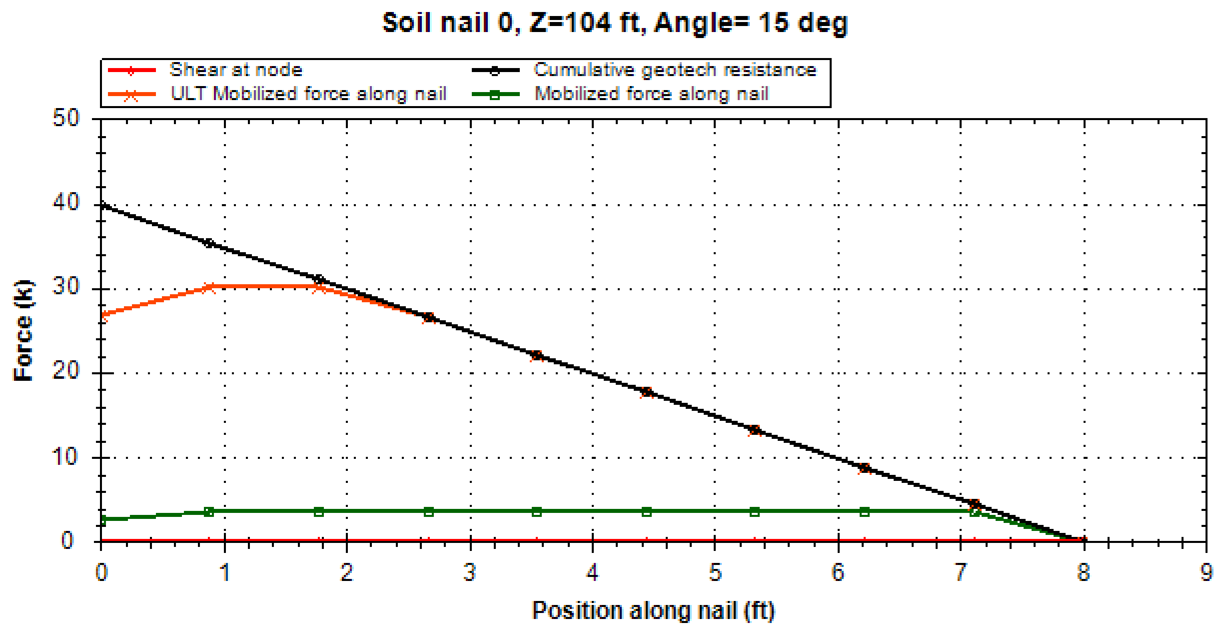
Nail uses 1, strands or bars

Nail strands outer diam= 1 in

	Units	3: Final stage
Tension	k	17.6
Max. tension stab. analysis	k	32.74
Force at head Po	k	3.01
Max. mob. force Pmax.mob	k	4.68
Tension stress check	-	0.142
Shear stress check	-	0
Critical stress check	-	0.142
Tension capacity STR	k	53.32
Design Tension cap GEO	k	40.92
Crit. shear GEO	k	0
Shear C2	k	Not included
Shear C3	k	Not included
Shear C4	k	Not included
Shear C4 LE	k	Not included
Modulus ks	ksf	N/A

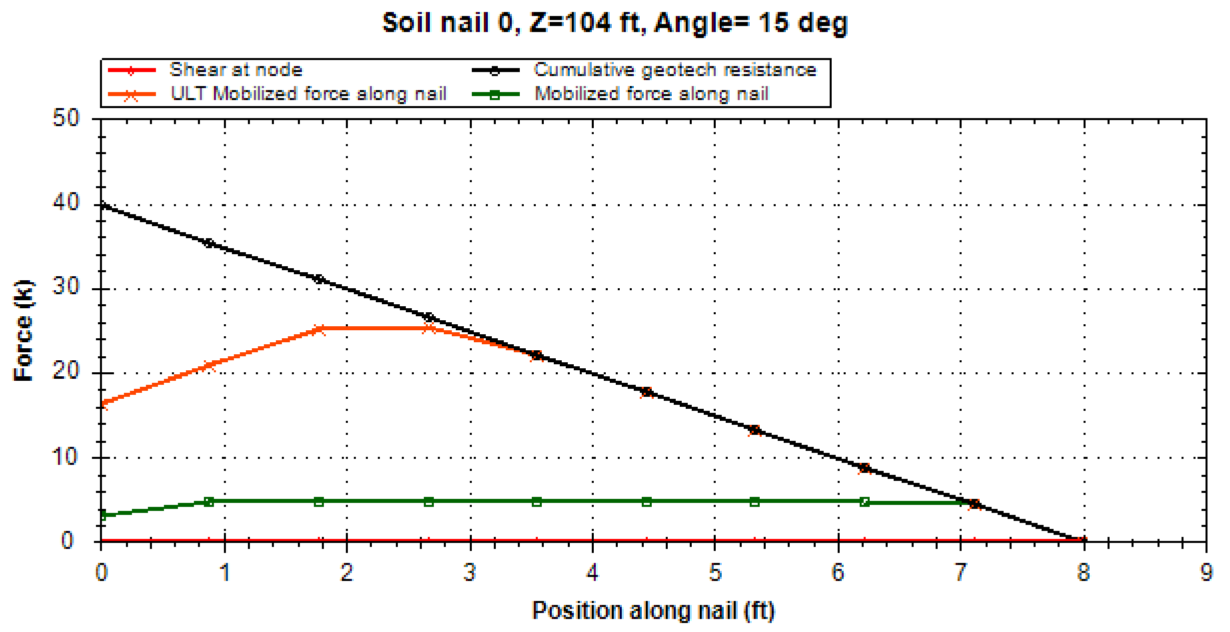
Lateral pressure Po	ksf	N/A
Ult. lateral pressure Pu	ksf	N/A
Length lo	ft	N/A
IxxCalc	in4	0.05
SxxCalc	in3	0.1
Thickness loss	in	N/A
% STR loss	%	N/A
Moment on plate M	k-ft	0.576551
Plate Mres	k-ft	5.46875
Punching perimeter	in	47.79
Punching depth Dp	in	3.948
Punching area Ap	ft2	0.99
Ultimate punching cap PLv	k	31
Required factored load PLde	k	2.74
Geotechnical plate cap PLge	k	N/A
Punching ratio chek RAT.Pv		0.133
Critical	Mode	GEO

Soil nail result graphs.



Soil nail 0, Z=104 ft, Angle= 15 deg

Company: My Company	DS: 0 Stage: 0 Soil nail 0 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021



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Company: My Company	DS: 0 Stage: 1 Soil nail 0 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
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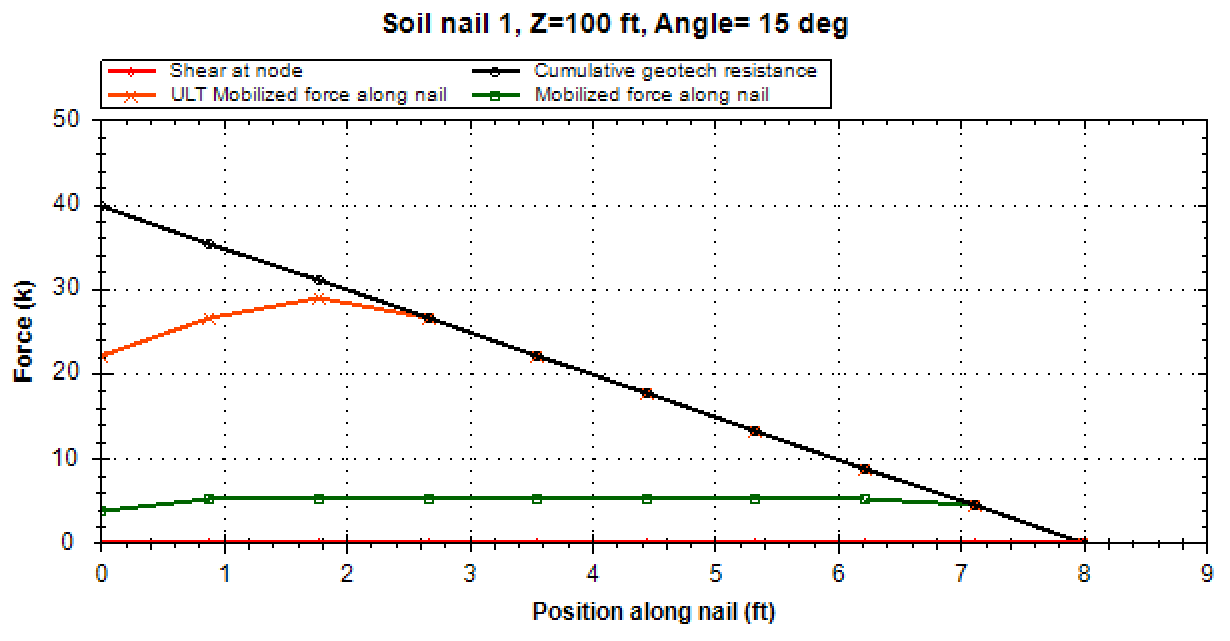
Soil nail 1, Z=100 ft, Angle= 15 deg

Company: My Company	DS: 0 Stage: 1	Deep Excavation LCC
Engineer: Engineer	Soil nail 1 results	SnailPlus 2021
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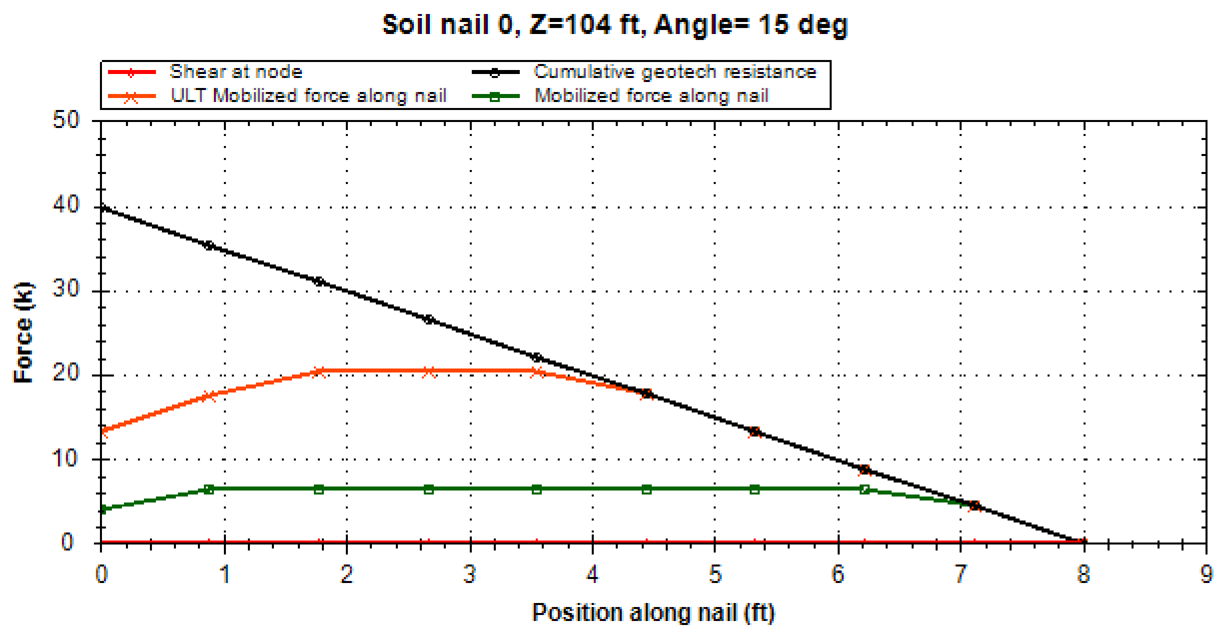
Soil nail 0, Z=104 ft, Angle= 15 deg

Company: My Company	DS: 0 Stage: 2	Deep Excavation LCC
Engineer: Engineer	Soil nail 0 results	SnailPlus 2021
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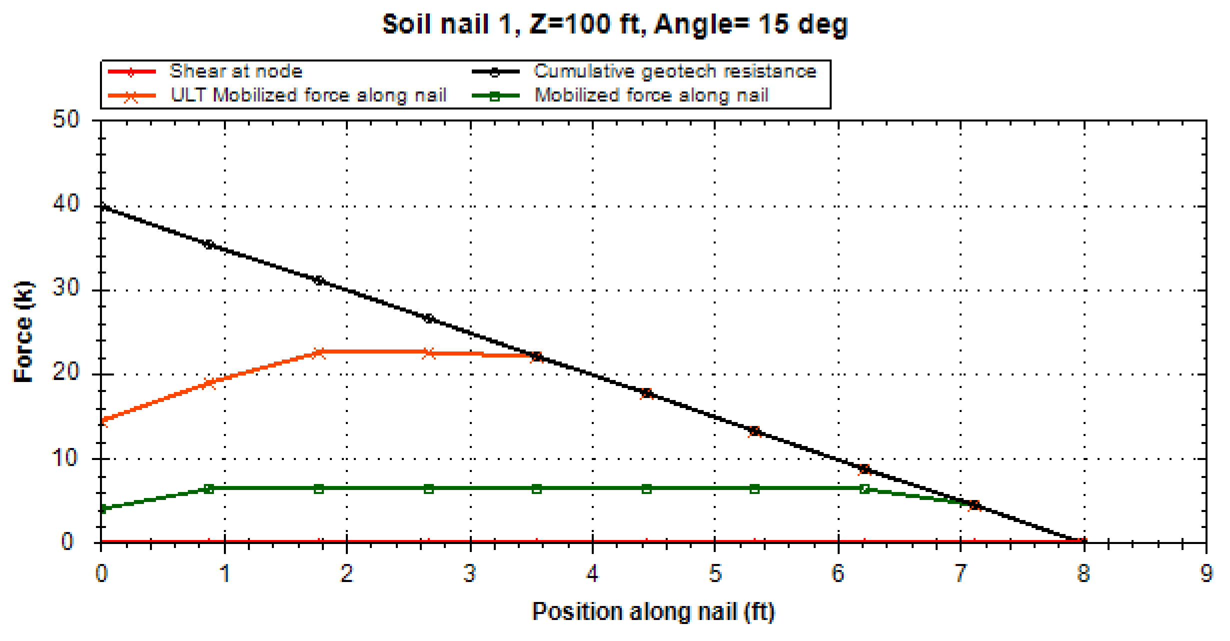

Company: My Company	DS: 0 Stage: 2 Soil nail 1 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
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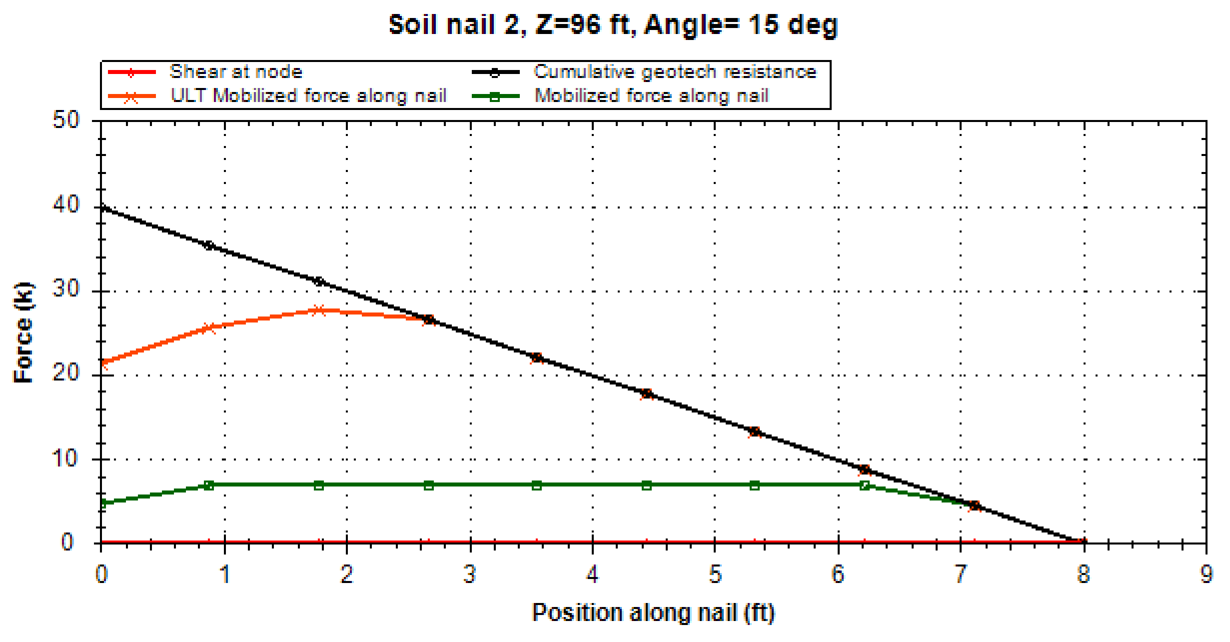

Company: My Company	DS: 0 Stage: 2 Soil nail 2 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
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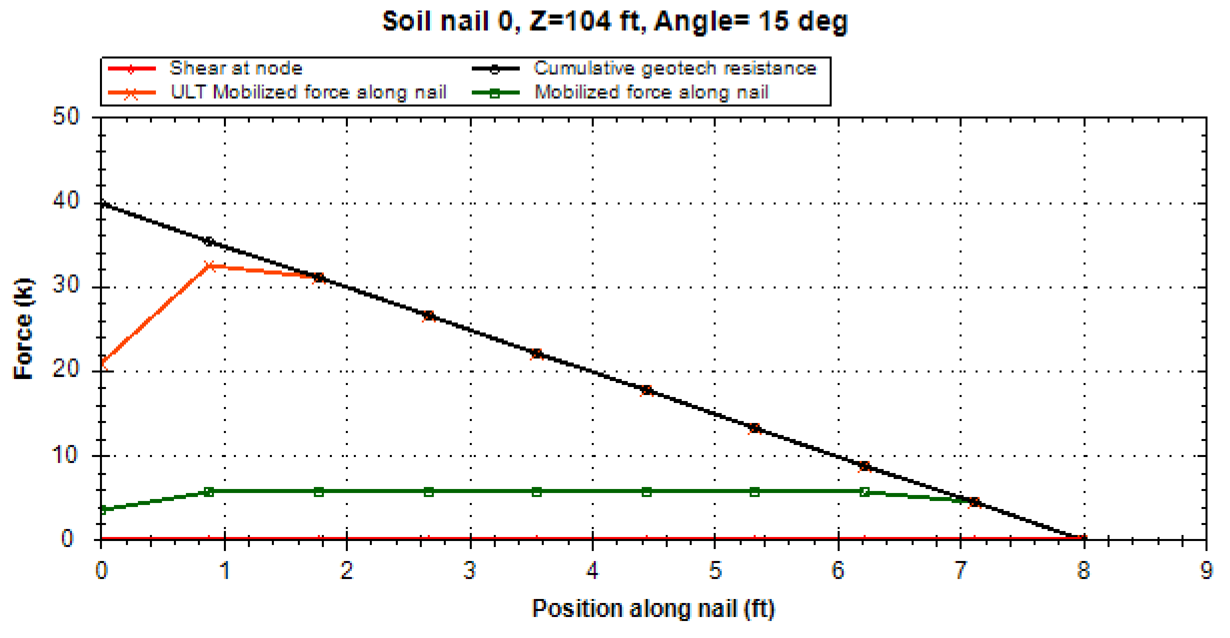
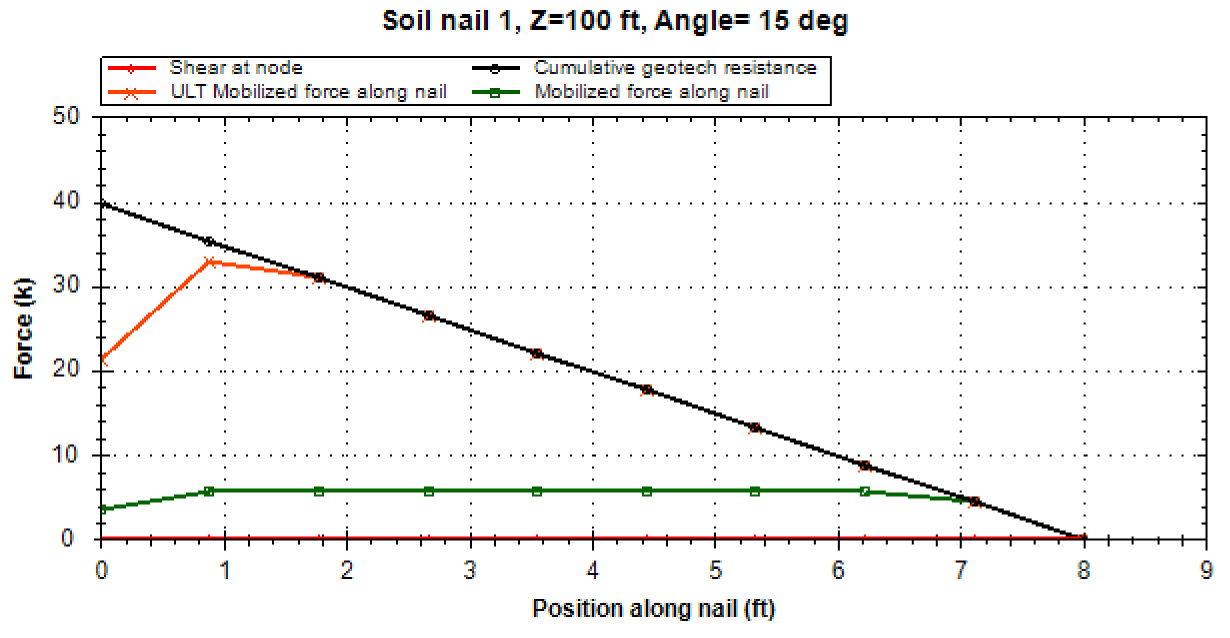
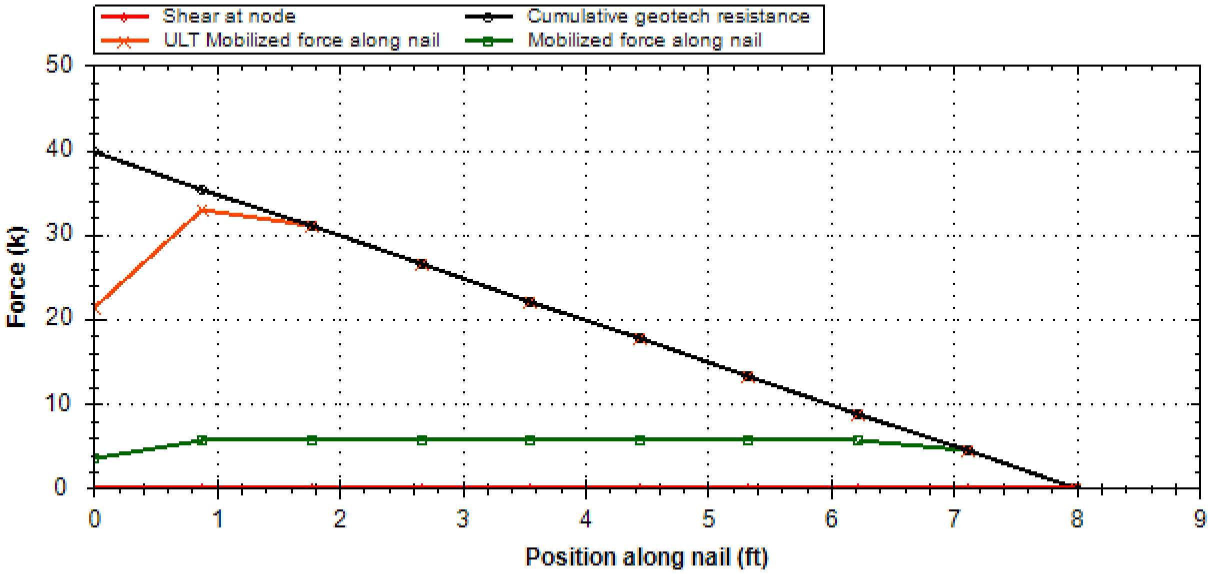

Soil nail 0, Z=104 ft, Angle= 15 deg

Company: My Company Engineer: Engineer	DS: 0 Stage: 3 Soil nail 0 results	Deep Excavation LCC SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021


Soil nail 1, Z=100 ft, Angle= 15 deg

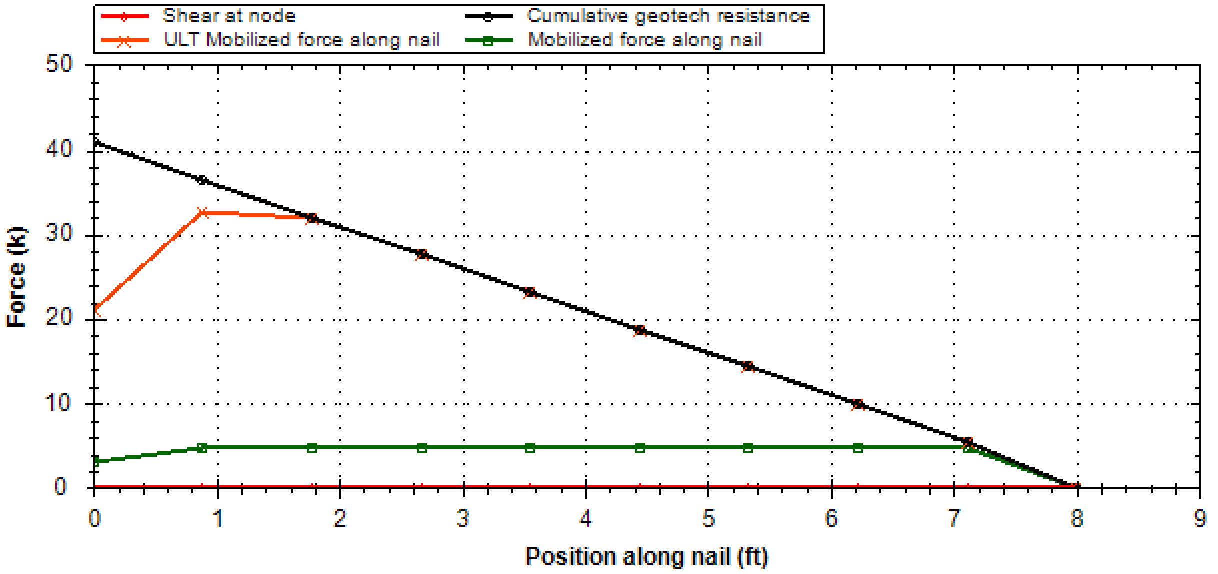
Company: My Company Engineer: Engineer	DS: 0 Stage: 3 Soil nail 1 results	Deep Excavation LCC SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

Soil nail 2, Z=96 ft, Angle= 15 deg



Company: My Company	DS: 0 Stage: 3 Soil nail 2 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

Soil nail 3, Z=92 ft, Angle= 15 deg



Company: My Company	DS: 0 Stage: 3 Soil nail 3 results	Deep Excavation LCC
Engineer: Engineer		SnailPlus 2021
C:\Users\jtucker\Documents\1.5H-1V slope - batter.SNLP		10/28/2021

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REGISTERED PROFESSIONAL ENGINEER
91897
OREGON
JAN. 10, 2017
GREGORY I. MINO
EXPIRES: 12/31/24

STORMWATER DRAINAGE REPORT

To
City of Wilsonville

For
Delta Logistics

Dated
April 8, 2022
(Revised June 10, 2022)
(Revised October 6, 2022)
(Revised November 15, 2022)

Project Number
2200502.04

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Appendix G – Geotechnical Report
Appendix H – Coffee Creek Stormwater Study (June 2019)

I. SITE OVERVIEW AND DESCRIPTION

This report documents the stormwater management calculations and design by Mackenzie to manage stormwater runoff and provide water quality treatment for the proposed Delta Logistics project. The proposed development (referred to as the "project site" or "site" throughout the report) is located south of SW Day Road, west of Boones Ferry Road, and north of the existing Delta Logistics site in Wilsonville, Oregon; refer to Figure 1.

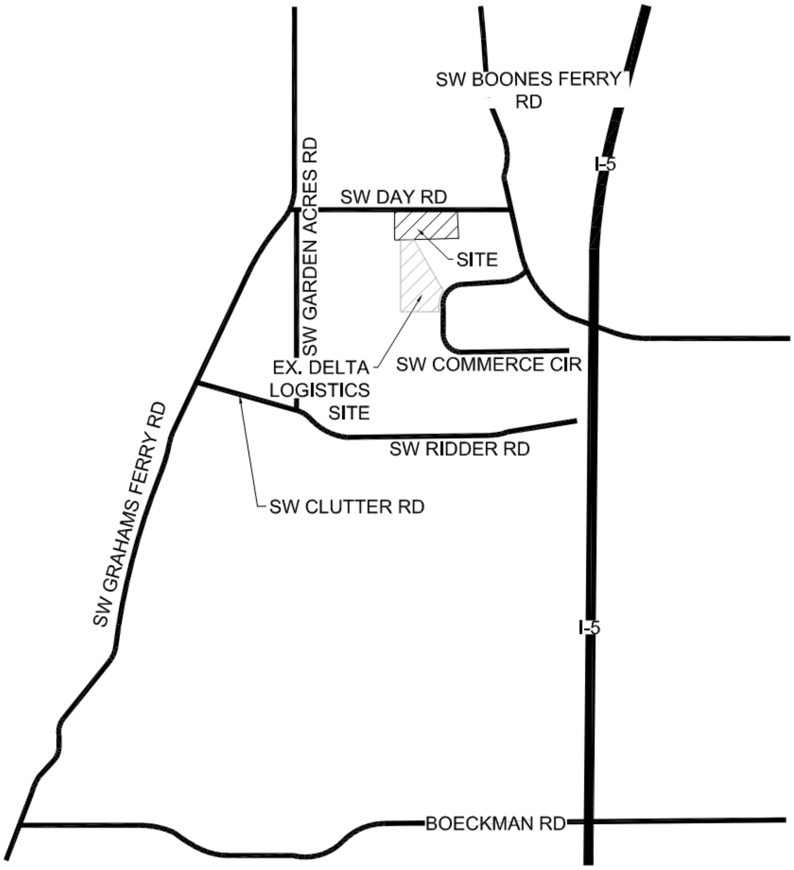


Figure 1: Vicinity Map

Existing Conditions

The existing property is bounded to the north by SW Day Road and to the east and west by other existing properties, and the south side border is split by the existing Delta Logistics site and adjacent neighbor site owned and occupied by others.

The site is currently undeveloped, except for a residential home that has recently been demolished. The site slopes down from the east to west at a gradient between 10 and 15%. The site is vegetated with grass, shrubbery, and trees. A 100-foot BPA right-of-way (ROW) is located in the southwest corner adjacent to the 125-foot easement.

A natural resource area, known as Tapman Creek, splits the site running north and south. From the Natural Resource Assessment report (see Appendix):

"Tapman Creek, a tributary to Seely Ditch and the Willamette River, flowed from double 36-inch diameter culverts under SW Day Road, south through the western portion of the site and into a culvert at the southwestern site corner. A compensatory wetland mitigation (CWM) site was located just west of and parallel to the creek. The CWM site was constructed to mitigate for the widening of SW Day Road and replacement of a single culvert with the existing 88-foot-long double culverts at Tapman Creek (DSL #25201-FP; Corps #2002-00173). Both of these features are within the 125-foot powerline/storm drainage easement."

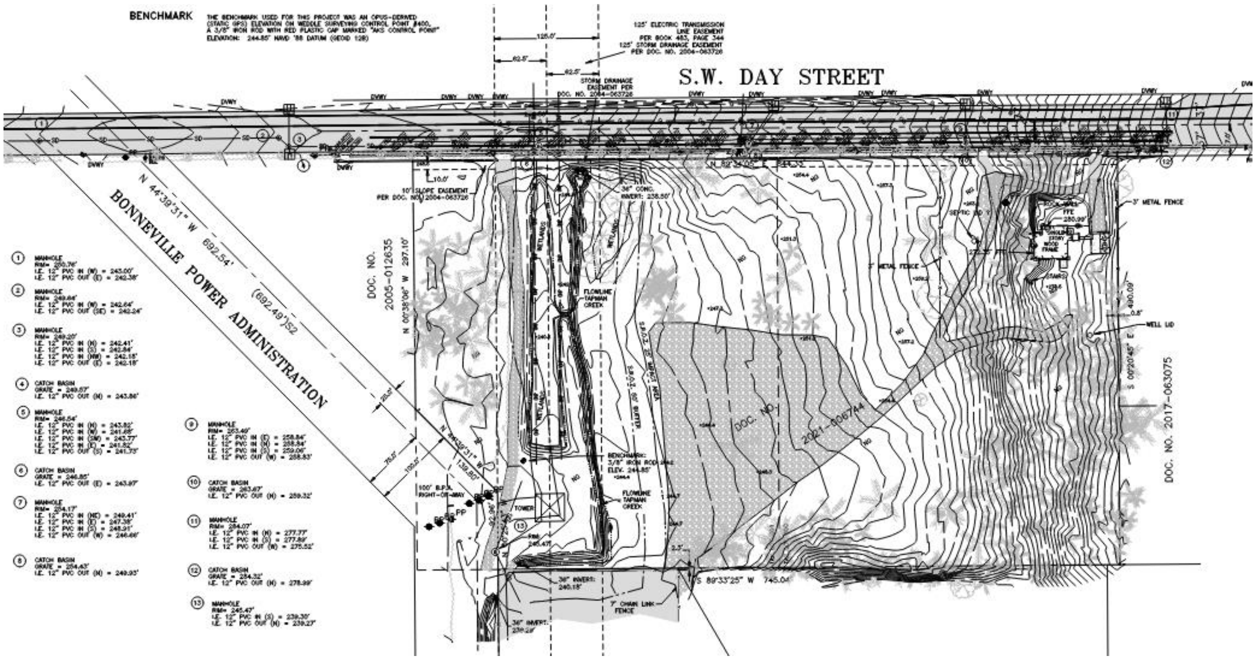


Figure 2: Existing Conditions Survey

Soil Conditions

Per the Geotechnical report, subsurface conditions encountered during in-field explorations consists of a thin mantle of silt underlain by basalt bedrock. See Geotechnical Report in Appendix.

Per the USDA Web Soil Survey, the existing soil is primarily a variety of silty and loamy soils. See Figure 3 for their locations across the site. The site has soils identified as Hydrologic Soil Groups B, C, and D for the purposes of relating to the Discharge Management Area (DMA) Soil Group in the BMP Sizing Tool.

Figure 3: Web Soil Survey Map

Proposed Improvements

The property will be developed for industrial use. The project will construct an approximately 58,118 SF (footprint) warehouse building with integral truck docks (approximately 15 docks), circulation drive aisles and parking, an exterior trash enclosure, associated utility services to the building and site, and landscaping.

SW Day Road will be required to be partially improved to half of the full future 5 lane arterial street section with bike lanes and separate pedestrian sidewalk. Public street frontage improvements will be provided along SW Day Road and will be developed following public standards. Stormwater runoff from SW Day Road will be treated with public facilities.

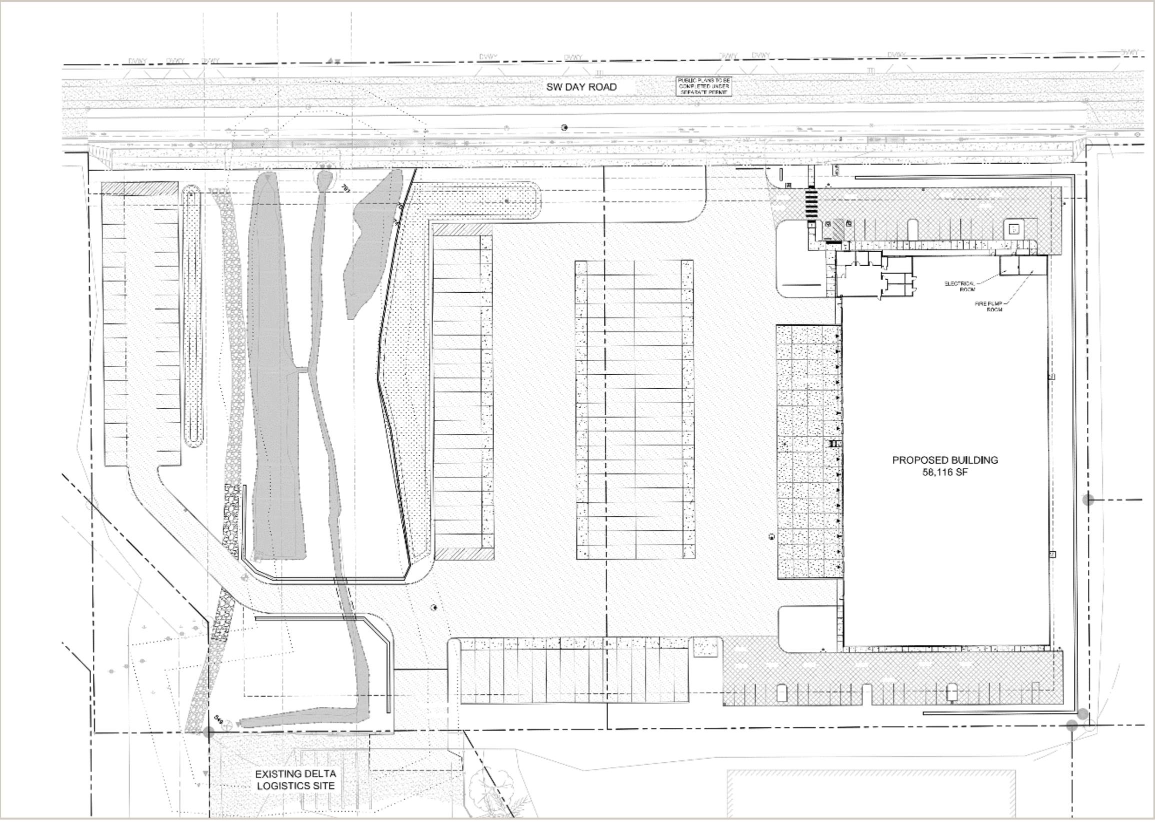


Figure 4: Site Plan

Refer to the Appendix for a map of the Drainage Management Areas (DMA) that provide a breakdown of impervious and pervious areas within each DMA.

The proposed grading mimics the predevelopment grading with the southwest corner of the site being the low spot with runoff generally draining toward Tapman Creek and in to one of two Rain Gardens on site.

This project followed the City of Wilsonville's 2015 Stormwater Management Manual (SWMM) for water quality and flow control requirements. Since the project replaces more than 500 SF of impervious area, it is subject to follow the requirements outlined in the 2015 SWMM.

II. BASIS OF DESIGN

The Basis of Design for Stormwater Quality and Flow Control, as determined by the City of Wilsonville's 2015 Stormwater and Surface Water Design Standards, section 3 of the Public Works Standards, is as follows:

1. Use of LID facilities to the Maximum Extent Practicable.
2. A factor of safety of 2 shall be applied to open pit falling head infiltration test rates, and the maximum design infiltration rate is 20 inches per hour.
3. Water quality facilities shall be designed to capture and treat 80% of the average annual runoff volume to the Maximum Extent Practicable (MEP) with the goal of 70% total suspended soils (TSS) removal. In this context, MEP means less effective treatment may not be substituted when it is practicable to provide more effective treatment. This treatment volume equates to a design storm of 1.0 inch over 24 hours.
    A. Treatment calculations shall be carried out using the Unit Hydograph method.
4. The duration of peak flow rates from post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42% of the 2-year storm peak flow rate up to the 10-year peak flow rate.
    A. The BMP Sizing Tool incorporated these flow control requirements to size stormwater facilities.
5. Onsite detention of the 100-year design storm is assumed to mitigate any potential downstream impact from this development.

III. ANALYSIS

Methodology

Infiltration tests conducted on-site by the Geotechnical engineer observed infiltration rates of the native soils to be 1.5 inches per hour or less. At TP-5, the infiltration rates at 2 feet BGS were observed to be 1.5 inches/hour, and at 3 feet BGS was observed to be 0 inches/hour. With other bores conducted on-site, refusal of bore was met at 3.5 feet BGS (TP-5, Rain Garden 2) and 4 feet BGS (TP-7, Rain Garden 1). Furthermore, subsurface conditions encountered during in-field explorations consists of a thin mantle of silt underlain by basalt bedrock. With those results, the Geotechnical engineer concluded the measured infiltration rates are extremely low and on-site stormwater infiltration is not feasible. Therefore, the stormwater management strategy was unable to utilize infiltration as a mitigation method. Stormwater will be treated and detained on-site prior to overflowing to the wetland/Tapman Creek. The stormwater facilities are installed on fill with a retaining wall directly adjacent to the west to protect the SROZ area and on-site wetlands.

Downstream Analysis

According to Section 4.4.1 of the City's Stormwater Master Plan (SWMP): "Day Road South to Stafford Business Park has poor drainage and is prone to flooding. Basalt Creek overtops its banks during moderate storm events, flooding the parking lot along the western side of the Commerce Circle Business Park. Some segments of Basalt Creek in this vicinity have negative slopes, preventing flooding from occurring downstream. Negative channel slopes in various sections along the channel in this segment are believed to contribute to the flooding in this area." A Coffee Creek Stormwater Facility Study conducted by AKS in June 2019 also identified the (2) – 36" stormwater pipes which conveys water just north of SW Ridder Road, also have limited capacity and are a constraint on the system.

Since there is a known limitation in the downstream conveyance system, additional stormwater detention volume was provided to mitigate this development's impact to the downstream system. See Flow Control section below.

Water Quality

To meet the goals of the Low Impact Development, rain gardens have been selected as the proposed BMP to provide water quality treatment for this private site. The stormwater rain gardens are situated on the site at strategic location to capture the runoff with minimal use of structures and piping. This treatment volume equates to a design storm of 1.0 inch over 24 hours.

Basins 1 through 15 are treated through Rain Garden 1. Basin 16 is treated in Rain Garden 2. Basin 17 is treated using proprietary stormwater management facilities, StormFilter by Contech.

The area of Basin 17 is 0.079 AC. Using the City's water quality storm event and the ration equation calculation Q=ciA the flow required to be treated is 32.0 GPM.

$$Q = ciA = 0.9\left(1.0\frac{in}{hr}\right)(0.079AC) = 0.071\ cfs$$

$$0.071\ cfs\ \times 448.83\frac{GPM}{cfs} = 32.0\ GPM$$

A single 27" StormFilter can treat 22.0 GPM. For Basin 17, two (2)-27" StormFilters in a steel catch basin will provide treatment for 44.0 GPM. This is adequate treatment.

Stormwater management compliance of the conditioned offsite frontage improvements is met through the proposed implementation of Stormwater Planters (Filtration + Orifice Control) located at select locations within the curbside planter strip of the roadway cross section.

Flow Control

Additional flow control measures are being implemented with this project due to limited downstream capacity to prevent adverse downstream impacts. Section 301.5.02 of the City's 2015 Stormwater and Surface Water Standards outlines Computational Methods allowed by the city to analyze existing, and to design proposed drainage systems and related facilities. Calculations for storm run-off and detentions were based on the SBUH, Type 1A rainfall distribution using the 24-hour precipitation isopluvials provided in Table 3.3.

Figure 6: Table 3.3 Rainfall Distribution

Recurrence Intervals (years)	Total Precipitation Depth (inches)
2	2.50
5	3.00
10	3.45
25	3.90
50	4.25
100	4.5

Rain Garden 1 and Rain Garden 2 have capacity to detain and provide flow control for the post-developed peak flow rate to match or release water at a slower rate than the pre-developed peak flow rate up to the 100-year storm event.

Figure 7: Rain Garden 1 Elevations and Flow Rates

	Elevation	Pre-Developed Flow rate (cfs)	Post-Developed Flow rate (cfs)
Pond Bottom	295.94	--	--
WQ	247.67	0.021	0.004
2-year	248.52	0.625	0.625

5-year	248.90	1.105	0.909
10-year	249.20	1.589	1.044
25-year	249.50	2.110	1.159
100-year	249.93	2.851	1.301
Top of Pond	250.27	--	--

Figure 8: Rain Garden 2 Elevations and Flow Rates

	Elevation	Pre-Developed Flowrate (cfs)	Post-Developed Flowrate (cfs)
Pond Bottom	244.79	--	--
WQ	245.04	0.009	0.001
2-year	245.33	0.298	0.180
5-year	245.78	0.475	0.373
10-year	245.66	0.682	0.547
25-year	245.83	0.906	0.674
100-year	246.02	1.224	0.792
Top of Pond	247.07	--	--

Rain Garden 1 and 2 are sized to provide flow control for stormwater for the entire site as to not adversely affect the downstream conveyance system, including over-detaining, to account for the area of Basin 17 that drains to the private property to the south.

See Appendix D of this report for Hydrographs.

Conveyance

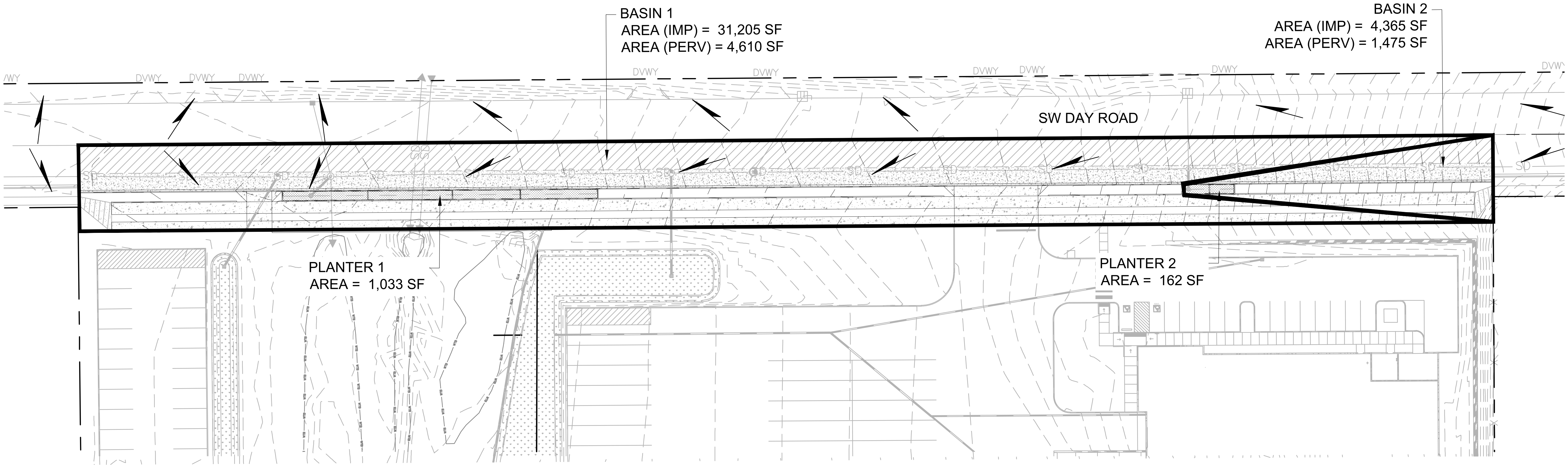
The proposed underground storm drainage system for this project has been designed to collect and convey the runoff from a 25-year storm event per the City of Wilsonville 2015 Stormwater & Surface Water Design & Construction Standards.

Conveyance of the runoff from the conditioned offsite frontage improvements is managed by capturing the roadway runoff in the Stormwater Planters, which then overflow to the existing storm system in the roadway, ultimately discharging through culverts into Tapman Creek directly abutting the roadway cross section to the south.

Emergency overland flow for any storm larger than the 25-year event has been described in the Proposed Improvement section of this report.

APPENDIX A

DRAINAGE MANAGEMENT AREA MAP – PUBLIC



DELTA LOGISTICS
BASIN MAP (OFFSITE)

MARCH 14, 2022
Job # 2200502.00

SCALE: 1"=60'
0 30 60

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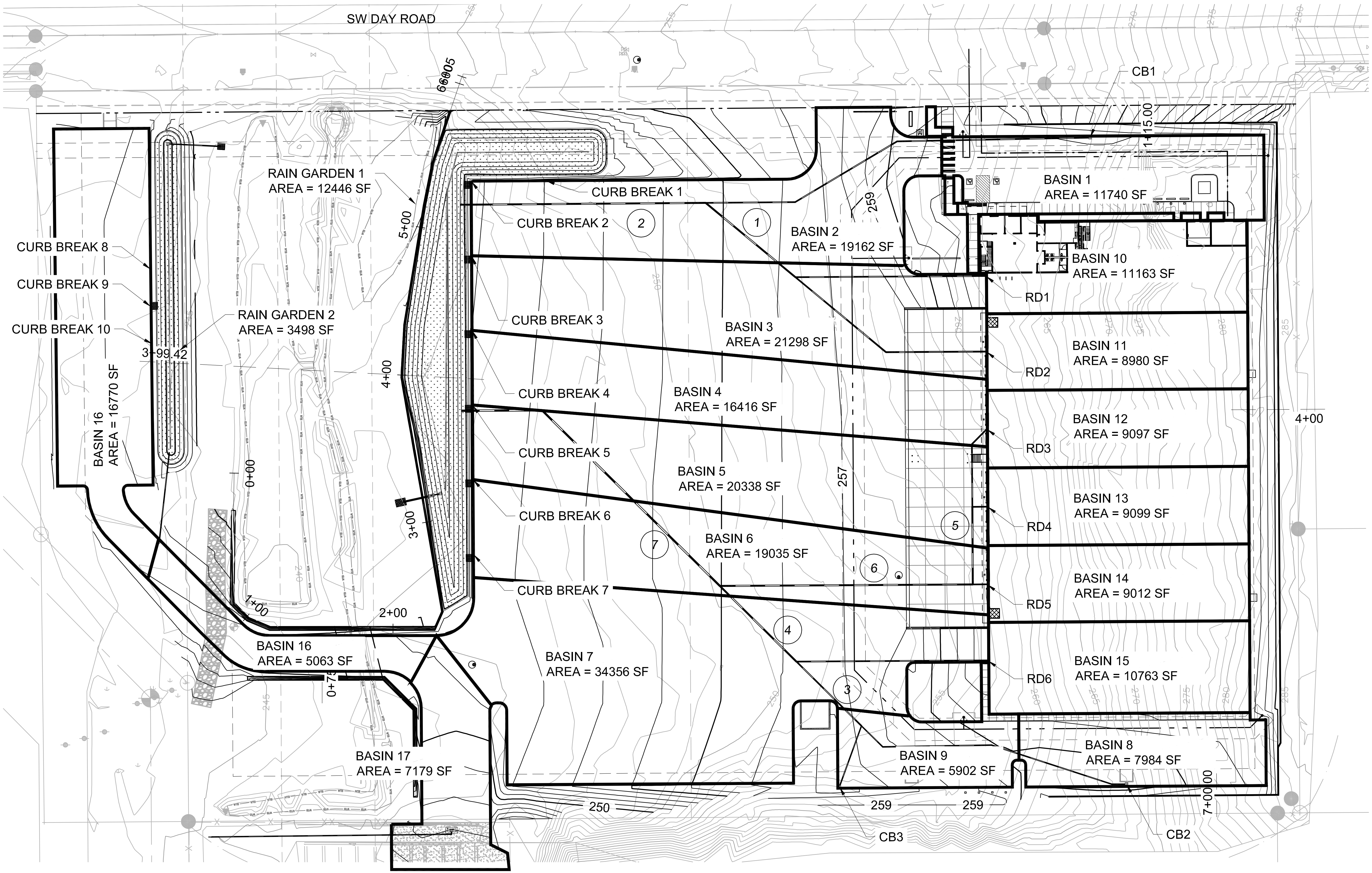
APPENDIX B

BASIN MAP



DELTA LOGISTICS

BASIN MAP

NOVEMBER 15, 2022
Job # 2200502.00

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0 30 60

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APPENDIX C

WES BMP SIZING TOOL REPORT – PUBLIC

WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	2200502.00 Delta Logistics - Day Road Frontage Improvements
Project Type	Industrial
Location	
Stormwater Management Area	1195
Project Applicant	
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
Planter 1 Impervious	31,205	Grass	ConventionalConcrete	D	Planter 1
Planter 2 Impervious	4,365	Grass	ConventionalConcrete	D	Planter 2
Planter 1 Pervious	4,610	Grass	LandscapeDsoil	D	Planter 1
Planter 2 Pervious	1,475	Grass	LandscapeDsoil	D	Planter 2

LID Facility Sizing Details

LID ID	Design Criteria	BMP Type	Facility Soil Type	Minimum Area (sq-ft)	Planned Areas (sq-ft)	Orifice Diameter (in)
Planter 1	FlowControlAndTreatment	Stormwater Planter - Filtration	D1	1,033.0	1,033.0	2.1
Planter 2	FlowControlAndTreatment	Stormwater Planter - Filtration	D1	161.9	162.0	0.9

Pond Sizing Details

1. FCWQT = Flow control and water quality treatment, WQT = Water quality treatment only

2. Depth is measured from the bottom of the facility and includes the three feet of media (drain rock, separation layer and growing media).

3. Maximum volume of the facility. Includes the volume occupied by the media at the bottom of the facility.

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a

40 percent porosity.

APPENDIX D

HYDROGRAPH RESULTS

1 - Year

2 - Year

5 - Year

10 - Year

25 - Year

100 - Year

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

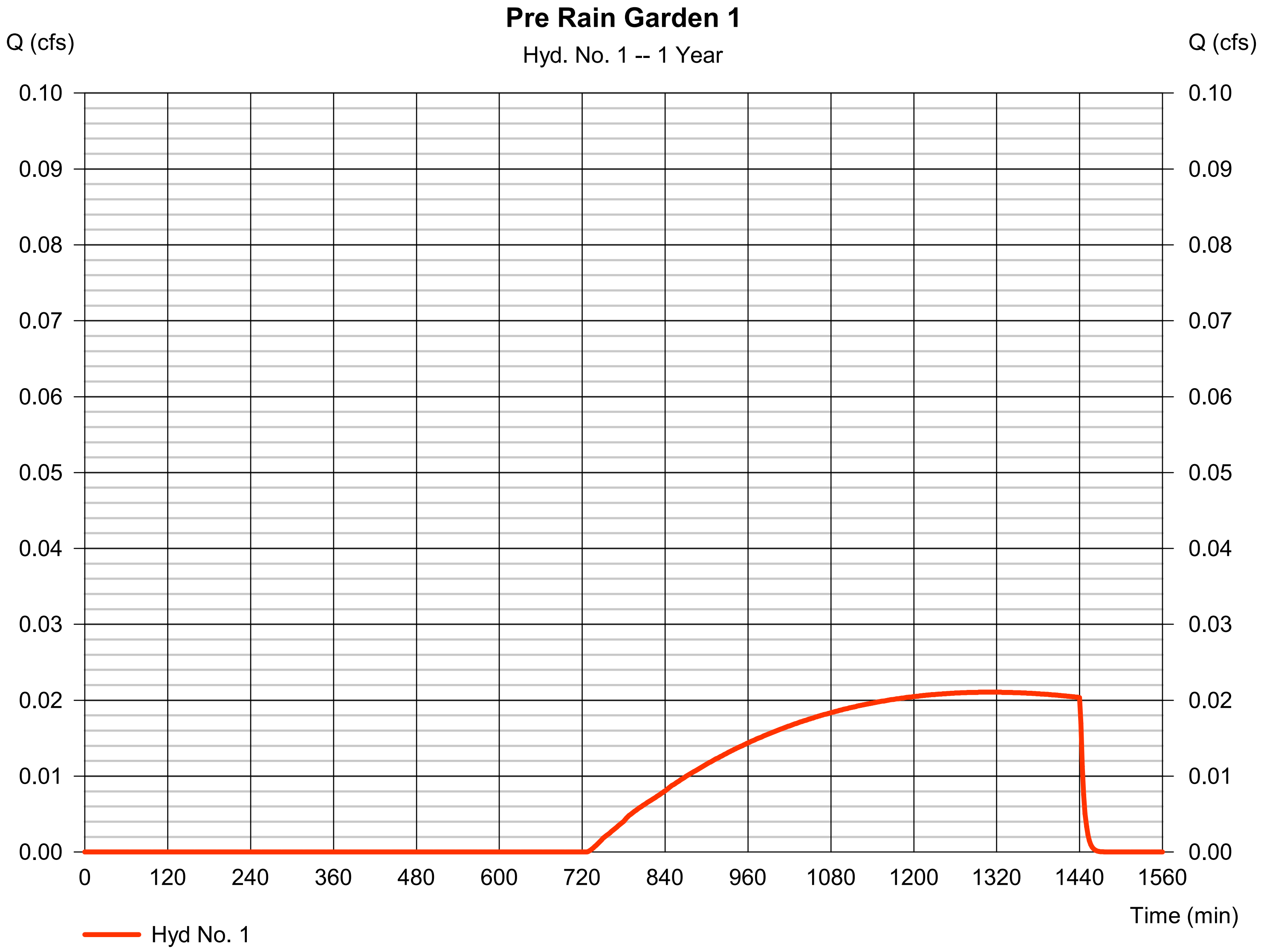
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	0.021	2	1310	679	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	0.727	2	478	11,282	------	------	------	Post Rain Garden 1
3	SBUH Runoff	0.009	2	1310	292	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	0.016	2	1168	675	------	------	------	Post Rain Garden 2
5	Reservoir	0.004	2	1442	17	2	247.67	7,492	Rain Garden 1
6	Reservoir	0.000	2	n/a	0	5	245.94	16.6	Rain Garden 2

Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.021 cfs
Storm frequency	= 1 yrs	Time to peak	= 1310 min
Time interval	= 2 min	Hyd. volume	= 679 cuft
Drainage area	= 6.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



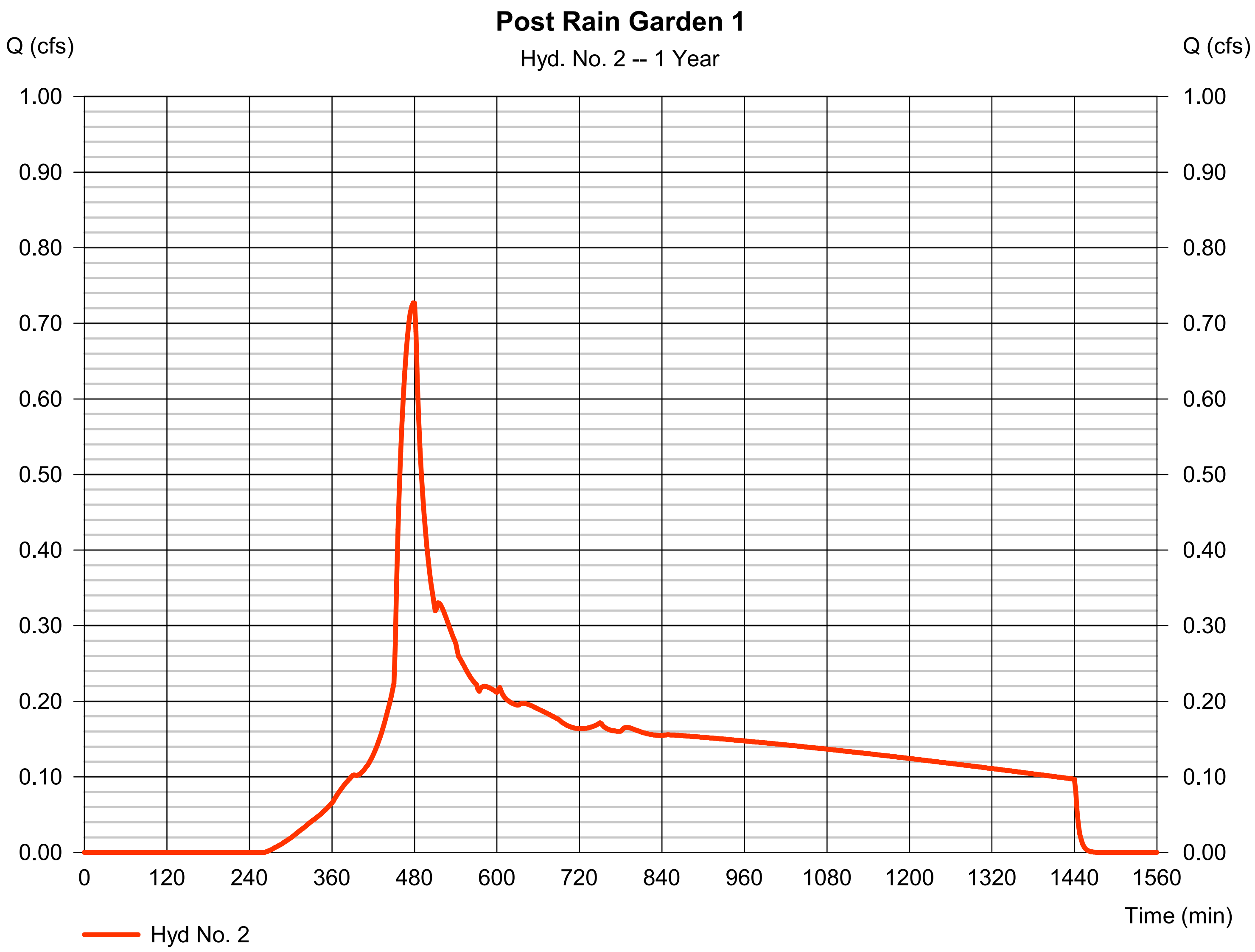
Hydrograph Report

Hyd. No. 2

Post Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.727 cfs
Storm frequency	= 1 yrs	Time to peak	= 478 min
Time interval	= 2 min	Hyd. volume	= 11,282 cuft
Drainage area	= 6.170 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



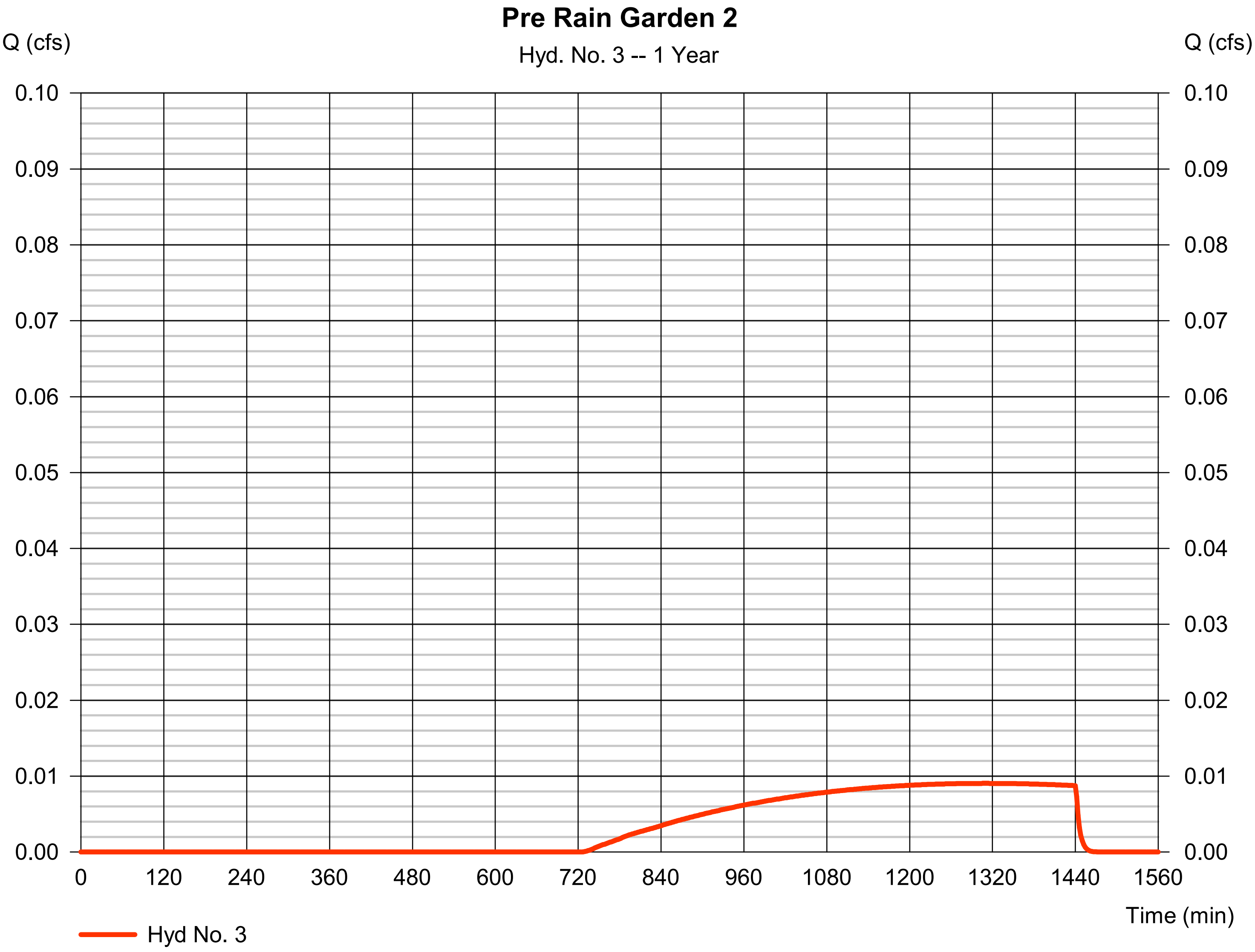
Hydrograph Report

Hyd. No. 3

Pre Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.009 cfs
Storm frequency	= 1 yrs	Time to peak	= 1310 min
Time interval	= 2 min	Hyd. volume	= 292 cuft
Drainage area	= 2.650 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



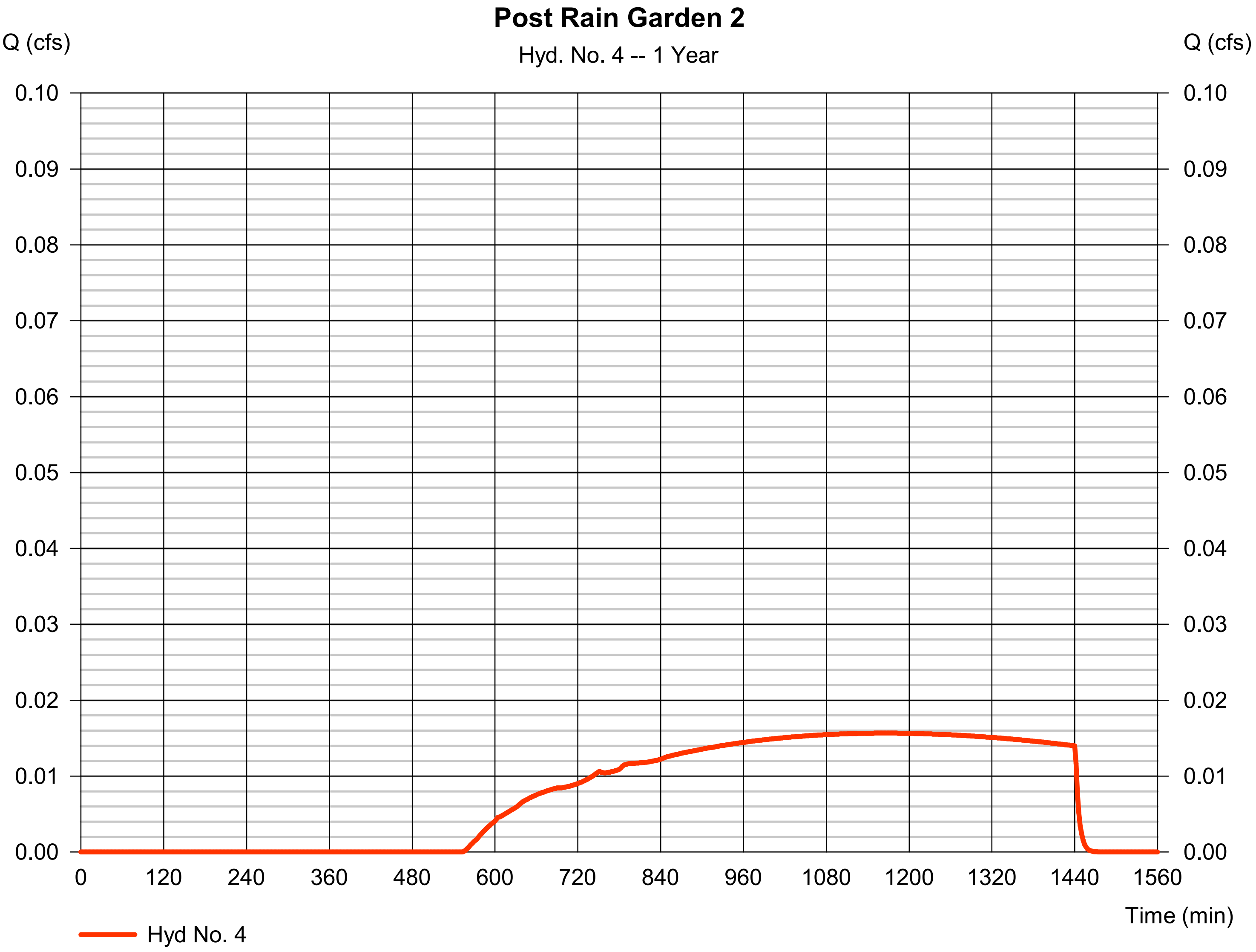
Hydrograph Report

Hyd. No. 4

Post Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.016 cfs
Storm frequency	= 1 yrs	Time to peak	= 1168 min
Time interval	= 2 min	Hyd. volume	= 675 cuft
Drainage area	= 2.650 ac	Curve number	= 79*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 1.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



Hydrograph Report

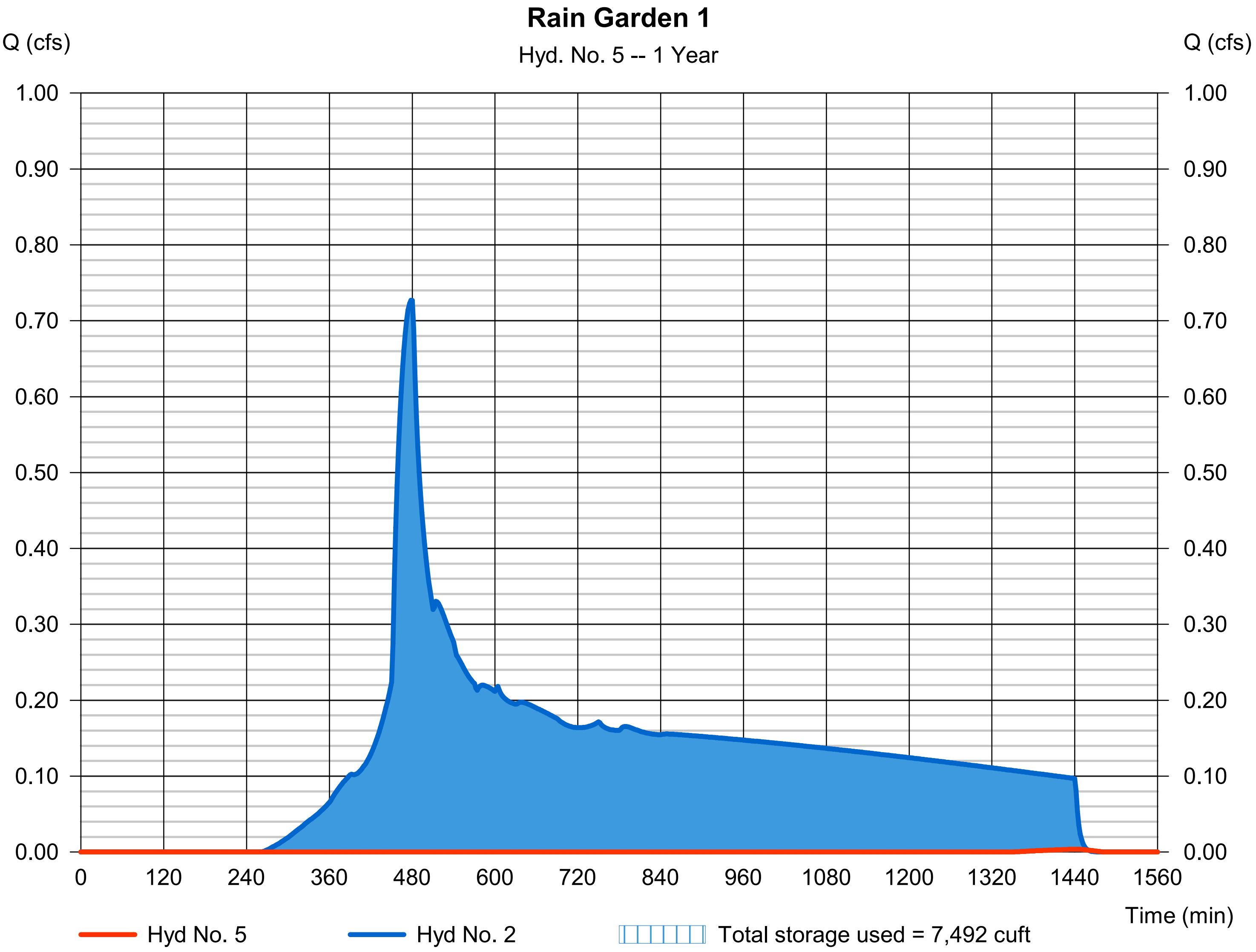
Hyd. No. 5

Rain Garden 1

Hydrograph type = Reservoir
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyd. No. = 2 - Post Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.004 cfs
Time to peak = 1442 min
Hyd. volume = 17 cuft
Max. Elevation = 247.67 ft
Max. Storage = 7,492 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 1 - Rain Garden 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 245.94 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	245.94	2,004	0	0
1.00	246.94	4,689	3,252	3,252
2.00	247.94	7,070	5,838	9,091
3.00	248.94	9,517	8,262	17,353
4.00	249.94	12,046	10,756	28,109
4.33	250.27	12,687	4,080	32,189

Culvert / Orifice Structures

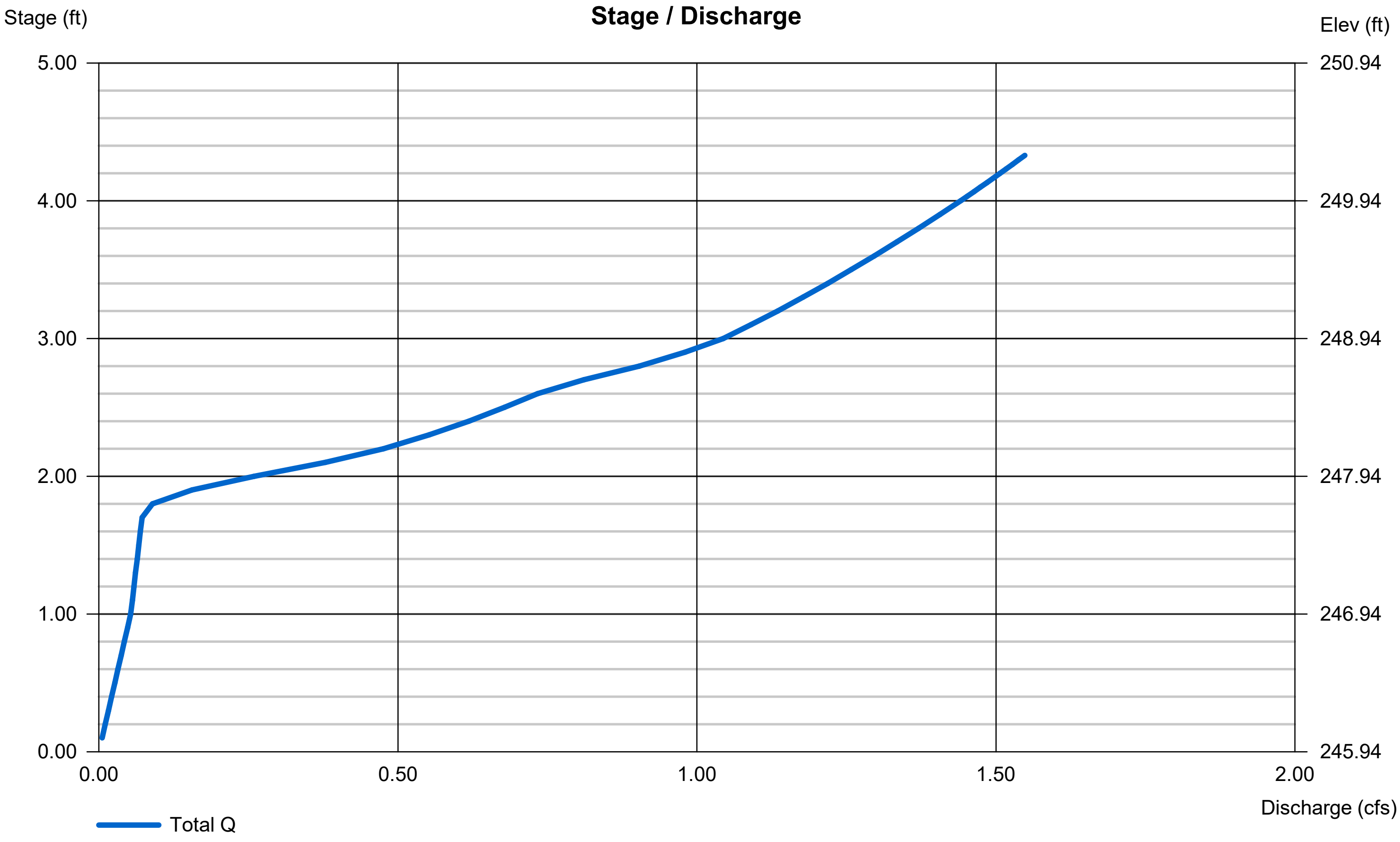
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 5.50	3.00	0.00	0.00
Span (in)	= 5.50	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 247.67	248.52	0.00	0.00
Length (ft)	= 20.00	20.00	0.00	0.00
Slope (%)	= 2.00	2.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	0.00	0.00	0.00
Crest El. (ft)	= 104.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.490 (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).



Hydrograph Report

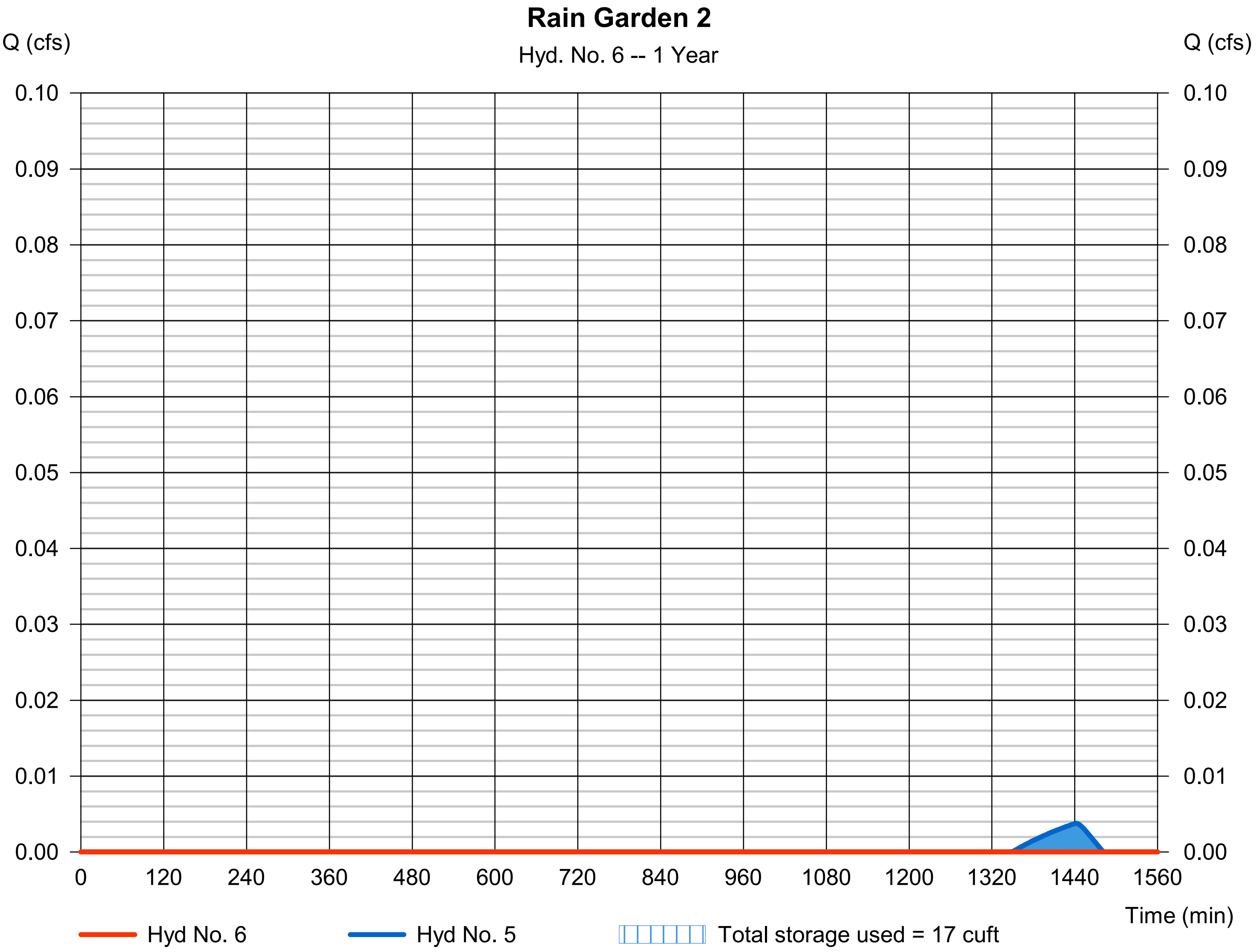
Hyd. No. 6

Rain Garden 2

Hydrograph type = Reservoir
Storm frequency = 1 yrs
Time interval = 2 min
Inflow hyd. No. = 5 - Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.000 cfs
Time to peak = n/a
Hyd. volume = 0 cuft
Max. Elevation = 245.94 ft
Max. Storage = 17 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Pond No. 1 - Rain Garden 1

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 245.94 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	245.94	2,004	0	0
1.00	246.94	4,689	3,252	3,252
2.00	247.94	7,070	5,838	9,091
3.00	248.94	9,517	8,262	17,353
4.00	249.94	12,046	10,756	28,109
4.33	250.27	12,687	4,080	32,189

Culvert / Orifice Structures

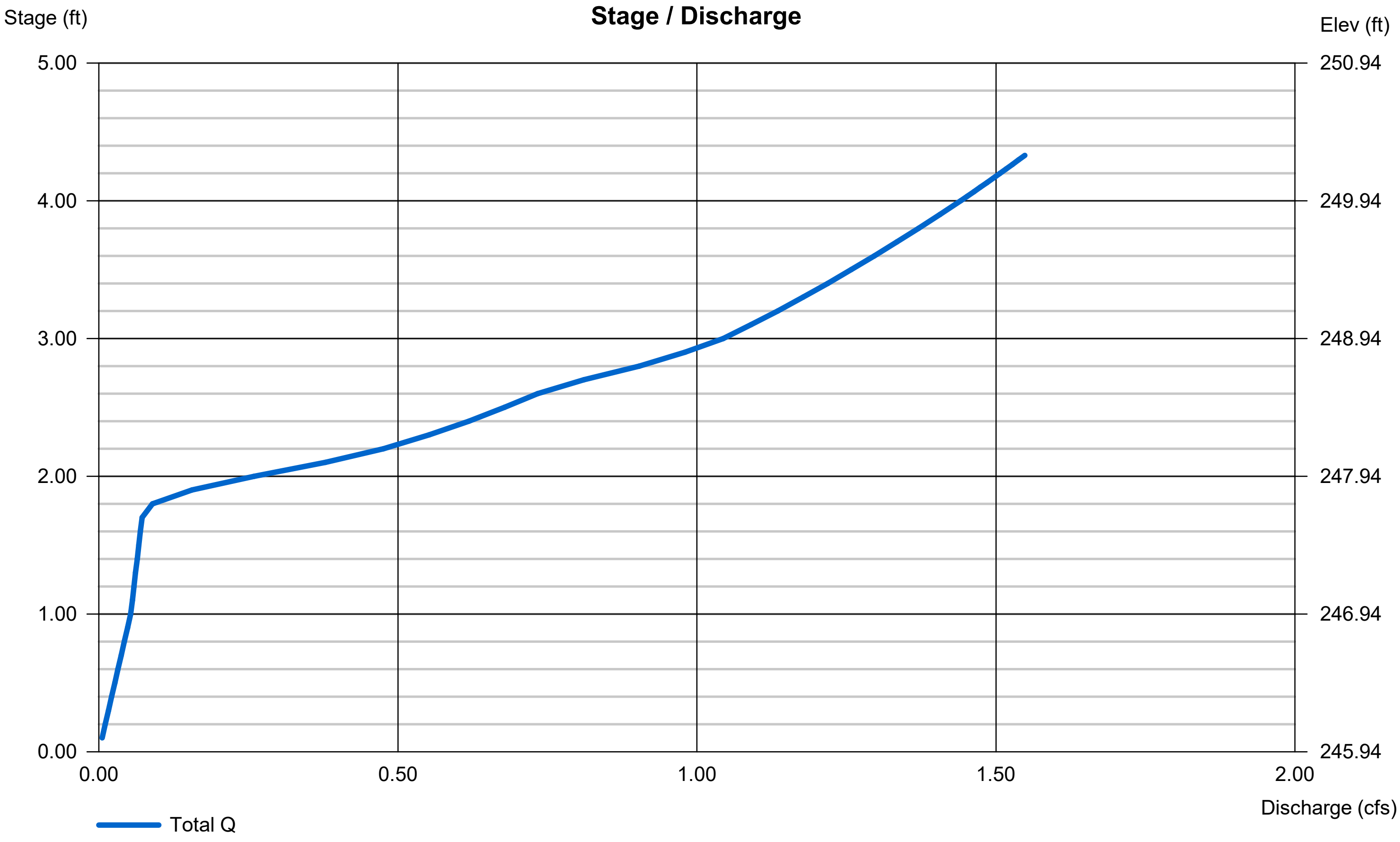
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 5.50	3.00	0.00	0.00
Span (in)	= 5.50	3.00	0.00	0.00
No. Barrels	= 1	1	0	0
Invert El. (ft)	= 247.67	248.52	0.00	0.00
Length (ft)	= 20.00	20.00	0.00	0.00
Slope (%)	= 2.00	2.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	Inactive	0.00	0.00	0.00
Crest El. (ft)	= 104.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.490 (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).



Hydrograph Summary Report

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	SBUH Runoff	0.625	2	480	14,570	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	2.975	2	476	41,869	------	------	------	Post Rain Garden 1
3	SBUH Runoff	0.268	2	480	6,258	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	0.427	2	480	8,056	------	------	------	Post Rain Garden 2
5	Reservoir	0.625	2	606	27,458	2	248.52	13,867	Rain Garden 1
6	Reservoir	0.362	2	988	14,240	5	248.11	10,501	Rain Garden 2

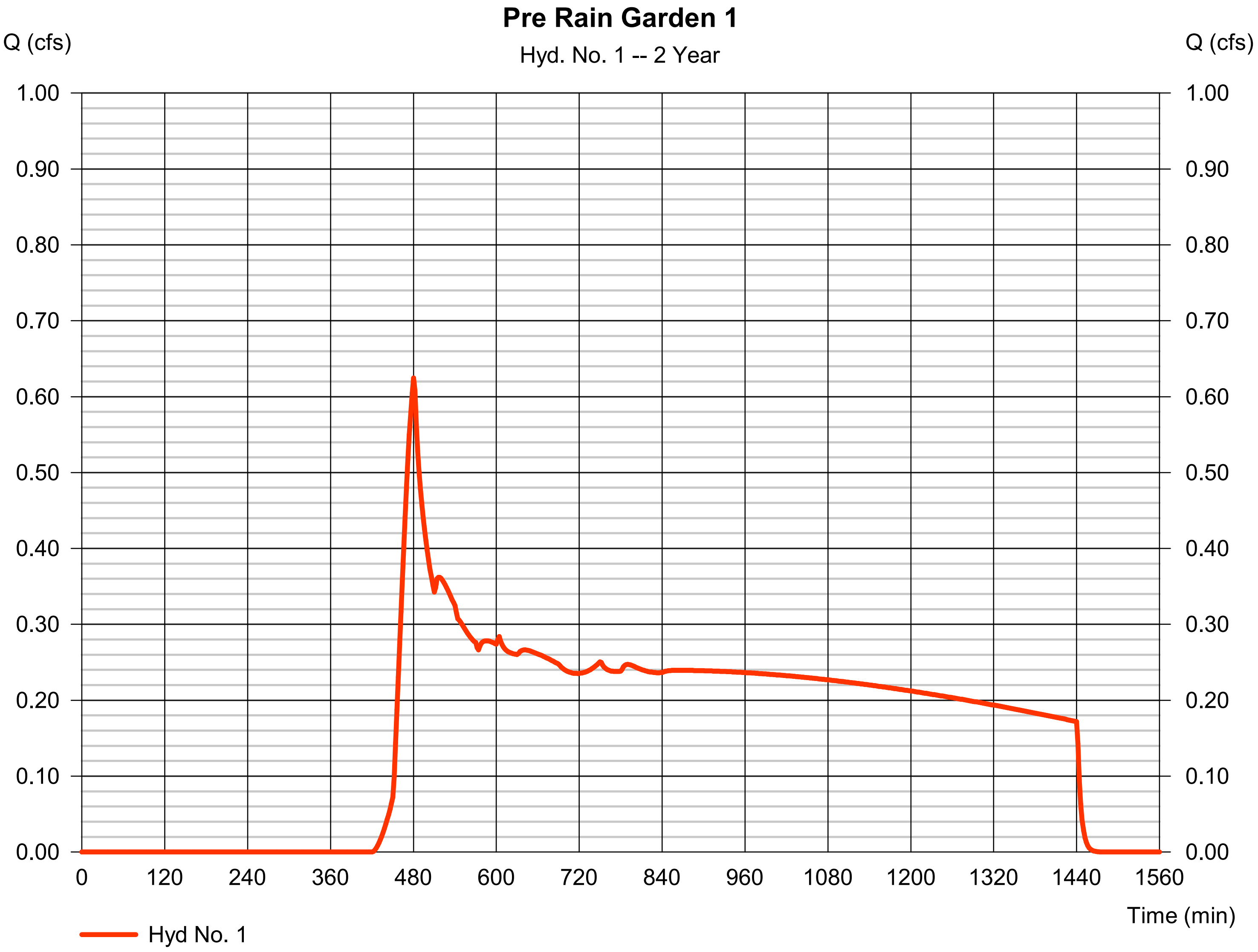
502-Hydraflow.gpw	Return Period: 2 Year	Sunday, 11 / 13 / 2022

Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.625 cfs
Storm frequency	= 2 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 14,570 cuft
Drainage area	= 6.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



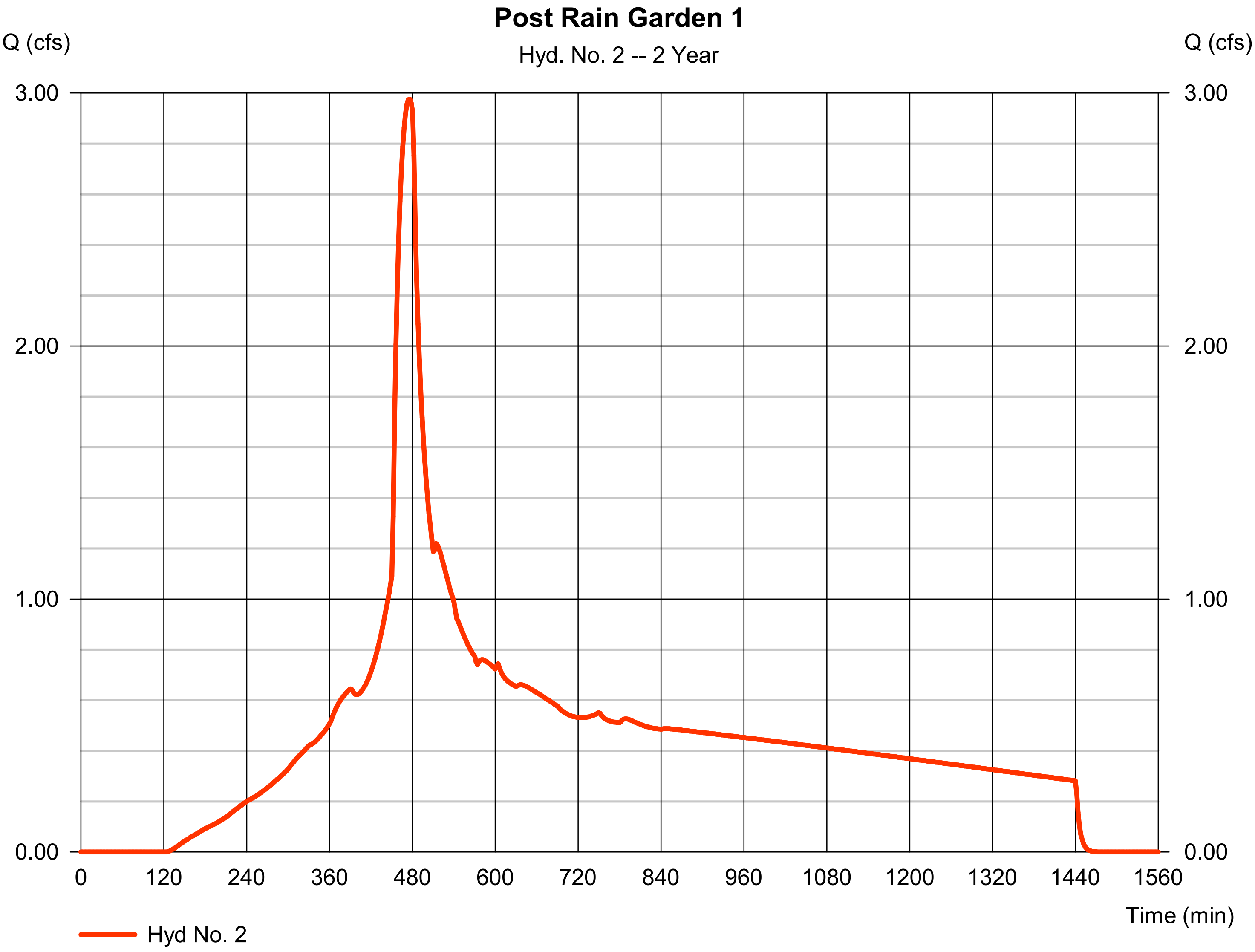
Hydrograph Report

Hyd. No. 2

Post Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 2.975 cfs
Storm frequency	= 2 yrs	Time to peak	= 476 min
Time interval	= 2 min	Hyd. volume	= 41,869 cuft
Drainage area	= 6.170 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



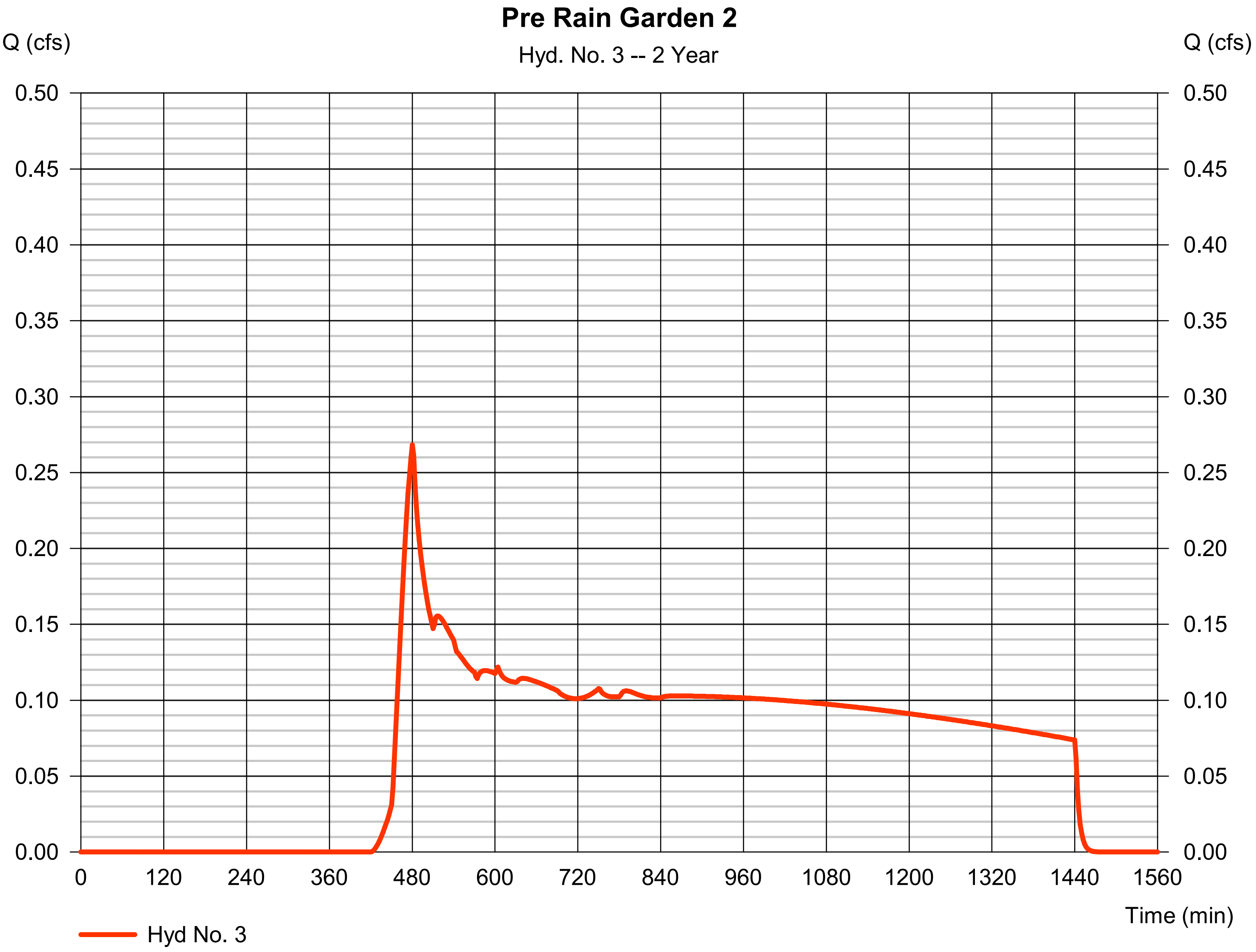
Hydrograph Report

Hyd. No. 3

Pre Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.268 cfs
Storm frequency	= 2 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 6,258 cuft
Drainage area	= 2.650 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



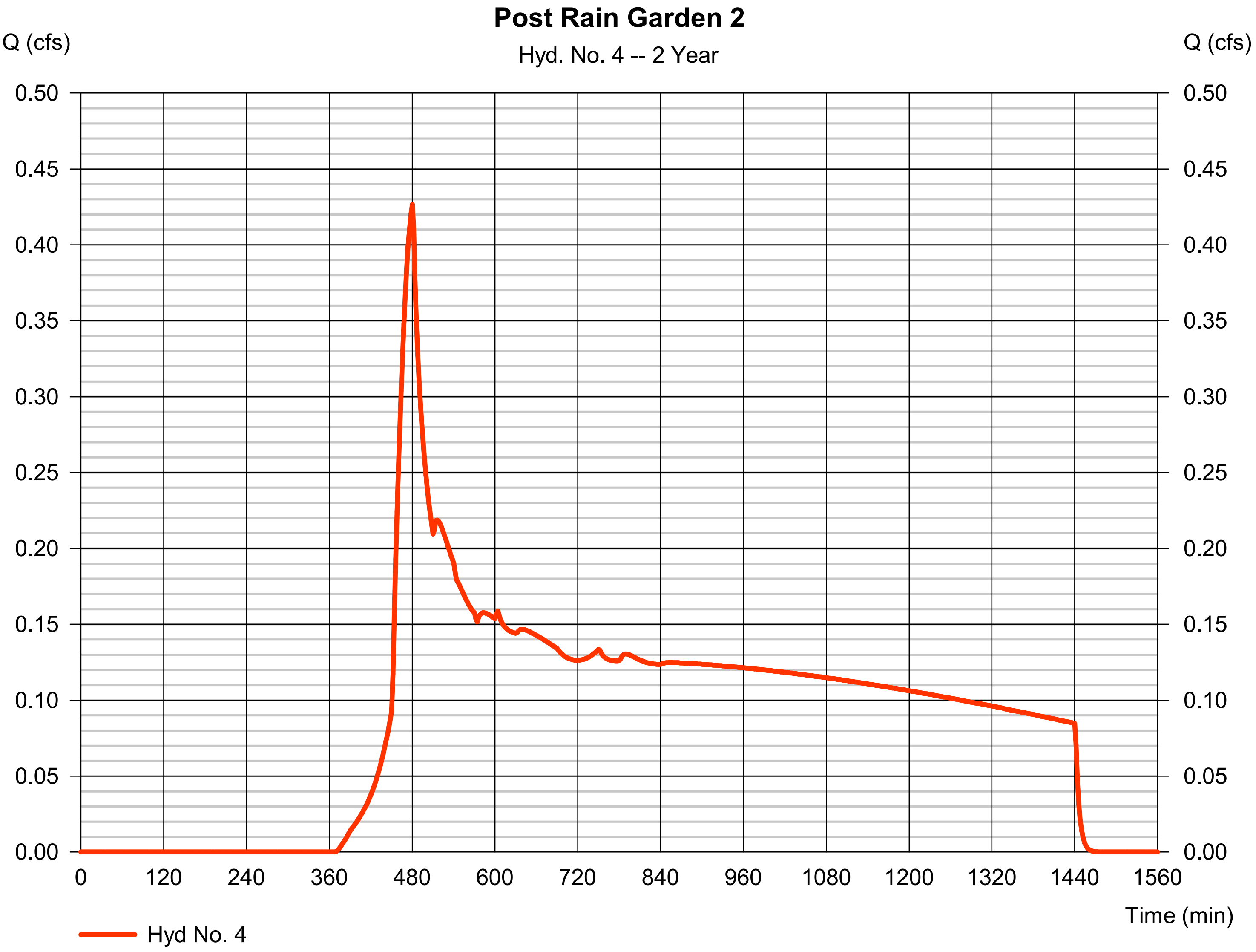
Hydrograph Report

Hyd. No. 4

Post Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.427 cfs
Storm frequency	= 2 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 8,056 cuft
Drainage area	= 2.650 ac	Curve number	= 79*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



Hydrograph Report

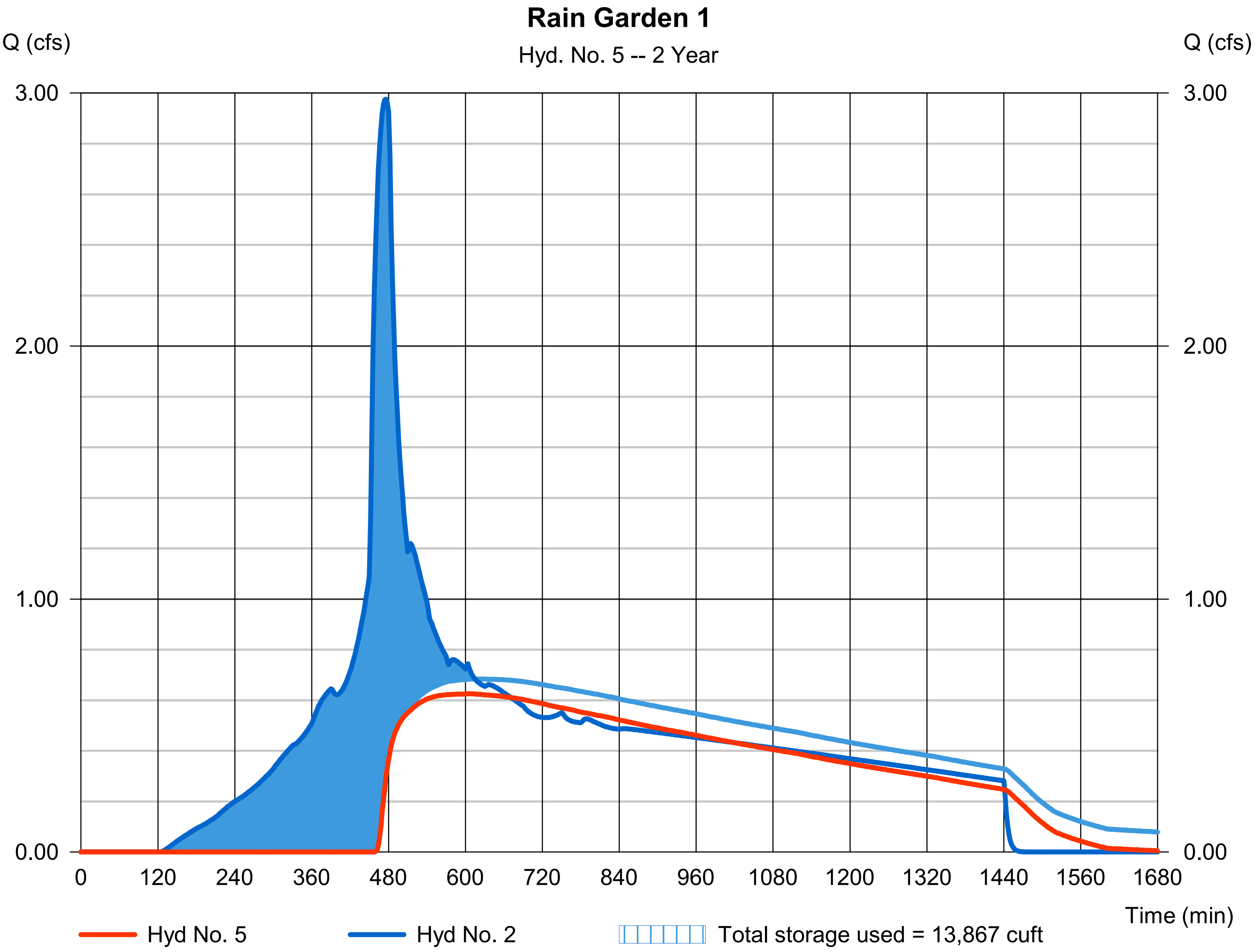
Hyd. No. 5

Rain Garden 1

Hydrograph type = Reservoir
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyd. No. = 2 - Post Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.625 cfs
Time to peak = 606 min
Hyd. volume = 27,458 cuft
Max. Elevation = 248.52 ft
Max. Storage = 13,867 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



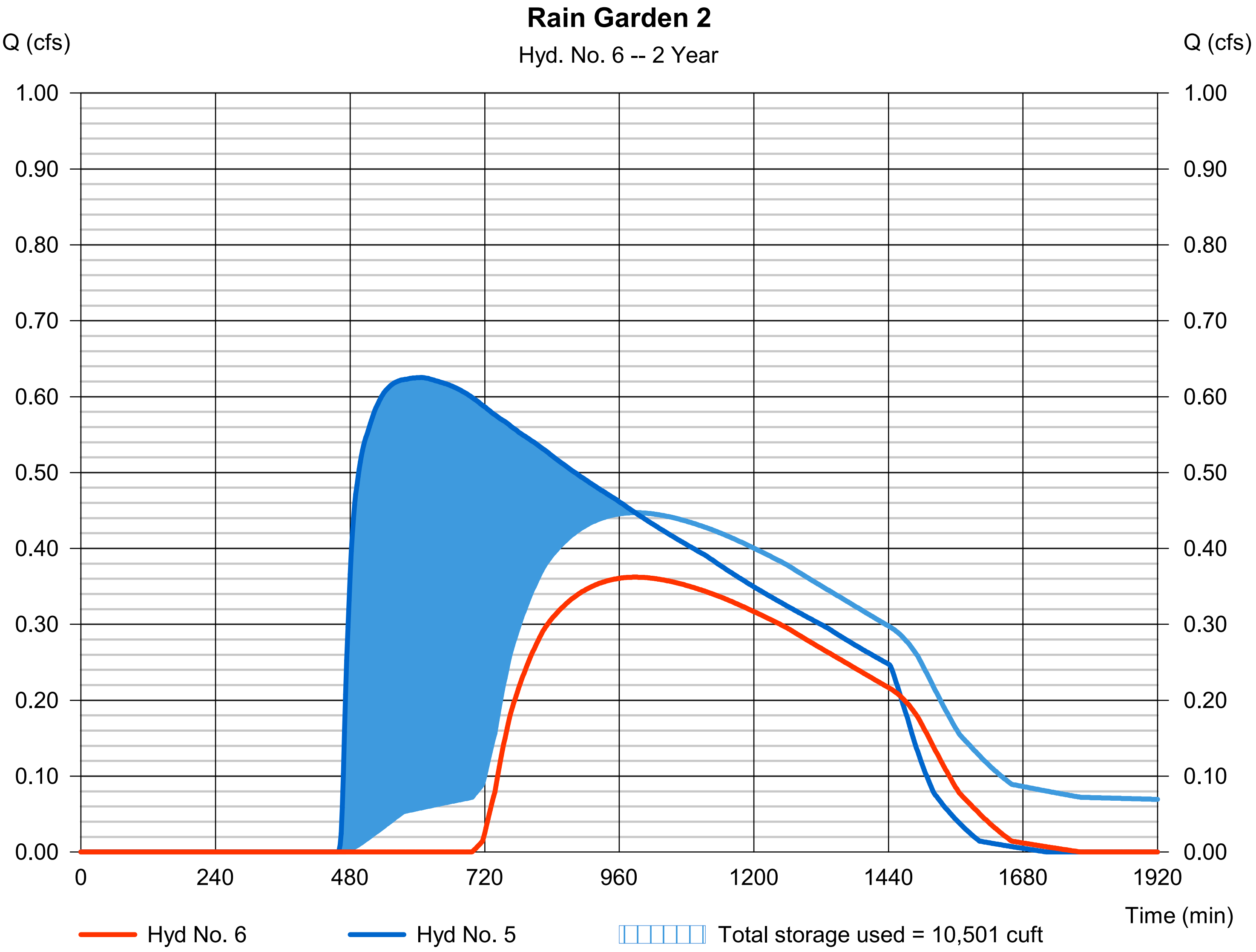
Hydrograph Report

Hyd. No. 6

Rain Garden 2

Hydrograph type	= Reservoir	Peak discharge	= 0.362 cfs
Storm frequency	= 2 yrs	Time to peak	= 988 min
Time interval	= 2 min	Hyd. volume	= 14,240 cuft
Inflow hyd. No.	= 5 - Rain Garden 1	Max. Elevation	= 248.11 ft
Reservoir name	= Rain Garden 1	Max. Storage	= 10,501 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

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	SBUH Runoff	1.105	2	480	21,519	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	3.752	2	474	52,635	------	------	------	Post Rain Garden 1
3	SBUH Runoff	0.475	2	480	9,242	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	0.667	2	480	11,432	------	------	------	Post Rain Garden 2
5	Reservoir	0.909	2	560	37,540	2	248.90	16,990	Rain Garden 1
6	Reservoir	0.507	2	938	23,637	5	248.31	12,135	Rain Garden 2

502-Hydraflow.gpw	Return Period: 5 Year	Sunday, 11 / 13 / 2022

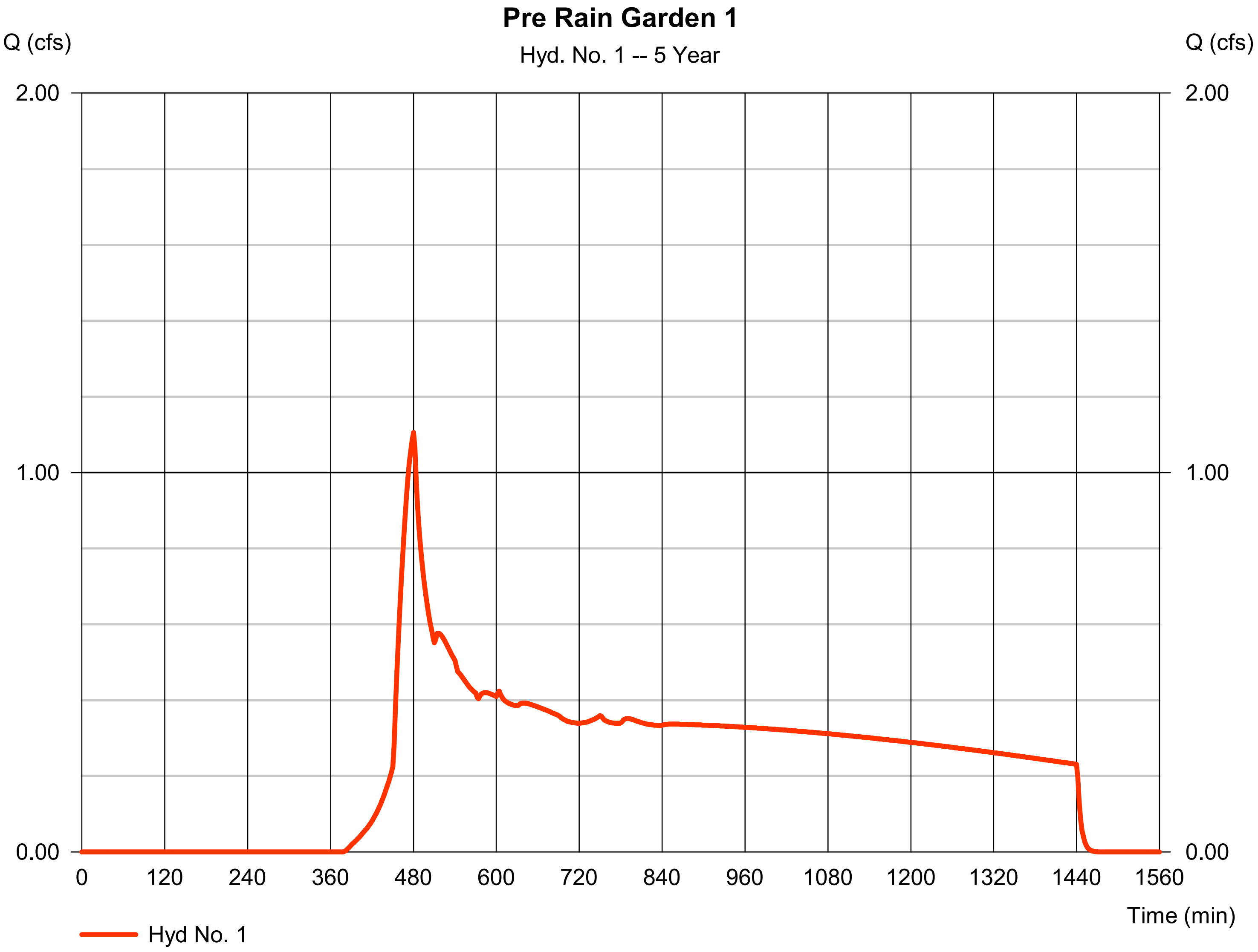
Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type = SBUH Runoff
Storm frequency = 5 yrs
Time interval = 2 min
Drainage area = 6.170 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 3.00 in
Storm duration = 24 hrs

Peak discharge = 1.105 cfs
Time to peak = 480 min
Hyd. volume = 21,519 cuft
Curve number = 75
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type IA
Shape factor = n/a



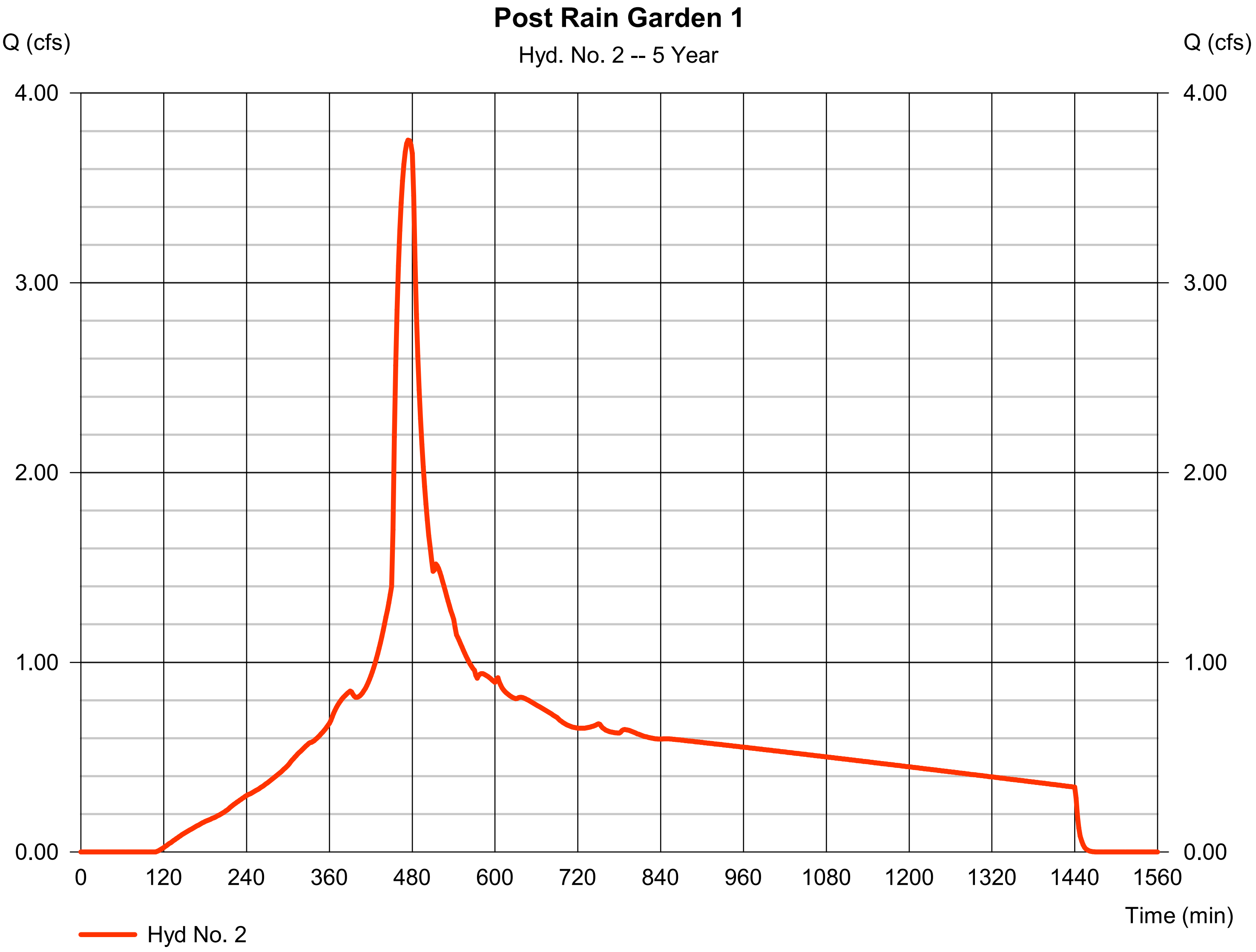
Hydrograph Report

Hyd. No. 2

Post Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 3.752 cfs
Storm frequency	= 5 yrs	Time to peak	= 474 min
Time interval	= 2 min	Hyd. volume	= 52,635 cuft
Drainage area	= 6.170 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



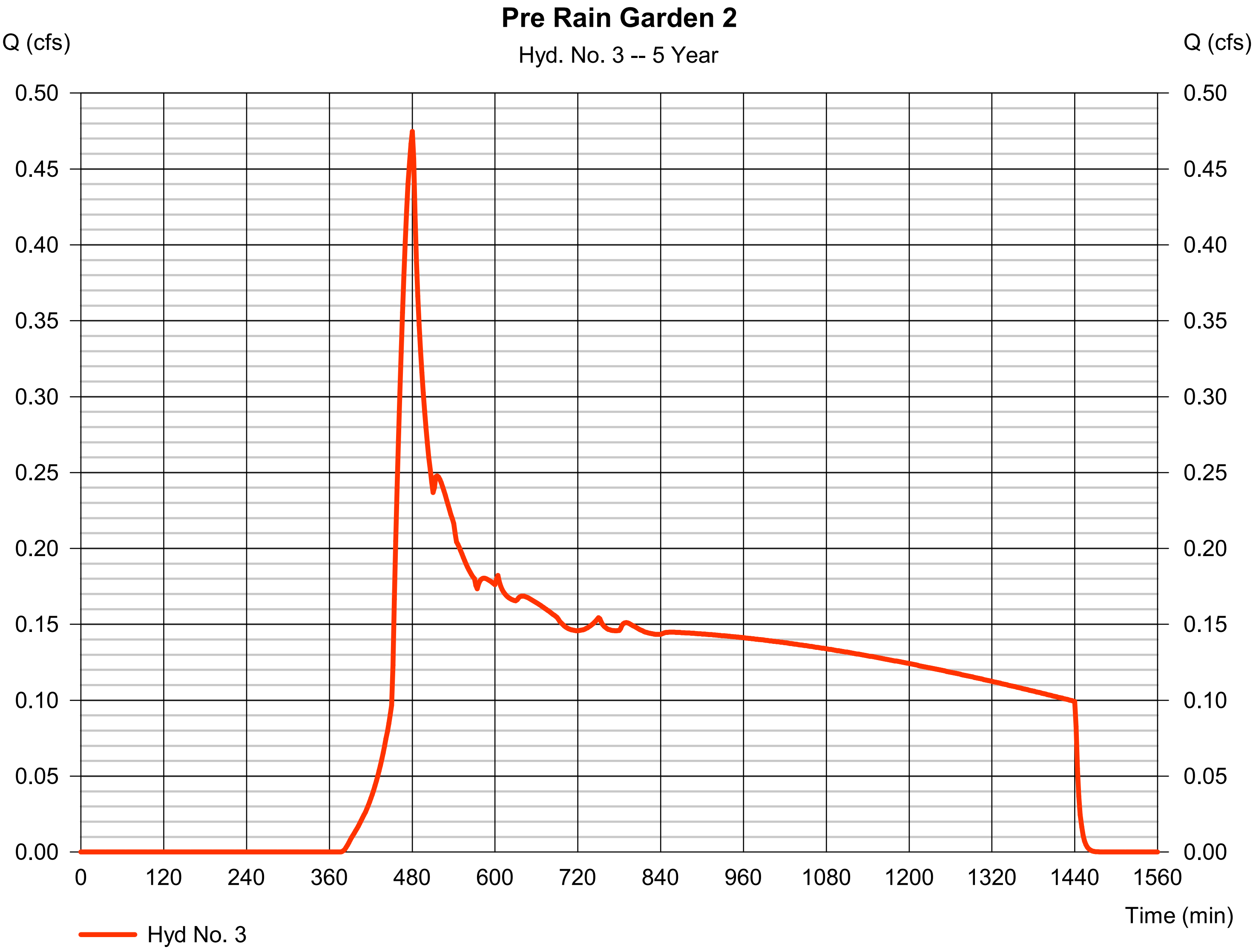
Hydrograph Report

Hyd. No. 3

Pre Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.475 cfs
Storm frequency	= 5 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 9,242 cuft
Drainage area	= 2.650 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



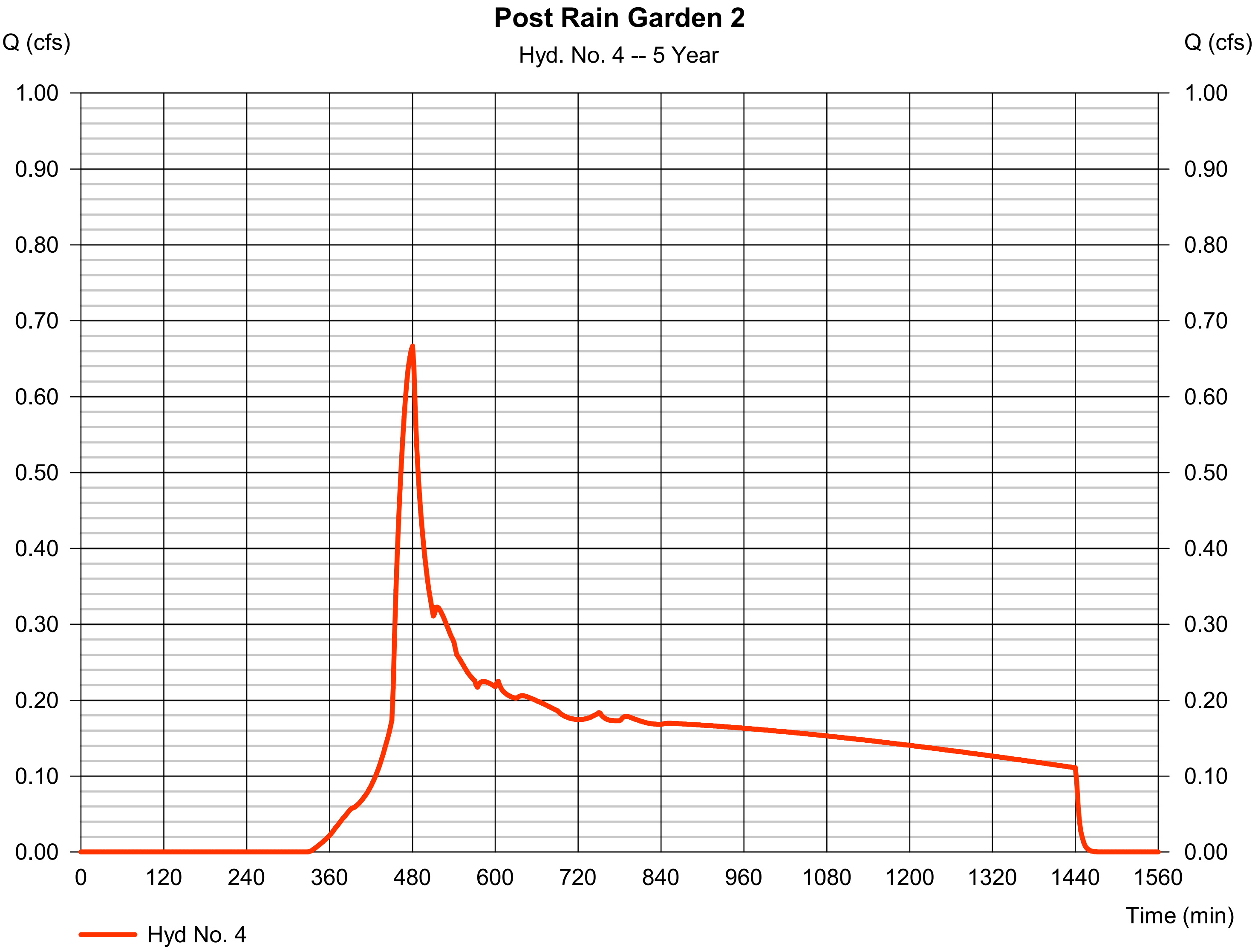
Hydrograph Report

Hyd. No. 4

Post Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.667 cfs
Storm frequency	= 5 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 11,432 cuft
Drainage area	= 2.650 ac	Curve number	= 79*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.00 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



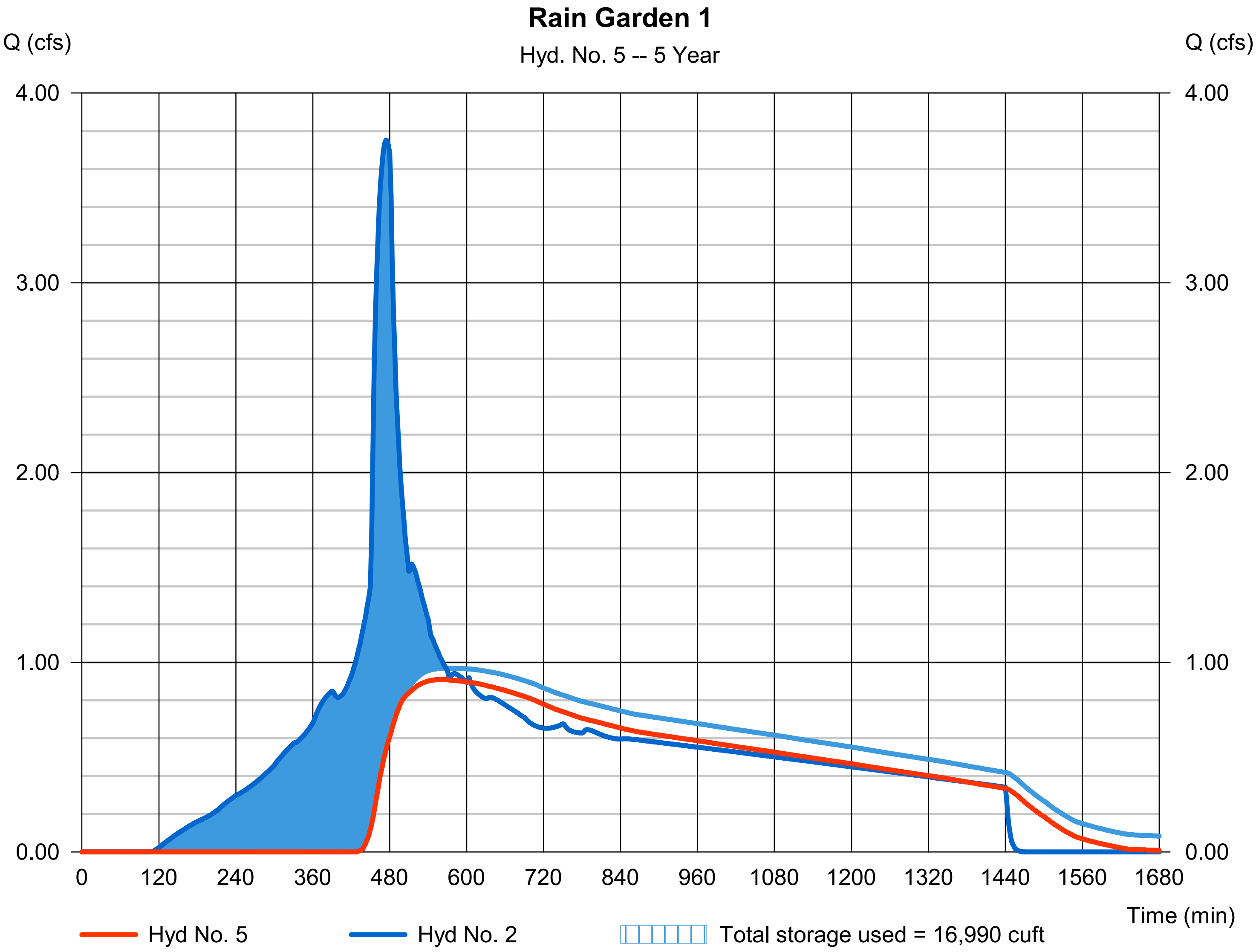
Hydrograph Report

Hyd. No. 5

Rain Garden 1

Hydrograph type	= Reservoir	Peak discharge	= 0.909 cfs
Storm frequency	= 5 yrs	Time to peak	= 560 min
Time interval	= 2 min	Hyd. volume	= 37,540 cuft
Inflow hyd. No.	= 2 - Post Rain Garden 1	Max. Elevation	= 248.90 ft
Reservoir name	= Rain Garden 1	Max. Storage	= 16,990 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

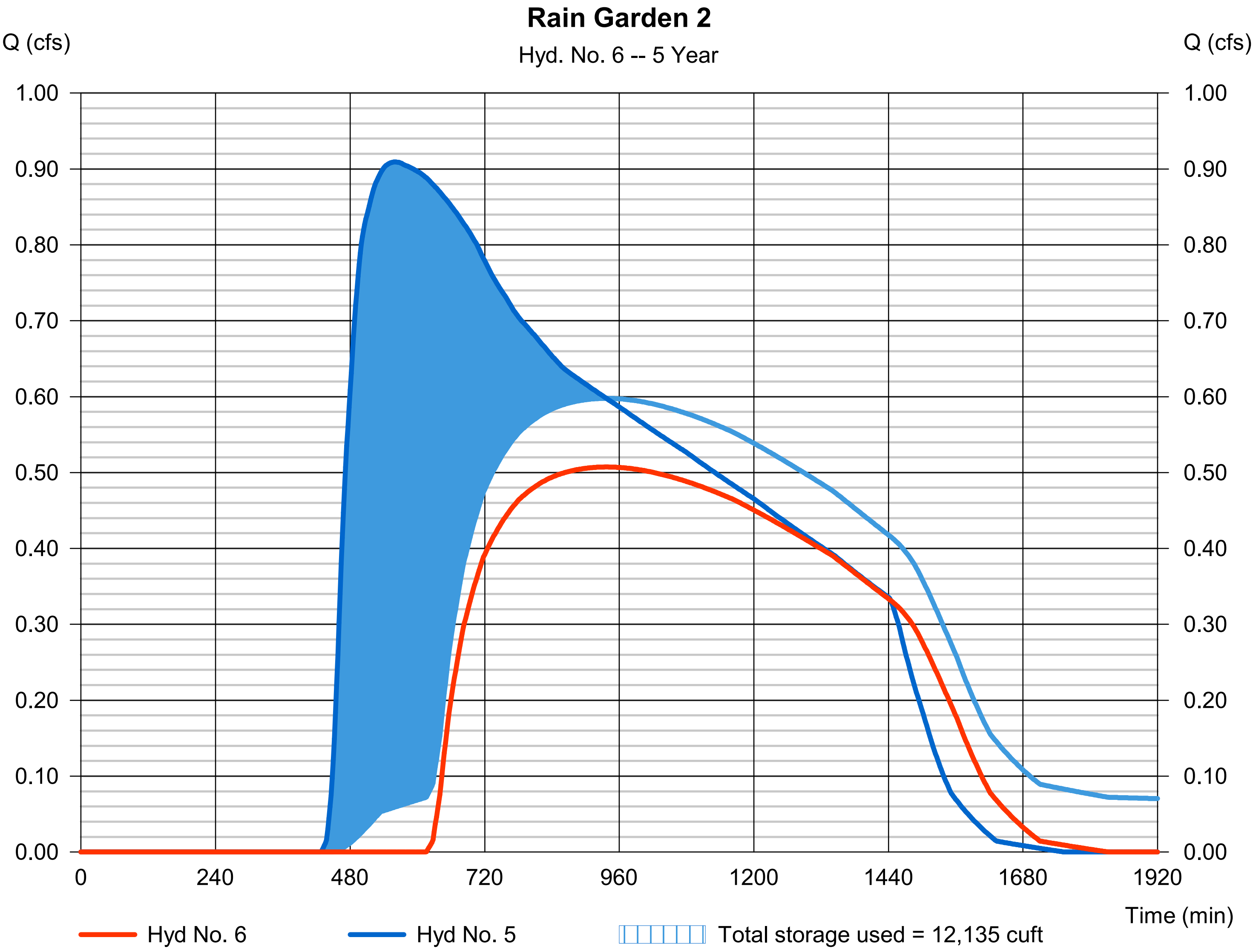
Hyd. No. 6

Rain Garden 2

Hydrograph type = Reservoir
Storm frequency = 5 yrs
Time interval = 2 min
Inflow hyd. No. = 5 - Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.507 cfs
Time to peak = 938 min
Hyd. volume = 23,637 cuft
Max. Elevation = 248.31 ft
Max. Storage = 12,135 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

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	SBUH Runoff	1.589	2	480	28,367	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	4.451	2	474	62,419	------	------	------	Post Rain Garden 1
3	SBUH Runoff	0.682	2	480	12,183	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	0.901	2	480	14,691	------	------	------	Post Rain Garden 2
5	Reservoir	1.044	2	564	46,682	2	249.20	20,129	Rain Garden 1
6	Reservoir	0.661	2	910	32,124	5	248.57	14,319	Rain Garden 2

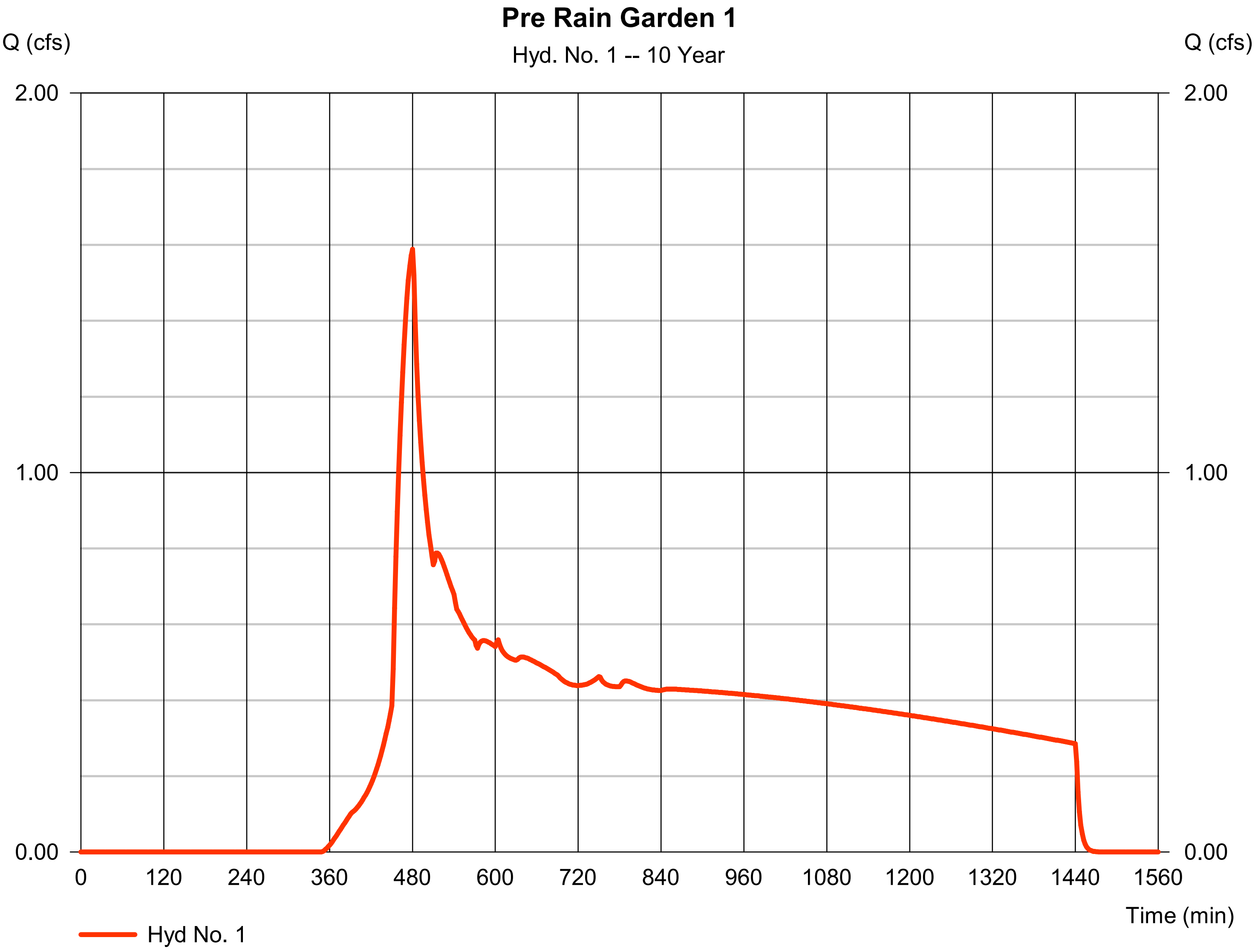
502-Hydraflow.gpw	Return Period: 10 Year	Sunday, 11 / 13 / 2022

Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 1.589 cfs
Storm frequency	= 10 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 28,367 cuft
Drainage area	= 6.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



Hydrograph Report

Hyd. No. 2

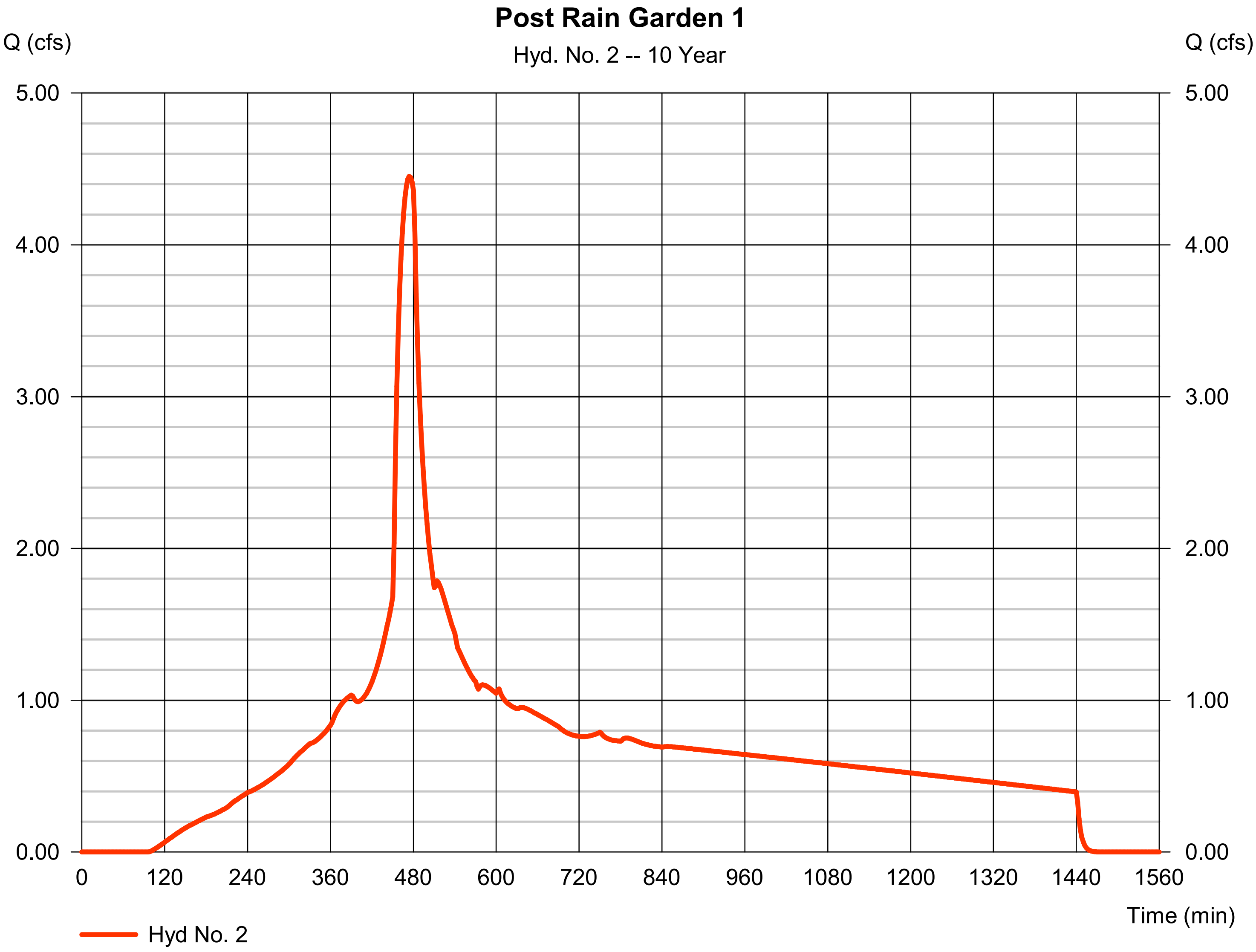
Post Rain Garden 1

Hydrograph type = SBUH Runoff
Storm frequency = 10 yrs
Time interval = 2 min
Drainage area = 6.170 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 3.45 in
Storm duration = 24 hrs

Peak discharge = 4.451 cfs
Time to peak = 474 min
Hyd. volume = 62,419 cuft
Curve number = 94*
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type IA
Shape factor = n/a

---

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



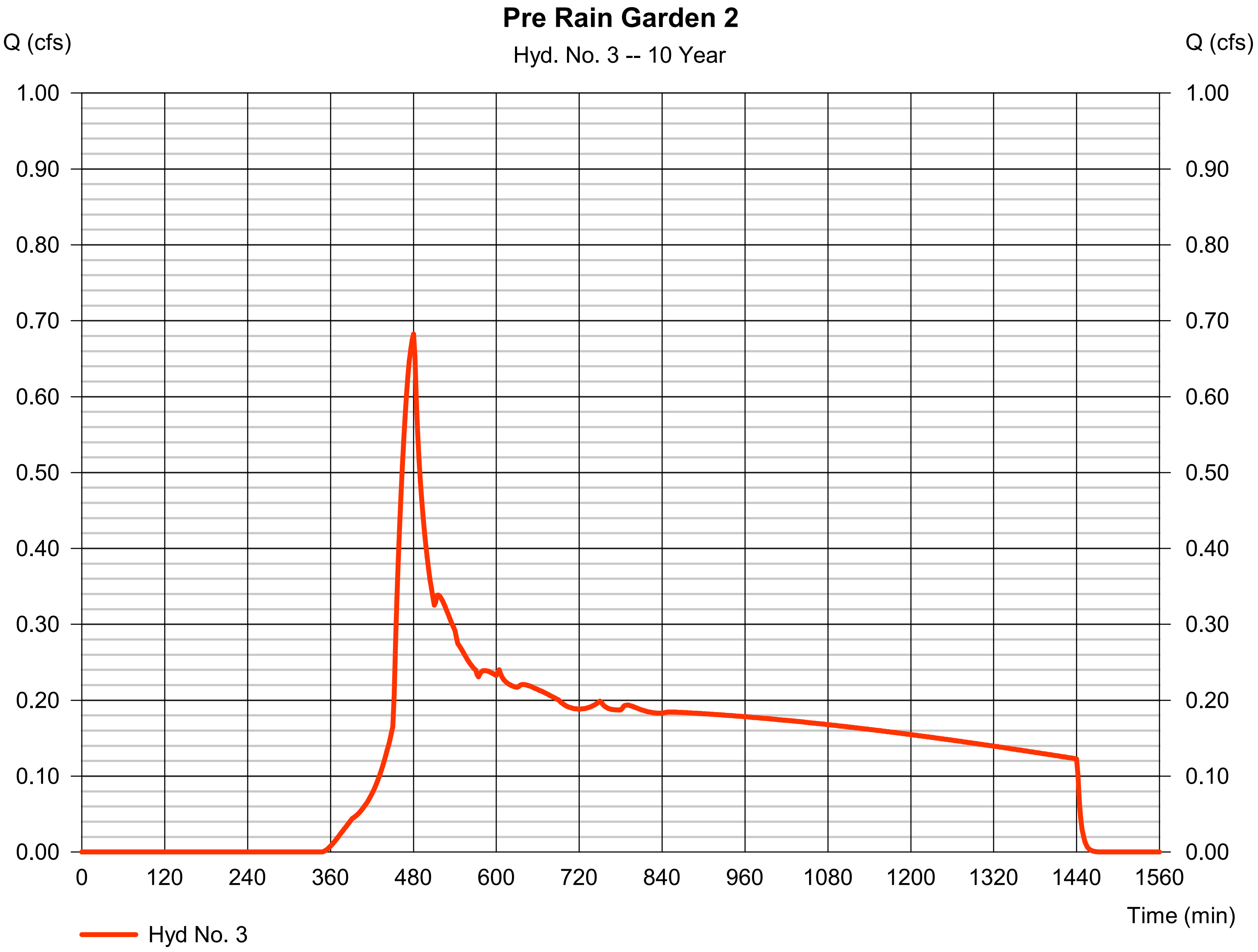
Hydrograph Report

Hyd. No. 3

Pre Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.682 cfs
Storm frequency	= 10 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 12,183 cuft
Drainage area	= 2.650 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



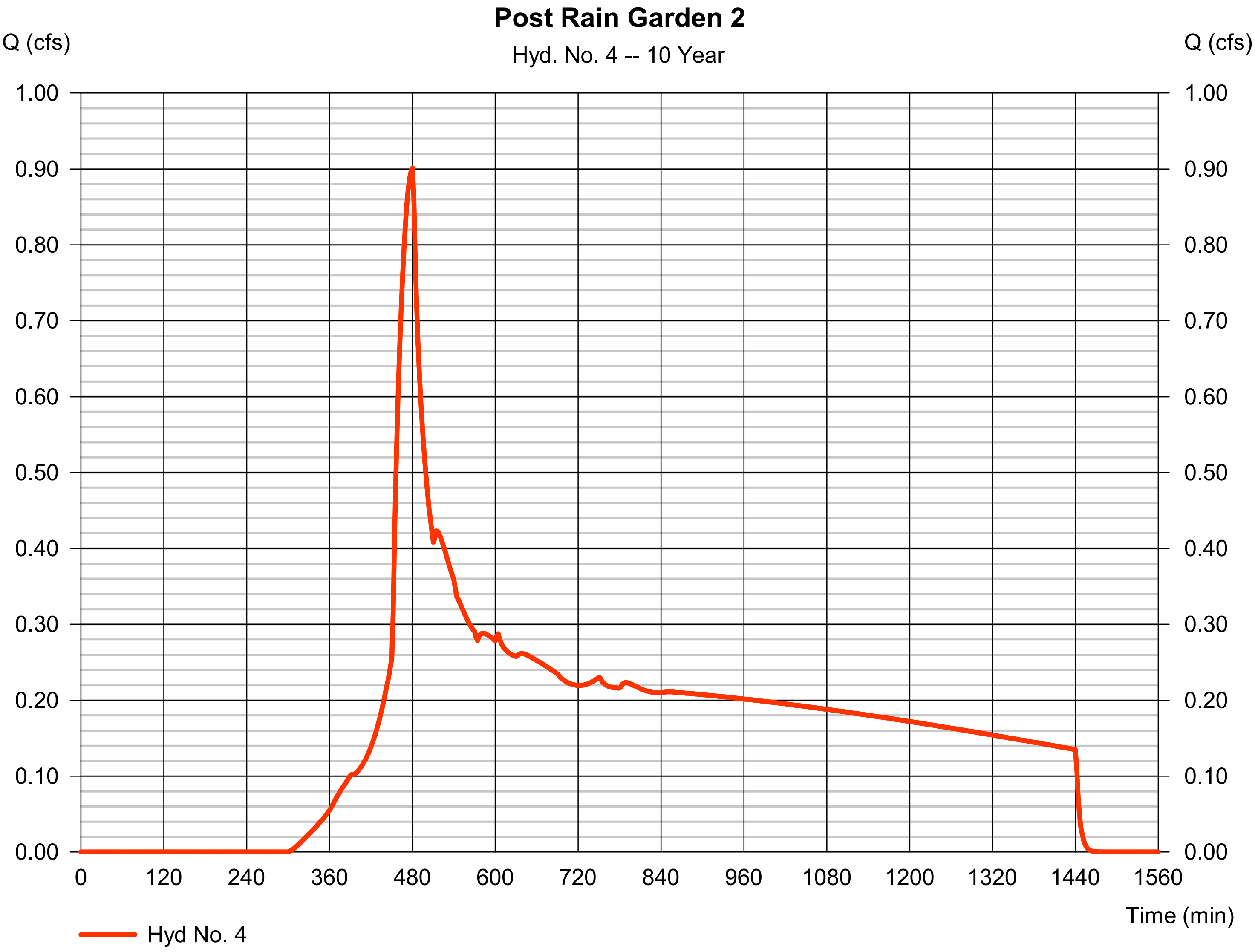
Hydrograph Report

Hyd. No. 4

Post Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.901 cfs
Storm frequency	= 10 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 14,691 cuft
Drainage area	= 2.650 ac	Curve number	= 79*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.45 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



Hydrograph Report

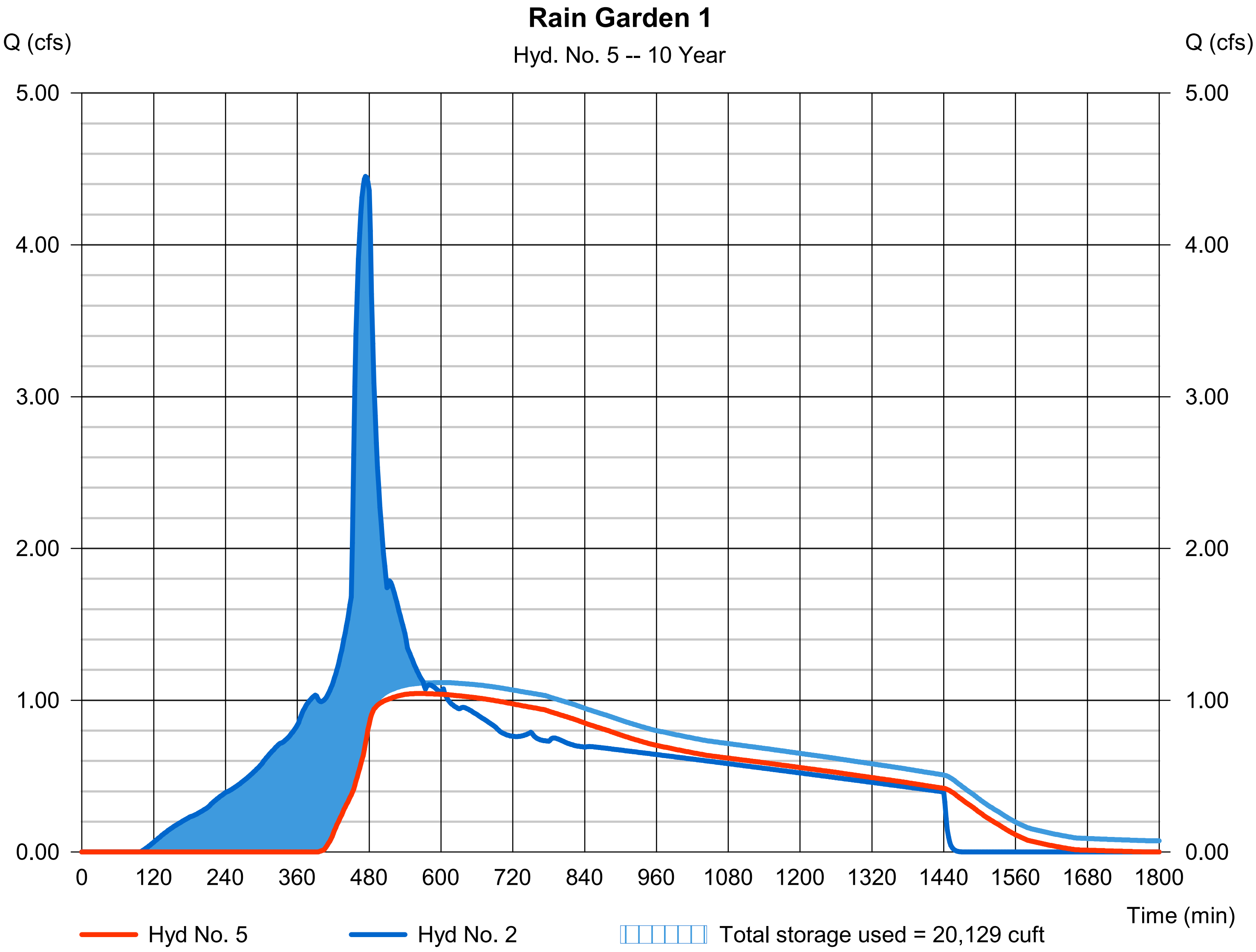
Hyd. No. 5

Rain Garden 1

Hydrograph type = Reservoir
Storm frequency = 10 yrs
Time interval = 2 min
Inflow hyd. No. = 2 - Post Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 1.044 cfs
Time to peak = 564 min
Hyd. volume = 46,682 cuft
Max. Elevation = 249.20 ft
Max. Storage = 20,129 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

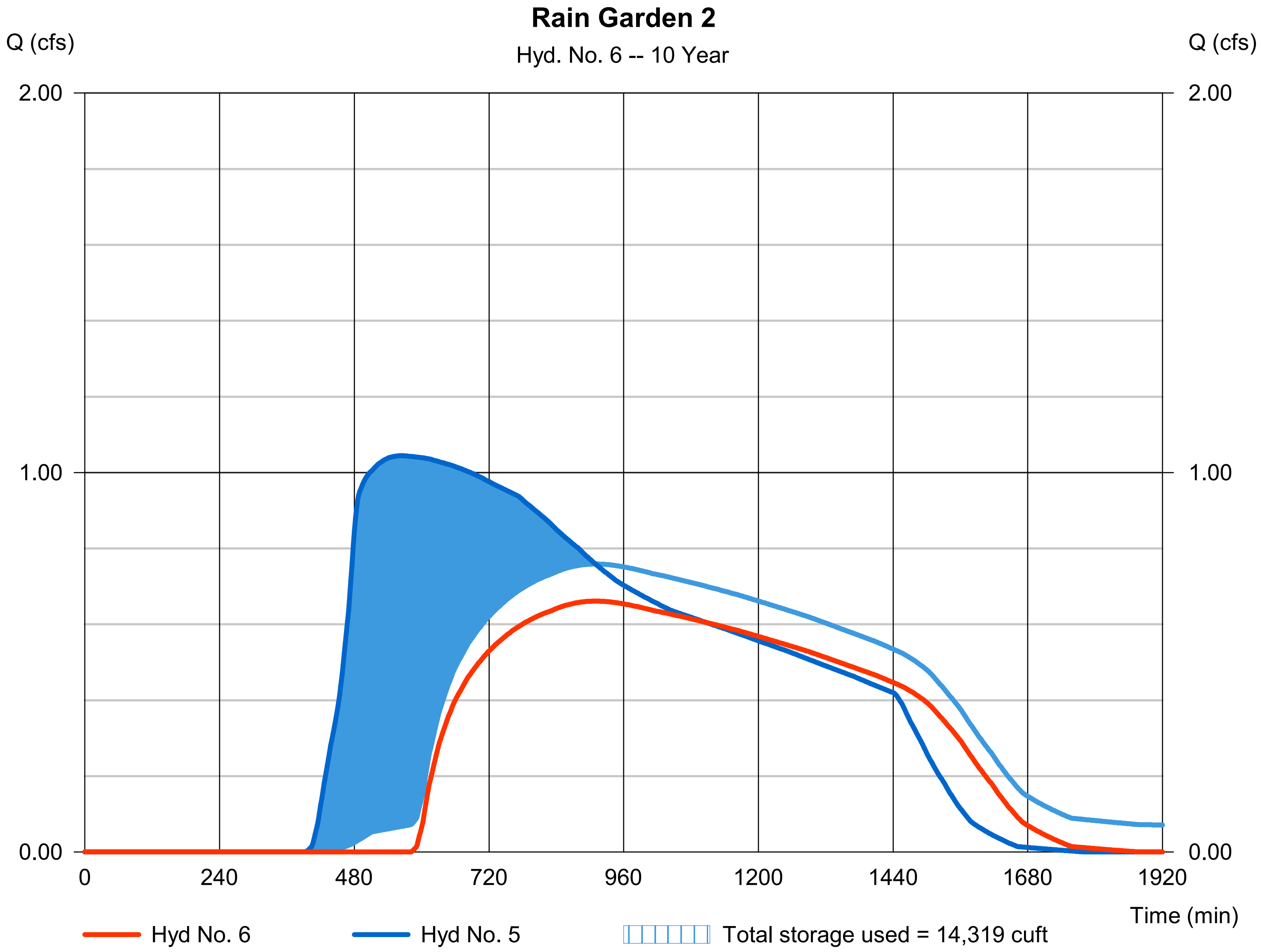
Hyd. No. 6

Rain Garden 2

Hydrograph type = Reservoir
Storm frequency = 10 yrs
Time interval = 2 min
Inflow hyd. No. = 5 - Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.661 cfs
Time to peak = 910 min
Hyd. volume = 32,124 cuft
Max. Elevation = 248.57 ft
Max. Storage = 14,319 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

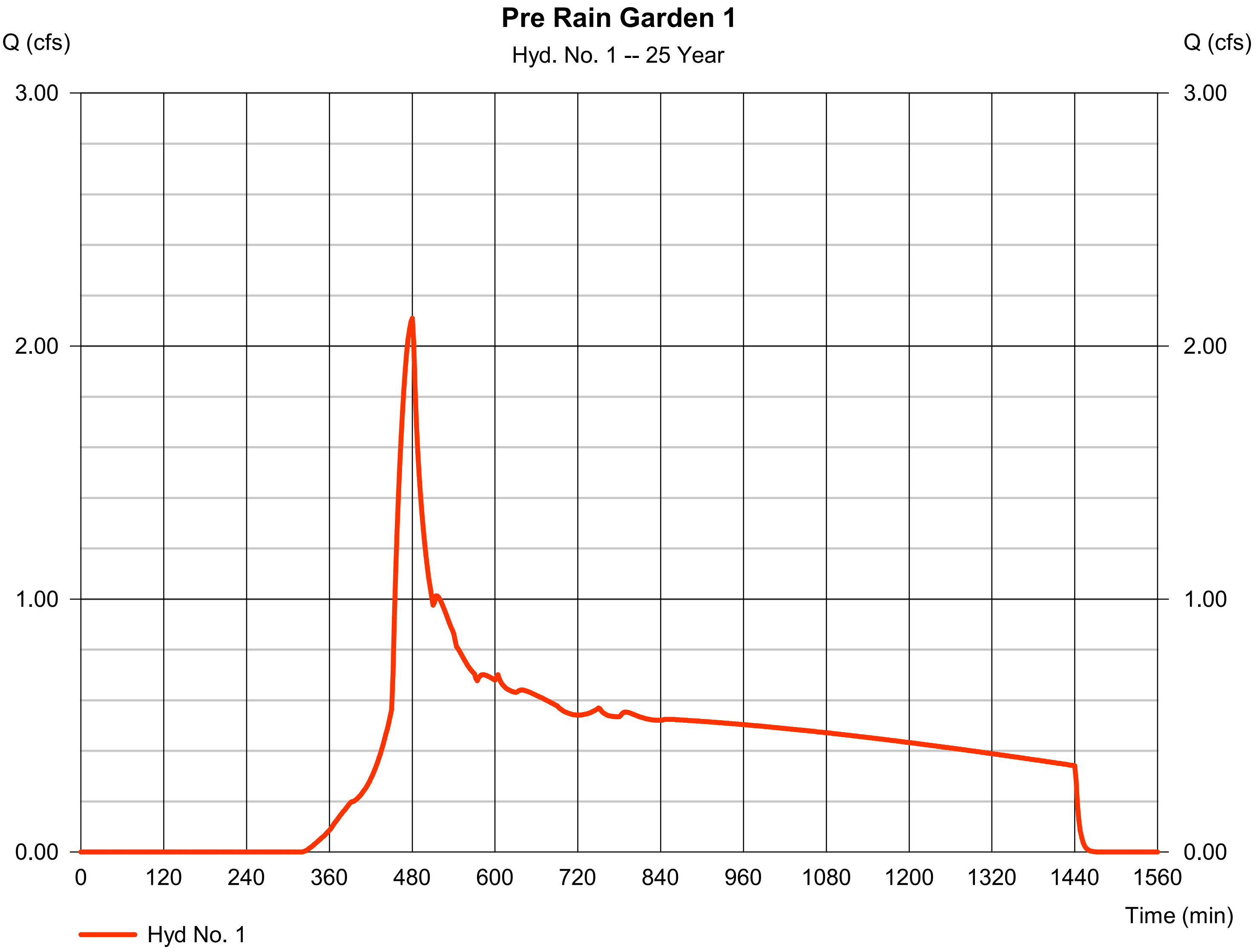
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SBUH Runoff	2.110	2	480	35,657	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	5.148	2	474	72,262	------	------	------	Post Rain Garden 1
3	SBUH Runoff	0.906	2	480	15,315	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	1.149	2	480	18,110	------	------	------	Post Rain Garden 2
5	Reservoir	1.159	2	570	55,851	2	249.50	23,427	Rain Garden 1
6	Reservoir	0.824	2	950	40,670	5	248.77	15,950	Rain Garden 2

Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 2.110 cfs
Storm frequency	= 25 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 35,657 cuft
Drainage area	= 6.170 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a



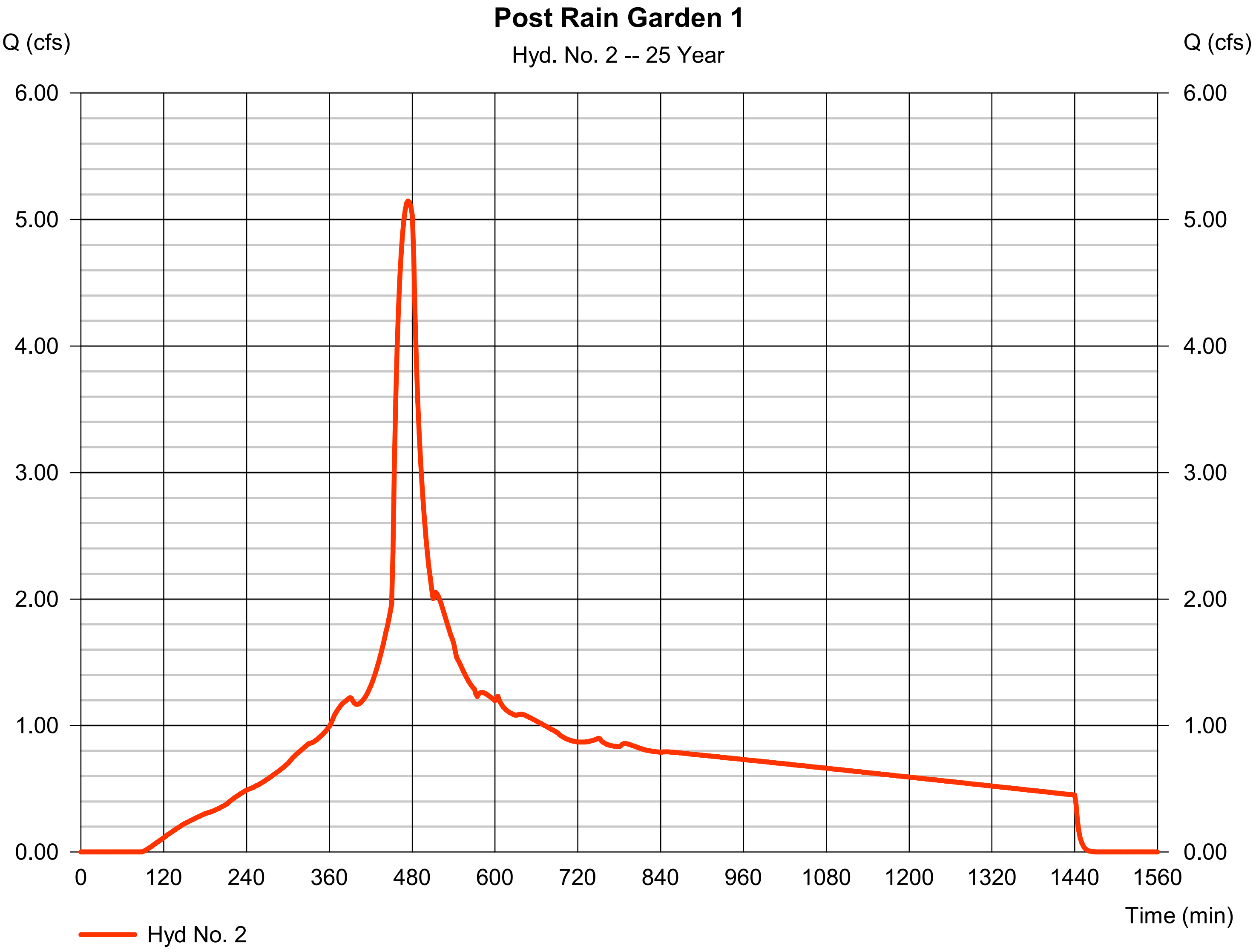
Hydrograph Report

Hyd. No. 2

Post Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 5.148 cfs
Storm frequency	= 25 yrs	Time to peak	= 474 min
Time interval	= 2 min	Hyd. volume	= 72,262 cuft
Drainage area	= 6.170 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



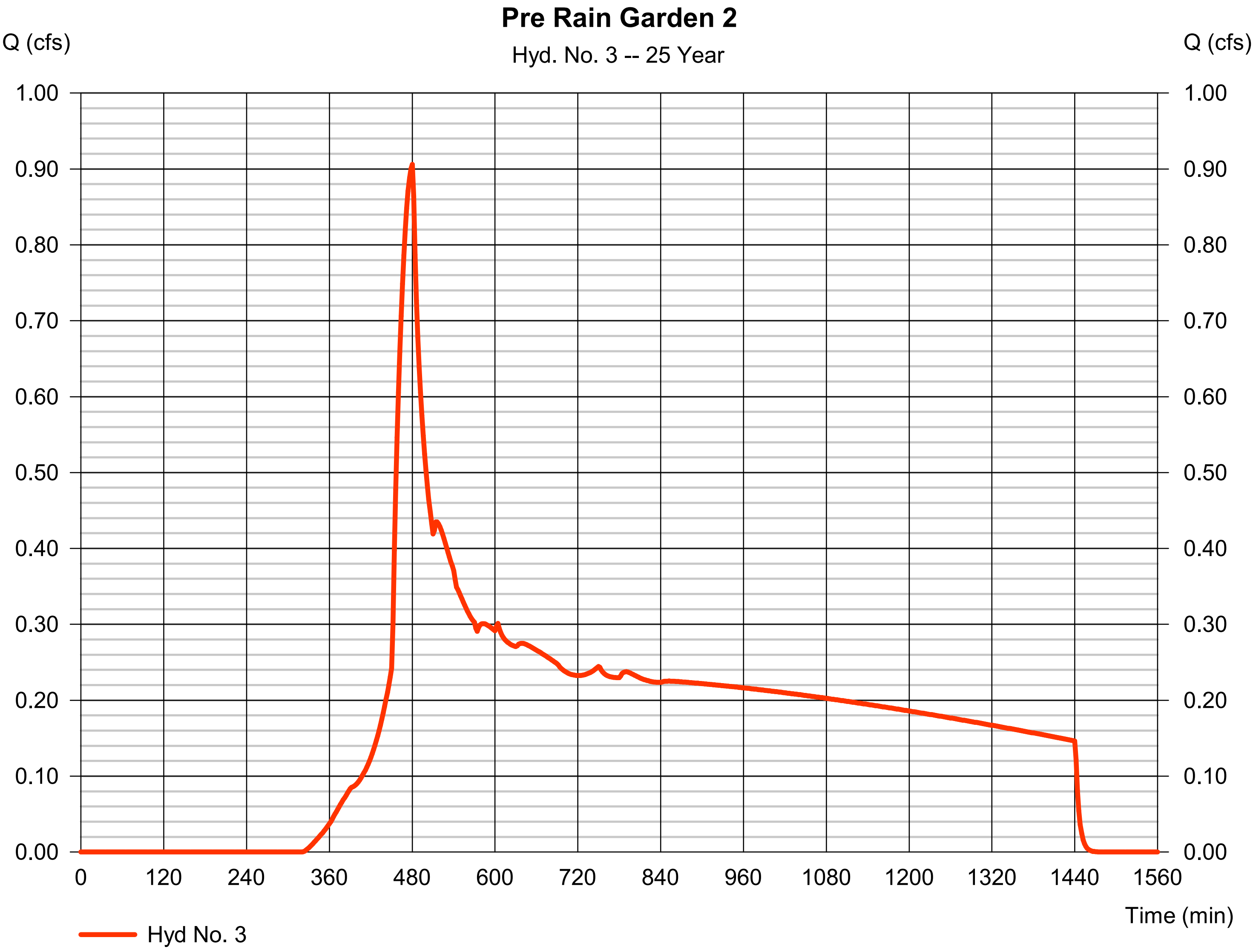
Hydrograph Report

Hyd. No. 3

Pre Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 0.906 cfs
Storm frequency	= 25 yrs	Time to peak	= 480 min
Time interval	= 2 min	Hyd. volume	= 15,315 cuft
Drainage area	= 2.650 ac	Curve number	= 75*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 3.90 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



Hydrograph Report

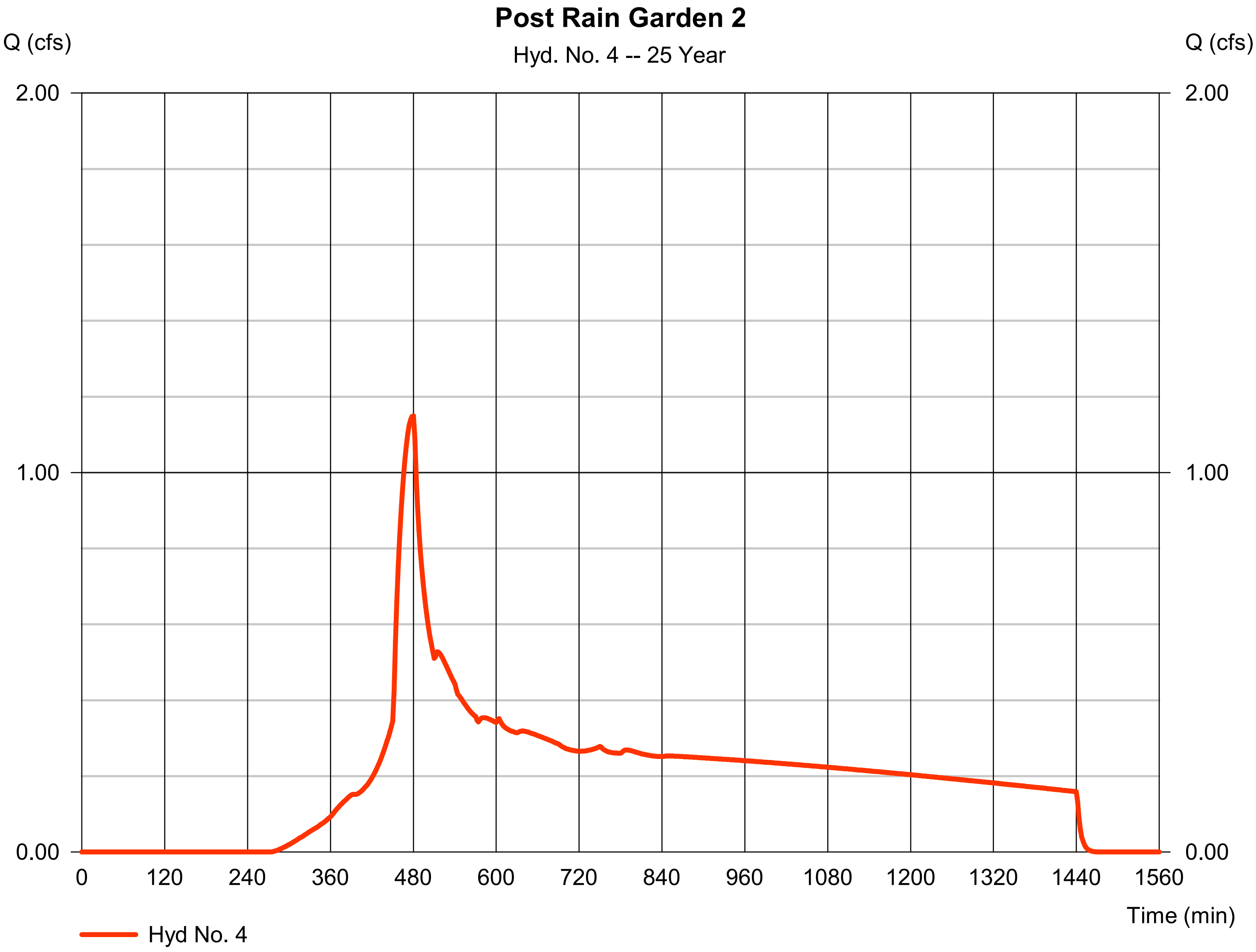
Hyd. No. 4

Post Rain Garden 2

Hydrograph type = SBUH Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 2.650 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 3.90 in
Storm duration = 24 hrs

Peak discharge = 1.149 cfs
Time to peak = 480 min
Hyd. volume = 18,110 cuft
Curve number = 79*
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type IA
Shape factor = n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



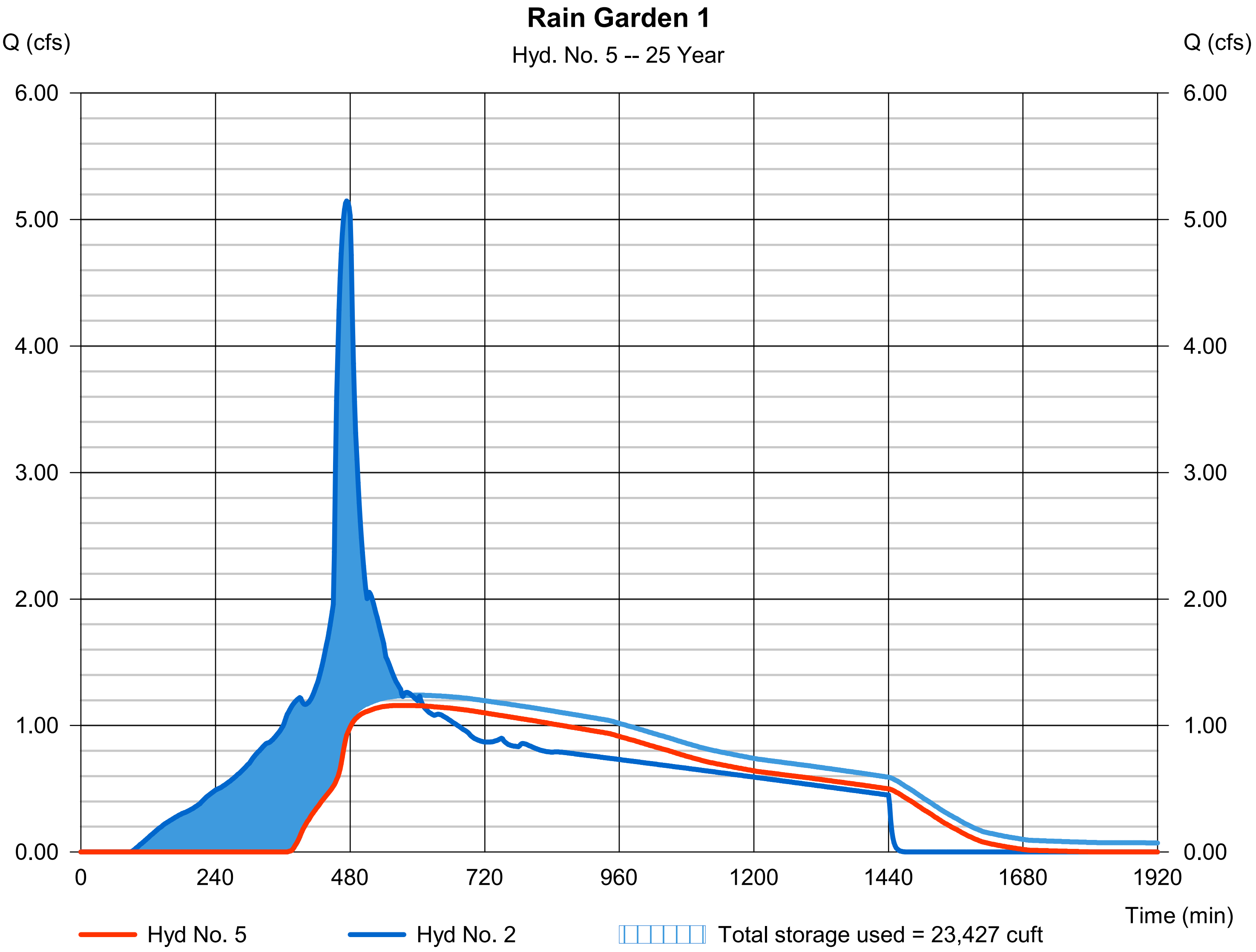
Hydrograph Report

Hyd. No. 5

Rain Garden 1

Hydrograph type	= Reservoir	Peak discharge	= 1.159 cfs
Storm frequency	= 25 yrs	Time to peak	= 570 min
Time interval	= 2 min	Hyd. volume	= 55,851 cuft
Inflow hyd. No.	= 2 - Post Rain Garden 1	Max. Elevation	= 249.50 ft
Reservoir name	= Rain Garden 1	Max. Storage	= 23,427 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



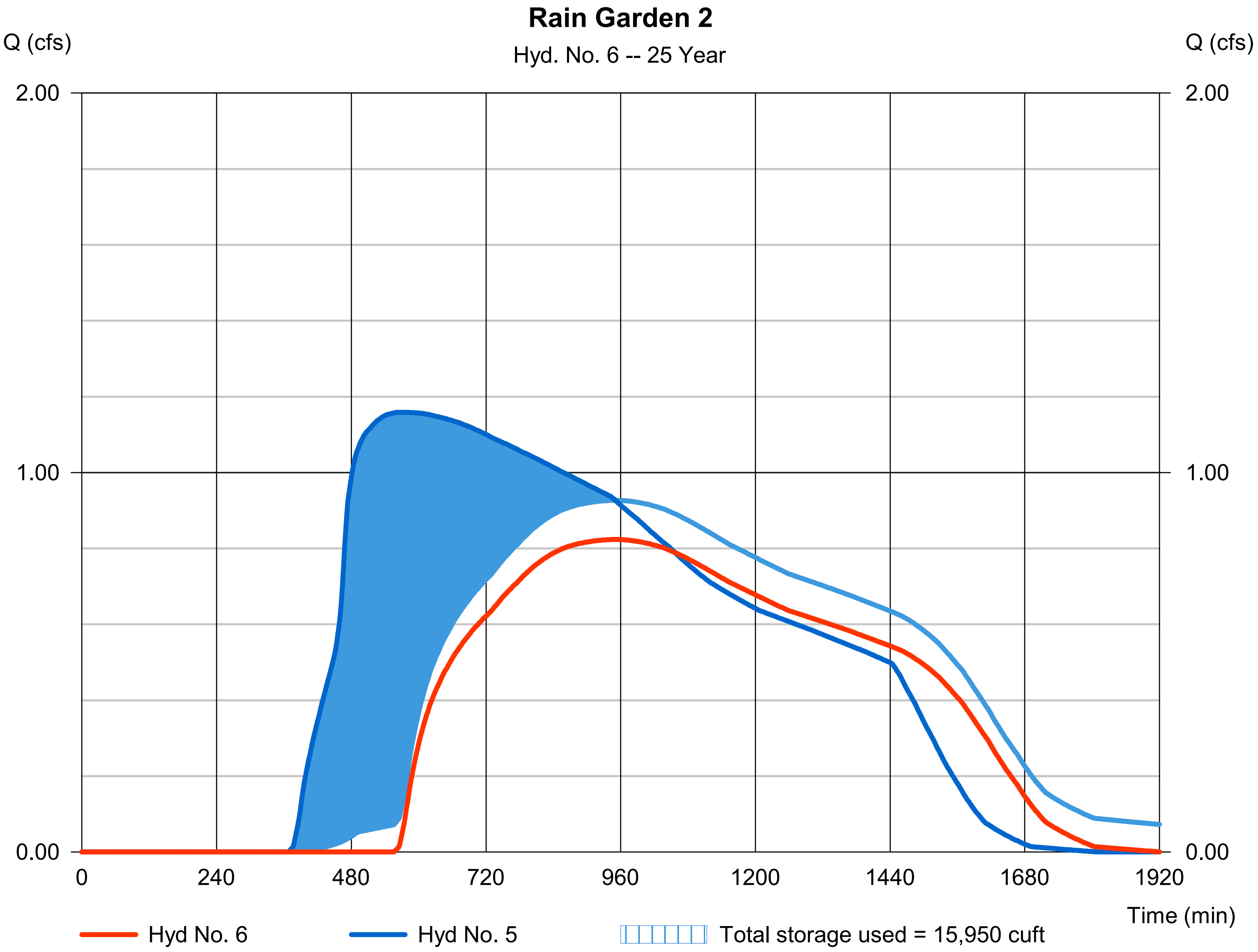
Hydrograph Report

Hyd. No. 6

Rain Garden 2

Hydrograph type	= Reservoir	Peak discharge	= 0.824 cfs
Storm frequency	= 25 yrs	Time to peak	= 950 min
Time interval	= 2 min	Hyd. volume	= 40,670 cuft
Inflow hyd. No.	= 5 - Rain Garden 1	Max. Elevation	= 248.77 ft
Reservoir name	= Rain Garden 1	Max. Storage	= 15,950 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021

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	SBUH Runoff	2.851	2	480	45,923	------	------	------	Pre Rain Garden 1
2	SBUH Runoff	6.073	2	474	85,453	------	------	------	Post Rain Garden 1
3	SBUH Runoff	1.224	2	480	19,724	------	------	------	Pre Rain Garden 2
4	SBUH Runoff	1.498	2	478	22,860	------	------	------	Post Rain Garden 2
5	Reservoir	1.301	2	592	68,094	2	249.93	27,981	Rain Garden 1
6	Reservoir	0.953	2	988	52,100	5	248.98	17,778	Rain Garden 2

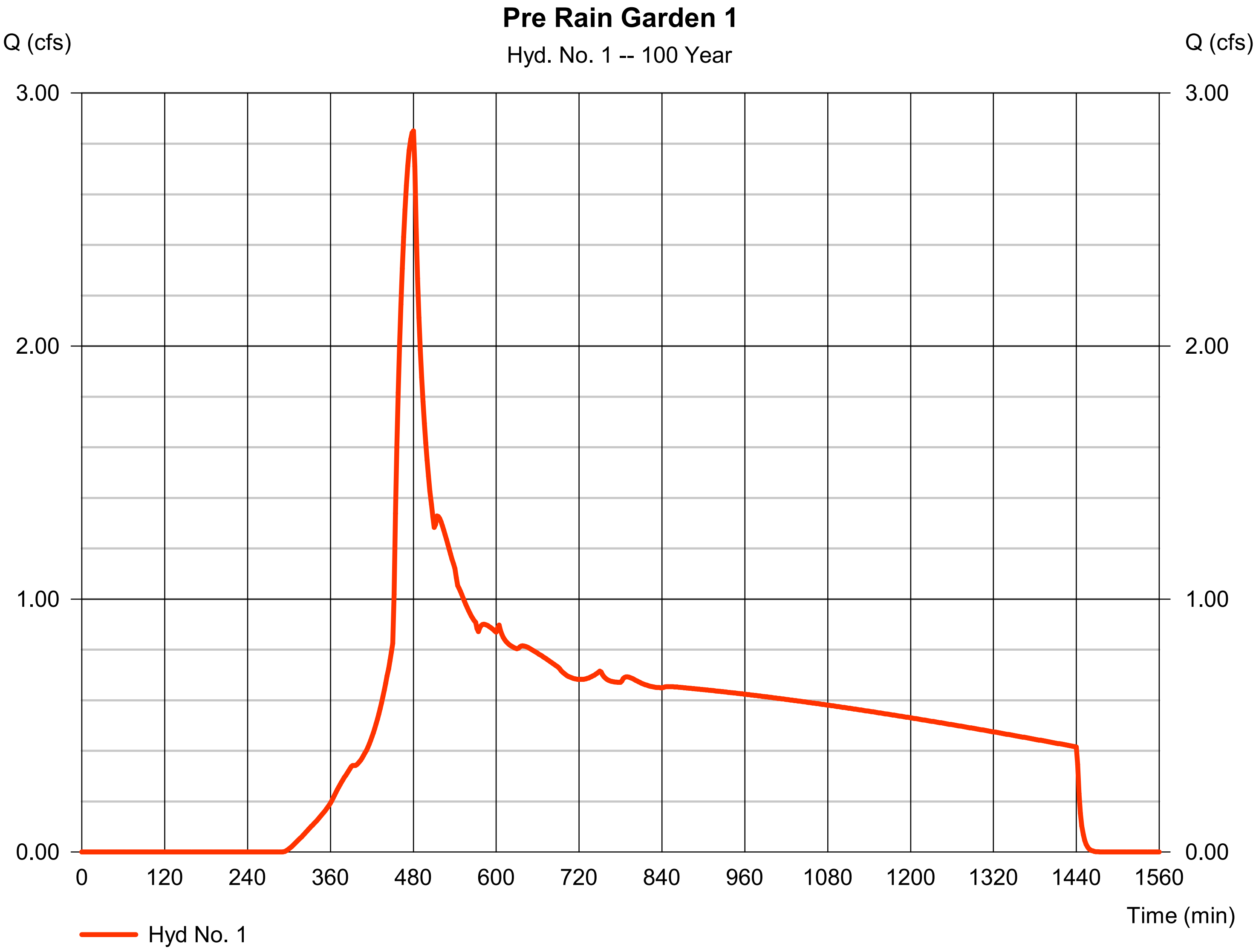
Hydrograph Report

Hyd. No. 1

Pre Rain Garden 1

Hydrograph type = SBUH Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 6.170 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 4.50 in
Storm duration = 24 hrs

Peak discharge = 2.851 cfs
Time to peak = 480 min
Hyd. volume = 45,923 cuft
Curve number = 75
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type IA
Shape factor = n/a



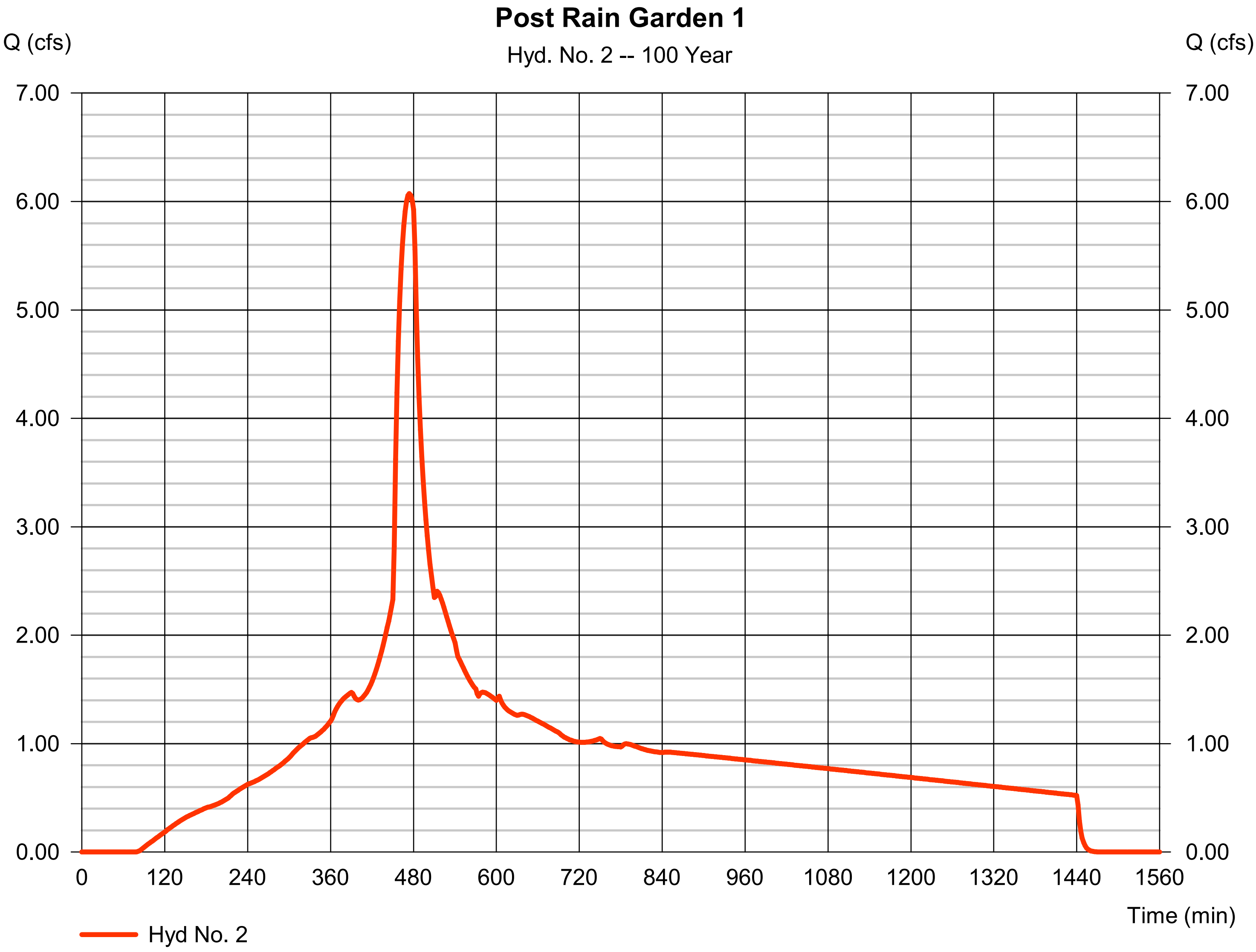
Hydrograph Report

Hyd. No. 2

Post Rain Garden 1

Hydrograph type	= SBUH Runoff	Peak discharge	= 6.073 cfs
Storm frequency	= 100 yrs	Time to peak	= 474 min
Time interval	= 2 min	Hyd. volume	= 85,453 cuft
Drainage area	= 6.170 ac	Curve number	= 94*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(3.920 x 98) + (0.910 x 72) + (1.336 x 98)] / 6.170



Hydrograph Report

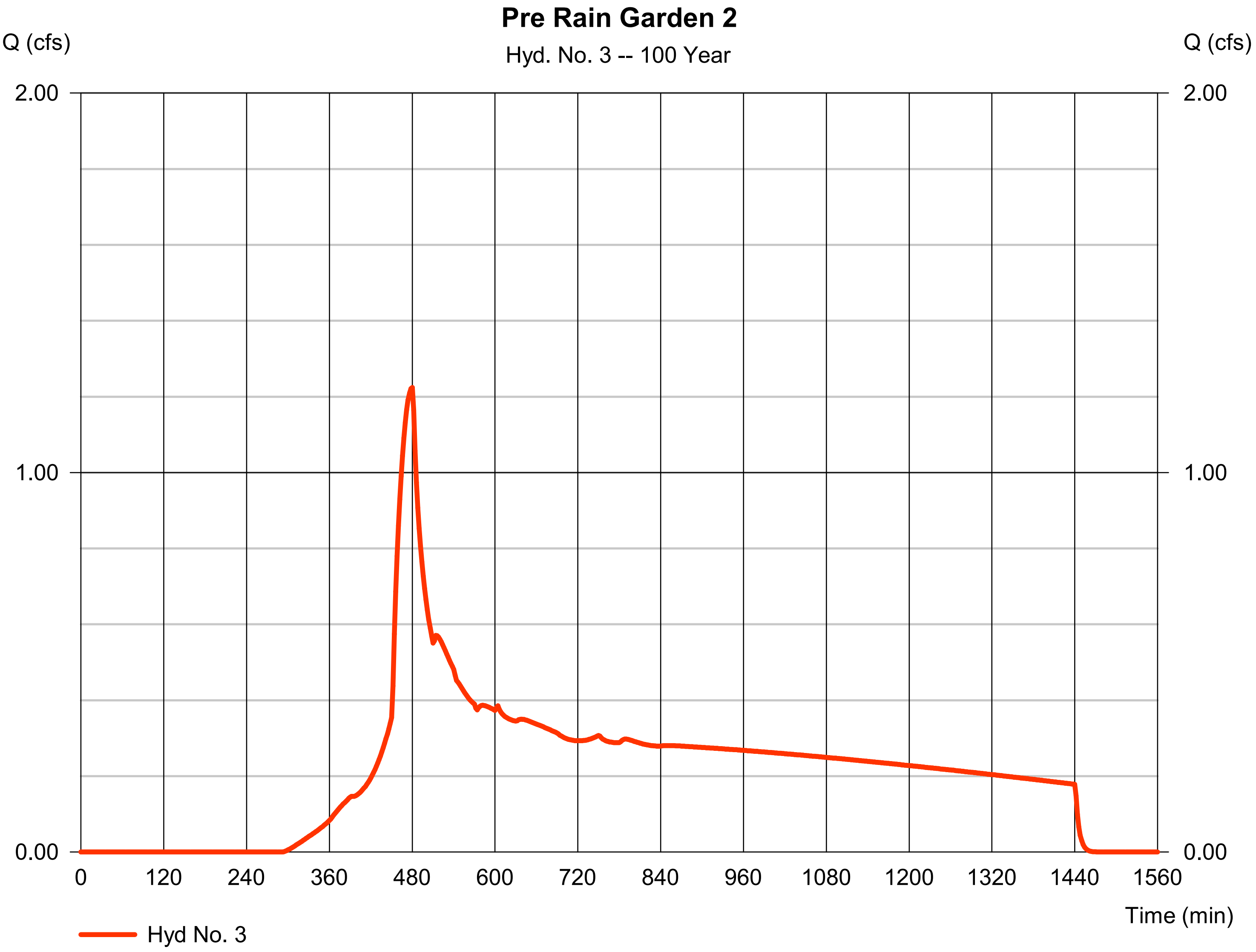
Hyd. No. 3

Pre Rain Garden 2

Hydrograph type = SBUH Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 2.650 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 4.50 in
Storm duration = 24 hrs

Peak discharge = 1.224 cfs
Time to peak = 480 min
Hyd. volume = 19,724 cuft
Curve number = 75*
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type IA
Shape factor = n/a

* Composite (Area/CN) = [(0.500 x 98) + (2.140 x 70)] / 2.650



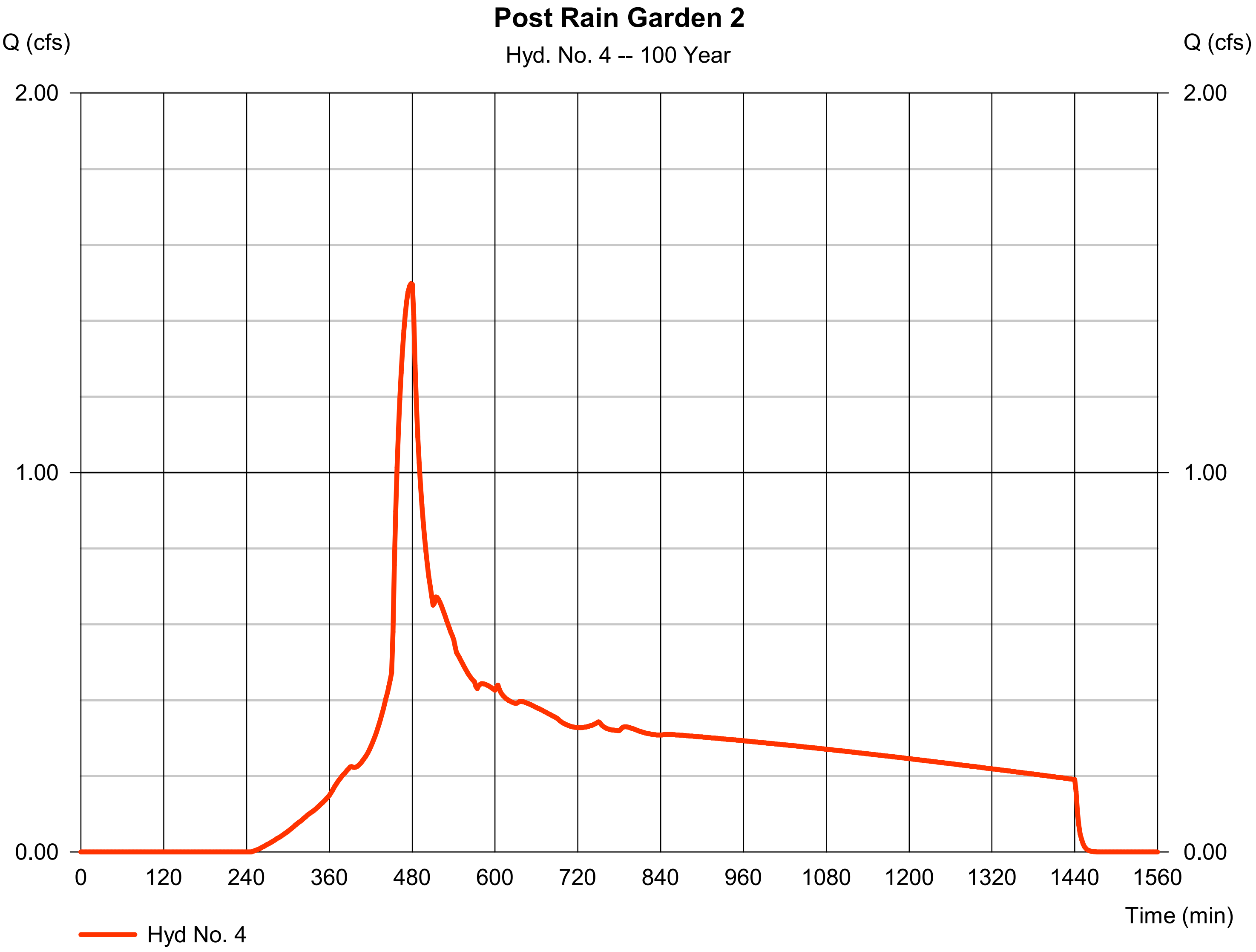
Hydrograph Report

Hyd. No. 4

Post Rain Garden 2

Hydrograph type	= SBUH Runoff	Peak discharge	= 1.498 cfs
Storm frequency	= 100 yrs	Time to peak	= 478 min
Time interval	= 2 min	Hyd. volume	= 22,860 cuft
Drainage area	= 2.650 ac	Curve number	= 79*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 4.50 in	Distribution	= Type IA
Storm duration	= 24 hrs	Shape factor	= n/a

* Composite (Area/CN) = [(0.510 x 98) + (2.140 x 75)] / 2.650



Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2021 Sunday, 11 / 13 / 2022

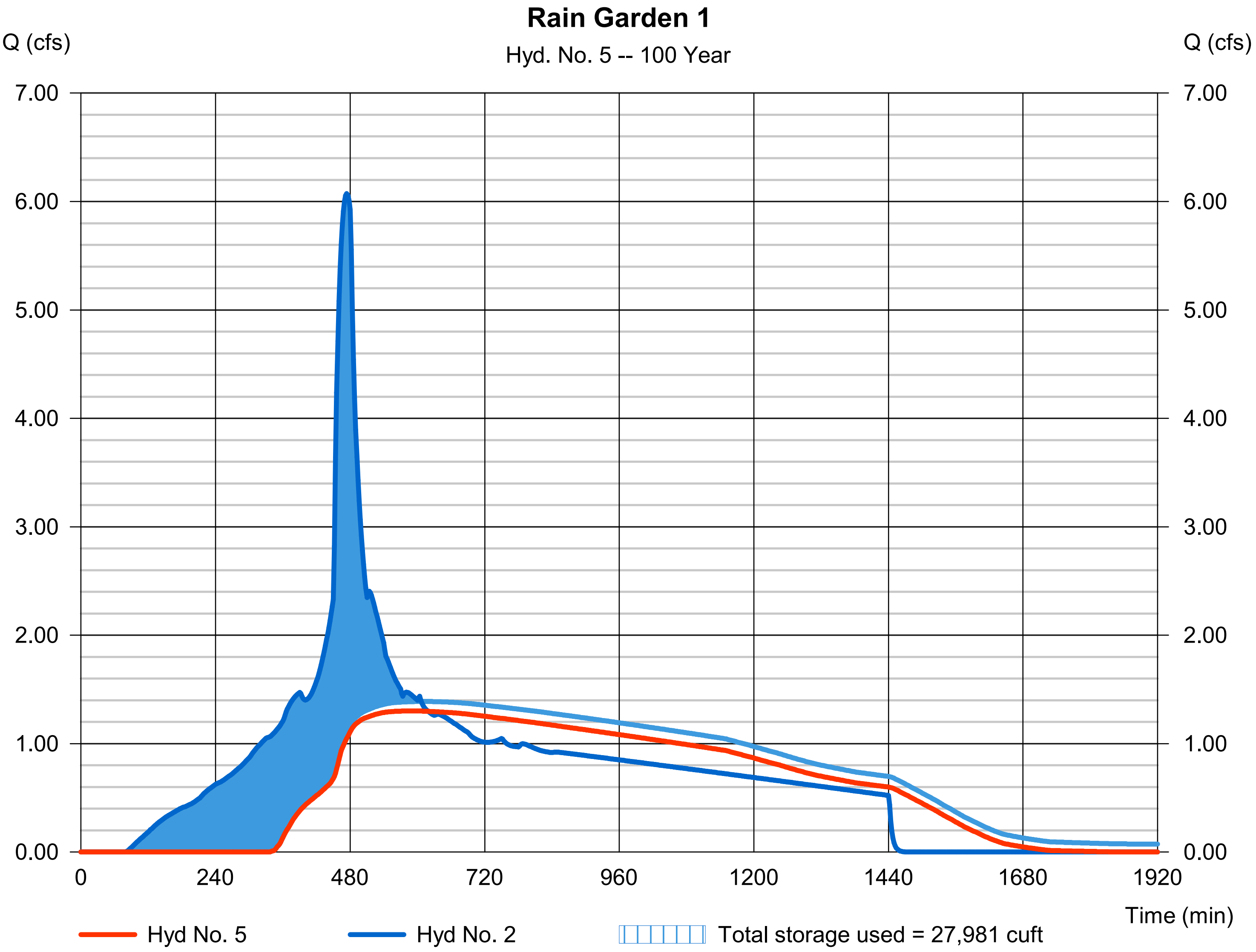
Hyd. No. 5

Rain Garden 1

Hydrograph type = Reservoir
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyd. No. = 2 - Post Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 1.301 cfs
Time to peak = 592 min
Hyd. volume = 68,094 cuft
Max. Elevation = 249.93 ft
Max. Storage = 27,981 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Report

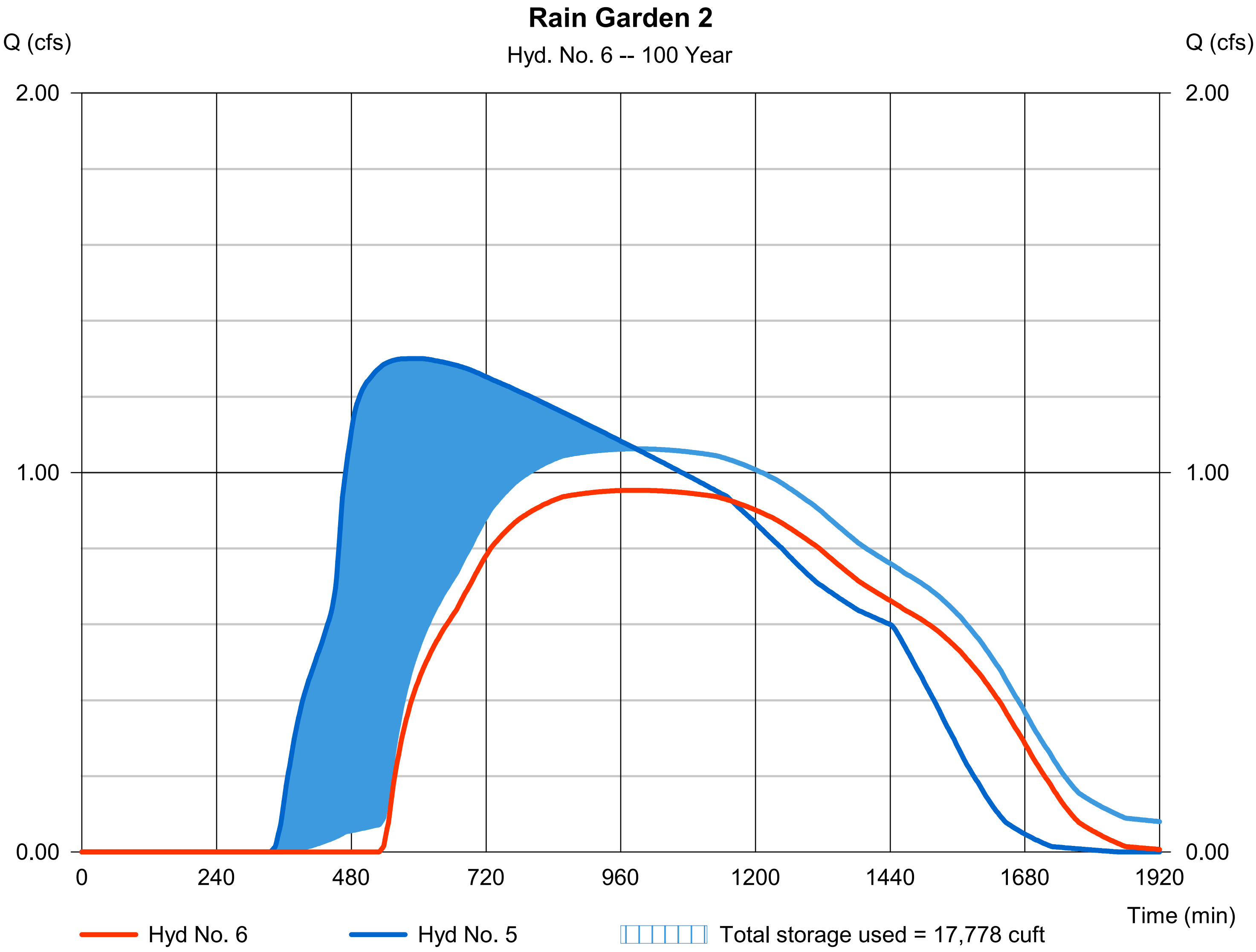
Hyd. No. 6

Rain Garden 2

Hydrograph type = Reservoir
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyd. No. = 5 - Rain Garden 1
Reservoir name = Rain Garden 1

Peak discharge = 0.953 cfs
Time to peak = 988 min
Hyd. volume = 52,100 cuft
Max. Elevation = 248.98 ft
Max. Storage = 17,778 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



APPENDIX E

CONVEYANCE CALCULATIONS

Project name: **Delta Logisitics** **Project number:** **2200502.00**

25 year/24-hour storm event

By: AOC Checked: BMR

Date: 11/23/2021 Date: 4/8/2022

n = 0.013

RD = Roof Drain
CI = Curb Inlet
AD= Area Drain

MH = Manhole
WQ = Water Quality
O/W = Oil Water Separator

Pipe Link	Drainage Basin	Time of Concentration (min)	Total Time(min)	25-yr Storm Intensity(in/hr)	Incr. Area(Ac)	Coef. Of Runoff	Incr. Equiv.(CxA)	Total Equiv. Area	**Runoff (cfs)**	Slope(%)	Diameter (in)	Pipe Area (sf)	Hydraulic Radius^2/3	**Capacity (cfs)**	Velocity at Design Flow (fps)	Runoff/Capacity (ratio)	Length(ft)	Incr. Time(min)
	CB1	5.00	5.00	3.40	0.270	0.9	0.24	0.24	**0.82**	1.17	8	0.349	0.303	**1.30**	3.91	0.63	261	1.11
	RD1	5.00	5.00	3.40	0.256	0.9	0.23	0.23	**0.78**	1.00	8	0.349	0.303	**1.20**	3.63	0.65	128	0.59
	RD2	5.00	5.00	3.40	0.206	0.9	0.19	0.19	**0.63**	1.50	8	0.349	0.303	**1.47**	4.02	0.43	146	0.61
1	RD1+RD2		5.61	3.40				0.42	**1.42**	0.50	10	0.545	0.351	**1.54**	3.17	0.92	79	0.42
2	CB1 + 1		6.72	3.40				0.66	**2.24**	2.50	10	0.545	0.351	**3.45**	6.66	0.65	170	0.43
	CB2	5.00	5.00	3.40	0.183	0.9	0.16	0.16	**0.56**	1.00	6	0.196	0.250	**0.56**	2.85	1.00	187	1.10
	CB3	5.00	5.00	3.40	0.135	0.9	0.12	0.12	**0.41**	0.60	6	0.196	0.250	**0.43**	2.48	0.96	44	0.30
3	CB2+CB3		6.10	3.40				0.29	**0.98**	0.50	10	0.545	0.351	**1.54**	2.96	0.63	61	0.34
	RD6	5.00	5.00	3.40	0.247	0.9	0.22	0.22	**0.76**	1.00	8	0.349	0.303	**1.20**	3.60	0.63	129	0.60
4	RD6 + 3		6.69	3.40				0.51	**1.73**	1.31	10	0.545	0.351	**2.50**	4.89	0.69	72	0.25
	RD3	5.00	5.00	3.40	0.209	0.9	0.19	0.19	**0.64**	0.50	8	0.349	0.303	**0.85**	2.65	0.75	56	0.35
	RD4	5.00	5.00	3.40	0.209	0.9	0.19	0.19	**0.64**	2.81	8	0.349	0.303	**2.02**	5.08	0.32	10	0.03
5	RD3+RD4		5.35	3.40				0.38	**1.28**	0.50	10	0.545	0.351	**1.54**	3.13	0.83	52	0.28
	RD5	5.00	5.00	3.40	0.207	0.9	0.19	0.19	**0.63**	5.41	8	0.349	0.303	**2.80**	6.42	0.23	10	0.03
6	RD5 + 5		5.63	3.40				0.56	**1.91**	1.57	10	0.545	0.351	**2.73**	5.36	0.70	170	0.53
7	4 + 6		7.22	3.40				1.07	**3.64**	1.66	12	0.785	0.397	**4.57**	6.39	0.80	221	0.58
	CB4	5.00	5.00	3.40	0.109	0.9	0.10	0.10	**0.33**	0.76	6	0.196	0.250	**0.49**	2.64	0.68	58	0.37

Project Number: 2200502
Project Name: Delta Logistics
Engineer: Breezy Rinehart
Date: 4/8/2022

Project City: Wilsonville, OR
Latitude:
Longitude:

NOAA Precipitation Atlas Data

Storm Frequency	2 yr	2 yr	100 yr	100 yr
Storm Duration	6 hr	24 hr	6 hr	24 hr
Precipitation (in)				

Precipitation Intensity-Duration-Frequency (IDF) Data (in/hr)

Time (min)	Return Period (yr)					
	2	5	10	25	50	100
5	1.90	2.50	3.00	3.40	4.00	4.50
10	1.90	2.50	3.00	3.40	4.00	4.50
15	1.30	1.70	2.20	2.50	3.00	3.50
20	1.10	1.40	1.80	2.10	2.50	2.90
25	0.90	1.20	1.50	1.80	2.10	2.40
30	0.75	0.95	1.20	1.40	1.65	1.90
35	0.60	0.75	1.00	1.15	1.30	1.60
40	0.55	0.70	0.85	1.00	1.15	1.35
45	0.45	0.55	0.70	0.82	0.95	1.10
50	0.40	0.45	0.55	0.67	0.75	0.90
60	0.35	0.40	0.50	0.60	0.70	0.85

Note: IDF values for the site are based on City of Wilsonvilles precipitation records presented in the City of Wilsonville's Stormwater & Surface Water Design & Construction Standards Section 3 - Public Works Standards Manual (2015).

APPENDIX F

NATURAL RESOURCE ASSESSMENT REPORT

SCHOTT & ASSOCIATES
Ecologists & Wetlands Specialists
21018 NE Hwy 99E • P.O. Box 589 • Aurora, OR 97002 • (503) 678-6007 • FAX: (503) 678-6011

NATURAL RESOURCE ASSESSMENT REPORT FOR

9710 SW Day Road

T3S, R1W, Section 2B, Tax Lot 600 & 601
Wilsonville, Washington County, Oregon

Prepared for

Vladmir Tkach & Igor Nichiporchik
Delta Logistics
9835 SW Commerce Circle
Wilsonville, Oregon 97070

Prepared by

Kim Biafora
of
Schott & Associates, Inc.

Date:

January 2022

Project #: 2739

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Introduction

Schott & Associates (S&A) was contracted to conduct a natural resource assessment for the proposed project site located at 9710 SW Day Road, Wilsonville, Washington County, OR (T3S, R1W, Section 2B, Tax Lot 600 & 601; Figure 1). The site features natural resources including streams, wetlands, and associated riparian corridors and Impact Areas that are subject to City of Wilsonville's Significant Resource Overlay Zone (SROZ) Ordinance (Section 4.139.00 of the Wilsonville Planning and Land Development Code). This report is intended to fulfil the requirements of SROZ Map Verification pursuant to Section 4.139.06(.01)(B-H) and a standard Significant Resource Impact Report (SRIR) pursuant to Section 4.139.06(0.02)(D)(1). Wetland delineation has been approved by the Oregon Department of State Lands (DSL; WD#2021-0556; Appendix H).

Statement of Qualifications

Schott & Associates has over 30 years of experience in environmental consultation and project permitting. S&A staff is composed of well qualified and experienced individuals. All have been through wetland delineation training and are proficient in performing wetland delineations and habitat assessments. Kim Biafora was assigned to manage this project and performed project coordination, fieldwork, and report and map production.

Kim Biafora is a wetland scientist and GIS analyst who joined Schott & Associates in April 2018. She received her Bachelor's degree from Portland State University in Environmental Science and Management. Kim contributes 10 years of experience in wetland delineation and reporting, permitting, habitat assessment and mapping, data collection and analysis, and GIS applications to the company. Kim has worked largely in the lower Columbia River region and has a foundation in Pacific Northwest ecology with expertise in lowland and montane rainforest, and tidal estuarine and freshwater wetland habitats. She is versed in general ecological survey and data analysis methods, as well as protocols specific to wetland delineation and functions assessment, habitat mapping and assessment and mitigation site monitoring. She is familiar with wetland/habitat ordinance and permitting requirements for many local jurisdictions throughout Oregon and Washington, as well as state and federal wetland regulation.

Site Description

The project site consisted of the entirety of tax lots 600 and 601. This site featured a single-family residence in the northeastern section and a graveled area and access road in the southern and central portion. An unimproved access road and associated 125-foot electric transmission line and storm drainage easement cut south across the western portion of the site from SW Day Road to a transmission tower located in the southwestern site corner. A 100-foot BPA right-of-way (ROW) is located in the southwest corner adjacent to the 125-foot utility easement (refer to Appendix B for topographic survey). The remainder of the site was undeveloped and generally vegetated by Douglas-fir (*Psuedotsuga menziesii*) forest in the eastern and western portions and English hawthorn (*Crataegus monogyna*)/Himalayan blackberry (*Rubus armeniacus*) shrubland in the central portion (refer to Appendix C for tree survey).

Site topography included a west-facing hillslope in the eastern portion which flattened out in the central portion and remained fairly level in the western portion. Tapman Creek, a tributary to Seely Ditch and the Willamette River, flowed from double 36-inch diameter culverts under SW Day Road, south through the western portion of the site and into a culvert at the southwestern site corner. A compensatory wetland mitigation (CWM) site was located just west of and parallel to the creek. The CWM site was constructed to mitigate for the widening of SW Day Road and replacement of a single culvert with the existing 88-foot-long double culverts at Tapman Creek (DSL #25201-FP; Corps #2002-00173). Both of these features are within the 125-foot utility easement.

The site was surrounded by commercial development to the north and south and rural residential development to the east and west. At the time of assessment, the site was zoned for 20-acre future development (Washington County zoning designation FD-20). According to the Wilsonville SROZ map, significant natural resources are mapped on the site (Appendix D).

Methods

Prior to visiting the site, the following existing data and information was reviewed:

- Washington County InterMap (http://washims.co.washington.or.us/InterMap/)
- U.S. Fish and Wildlife Service (UFWS) National Wetland Inventory (NWI) and Oregon Department of Forestry (ODF) mapping
- Metro Title 3 lands mapping
- U.S. Department of Agriculture (USDA) NRCS gridded Soil Survey Geographic (gSSURGO) database for Washington County
- Google Earth aerial photographs from the time period between 1994 and 2019
- Oregon Department of Geology and Mineral Industries (DOGAMI) LiDAR data

Schott & Associates initially visited the site October 23, 2019. Follow-up fieldwork was performed on September 1, 2021 to document any changes since 2019 fieldwork. Data on vegetation, hydrology, and soils were collected according to methods described in the *Corps Wetland Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Delineation Manual: Western Mountains, Valleys, and Coast (Version 2)* (Environmental Laboratory 2010). Nineteen sample plots were established throughout the site to locate the boundaries of wetlands. Plant indicator status was determined using the 2018 National Wetland Plant List (Corps 2018). Onsite streams were delineated via the ordinary high-water mark (OHWM) as indicated by top of bank, wrack or scour lines, change in vegetation communities, or gage elevation where applicable.

All identified wetlands and waters are classified according to the USFWS *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) and the *Guidebook for Hydrogeomorphic (HGM)-based Assessment of Oregon Wetland and*

Riparian Sites (DSL 2001). A wetland delineation report was prepared and submitted to DSL. The report received DSL concurrence in December 2021 (Appendix H).

Wetland functional analysis was conducted according to the Oregon Freshwater Wetlands Assessment Methodology (OFWAM) per section 4.139.06(.02)(D)(3)(c).

Application and width of Vegetated Corridors were determined based on water type, flow period, drainage basin, and adjacent slopes according to Table NR-1 of Section 4.139.00. Water type and flow period were determined based on a combination of field observations, available data and information, and guidance from state and federal agencies. Drainage basins were delineated using topography data available from the Oregon Department of Geology and Mineral Industries (DOGAMI) LiDAR data. Adjacent slopes were measured at a minimum of three slope cross-sections established perpendicular to the water feature spaced at no more than 100-foot increments using a combination of field measurements and topographical survey data. Vegetated corridor width in areas where the slopes are equal to or greater than 25% gradient are extended to 50 feet beyond the break in slope, up to 200 feet from the edge of the water resource for primary protected water features and 50 feet for secondary protected water features.

The composition, structure, and condition of Vegetated Corridors were assessed at representative sample points established in each community type. Wildlife habitat assessment of Vegetated Corridors was conducted according to Metro's 2001 Wildlife Habitat Assessment Methodology.

Ground-level photographs were collected to document site conditions (Appendix E).

Results

Physical Analysis

Five soil series were mapped within the study site boundary according to the USDA NRCS soil survey for Washington County. Saum silt loam at slopes from 2-20% was mapped in the eastern, southern, and much of the northern site margins. The Saum series consists of very deep, well drained soils that formed in colluvium and residuum from the Columbia River Basalt Group and occurs on summits and side slopes in areas affected by mass movement. This series is nonhydric and not subject to flooding or ponding. Quatama loam at slopes of 0-30% was mapped over a small area along the northern site margin. The Quatama series consists of very deep, moderately well-drained soils that formed from stratified glaciolacustrine deposits from the Missoula Floods and occurs on terrace steps and risers. This series is predominantly nonhydric (4% hydric inclusions) and not subject to flooding or ponding. Salem gravelly silt loam at slopes of 0-12% was mapped in the western site margin. The Salem series is a very deep, well-drained soil that formed from loamy alluvium over sandy and gravelly alluvium and occurs on stream terraces. This series is nonhydric and not subject to flooding or ponding. Briedwell stony silt loam at slopes of 0-20% was mapped in the central portion of the site. The Briedwell series consists of very deep, well drained soils that formed in mixed alluvium and occurs on stream terraces. This series is nonhydric and not subject to flooding or ponding.

Wapato silty clay loam at slopes of 0-3% was mapped through the western portion of the site in the area corresponding with the location of Tapman Creek and the CWM site. The Wapato series consists of very deep, poorly drained soils that formed in loamy mixed alluvium and occur on floodplains and basins. This series is predominantly hydric (92% hydric inclusions) and subject to frequent flooding and ponding.

Wetlands and Waters

Two wetlands and one wetland drainage (Tapman Creek) were identified within the study site; Wetlands 1 and 2 totaled 0.33 acre and Tapman Creek totaled 0.10 acre on site. Wetland, sample plots, and photo point locations are shown on Figure 2.

Tapman Creek: Tapman Creek was a wetland drainage which originated on the site from a pair of culverts installed under SW Day Road and drained south through the western portion of the study site between Wetlands 1 and 2 (described below). At the southern boundary, the creek turned sharply west and drained into a collapsed metal culvert. The creek featured a defined bed and bank and was identified as a creek by ODF; however, this study classified it as a wetland drainage based on the presence of hydric soils and vegetation throughout its length onsite. The boundary was mapped based on top of bank, scour, and paired plots and covered 0.10 acre onsite. At the approximate center, Tapman Creek connected with Wetland 1 (CWM site). The channel was 5-10 feet wide and approximately 3-4 feet deep with steep, incised banks featuring some erosion and undercutting. The channel has likely been artificially deepened and rerouted along its southern reach at some point. It was almost entirely vegetated along its length with reed canarygrass (*Phalaris arundinacea*; FACW), water parsley (*Oenanthe sarmentosa*; OBL), creeping buttercup (*Ranunculus repens*; FAC), and Himalayan blackberry (FAC). Riparian vegetation included Oregon ash (*Fraxinus latifolia*; FACW), English hawthorn (FAC), Himalayan blackberry, serviceberry (*Amelanchier alnifolia*; FACU), snowberry (*Symphoricarpos albus*; FACU), English ivy (*Hedera helix*; FACU), and trailing blackberry (*Rubus ursinus*; FACU), According to ODF stream mapping, Tapman Creek is a small, seasonal, fish-bearing tributary to Seely Ditch located approximately two miles south of the site. It drains a basin of approximately 400 acres. The drainage was assessed as a riverine flow-through HGM class with a Cowardin class of seasonally flooded, palustrine emergent (PEMC). It meets the definition of a Primary Protected Water Feature according to Table NR-1 of Section 4.139.00.

The soil sample met the Corps hydric soil indicator for redox dark surface. Soils were black in matrix color with common to many yellow-red redoximorphic concentrations occurring as soft masses and pore linings. Soil texture was silty clay loam. Corps wetland hydrological indicators observed included sparsely vegetated concave surface, water-stained leaves, sediment deposits, FAC-neutral test, and geomorphic position. No surface water was present during October 2019 or September 2021 fieldwork and a seasonal flow period was assumed.

Wetland 1: Wetland 1 consisted of the CWM site constructed in 2002 and covered 0.26 acre. The wetland was sustained by seasonal flows conducted south under SW Day Road through a culvert as well as high flows from Tapman Creek. The CWM site was excavated from hydric soils to increase stormwater capacity and alleviate downstream flooding of Tapman Creek. According to the CWM plan, the northern portion of the CWM site (0.1 acre) was designed as a water quality facility and the remaining 0.25 acre was to serve as mitigation. The CWM site was planted with Pacific willow (*Salix lasiandra*; FACW), spiraea (*Spiraea douglasii*; FACW), black hawthorn (*Crataegus douglasii*; FAC), Nootka rose (*Rosa nutkana*; FAC), slough sedge (*Carex obnupta*; OBL), spreading rush (*Juncus patens*; FACW), and red fescue (*Festuca rubra*; FAC). The wetland featured steep, well-defined banks that were graded at a 3:1 slope. It connected with Tapman Creek in the approximate center of the wetland, though this connection does not appear part of the original design. Additionally, a pipe outlet was present in the southwestern portion of the wetland, that isn't shown on site design plan. It is unknown whether this pipe serves as an overflow pipe or discharges into the wetland.

The wetland was assessed as a depressional outflow HGM class and an excavated, seasonally flooded palustrine scrub-shrub (PSSCx) Cowardin class. Vegetation included a patchy canopy of Oregon ash with a dense understory of Pacific willow, Scouler's willow (*Salix scouleriana;* FAC), Sitka willow (*S. sitchensis*; FACW), spiraea, Nootka rose, Himalayan blackberry, reed canarygrass, and soft rush (*Juncus effusus*; FACW). The northern portion of the wetland featured more shrub and tree cover while the southern portion featured more herbaceous cover. This wetland does not meet the definition of a primary or secondary protected water resource according to Table NR-1.

The soil samples met the Corps hydric soil indicator for redox dark surface. Soils were black (10 YR 2/1) to very dark gray (10 YR 3/1) in matrix color with common to many yellow-red redoximorphic concentrations occurring as soft masses. Soil texture was silty clay loam. Corps wetland hydrological indicators including high water table and soil saturation were observed during October 2019 fieldwork.

Wetland 2: Wetland 2 occupied a broad, very shallow depression to the east of Tapman Creek and covered 0.07 acre. It appeared to have no inlet or outlet and was likely hydrologically sustained by high groundwater and impounded precipitation and possibly received overbank flooding from Tapman Creek during very high flow events. The wetland was assessed as a flats HGM class and a seasonally flooded palustrine forested (PFOC) Cowardin class. Vegetation consisted of an Oregon ash stand with a sparse understory of Nootka rose, English hawthorn, Himalayan blackberry, and spiraea. This wetland does not meet the definition of a primary or secondary protected water resource according to Table NR-1.

The soil samples met the Corps hydric soil indicator for redox dark surface. Soils were black in matrix color with common to many yellow-red redoximorphic concentrations occurring as soft masses and pore linings. Soil texture was silty clay loam. Corps wetland hydrological indicators observed included oxidized rhizospheres along living roots, geomorphic position, and FAC-neutral test.

Vegetated Corridors

According to Table NR-1, the Vegetated Corridor applied to primary protected water features (Tapman Creek, an intermittent stream draining more than 100 acres) has a base width of 50 feet. The base width can extend up to 200 feet in cases where the adjacent slope gradient is greater than or equal to 25%. Slope gradients adjacent to Tapman Creek varied from 2-4%. Thus, the Vegetated Corridor applied to the creek was 50 feet wide and totaled 0.99 acre (43,189 sq. ft) onsite. The Vegetated Corridor boundary is coincident with the Goal 5 safe harbor boundary according to the standards within the Oregon Administrative Rule OAR 660-023-990(5). This rule accords all streams with average annual stream flow less than 1,000 cubic feet per second a 50-foot riparian corridor. The Vegetated Corridor and safe harbor boundary are shown in Figure 2.

Vegetation in the onsite Vegetated Corridor was dominated by nonnative vegetation including English hawthorn, Himalayan blackberry, orchardgrass (*Dactylis glomerata*), creeping bentgrass (*Agrostis stolonifera*), tall fescue (*Schedonorus arundinaceus*), hairy cat's ear (*Hypochaeris radicata*), wild carrot (*Daucus carota*), oxeye daisy (*Leucanthemum vulgare*), and dovefoot geranium (*Geranium molle*). A few Oregon ash trees were present within the Vegetated Corridor, as well as in Wetlands 1 and 2 as described above.

Impact Areas

Impact Areas consist of the 25 ft. wide band adjacent to the outer 50 ft. Vegetated Corridor boundary. The Impact Area featured a utility maintenance access road west of the Vegetated Corridor and mixed shrubs east of the Vegetated Corridor. Vegetation included English hawthorn, Himalayan blackberry, and Nootka rose with nonnative turfgrasses and weedy forbs. Impact Areas onsite totaled 0.51 acre (22,332 sq. ft.)

Ecological Analysis

Wetlands

Wetlands were assessed based on evaluation criteria in the Oregon Freshwater Wetlands Assessment Methodology (OFWAM). OFWAM evaluates wildlife habitat, fish habitat, water quality, and hydrologic control functions. A summary of functional analysis is presented in Table 1 below. OFWAM assessment forms are included as Appendix F.

Table 1. Wetland Functional Analysis Summary

Function	Tapman Creek	Wetland 1	Wetland 2
Wildlife Habitat	Habitat for some species	Habitat for some species	Habitat for some species
Fish Habitat	Impacted/degraded	Impacted/degraded	N/A
Water Quality	Intact	Intact	None
Hydrologic Control	Impacted/degraded	Impacted/degraded	Impacted/degraded

Tapman creek provides some wildlife habitat based on its surface water connection to other wetlands, presence of vegetative buffer greater than 25 feet, and unimpacted water quality in upstream reaches; however, it lacks diversity of habitat and vegetation structure and is surrounded by developed land uses. Fish habitat function was assessed as impacted/degraded based on the modified character of the channel, low cover of stream shading by riparian vegetation, developed surroundings, and lack of fish access. Water quality function was assessed as intact based on a surface water hydrological source, flooding or ponding during a portion of the growing season, high cover of wetland vegetation, and surrounding developed uses. Hydrological control function was assessed as impacted/degraded as the stream is not within a 100-year floodplain or closed basin, is dominated by emergent vegetation, and has an upstream forested/natural area land use.

Wetland 1 provides some wildlife habitat based on the presence of multiple habitat types, woody vegetation, surface water connection to other wetlands, vegetative buffer, and unimpacted water quality in upstream reaches; however, it is less than 0.5 acre in size and is surrounded by developed uses. Fish habitat function was assessed as impacted/degraded based on developed surroundings and lack of fish access. Water quality function was assessed as intact based on a surface water hydrological source, flooding or ponding during a portion of the growing season, high cover of wetland vegetation, and surrounding developed uses. Hydrological control function was assessed as impacted/degraded as the wetland is not within a 100-year floodplain or closed basin, has minor outlet restriction, and has an upstream forested/natural area land use.

Wetland 2 provides some wildlife habitat based on the presence of woody vegetation, waterbodies within one mile, vegetative buffer, and unimpacted water quality in upstream reaches; however, it features low habitat interspersion, is less than 0.5 acre in size, and is surrounded by developed uses. Fish habitat function was assessed as not present due to lack of surface water and fish access. Water quality function was assessed as not present based on a ground water hydrological source, lack of flooding or ponding during the growing season, small size, lack of connected wetlands, and lack of water quality impairments in upstream reaches   Hydrological control function was assessed as impacted/degraded as the wetland is not within a 100-year floodplain or closed basin, has no evidence of flooding or ponding during the growing season, and has an upstream forested/natural area land use.

Wildlife Habitat

Wildlife habitat in riparian/Vegetated Corridors was assessed according to Metro’s 2001 Wildlife Habitat Assessment (WHA) Methodology. The assessment evaluates wildlife habitat diversity (food, cover, water sources), water quality protection, ecological integrity (disturbance), connectivity, and uniqueness. Riparian/Vegetated Corridors were generally vegetated by invasive species including Himalayan blackberry, English hawthorn, nonnative grasses, and weedy forbs along with some native Oregon ash, Scouler’s willow, Nootka rose, spiraea, snowberry, and trailing blackberry cover.

Based on WHA results, overall wildlife habitat value provided onsite was moderate to low. The results are summarized in Table 2 and discussed below. The WHA form is included as Appendix G.

Table 2. Wildlife Habitat Assessment Scores

Parameter	Component	Score/Total	Rating
Habitat Diversity	Water	15/28	Moderate
	Food	10/24	Moderate
	Cover	14/28	Moderate
Ecological Integrity	Physical Disturbance	1/4	Low
	Human Disturbance	2/4	Moderate
Connectivity			Low
Uniqueness		0/4	Low

Habitat diversity scored moderate based on the presence of a seasonal stream/wetlands, limited food sources with a short season, and primarily shrub cover. Habitat features generally favored small mammals and passerine birds common to urban and suburban areas. Ecological integrity scored low-moderate based on the dominance of invasive species within the vegetation community, low tree cover, and developed surrounding land use but infrequent direct human use. Connectivity was scored low due to the developed surrounding land use, busy adjacent road corridor, and piping of the stream as it enters and exits the site. Uniqueness was scored low due to a lack of rare, threatened, or sensitive plant or wildlife species, rare habitat types, scenic value, or educational potential.

<u>Riparian Corridor Condition</u>

Riparian corridor condition was assessed as generally moderate. Little large woody debris was present in or adjacent to the stream as few trees grow in the riparian area or could be recruited from offsite areas since Tapman Creek is conducted onsite via culverts. Some shading is present in the northern portion of the site where larger woody shrubs (willow) or trees occur, but as Himalayan blackberry generally dominates the riparian vegetation community, there is little overhanging vegetation to provide stream shading. Erosion and sediment control is provided by dense growth of invasive reed canarygrass, which dominates the creek channel. Some erosion and scour was evident within the stream channel, but was not significant. The well-vegetated riparian buffer provides good water quality protection as demonstrated by the OFWAM functional analysis of Tapman Creek. Due to channelization and the constrained nature of the creek, little floodplain connectivity is evident, though some minor overbank flooding may occur during very high-water events. Habitat onsite is connected with larger, intact, high-quality wetland/stream and forested upland habitat to the north of the site across SW Day Road; however, the habitat onsite is poorer quality, disturbed by utility maintenance, and cut off from the habitat to the north by the high-traffic road. South of the site, the area is developed for commercial and utility use and no habitat functions are present.

Proposed Plan

The proposed project consists of the expansion of the transportation company to the south (Delta Logistics) and includes the construction of a large warehouse in the eastern portion of the site with parking and truck trailer storage in the central and western portions of the property. Crossing of Tapman Creek is required to access the western portion of the property. Construction of direct access from SW Day Road to the western portion of the site is prohibited by the City for the purpose of achieving preferred access spacing. Widening and improvements along the property's frontage of SW Day Road is also required by the City as a condition of project approval. The site plan has been designed to avoid encroachments to the stream and wetland and minimize encroachments to the Vegetated Corridor while meeting those City goals. The site plan also positions vegetated water quality treatment facilities as a buffer between the proposed development and remaining SROZ area. Areas of proposed encroachment are vegetated entirely by invasive species and contain no tree canopy. The site plan included in Appendix A. The development design implements the following habitat friendly development practices:

- Incorporates stormwater management in road rights-of-way
- Disconnects downspouts from roofs and directs the flow to vegetated water qualify facility
- Minimizes the number of stream crossings and places crossing perpendicular to stream channel
- Uses a bridge crossing rather than culverts
- Uses native vegetation throughout the development
- Locates landscaping adjacent to SROZ
- Reduces light spill-off into SROZ areas from development
- Preserves and maintains existing trees and tree canopy coverage, and plans trees, where appropriate to maximize future tree canopy coverage

Prior to any site clearing, grading or construction, the SROZ area shall be staked, and fenced per approved plan. During construction, the SROZ area shall remain fenced and undisturbed except as allowed by an approved development permit.

Proposed Encroachments

Encroachments are proposed to the Vegetated Corridor and Impact Area. Encroachments will occur in the northern portion of the Vegetated Corridor for the City required widening of SW Day Rd and in the southern portion for the Tapman Creek crossing. These areas are vegetated entirely by invasive species including Himalayan blackberry and reed canarygrass. No trees or native species will be removed as a result of construction. Encroachments will occur on both sides of the creek for the road crossing and along the eastern portion of the Impact Area for the road widening, creek crossing, and construction of a vegetated water quality and stormwater detention facility. No encroachments to Tapman Creek or the wetlands are proposed. No trees will be removed from the SROZ. Development activity has been limited to the Impact Area where practical except where necessary to widen SW Day Road and cross Tapman Creek to access the western portion of the site. Encroachments are summarized in Table 3 below

Table 3. Encroachment Summary

SROZ	Total Area	Encroachment (sq. ft.)	Remaining Area
Vegetated corridor	43,189	10,300	32,889
Impact area	22,332	14,500	7,332
TOTAL	65,521	23,300	42,222

Proposed encroachments will reduce the overall area of Vegetated Corridor by 10,300 sq. ft.; however, the impact to the overall functions and values of the water resources and riparian corridor is expected to be minimal since it will be left largely intact and the encroachment area is currently low functioning and dominated with nonnative species. The encroachments are proposed at the margins of the site adjacent to or in the vicinity of existing development. The elements with existing moderate function will not be affected. The proposed vegetated stormwater quality facilities located to the east and west of the remaining Vegetated Corridor will operate as a buffer to the SROZ area by intercepting and treating stormwater runoff before it reaches the area. The mitigation plan described below has been developed to improve the existing function of the riparian corridor and offset any potential impacts.

Mitigation and Enhancement Plan

The mitigation plan was developed with guidance from Wilsonville Development Code Section 4.139.06(.02)(E)(1)(b) and Table NR-4. Section 4.139.06(.02)(E)(1)(b) requires native trees and shrubs to be planted at a minimum rate of five (5) trees and twenty-five (25) shrubs per every 500 sq.ft. of disturbance area. For a disturbance area of 10,300 sq. ft., planting at this rate amounts to 103 trees and 515 shrubs. Table NR-4 prescribes a ratio of mitigation area to disturbance area based on the existing function of the site and proposed function of the site. Based on the functional assessment of the vegetated corridor/riparian corridor described above, both the impact site and mitigation site have low-to-moderate natural resource function based on low canopy cover, high invasive species cover, proximity to developed land uses, channelization of Tapman Creek, and fragmented connectivity to other habitats. The proposed mitigation plan is expected to provide ecological uplift and increase wildlife habitat, ecological integrity, and water quality protection functions as shown in Table 4 below. The prescribed mitigation ratio was determined as 2.5:1.

Table 4. Natural Resource Enhancement Mitigation Ratios

Function	Mitigation Site/Impact Site Existing Function	Mitigation Site Proposed Function	Change
Wildlife Habitat	Moderate	High	Increase

Ecological Integrity	Low	Moderate	Increase
Connectivity	Low	Low	None
Water Quality Protection	Moderate	High	Increase
Uniqueness	Low	Low	None
Ratio per Table NR-4			**2.5:1**
Proposed Mitigation Ratio			**3.2:1**

The proposed mitigation plan will enhance the remaining vegetated corridor/riparian area east of the existing access road which is assessed as low-to-moderate in natural resource function with low canopy cover and high nonnative species cover. The enhancement activities involve removal of invasive species and planting of native trees, shrubs, and herbs over 32,863 sq. ft of SROZ area. As much of the SROZ west of Wetland 1 is located within the utility ROW, tree planting will be limited to areas outside of the easements. Trees will be planted at the higher end of the required density (8 ft. on center) in this area to compensate for the lack of tree planting within the utility ROW. A total of 134 trees and 1,643 shrubs are proposed to be planted. Bare ground shall be planted or seeded with native grasses or herbs. The proposed mitigation plan far exceeds the planting numbers prescribed by 4.139.06(.02)(E)(1)(b) and results in a mitigation ratio of 3.2:1 exceeding the ratio prescribed by Table NR-4.

Planting Plan

The planting plan is proposed for the 32,863 sq. ft. of vegetated/riparian corridor and is shown on Figure 3. As the planting site is adjacent to a stream and wetlands, a riparian community was selected. The forest community will include 134 trees and 430 shrubs planted over 8,600 sq. ft. outside of the utility ROW. The shrub community will include 1,213 shrubs over 24,263 sq. ft. inside of the utility ROW. The planting palette is listed in Table 5 below. The species selected are appropriate to proposed site conditions. All bare ground within the enhancement area will be seeded with ProTime 400 or equivalent at a rate to achieve 100% aerial cover.

Table 5. Planting Palette for Vegetated Corridor Enhancement Area (32,863 ft²)

Species	**Category**	**Minimum Size***	**Spacing**	**Quantity**
Riparian Forest Community (outside the ROW): 8,600 sq. ft.				
Oregon ash *Fraxinus latifolia*	Tree	2 gal.	8’OC	37
Scouler’s willow *Salix scouleriana*	Tree	2 gal. or bare root	8’OC	37
Western redcedar Thuja plicata	Tree	2 gal. or bare root	8’OC	60
Redosier dogwood *Cornus stolonifera*	Shrub	1 gal. or bare root	5’OC cluster	86
Red elderberry *Sambucus racemosa*	Shrub	1 gal. or bare root	5’OC cluster	86

Snowberry *Symphoricarpos albus*	Shrub	1 gal. or bare root	5'OC cluster	86
Salmonberry *Rubus spectabilis*	Shrub	1 gal. or bare root	5'OC cluster	86
Swamp rose *Rosa pisocarpa*	Shrub	1 gal. or bare root	5'OC cluster	86
Riparian Shrub Community (inside the ROW): 24,263 sq. ft.				
Redosier dogwood *Cornus stolonifera*	Shrub	1 gal. or bare root	5'OC cluster	200
Red elderberry *Sambucus racemosa*	Shrub	1 gal. or bare root	5'OC cluster	200
Snowberry *Symphoricarpos albus*	Shrub	1 gal. or bare root	5'OC cluster	213
Salmonberry *Rubus spectabilis*	Shrub	1 gal. or bare root	5'OC cluster	200
Swamp rose *Rosa pisocarpa*	Shrub	1 gal. or bare root	5'OC cluster	200
Indian plum *Oemleria cerasiformis*	Shrub	1 gal. or bare root	5'OC cluster	200
ProTime 402*	herb		25 lbs/acre	17.5 lbs

*Native riparian mix includes blue wildrye (*Elymus glaucus*), meadow barley (*Hordeum brachyantherum*), and tufted hairgrass (*Deschampsia cespitosa*)

The mitigation planting plan was designed according Section 4.139.07(.02)(E) and shall meet the following:

- The planting plan shall be implemented prior to or at the same time as the impact activity is conducted
- All trees, shrubs and ground cover shall be native vegetation.
- Trees and shrubs shall be at least one-gallon in size and shall be at least twelve (12) inches in height.
- Trees shall be planted between eight (8) and twelve (12) feet on center, and shrubs shall be planted between four (4) and five (5) feet on center, or clustered in single species groups of no more than four (4) plants, with each cluster planted between eight (8) and ten (10) feet on center. When planting near existing trees, the drip line of the existing tree shall be the starting point for plant spacing measurements
- Shrubs shall consist of at least two (2) different species. If five (5) trees or more are planted, then no more than fifty (50) percent of the trees may be of the same genus.
- Invasive non-native or noxious vegetation shall be removed within the mitigation area prior to planting and shall be removed or controlled for five (5) years following the date that the mitigation planting is completed.

- Mulch shall be applied around new plantings at a minimum of three inches in depth and eighteen inches in diameter. Browse protection shall be installed on trees and shrubs. Mulching and browse protection shall be maintained during the two-year plant establishment period.
- Trees and shrubs that die shall be replaced in kind to the extent necessary to ensure that a minimum of eighty (80) percent of the trees and shrubs initially required shall remain alive on the fifth anniversary of the date that the mitigation planting is completed

Mitigation Goals and Performance Standards

The mitigation site goal is as follows:

Enhance 32,890 sq. ft. of vegetated corridor to improve riparian corridor, water quality protection, ecological integrity and wildlife habitat functions by removing invasive species and maintaining a native, woody-dominated plant community.

Performance standards are based on Metro’s Title 3 water quality performance standards to protect and improve water quality and protect the functions and values of Water Quality Resource Areas (Metro 2018). This plan’s performance standards for forest and/or shrub dominated areas and shall consist of the following:

1. Establishment of permanent monitoring locations during the first annual monitoring.
2. Cover of native herbaceous species is at least 60%
3. Cover of invasive species is no more than 10%. After the site has matured to the stage when desirable canopy species reach 50% cover, the cover of invasive species may increase but may not exceed 30%.
4. Bare substrate represents no more than 20% cover
5. Density of woody vegetation is at least 1,600 live trees or shrubs per acre OR the cover of native woody vegetation on site is at least 50%. Native volunteer species may be included in the cover or density estimate.
6. By Year 3 and thereafter, at least 6 different native species must be present. To qualify, a species must have at least 5% average cover in the habitat class and occur in at least 10% of the plots sampled
7. By Year 5, a minimum of eighty (80) percent of the trees and shrubs initially required shall remain alive

Maintenance and Monitoring

Monitoring will occur annually over a 5-year monitoring period to assess condition of plantings, irrigation, mulch etc. Monitoring will be conducted by qualified personnel during peak growing season (July-August). Annual monitoring reports will be provided to the Planning Director for review by December of each monitoring year. The report shall contain, at a minimum, photographs from established photo points, quantitative measure of success criteria, including plant survival and vigor. The Year 1 annual report shall be submitted one year following mitigation action implementation. The final annual report (Year 5 report) shall document successful satisfaction of mitigation goals, as per the stated performance standards

The applicant will be responsible for coordinating ongoing maintenance and management. If the ownership of the mitigation site property changes, the new owners will have the continued responsibilities Maintenance activities including mulching, weed removal, herbivory control, and supplemental planting will be conducted by a qualified contractor at least twice per growing season and once prior to the growing season or more frequently as indicated by monitoring results. Any failed plants will be replaced in-kind with the cause of loss (wildlife damage, poor plant stock, drought, weed overgrowth, etc.) documented and additional maintenance done to address the cause of loss and ensure future plant survival.

Summary and Conclusions

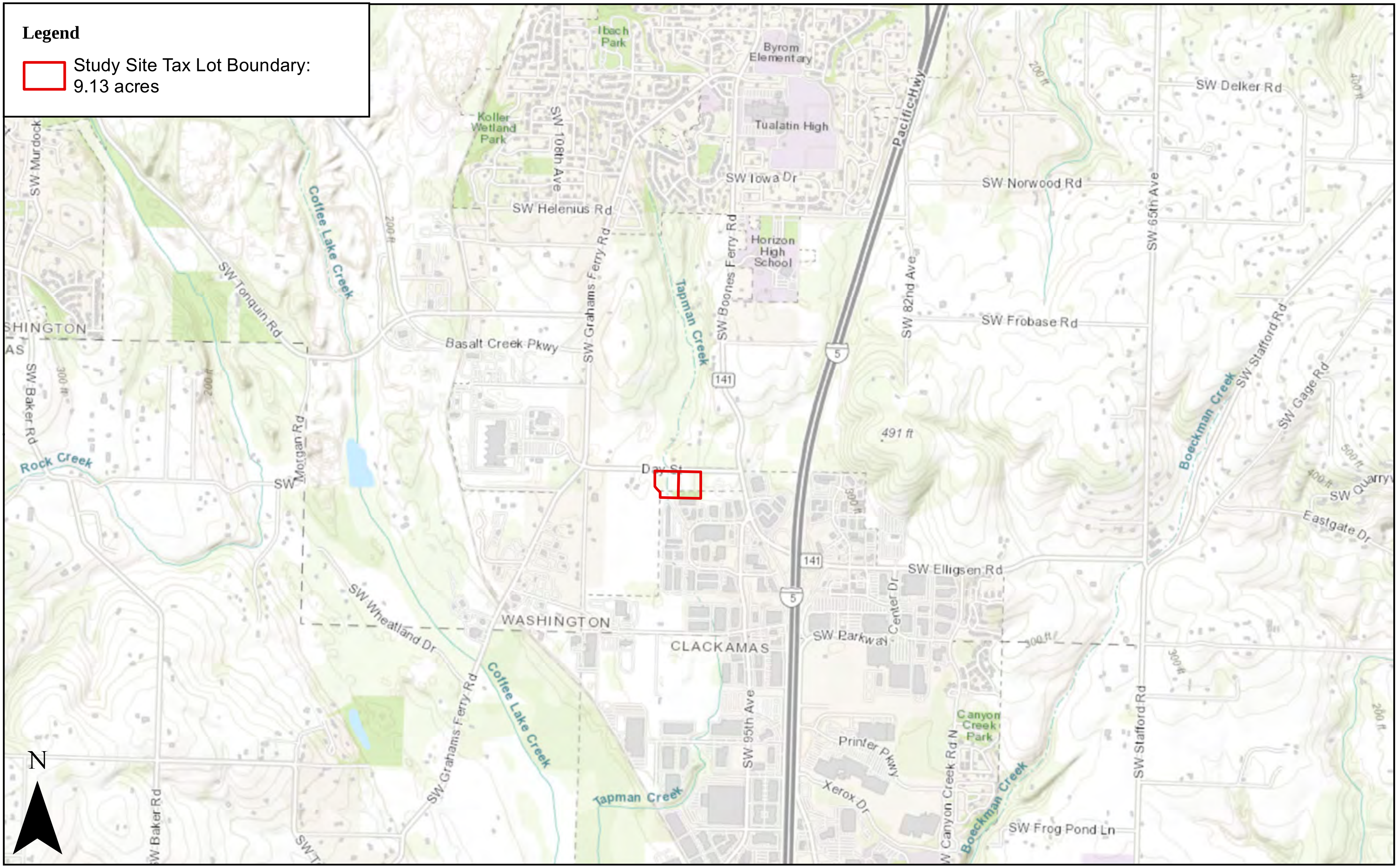
In summary, the applicant (Delta Logistics) proposes a commercial development on a property located at 9710 SW Day Road (T3S, R1W, Section 2B, Tax Lot 600 & 601).

- The property features SROZ area in the western portion including wetlands (0.33 acre), Tapman Creek (0.10 acre), and associated Vegetated Corridor (43,189 sq. ft) and Impact Areas (22,332 sq. ft.).
- The proposed design maximizes use of the site while minimizing adverse impacts to natural resources and incorporates several habitat friendly development practices. No encroachments to onsite wetlands or waters are proposed and no trees will be removed from the SROZ.
- Encroachments to Vegetated Corridor (10,300 sq. ft.) and Impact Areas (14,500 sq. ft.) are proposed due to City-required widening and improvements along the property's frontage of SW Day Road and to access the west side of Tapman Creek. Accessing the western portion of the property from SW Day Road is prohibited by the City, leaving a stream crossing as the only option to utilize this valuable area.
    - The existing Vegetated Corridor/riparian corridor conditions were assessed as low-to-moderate in function with high invasive species cover and low tree canopy cover. These areas are within a utility easement and are historically disturbed.
    - The specific areas of the of the SROZ proposed for encroachment (particularly along SW Day Road) are low-functioning and vegetated entirely by invasive or nonnative species (primarily Himalayan blackberry and reed canarygrass) and lack tree cover.
    - The proposed encroachments are not expected to affect the overall functions of the riparian/Vegetated Corridor as the preponderance of the SROZ will remain intact and the elements with existing moderate function will not be affected. Vegetated water quality treatment facilities are positioned between the remaining SROZ area and the development and will serve as a buffer by intercepting and treating stormwater runoff. The encroachments are proposed at the margins of the site adjacent to or

    in the vicinity of existing development. A mitigation plan has been developed to offset any potential impacts to natural resources.

- The Mitigation and Enhancement Plan provides functional uplift to the remaining onsite riparian/Vegetated Corridor. The Plan will enhance 32,863 sq. ft. of riparian/Vegetated Corridor and provide benefits that exceed the mitigation recommendations of the SROZ regulation.
    - A total of 134 trees and 1,643 shrubs are proposed to be planted. Bare ground shall be planted or seeded with native grasses or herbs
    - Trees will be planted at the higher end of the required density (8 ft. on center) outside the ROW to compensate for the lack of tree planting within the utility ROW.
    - The proposed mitigation plan far exceeds the planting numbers prescribed by 4.139.06(.02)(E)(1)(b) and results in a mitigation ratio of 3.2:1 exceeding the ratio prescribed by Table NR-4.
    - While the overall area of the riparian/Vegetated Corridor will be smaller, wildlife habitat, ecological integrity, and water quality protection functions will substantially improve through removal of widespread invasive species and establishment of native forest and shrub communities.
    - Connectivity and uniqueness functions will remain the same.

<u>FIGURE 1: PROJECT VICINITY MAP</u>



Date: 9/9/2021

Data Source: ESRI, 2021; Washington County Intermap, 2021

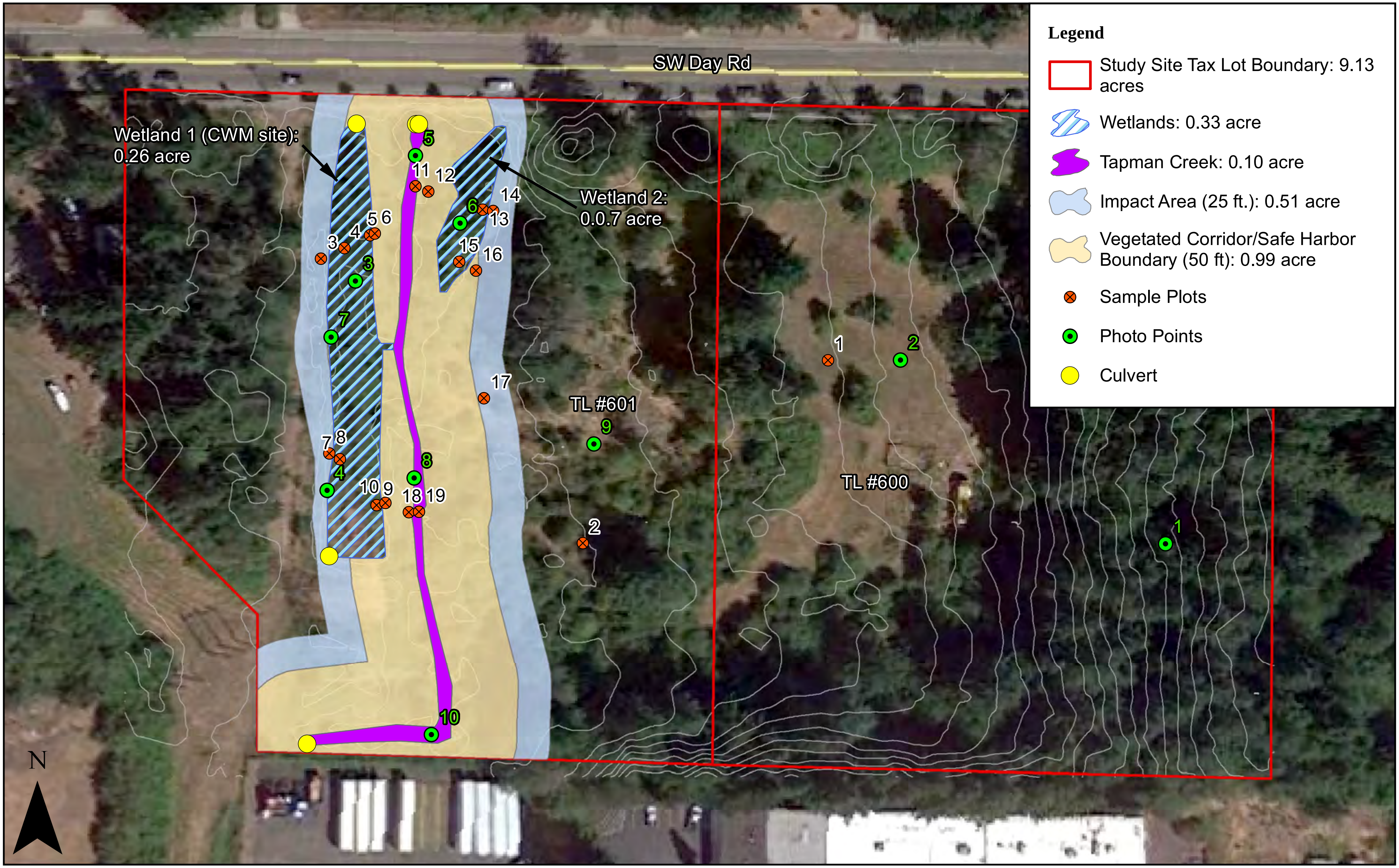
Figure 1. Location Map

SW Day Road Project Site: S&A #2739

0 1,000 2,000 4,000 Feet

SCHOTT & ASSOCIATES, Inc.

FIGURE 2: EXISTING CONDITIONS – SIGNIFICANT RESOURCE OVERLAY ZONE



Date: 1/11/2022

Data Source: Google Earth, 2021; Washington County Intermap, 2021; DOGAMI, 2014

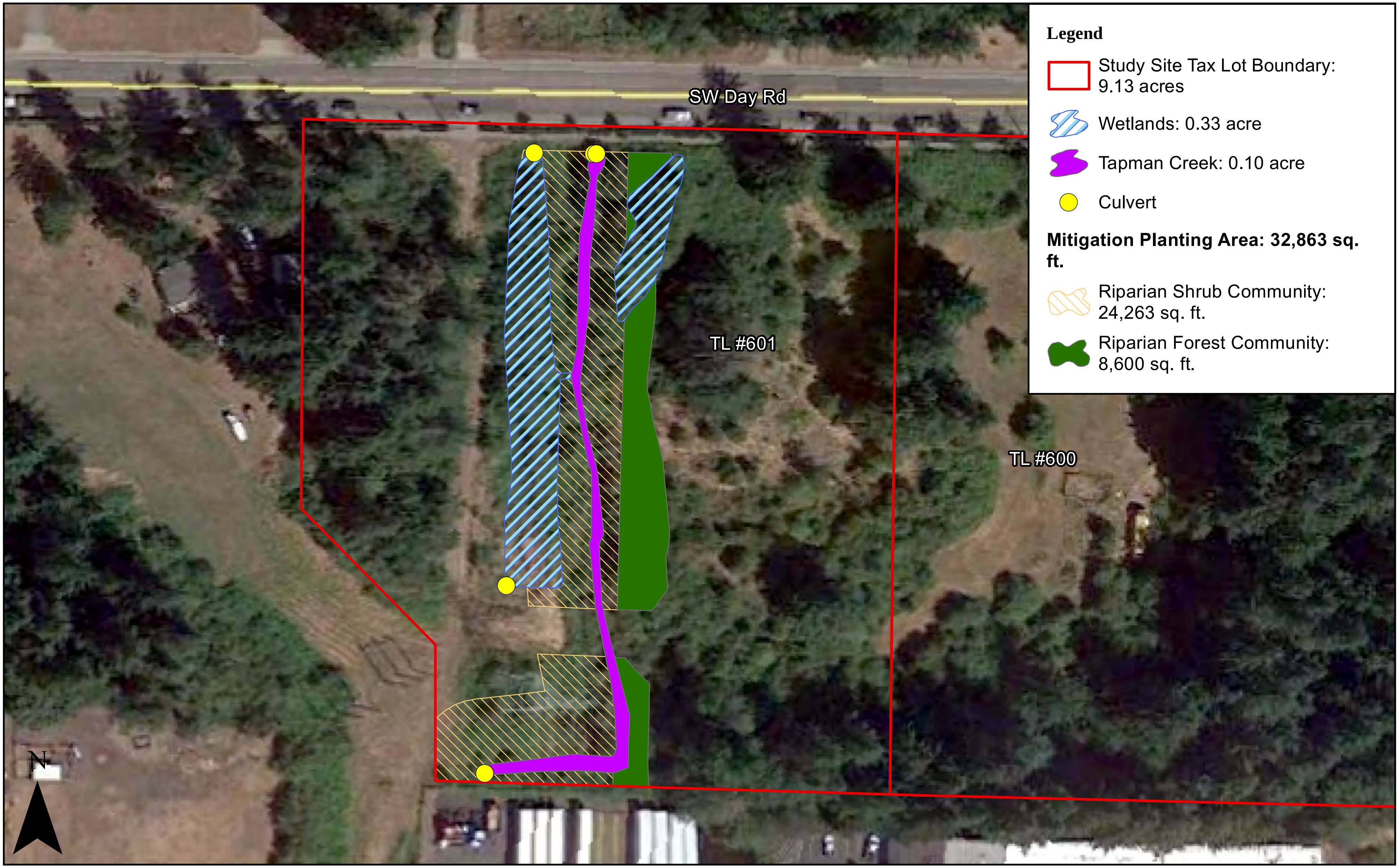
Figure 2. Existing Conditions - Significant Resources Overlay Zone

SCHOTT & ASSOCIATES, Inc.

SW Day Road Project Site: S&A #2739

0 50 100 200 Feet

FIGURE 3: MITIGATION PLANTING AREA



Date: 1/11/2022

Data Source: Google Earth, 2021;
Washington County Intermap, 2021

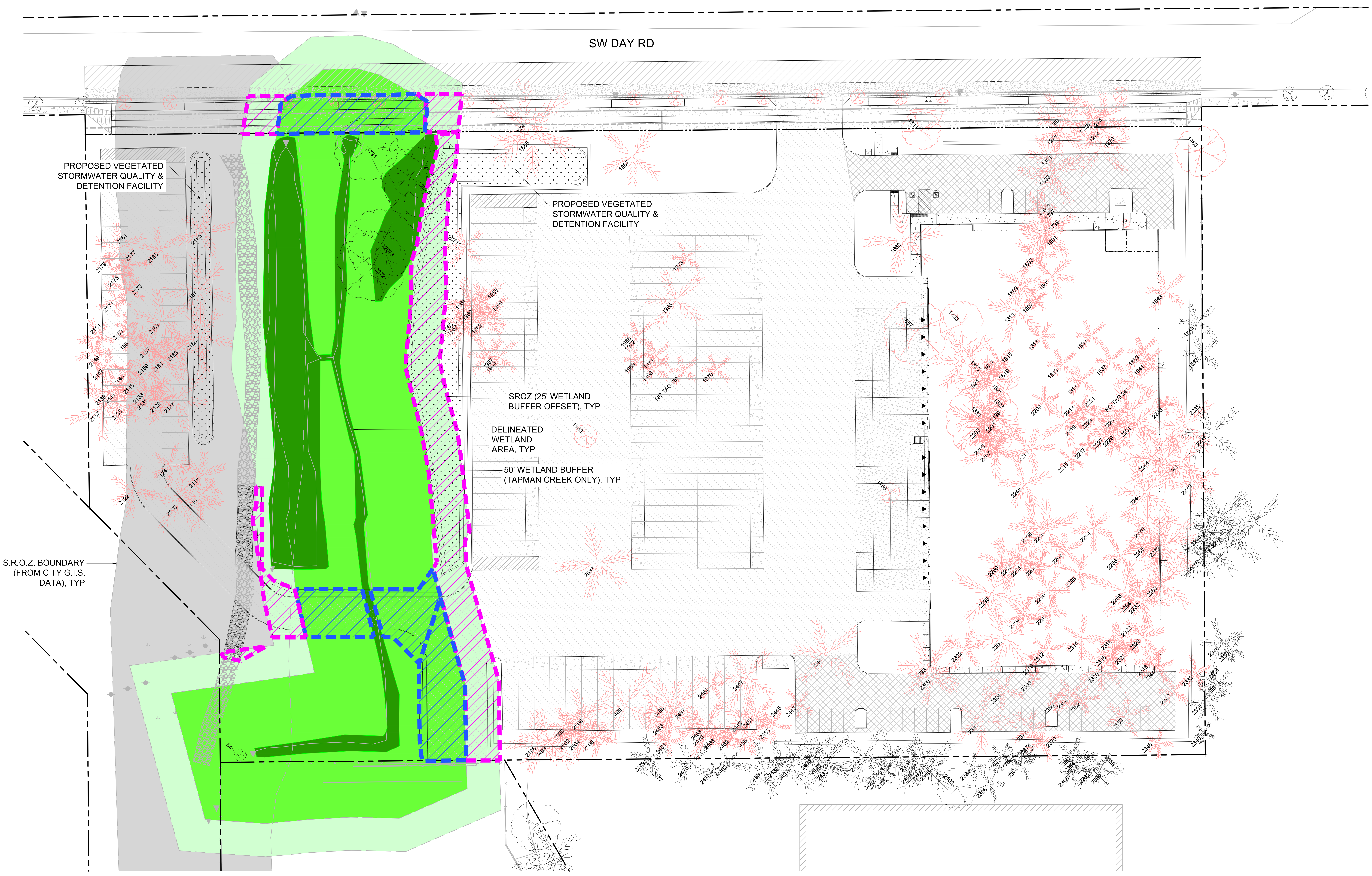
Figure 3. Mitigation Planting Area

SW Day Road Project Site: S&A #2739

0 50 100 200 Feet

SCHOTT & ASSOCIATES, Inc.

APPENDIX A: SITE PLAN



1 - WETLANDS IMPACT EXHIBIT

30 0 15 30 60 120 1:1

(IN FEET)
1 inch = 30 ft.

		DAY ROAD WIDENING		GENERAL SITEWORK		CREEK BRIDGING & SEMI-TRACTOR STORAGE		
IMPACT AREA	**ESTABLISHMENT**	**TEMPORARY**	**PERMANENT**	**TEMPORARY**	**PERMANENT**	**TEMPORARY**	**PERMANENT**	**TOTALS**
WETLAND, SQ FT	DELINEATED	0	0	0	0	0	0	**0**
WETLAND BUFFER, SQ FT	50' DELINEATION OFFSET	0	3,200	0	3,300	0	3,800	**10,300**
SROZ, SQ FT	25' OFFSET FROM BUFFER	0	1,500	0	11,500	0	1,500	**14,500**
TREES (IN SROZ), EA	SURVEY	-	0	-	0	-	0	**0**
TREES (NON-SROZ), EA	SURVEY	-	4	-	174	-	33	**211**

STREET TREES NOT TABULATED & WILL BE REPLACED

Architecture ▪ Interiors
Planning ▪ Engineering

Portland, OR
503.224.9560
Vancouver, WA
360.695.7879
Seattle, WA
206.749.9993
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DESIGN DRIVEN I CLIENT FOCUSED

Client

DELTA LOGISTICS
9835 SW COMMERCE
CIRCLE
WILSONVILLE, OR
97070

Project

**DELTA LOGISTICS
SITE EXPANSION
FRONTAGE
MPROVEMENTS**
9710 SW DAY RD.
CITY OF
WILSONVILLE, OR

REVISION SCHEDULE		
Delta	Issued As	Issue Date
-	ISSUED	11/30/2021
-	ISSUED	12/02/2021
.	ISSUED	12/15/2021
-	ISSUED	01/18/2022

SHEET TITLE:
**WETLANDS
IMPACT EXHIBIT**

DRAWN BY: CME

CHECKED BY: GIM

SHEET

JOB NO. **2200502.04**

DESIGN DEVELOPMENT SET 12/17/21

220050200\DRAWINGS\CIVIL\EXHIBIT\502-WETLAND IMPACT.DWG GIM 01/18/22 09:29 1:30.00

APPENDIX B. TOPOGRAPHIC SURVEY

TOPOGRAPHIC SURVEY
9710 SW DAY ROAD
LOCATED IN THE SW 1/4 AND THE NW 1/4
SECTION 2, T.3S., R.1W., W.M.
WASHINGTON COUNTY, OREGON

PRELIMINARY RESULTS

0 60 120 180
SCALE: 1" = 60'
1-FT. CONTOUR INTERVAL
SEPTEMBER 20, 2021
UPDATED NOV. 11, 2021 (ADDED SEWER PIPE DATA)

FOR: DELTA LOGISTICS
9835 SW COMMERCE CIRCLE
WILSONVILLE, OR 97070

REQUESTED BY: VLAD TKACH, PRESIDENT
VLAD@DELTAGOV.COM

BENCHMARK THE BENCHMARK USED FOR THIS PROJECT WAS AN OPUS-DERIVED (STATIC GPS) ELEVATION ON WEDDLE SURVEYING CONTROL POINT #400, A 3/8" IRON ROD WITH RED PLASTIC CAP MARKED "AKS CONTROL POINT"
ELEVATION: 244.85' NAVD '88 DATUM (GEOID 12B)

① MANHOLE
RIM= 250.76'
I.E. 12" PVC IN (W) = 243.00'
I.E. 12" PVC OUT (E) = 242.38'

② MANHOLE
RIM= 249.64'
I.E. 12" PVC IN (W) = 242.64'
I.E. 12" PVC OUT (SE) = 242.24'

③ MANHOLE
RIM= 249.20'
I.E. 12" PVC IN (N) = 242.41'
I.E. 12" PVC IN (S) = 242.84'
I.E. 12" PVC IN (NW) = 242.18'
I.E. 12" PVC OUT (E) = 242.18'

④ CATCH BASIN
GRATE = 249.57'
I.E. 12" PVC OUT (N) = 243.86'

⑤ MANHOLE
RIM= 246.54'
I.E. 12" PVC IN (N) = 243.82'
I.E. 12" PVC IN (W) = 241.68'
I.E. 12" PVC IN (SW) = 243.77'
I.E. 12" PVC IN (E) = 241.82'
I.E. 12" PVC OUT (S) = 241.73'

⑥ CATCH BASIN
GRATE = 246.85'
I.E. 12" PVC OUT (E) = 243.97'

⑦ MANHOLE
RIM= 254.17'
I.E. 12" PVC IN (NE) = 249.41'
I.E. 12" PVC IN (E) = 247.38'
I.E. 12" PVC IN (S) = 248.91'
I.E. 12" PVC OUT (W) = 246.66'

⑧ CATCH BASIN
GRATE = 254.43'
I.E. 12" PVC OUT (N) = 249.93'

⑨ MANHOLE
RIM= 263.49'
I.E. 12" PVC IN (E) = 258.84'
I.E. 12" PVC IN (N) = 258.84'
I.E. 12" PVC IN (S) = 259.06'
I.E. 12" PVC OUT (W) = 258.83'

⑩ CATCH BASIN
GRATE = 263.67'
I.E. 12" PVC OUT (N) = 259.32'

⑪ MANHOLE
RIM= 284.07'
I.E. 12" PVC IN (N) = 277.77'
I.E. 12" PVC IN (S) = 277.89'
I.E. 12" PVC OUT (W) = 275.52'

⑫ CATCH BASIN
GRATE = 284.32'
I.E. 12" PVC OUT (N) = 278.99'

⑬ MANHOLE
RIM= 245.47'
I.E. 12" PVC IN (S) = 239.30'
I.E. 12" PVC OUT (N) = 239.27'

SURVEYOR'S NOTES

1. THE BASIS OF BEARINGS FOR THIS SURVEY IS PER SURVEY NO. 33,753, WASHINGTON COUNTY SURVEY RECORDS. THIS IS NOT A RECORDABLE BOUNDARY SURVEY,
2. UNDERGROUND UTILITIES ARE SHOWN PER SURFACE MARKINGS. THE SURVEYOR MAKES NO GUARANTEE AS TO THE EXACT LOCATION, EXISTENCE, NON-EXISTENCE OR COMPLETENESS OF ANY SUBSURFACE UTILITIES SHOWN, OR NOT SHOWN ON THE MAP. CALL 811 BEFORE DIGGING.
3. TOTAL SURVEYED SITE AREA = 9.169 ACRES
BUILDABLE AREA EAST OF EASTERLY S.R.O.Z. = 6.338 ACRES

LEGEND:

	CONIFEROUS TREE
▼	CULVERT INVERT
	CURB INLET
	DECIDUOUS TREE
	DECORATIVE SHRUB
	DOWNSPOUT
FFE	FINISH FLOOR ELEV.
	FIRE HYDRANT
G	GAS METER
	GAS RISER
	GATE POST
	GUY ANCHOR
	MAILBOX
NG	NATURAL GROUND
EM	POWER METER
PP	POWER POLE
	SIGN "AS NOTED"
	SITE BENCHMARK
	SPOT ELEVATION
G	GUTTER
TC	TOP OF CURB
S.R.O.Z.	SIGNIFICANT RESOURCE OVERLAY ZONE
D	STORM DRAIN MANHOLE
●	SURVEY MONUMENTS FOUND
○	SURVEY MONUMENTS SET
○	UTILITY LID
W	WATER METER
	WATER RISER
⋈	WATER VALVE
☐	WETLANDS BUFFER/LINE STAKES
	BRUSH LINE
	BUILDING EAVE
	BUILDING FOOTPRINT
	CENTERLINE
	EASEMENT LINE
—X—X—	FENCE LINE
—G—	GAS LINE
—E—	OVERHEAD POWER
—SD—	STORM DRAIN LINE
	TAX LOT LINE
—W—	WATER LINE
	WETLANDS AS FLAGGED BY OTHERS
▨	ASPHALT
▨	CONCRETE
▨	GRAVEL

REGISTERED
PROFESSIONAL
LAND SURVEYOR
Michael Rennick
OREGON
JULY 25, 1995
MICHAEL D. RENNICK
2718
EXPIRES: DECEMBER 31, 2022

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PH: (503) 941-9585 FAX: (503) 941-9640
www.weddlesurveying.net

JOB NO. 5727

APPENDIX C. TREE SURVEY

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
549	English hawthorn	*Crataegus monogyna*	5	2.5	Fair	Fair	Multiple stems		tbd	tbd
791	Willow	*Salix sp.*	20	10	Poor	Very Poor	Data visually collected due to inaccessible area		tbd	tbd
874	Douglas-fir	*Pseudotsuga menziesii*	36	18	Good	Fair	Broken limbs at base		tbd	tbd
1270	Douglas-fir	*Pseudotsuga menziesii*	47	23.5	Fair	Fair	Co-dominant stem with included bark, broken limbs in crown		tbd	tbd
1272	Douglas-fir	*Pseudotsuga menziesii*	41	20.5	Good	Good			tbd	tbd
1274	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Good	Fair	Wood pecker damage at base		tbd	tbd
1276	Douglas-fir	*Pseudotsuga menziesii*	28	14	Fair	Fair	Thin crown		tbd	tbd
1278	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Fair	Fair	Thin crown, sap sucker damage at base		tbd	tbd
1280	Douglas-fir	*Pseudotsuga menziesii*	43	21.5	Good	Good			tbd	tbd
1301	Douglas-fir	*Pseudotsuga menziesii*	40	20	Good	Good			tbd	tbd
1303	Douglas-fir	*Pseudotsuga menziesii*	50	25	Fair	Poor	Weeping crack at 12', decay with sloughing bark at base		tbd	tbd
1311	sweet cherry	*Prunus avium*	20	10	Very Poor	Very Poor	Tree in heavy decline		tbd	tbd
1333			Tree not present				Tree not present		tbd	tbd
1480	sweet cherry	*Prunus avium*	8	4	Fair	Poor	Data visually collected	x	tbd	tbd
1501	Douglas-fir	*Pseudotsuga menziesii*	30	15	Good	Good			tbd	tbd
1657			Tree not present				Tree not present		tbd	tbd
1660	Douglas-fir	*Pseudotsuga menziesii*	39	19.5	Fair	Fair	Broken limbs at base, thin crown		tbd	tbd
1766			Tree not present				Tree not present		tbd	tbd
1797	Douglas-fir	*Pseudotsuga menziesii*	49	24.5	Fair	Fair	Wood pecker damage at base		tbd	tbd
1799	Douglas-fir	*Pseudotsuga menziesii*	44	22	Fair	Fair	Co-dominant stem with included bark		tbd	tbd
1801	Douglas-fir	*Pseudotsuga menziesii*	44	22	Fair	Fair	Co-dominant stem with included bark, cracks and wood pecker holes at base		tbd	tbd
1803	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Thin crown, excavation in root zone		tbd	tbd
1805	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Fair	Fair	Buried root flare		tbd	tbd
1807	Douglas-fir	*Pseudotsuga menziesii*	26	13	Good	Good			tbd	tbd
1809	Douglas-fir	*Pseudotsuga menziesii*	41	20.5	Fair	Fair	Torsion cracks at base, excavation in root zone		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
1811	Douglas-fir	*Pseudotsuga menziesii*	49	24.5	Fair	Fair	Torsion cracks in stem, wood pecker damage at base		tbd	tbd
1813	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Fair	Fair	Thin crown, bark damage at base		tbd	tbd
1815	Douglas-fir	*Pseudotsuga menziesii*	22	11	Good	Fair	Crack with good response growth at base		tbd	tbd
1817	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Dead	Dead			tbd	tbd
1819	Douglas-fir	*Pseudotsuga menziesii*	20	10	Good	Good			tbd	tbd
1821	Douglas-fir	*Pseudotsuga menziesii*	18	9	Fair	Fair	Contorted stem at 25’		tbd	tbd
1821.1	Douglas-fir	*Pseudotsuga menziesii*	24	12	Good	Fair	Swelling at base where other tree was removed		tbd	tbd
1821.2	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Contorted stem at 15’, bark damage at base		tbd	tbd
1823			Tree not present				Tree not present		tbd	tbd
1825			Tree not present				Tree not present		tbd	tbd
1827			Tree not present				Tree not present		tbd	tbd
1831			Tree not present				Tree not present		tbd	tbd
1833	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Good	Good			tbd	tbd
1835	Douglas-fir	*Pseudotsuga menziesii*	34	17	Fair	Fair	Thin crown		tbd	tbd
1837	Douglas-fir	*Pseudotsuga menziesii*	28	14	Good	Fair	Excavation in root zone		tbd	tbd
1839	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Thin crown		tbd	tbd
1841	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Good	Fair	Holes in trunk at base		tbd	tbd
1843	Douglas-fir	*Pseudotsuga menziesii*	51	25.5	Fair	Fair	Thin crown		tbd	tbd
1845	Douglas-fir	*Pseudotsuga menziesii*	48	24	Fair	Fair	Thin crown, dead limbs in crown		tbd	tbd
1847	Douglas-fir	*Pseudotsuga menziesii*	22	11	Fair	Fair	Thin crown, bark damage at base		tbd	tbd
1849	Douglas-fir	*Pseudotsuga menziesii*	26	13	Good	Good			tbd	tbd
1885	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Good	Fair	Broken limbs at base		tbd	tbd
1887	Douglas-fir	*Pseudotsuga menziesii*	38	19	Good	Fair	Broken limbs at base		tbd	tbd
1933			Tree not present				Tree not present		tbd	tbd
1957	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Dead	Dead			tbd	tbd
1958	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Dead	Dead			tbd	tbd
1959	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Dead	Dead			tbd	tbd
1960	Douglas-fir	*Pseudotsuga menziesii*	14	7	Poor	Poor	Thin crown, dead top		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
1961	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Dead	Dead			tbd	tbd
1962	Douglas-fir	*Pseudotsuga menziesii*	22	11	Dead	Dead			tbd	tbd
1963	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Poor	Poor	Dead top		tbd	tbd
1964	Douglas-fir	*Pseudotsuga menziesii*	26	13	Poor	Poor	Tree in decline		tbd	tbd
1965	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Fair	Thin crown		tbd	tbd
1966	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Fair	Thin crown		tbd	tbd
1967	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Good	Epicormic growth on limbs		tbd	tbd
1968	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Good	Fair	Broken limbs at base		tbd	tbd
1969	Douglas-fir	*Pseudotsuga menziesii*	28	14	Good	Fair	Broken limbs at base		tbd	tbd
1970	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Fair	Fair	Thin crown		tbd	tbd
1971	Douglas-fir	*Pseudotsuga menziesii*	22	11	Fair	Fair	Thin crown		tbd	tbd
1972	Douglas-fir	*Pseudotsuga menziesii*	24	12	Fair	Fair	Thin crown		tbd	tbd
1973	Douglas-fir	*Pseudotsuga menziesii*	51	25.5	Fair	Fair	Broken limbs at base, over extended limbs		tbd	tbd
2071	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Good	Fair	Bark damage at base, ivy at base		tbd	tbd
2072	Oregon ash	*Fraxinus latifolia*	11	5.5	Poor	Poor	Contorted stem, thin crown		tbd	tbd
2073	Willow	*Salix sp.*	14	7	Dead	Dead			tbd	tbd
2074	Oregon ash	*Fraxinus latifolia*	20	10	Poor	Poor	Dead limbs in crown, over extended limbs		tbd	tbd
2075	Oregon ash	*Fraxinus latifolia*	14	7	Fair	Poor	One failed stem at base, decay at base, heavy lean		tbd	tbd
2116	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Dead	Dead			tbd	tbd
2118	Douglas-fir	*Pseudotsuga menziesii*	24	12	Dead	Dead			tbd	tbd
2120	Douglas-fir	*Pseudotsuga menziesii*	32	16	Poor	Poor	Dead top		tbd	tbd
2122	Douglas-fir	*Pseudotsuga menziesii*	32	16	Fair	Fair	Thin crown, bark damage at base		tbd	tbd
2124	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Fair	Fair	Bark damage at base, ivy in crown		tbd	tbd
2127	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Good	Fair	Bark damage at base		tbd	tbd
2129	Douglas-fir	*Pseudotsuga menziesii*	18	9	Very Poor	Very Poor	Dead top		tbd	tbd
2131	Douglas-fir	*Pseudotsuga menziesii*	16	8	Poor	Poor	Ivy in crown, thin crown		tbd	tbd
2133	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Fair	Fair	Ivy in crown		tbd	tbd
2135	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Fair	Fair	Thin crown, ivy covering base		tbd	tbd
2137	Douglas-fir	*Pseudotsuga menziesii*	30	15	Fair	Good	Bark damage at base		tbd	tbd
2139	Douglas-fir	*Pseudotsuga menziesii*	37	18.5	Good	Good			tbd	tbd
2141	Douglas-fir	*Pseudotsuga menziesii*	19	9.5	Fair	Fair	Co-dominant stem with included bark at bas, fruiting body at base		tbd	tbd
2143	Douglas-fir	*Pseudotsuga menziesii*	16	8	Dead	Dead			tbd	tbd
2145	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Fair	Thin crown		tbd	tbd
2147	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Fair	Fair	Thin crown		tbd	tbd
2149	Douglas-fir	*Pseudotsuga menziesii*	24	12	Fair	Poor	Thin crown, contorted stem, ivy covering base		tbd	tbd
2151	Douglas-fir	*Pseudotsuga menziesii*	29	14.5	Poor	Poor	Thin crown, ivy covering stem		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
2153	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Dead	Dead			tbd	tbd
2155	Douglas-fir	*Pseudotsuga menziesii*	12	6	Fair	Fair	Ivy covering base		tbd	tbd
2157	Douglas-fir	*Pseudotsuga menziesii*	19	9.5	Dead	Dead			tbd	tbd
2159	Douglas-fir	*Pseudotsuga menziesii*	32	16	Good	Fair	Ivy covering base		tbd	tbd
2161	Douglas-fir	*Pseudotsuga menziesii*	16	8	Dead	Dead			tbd	tbd
2163	Douglas-fir	*Pseudotsuga menziesii*	24	12	Fair	Fair	Thin crown		tbd	tbd
2165	Douglas-fir	*Pseudotsuga menziesii*	26	13	Dead	Dead			tbd	tbd
2167	Douglas-fir	*Pseudotsuga menziesii*	34	17	Fair	Fair	Bark damage at base, thin crown		tbd	tbd
2169	Douglas-fir	*Pseudotsuga menziesii*	28	14	Poor	Fair	Thin crown		tbd	tbd
2171	Douglas-fir	*Pseudotsuga menziesii*	22	11	Fair	Fair	Thin crown, ivy covering base, bark damage at base		tbd	tbd
2173	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Very Poor	Very Poor	Tree in heavy decline		tbd	tbd
2175	Douglas-fir	*Pseudotsuga menziesii*	26	13	Dead	Dead			tbd	tbd
2177	Douglas-fir	*Pseudotsuga menziesii*	24	12	Very Poor	Very Poor	Tree in heavy decline		tbd	tbd
2179	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Dead	Dead			tbd	tbd
2181	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Dead	Dead			tbd	tbd
2183	Douglas-fir	*Pseudotsuga menziesii*	24	12	Dead	Dead			tbd	tbd
2185	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Poor	Very Poor	Tree previously topped		tbd	tbd
2199	Douglas-fir	Pseudotsuga menziesii	30	15	Good	Fair	Limb with included bark at 25', bark damage at base		tbd	tbd
2201	Douglas-fir	*Pseudotsuga menziesii*	14	7	Good	Poor	Co-dominant stem at base, heavy lean		tbd	tbd
2203	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Good	Fair	Co-dominant stem at base		tbd	tbd
2205	Douglas-fir	*Pseudotsuga menziesii*	29	14.5	Good	Fair	Bark damage at base		tbd	tbd
2207	Douglas-fir	*Pseudotsuga menziesii*	26	13	Good	Good			tbd	tbd
2209	Douglas-fir	*Pseudotsuga menziesii*	19	9.5	Fair	Fair	Thin crown, bark damage at base		tbd	tbd
2211	Douglas-fir	*Pseudotsuga menziesii*	42	21	Fair	Poor	Thin crown, decay at base		tbd	tbd
2213	Douglas-fir	*Pseudotsuga menziesii*	24	12	Poor	Fair	Thin crown		tbd	tbd
2215	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Fair	Fair	Bark damage at base		tbd	tbd
2217	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Fair	Fair	Pistol butt stem, thin crown		tbd	tbd
2219	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Thin crown		tbd	tbd
2221	Douglas-fir	*Pseudotsuga menziesii*	16	8	Good	Good			tbd	tbd
2223	Douglas-fir	*Pseudotsuga menziesii*	12	6	Fair	Fair	Thin crown		tbd	tbd
2225	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Poor	Poor	Sloughing bark at base, thin crown		tbd	tbd
2227	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Good	Good			tbd	tbd
2229	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Fair	Fair	Thin crown		tbd	tbd
2231	Douglas-fir	*Pseudotsuga menziesii*	22	11	Poor	Poor	Red ring rot fruiting bodies on stem		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
2233	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Poor	Poor	Bark damage at base, thin crown, decay at base		tbd	tbd
2235	Douglas-fir	*Pseudotsuga menziesii*	38	19	Fair	Fair	Thin crown, excavation in root zone		tbd	tbd
2237	Douglas-fir	*Pseudotsuga menziesii*	32	16	Fair	Fair	Data visually collected	x	tbd	tbd
2239	Douglas-fir	*Pseudotsuga menziesii*	35	17.5	Fair	Poor	Insect damage at base, thin crown		tbd	tbd
2241	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Poor	Poor	Bark damage at base, thin crown		tbd	tbd
2241.1	Douglas-fir	*Pseudotsuga menziesii*	14	7	Dead	Dead			tbd	tbd
2244	Douglas-fir	*Pseudotsuga menziesii*	29	14.5	Fair	Fair	Thin crown, decay at base		tbd	tbd
2246	Douglas-fir	*Pseudotsuga menziesii*	28	14	Fair	Fair	Thin crown		tbd	tbd
2248	Douglas-fir	*Pseudotsuga menziesii*	47	23.5	Good	Good			tbd	tbd
2250	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Decay at base, thin crown, barbed wire in base		tbd	tbd
2252	Douglas-fir	*Pseudotsuga menziesii*	14	7	Fair	Fair	Thin crown, soil around base		tbd	tbd
2254	Douglas-fir	*Pseudotsuga menziesii*	14	7	Fair	Fair	Thin crown		tbd	tbd
2256	Douglas-fir	Pseudotsuga menziesii	16	8	Fair	Fair	Thin crown		tbd	tbd
2258	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Good	Poor	Excavation in root zone, bark damage at base		tbd	tbd
2260	Douglas-fir	Pseudotsuga menziesii	16	8	Fair	Fair	Bark damage at base, thin crown		tbd	tbd
2262	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Fair	Contorted stem, thin crown		tbd	tbd
2264	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Poor	Poor	Contorted top, bark damage at base, thin crown		tbd	tbd
2266	Douglas-fir	*Pseudotsuga menziesii*	11	5.5	Fair	Fair	Thin crown, rock piled at base		tbd	tbd
2268	Douglas-fir	*Pseudotsuga menziesii*	26	13	Poor	Poor	Thin crown, ivy at base		tbd	tbd
2270	Douglas-fir	*Pseudotsuga menziesii*	32	16	Poor	Poor	Decay at base		tbd	tbd
2272	Douglas-fir	*Pseudotsuga menziesii*	46	23	Fair	Fair	Old wound with decay at base, thin crown		tbd	tbd
2274	Douglas-fir	*Pseudotsuga menziesii*	16	8	Good	Good	Data visually collected	x	tbd	tbd
2276	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Good	Good	Data visually collected	x	tbd	tbd
2278	Douglas-fir	*Pseudotsuga menziesii*	14	7	Poor	Poor	Thin crown, bark damage at base, appears to be on edge of property line		tbd	tbd
2280	Douglas-fir	*Pseudotsuga menziesii*	32	16	Poor	Fair	Decay at base, thin crown		tbd	tbd
2282	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Poor	Poor	Decay at base, thin crown		tbd	tbd
2284	Douglas-fir	*Pseudotsuga menziesii*	20	10	Poor	Poor	Decay at base		tbd	tbd
2286	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Fair	Fair	Thin crown		tbd	tbd
2288	Douglas-fir	*Pseudotsuga menziesii*	32	16	Fair	Fair	Thin crown		tbd	tbd
2290	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Very Poor	Very Poor	Dead top		tbd	tbd
2292	Douglas-fir	*Pseudotsuga menziesii*	18	9	Fair	Fair	Ivy covering base, thin crown		tbd	tbd
2294	Douglas-fir	*Pseudotsuga menziesii*	31	15.5	Poor	Poor	Decay at base, ivy covering base		tbd	tbd
2296	Douglas-fir	*Pseudotsuga menziesii*	41	20.5	Fair	Poor	Decay at base, thin crown		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
2298	Douglas-fir	*Pseudotsuga menziesii*	39	19.5	Fair	Fair	Thin crown		tbd	tbd
2300	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Thin crown		tbd	tbd
2302	Douglas-fir	*Pseudotsuga menziesii*	16	8	Poor	Poor	Decay in stem at 20', thin crown		tbd	tbd
2304	Douglas-fir	*Pseudotsuga menziesii*	24	12	Good	Fair	Fence in base		tbd	tbd
2306	Douglas-fir	*Pseudotsuga menziesii*	54	27	Fair	Fair	Broken limb at base, thin crown		tbd	tbd
2308	Douglas-fir	*Pseudotsuga menziesii*	18	9	Fair	Fair	Thin crown		tbd	tbd
2310	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Fair	Fair	Thin crown		tbd	tbd
2312	Douglas-fir	*Pseudotsuga menziesii*	14	7	Poor	Poor	Thin crown		tbd	tbd
2314	Douglas-fir	*Pseudotsuga menziesii*	16	8	Poor	Poor	Thin crown		tbd	tbd
2316	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Fair	Fair	Ivy covering base		tbd	tbd
2318	Douglas-fir	*Pseudotsuga menziesii*	24	12	Fair	Fair	Ivy covering base		tbd	tbd
2320	Douglas-fir	*Pseudotsuga menziesii*	39	19.5	Good	Fair	Pistol butt		tbd	tbd
2322	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Ivy covering base		tbd	tbd
2324	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Ivy covering base		tbd	tbd
2326	Douglas-fir	*Pseudotsuga menziesii*	15	7.5	Fair	Fair	Ivy growing on stem		tbd	tbd
2328	Douglas-fir	*Pseudotsuga menziesii*	20	10	Good	Good	Data visually collected	x	tbd	tbd
2330	Douglas-fir	*Pseudotsuga menziesii*	16	8	Poor	Poor	Data visually collected	x	tbd	tbd
2332	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Good	Good			tbd	tbd
2334	Douglas-fir	*Pseudotsuga menziesii*	18	9	Fair	Fair	Data visually collected	x	tbd	tbd
2336	Douglas-fir	*Pseudotsuga menziesii*	18	9	Fair	Fair	Data visually collected	x	tbd	tbd
2338	Douglas-fir	*Pseudotsuga menziesii*	32	16	Good	Good	Data visually collected	x	tbd	tbd
2340	Douglas-fir	*Pseudotsuga menziesii*	22	11	Good	Fair	Bark damage on roots, appears to be on edge of property line		tbd	tbd
2342	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Fair	Fair	Thin crown		tbd	tbd
2344	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Thin crown		tbd	tbd
2346	Douglas-fir	*Pseudotsuga menziesii*	14	7	Fair	Poor	Decay in stem, bark damage at base		tbd	tbd
2348	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Poor	Poor	Decay in stem, thin crown		tbd	tbd
2350	Douglas-fir	*Pseudotsuga menziesii*	39	19.5	Good	Good			tbd	tbd
2352	Douglas-fir	*Pseudotsuga menziesii*	18	9	Poor	Poor	Exposed roots, thin crown		tbd	tbd
2354	Douglas-fir	*Pseudotsuga menziesii*	19	9.5	Fair	Fair	Thin crown		tbd	tbd
2356	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Good	Good			tbd	tbd
2358	Pacific madrone	*Arbutus menziesii*	18	9	Poor	Fair	Data visually collected	x	tbd	tbd
2360	Douglas-fir	*Pseudotsuga menziesii*	20	10	Good	Good	Data visually collected	x	tbd	tbd
2362	Douglas-fir	*Pseudotsuga menziesii*	16	8	Good	Fair	Data visually collected	x	tbd	tbd
2364	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Fair	Good	Data visually collected	x	tbd	tbd
2366	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Poor	Fair	Thin crown, appears to be on edge of property line		tbd	tbd
2368	Douglas-fir	*Pseudotsuga menziesii*	22	11	Good	Good	Data visually collected	x	tbd	tbd
2370	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Fair	Good	Thin crown		tbd	tbd
2372	Douglas-fir	*Pseudotsuga menziesii*	26	13	Good	Good			tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
2374	Douglas-fir	*Pseudotsuga menziesii*	12	6	Good	Good	Appears to be on edge of property line		tbd	tbd
2376	Douglas-fir	*Pseudotsuga menziesii*	34	17	Good	Good	Data visually collected	x	tbd	tbd
2378	Douglas-fir	*Pseudotsuga menziesii*	14	7	Good	Fair	Data visually collected	x	tbd	tbd
2380	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Fair	Good	Data visually collected	x	tbd	tbd
2382	Douglas-fir	*Pseudotsuga menziesii*	36	18	Poor	Fair	Ivy covering base, thin crown		tbd	tbd
2384	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Poor	Poor	Data visually collected	x	tbd	tbd
2386	Douglas-fir	*Pseudotsuga menziesii*	22	11	Good	Good	Data visually collected	x	tbd	tbd
2388	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Poor	Poor	Data visually collected	x	tbd	tbd
2390	Douglas-fir	*Pseudotsuga menziesii*	36	18	Fair	Fair	Data visually collected	x	tbd	tbd
2392	Douglas-fir	*Pseudotsuga menziesii*	36	18	Fair	Good	Data visually collected	x	tbd	tbd
2398	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Good	Good	Data visually collected	x	tbd	tbd
2400	bigleaf maple	*Acer macrophyllum*	10	5	Good	Fair	Data visually collected	x	tbd	tbd
2420	Douglas-fir	*Pseudotsuga menziesii*	14	7	Fair	Poor	Data visually collected	x	tbd	tbd
2423	Douglas-fir	*Pseudotsuga menziesii*	28	14	Good	Fair	Data visually collected	x	tbd	tbd
2425	Douglas-fir	*Pseudotsuga menziesii*	10	5	Poor	Poor	Data visually collected	x	tbd	tbd
2427	Douglas-fir	*Pseudotsuga menziesii*	32	16	Fair	Good	Data visually collected	x	tbd	tbd
2430	Douglas-fir	*Pseudotsuga menziesii*	17	8.5	Good	Fair	Data visually collected	x	tbd	tbd
2432	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Good	Fair	Data visually collected	x	tbd	tbd
2434	Douglas-fir	*Pseudotsuga menziesii*	21	10.5	Fair	Fair	Fence in base, thin crown, appears to be on edge of property line		tbd	tbd
2437	Douglas-fir	*Pseudotsuga menziesii*	28	14	Good	Fair	Data visually collected	x	tbd	tbd
2439	Douglas-fir	*Pseudotsuga menziesii*	16	8	Good	Good	Data visually collected	x	tbd	tbd
2441	Douglas-fir	*Pseudotsuga menziesii*	28	14	Fair	Fair	Thin crown		tbd	tbd
2443	Douglas-fir	*Pseudotsuga menziesii*	20	10	Fair	Fair	Thin crown, bark damage at base		tbd	tbd
2445	Douglas-fir	*Pseudotsuga menziesii*	20	10	Fair	Fair	Thin crown		tbd	tbd
2447	Douglas-fir	*Pseudotsuga menziesii*	13	6.5	Good	Fair	Bark damage at base		tbd	tbd
2449	Douglas-fir	*Pseudotsuga menziesii*	22	11	Fair	Fair	Thin crown		tbd	tbd
2451	Douglas-fir	*Pseudotsuga menziesii*	28	14	Fair	Poor	Wood pecker damage at base, thin crown, decay at base		tbd	tbd
2453	Douglas-fir	*Pseudotsuga menziesii*	12	6	Fair	Fair	Thin crown		tbd	tbd
2455	Douglas-fir	*Pseudotsuga menziesii*	18	9	Poor	Poor	Red ring rot, thin crown		tbd	tbd
2458	Douglas-fir	*Pseudotsuga menziesii*	25	12.5	Good	Good	Data visually collected	x	tbd	tbd
2460	Douglas-fir	*Pseudotsuga menziesii*	18	9	Good	Good	Data visually collected	x	tbd	tbd
2462	Douglas-fir	*Pseudotsuga menziesii*	12	6	Fair	Fair	Thin crown		tbd	tbd
2464	Douglas-fir	*Pseudotsuga menziesii*	14	7	Poor	Poor	Broken top, decay in stem		tbd	tbd
2466	Douglas-fir	*Pseudotsuga menziesii*	10	5	Fair	Fair	Thin crown		tbd	tbd
2468	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Co-dominant stem with included bark		tbd	tbd
2470	Douglas-fir	*Pseudotsuga menziesii*	23	11.5	Fair	Fair	Co-dominant stem with included bark, ivy covering stem		tbd	tbd

Tree No.	Common Name	Scientific Name	DBH[1]	C-Rad[2]	Condition[3]	Structure	Comments	Not On Property	Treatment	Mitigation[4]
2472	Douglas-fir	*Pseudotsuga menziesii*	10	5	Good	Fair	Data visually collected	x	tbd	tbd
2475	Douglas-fir	*Pseudotsuga menziesii*	40	20	Good	Good	Data visually collected	x	tbd	tbd
2477	Oregon white oak	*Quercus garryana*	12	6	Fair	Fair	Data visually collected	x	tbd	tbd
2479	Douglas-fir	*Pseudotsuga menziesii*	26	13	Fair	Fair	Thin crown, fence in base		tbd	tbd
2481	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Thin crown		tbd	tbd
2483	Douglas-fir	*Pseudotsuga menziesii*	18	9	Good	Good			tbd	tbd
2485	Douglas-fir	*Pseudotsuga menziesii*	14	7	Fair	Fair	Bark damage at base		tbd	tbd
2487	Douglas-fir	*Pseudotsuga menziesii*	26	13	Poor	Poor	Broken limbs in crown, thin crown		tbd	tbd
2489	Douglas-fir	*Pseudotsuga menziesii*	33	16.5	Poor	Poor	Thin crown		tbd	tbd
2496	Douglas-fir	*Pseudotsuga menziesii*	24	12	Fair	Fair	Thin crown		tbd	tbd
2498	Douglas-fir	*Pseudotsuga menziesii*	27	13.5	Fair	Fair	Co-dominant stem with included bark, thin crown		tbd	tbd
2500	Douglas-fir	*Pseudotsuga menziesii*	19	9.5	Dead	Dead			tbd	tbd
2502	Douglas-fir	*Pseudotsuga menziesii*	24	12	Good	Good			tbd	tbd
2504	Douglas-fir	*Pseudotsuga menziesii*	16	8	Fair	Fair	Thin crown		tbd	tbd
2506	Douglas-fir	*Pseudotsuga menziesii*	20	10	Fair	Fair	Bark damage at base, thin crown		tbd	tbd
2508	Douglas-fir	*Pseudotsuga menziesii*	24	12	Poor	Fair	Thin crown		tbd	tbd
2587	Douglas-fir	*Pseudotsuga menziesii*	36	18	Fair	Poor	Co-dominant stem with included bark		tbd	tbd

[1] **DBH** is the trunk diameter in inches measured per International Society of Arboriculture (ISA) standards.

[2] **C-Rad** is the approximate crown radius in feet.

[3] **Condition and Structure** ratings range from dead, very poor, poor, fair, to good.

[4] **Mitigation** is recommended for the removal of trees over 6-inch DBH. Trees that are less than 6-inch DBH are not recommended for mitigation.

REQUESTED BY:

LEE LEIGHTON (MACKENZIE)

FOR: DELTA LOGISTICS
9835 SW COMMERCE CIRCLE
WILSONVILLE, OR 97070

TREE SURVEY
9710 SW DAY ROAD

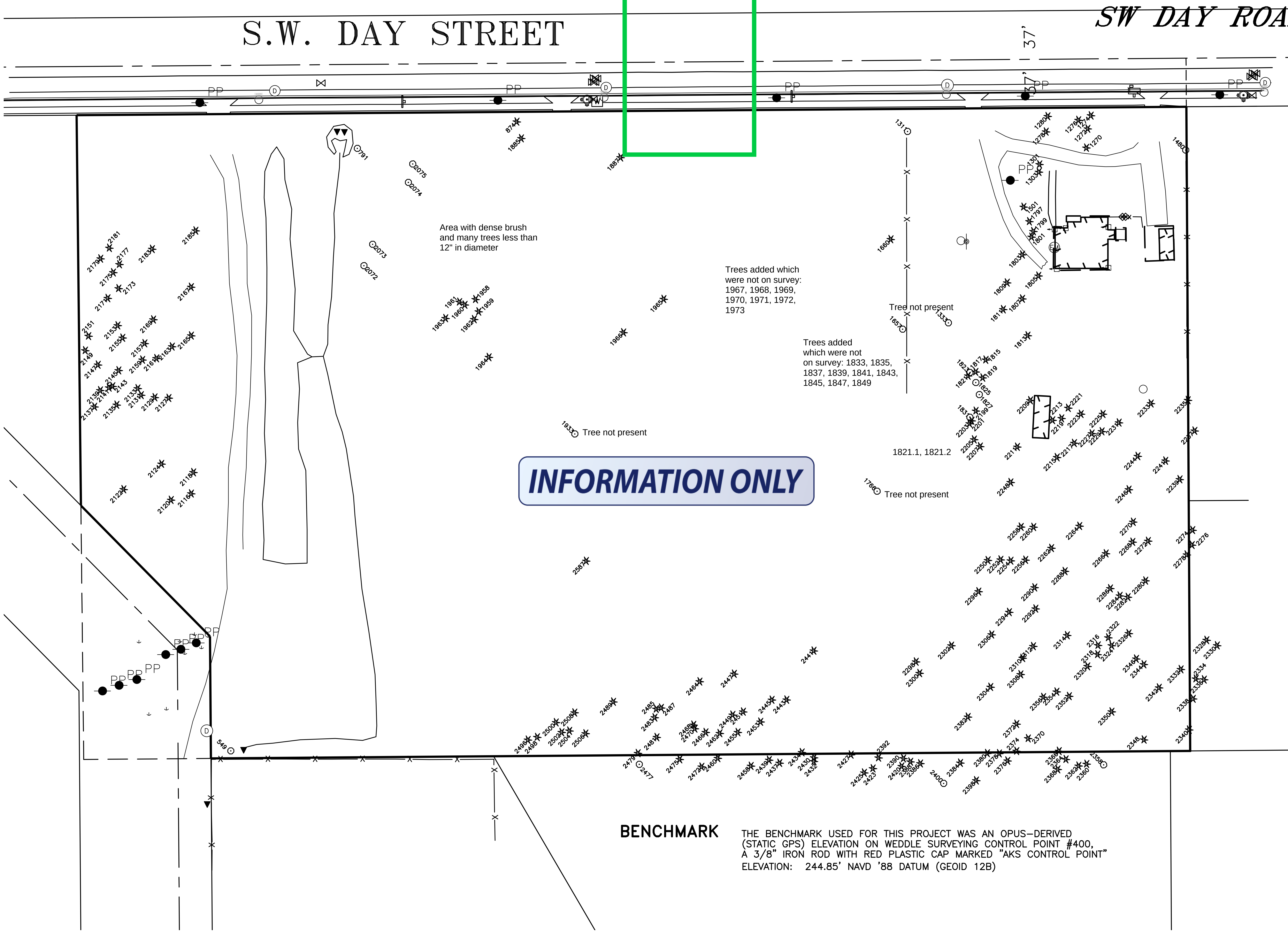
LOCATED IN THE SW 1/4 AND THE NW 1/4
SECTION 2, T.3S., R.1W., W.M.
WASHINGTON COUNTY, OREGON

SURVEYOR'S NOTES

1. THE BASIS OF BEARINGS FOR THIS SURVEY IS PER SURVEY NO. 29,223, WASHINGTON COUNTY SURVEY RECORDS. THIS IS NOT A RECORDABLE BOUNDARY SURVEY, A RECORD OF SURVEY IS IN PROGRESS.
2. UNDERGROUND UTILITIES ARE SHOWN PER SURFACE MARKINGS. THE SURVEYOR MAKES NO GUARANTEE AS TO THE EXACT LOCATION, EXISTENCE, NON-EXISTENCE OR COMPLETENESS OF ANY SUBSURFACE UTILITIES SHOWN, OR NOT SHOWN ON THE MAP. CALL 811 BEFORE DIGGING.
3. TOTAL SURVEYED SITE AREA = 9.169 ACRES
BUILDABLE AREA EAST OF EASTERLY S.R.O.Z. = 6.338 ACRES
4. DUE TO THE DENSE, OVERGROWN NATURE OF VEGETATION ON SITE, NOT ALL TREES WERE MAPPED AND A 3-D SURFACE OVER THE ENTIRE SITE WAS NOT OBTAINABLE.

0 60 120 180

SCALE: 1" = 60'
OCTOBER, 2019
SEPTEMBER, 2021



LEGEND

- ✱ CONIFEROUS TREE
- ▼ CULVERT INVERT
- CURB INLET
- DECIDUOUS TREE
- DECORATIVE SHRUB
- DOWNSPOUT
- FFE FINISH FLOOR ELEV.
- FIRE HYDRANT
- G GAS METER
- GAS RISER
- GATE POST
- GUY ANCHOR
- MAILBOX
- NG NATURAL GROUND
- PM POWER METER
- ● PP POWER POLE
- SIGN "AS NOTED"
- SITE BENCHMARK
- SPOT ELEVATION
- G GUTTER
- TC TOP OF CURB
- S.R.O.Z. SIGNIFICANT RESOURCE OVERLAY ZONE
- Ⓓ STORM DRAIN MANHOLE
- ● SURVEY MONUMENTS FOUND
- ○ SURVEY MONUMENTS SET
- ○ UTILITY LID
- W WATER METER
- WATER RISER
- ⋈ WATER VALVE
- ☐ WETLANDS BUFFER/LINE STAKES
- BRUSH LINE
- BUILDING EAVE
- BUILDING FOOTPRINT
- CENTERLINE
- EASEMENT LINE
- —X—X— FENCE LINE
- —G— GAS LINE
- —E— OVERHEAD POWER
- —SD— STORM DRAIN LINE
- TAX LOT LINE
- —W— WATER LINE
- WETLANDS BUFFER
- ☐ ASPHALT
- ☐ CONCRETE
- ☐ GRAVEL

REGISTERED
PROFESSIONAL
LAND SURVEYOR

OREGON
JULY 13, 2004
ANTHONY B. RYAN
58833

EXPIRES: DECEMBER 31, 2022

BENCHMARK

THE BENCHMARK USED FOR THIS PROJECT WAS AN OPUS-DERIVED (STATIC GPS) ELEVATION ON WEDDLE SURVEYING CONTROL POINT #400, A 3/8" IRON ROD WITH RED PLASTIC CAP MARKED "AKS CONTROL POINT"
ELEVATION: 244.85' NAVD '88 DATUM (GEOID 12B)

WEDDLE SURVEYING Inc.
Excellence is our benchmark.

6950 SW HAMPTON ST., STE. 170, TIGARD, OR 97223
PH: (503) 941-9585 FAX: (503) 941-9640
www.weddlesurveying.net

JOB NO. 5727

APPENDIX D. WILSONVILLE SIGNIFICANT RESOURCE OVERLAY ZONE MAP

The City of Wilsonville SROZ

Note: All information is subject to change . Every effort is taken to eliminate errors and ommissions but please contact the City of Wilsonville to confirm information before taking any action.

APPENDIX E. GROUND LEVEL PHOTOGRAPHS

Photo Point 1. From forested hillside in the eastern portion of the site facing north (photo date: 10/23/2019).

Photo Point 1. From forested hillside in the eastern portion of the site facing east (photo date: 10/23/2019).

Photo Point 1. From forested hillside in the eastern portion of the site facing south (photo date: 10/23/2019).

Photo Point 1. From forested hillside in the eastern portion of the site facing west (photo date: 10/23/2019).

Photo Point 2. From the bottom of the hill in the central portion of the site facing north (photo date: 10/23/2019).

Photo Point 2. From the bottom of the hill in the central portion of the site facing east (photo date: 10/23/2019).

Photo Point 2. From the bottom of the hill in the central portion of the site facing south (photo date: 10/23/2019).

Photo Point 2. From the bottom of the hill in the central portion of the site facing west (photo date: 10/23/2019).

Photo Point 3. From the northern portion of Wetland 1 (CWM site) facing north toward wetland area (photo date: 10/23/2019).

Photo Point 3. From the northern portion of Wetland 1 (CWM site) facing east toward wetland boundary (photo date: 10/23/2019).

Photo Point 3. From the northern portion of Wetland 1 (CWM site) facing south toward wetland area (photo date: 10/23/2019).

Photo Point 3. From the northern portion of Wetland 1 (CWM site) facing west toward wetland boundary (photo date: 10/23/2019).

Photo Point 4. From the southern portion of Wetland 1 (CWM site) facing north along wetland boundary at toe of slope (photo date: 10/23/2019).

Photo Point 4. From Wetland 1 (CWM site) facing east toward wetland area (photo date: 10/23/2019).

Photo Point 4. From the southern portion of Wetland 1 (CWM site) facing south along wetland boundary at toe of slope (photo date: 10/23/2019).

Photo Point 4. From Wetland 1 (CWM site) facing west toward access road and upland forest area (photo date: 10/23/2019).

Photo Point 5. From the northern portion of Tapman Creek (wetland drainage) facing north toward double culverts (photo date: 10/23/2019).

Photo Point 5. From the northern portion of Tapman Creek (wetland drainage) facing east toward drainage bank (photo date: 10/23/2019).

Photo Point 5. From the northern portion of Tapman Creek (wetland drainage) facing south, downslope (photo date: 10/23/2019).

Photo Point 5. From the northern portion of Tapman Creek (wetland drainage) facing west toward drainage bank (photo date: 10/23/2019).

Photo Point 6. From Wetland 2 facing north toward wetland area (photo date: 10/23/2019).

Photo Point 6. From Wetland 2 facing east toward wetland boundary (photo date: 10/23/2019).

Photo Point 6. From Wetland 2 facing south toward wetland area (photo date: 10/23/2019).

Photo Point 6. From Wetland 2 facing west toward wetland boundary (photo date: 10/23/2019).

Photo Point 7. From the top of bank of the CWM site (Wetland 1) facing south (photo date: 9/1/2021).

Photo Point 7. From the top of bank of the CWM site (Wetland 1) facing north (photo date: 9/1/2021).

Photo Point 7. From the top of bank of the CWM site (Wetland 1) facing west (photo date: 9/1/2021).

Photo Point 8. From the top of bank of Tapman Creek (wetland drainage) in the central portion facing north, upslope (photo date: 9/1/2021).

Photo Point 8. From the top of bank of Tapman Creek (wetland drainage) in the central portion facing east across the drainage (photo date: 9/1/2021).

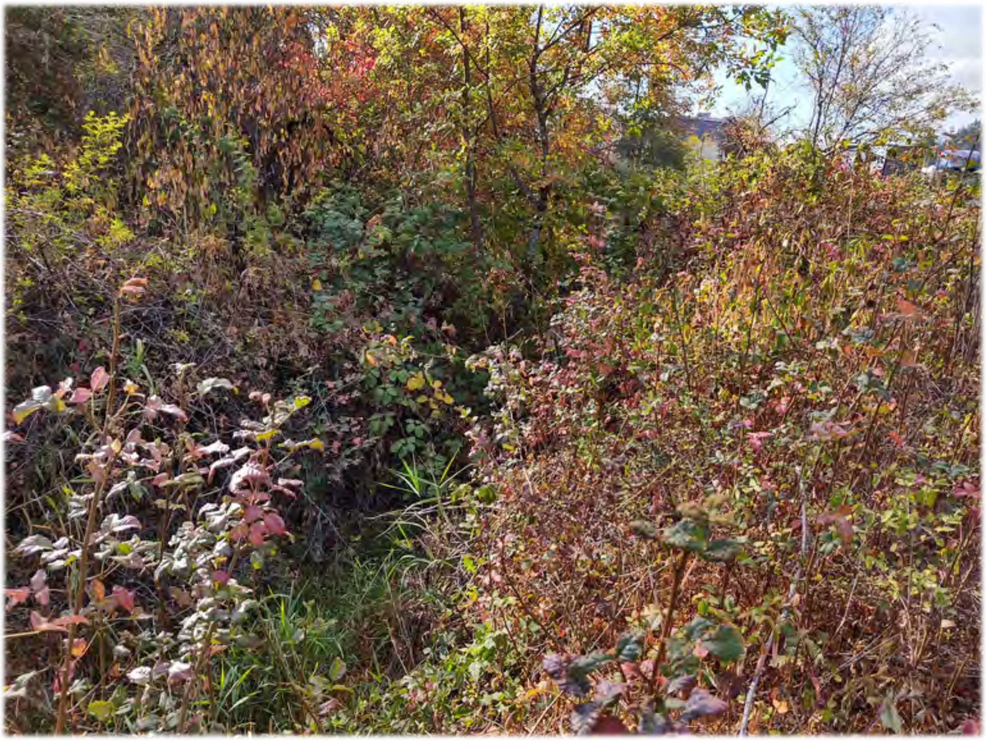


Photo Point 8. From the top of bank of Tapman Creek (wetland drainage) in the central portion facing south, downslope (photo date: 9/1/2021).

Photo Point 8. From the top of bank of Tapman Creek (wetland drainage) in the central portion facing west toward CWM site (Wetland 1) (photo date: 9/1/2021).

Photo Point 9. From the recently graveled area facing west (photo date: 9/1/2021).

Photo Point 9. From the recently graveled area facing north (photo date: 9/1/2021).

Photo Point 9. From the recently graveled area facing east (photo date: 9/1/2021).

Photo Point 9. From the recently graveled area facing south (photo date: 9/1/2021).

Photo Point 10. From the southern end of Tapman Creek facing west (photo date: 9/1/2021).

Photo Point 10. From the southern end of Tapman Creek facing east (photo date: 9/1/2021).

APPENDIX F. OFWAM FORMS

OREGON FRESHWATER WETLAND ASSESSMENT METHODOLOGY (OFWAM)
ASSESSMENT QUESTIONS

Wetland______1____

Wildlife Habitat (WH)

1. How many Cowardin wetland classes are present (include vertical strata ≥20% cover)?
    [✓ a.] 2 or more b. 1 with >5 plant species c. 1 w/ ≤5 plant species
2. What is the dominant wetland vegetation cover type?
    [✓ a.] Woody vegetation b. Emergent vegetation and ponding, or open water only
    c. Emergent vegetation or wet meadow
3. What is the degree of Cowardin class interspersion for the wetland being observed (Fig. 3)?
    a. High [✓ b.] Moderate c. Low
4. How many acres of unvegetated open water are present?
    a. More than 1 acre b. Between 0.5 and 1 acre [✓ c.] Less than 0.5 acre
5. How is the wetland connected to another body of water, such as a stream, lake or pond (F. 2)?
    [✓ a.] The wetland is connected by surface water to another body of water
    b. No surface water connection exists, but other bodies of water lie within 1 mile
    c. No surface water connection exits, and no other bodies of water lie within 1 mile
6. How is the wetland connected to other wetlands?
    [✓ a.] Connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, culvert, canal or lake
    b. Not connected by surface water, but other unconnected wetlands lie within a 3-mile radius
    c. Not connected to other wetlands by surface waters, and no other unconnected wetlands lie within a 3-mile radius
7. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland?
    [✓ a.] No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
    b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
    c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
8. What is the dominant existing land use within 500 feet of the wetland's edge?
    a. Exclusive Forest Use or Open Space b. Agriculture [✓ c.] Developed uses

9b. What percent of the wetland's edge is bordered by a vegetative buffer at least 25 feet wide?
    a. Greater than 40% [✓ b.] Between 10 and 40% c. Less than 10%
    Is it 50 feet wide or wider? [✓ yes]___ no___ notes:

Wildlife Habitat Assessment Criteria	
The wetland provides *diverse* wildlife habitat if:	At least four questions are answered "a," and no more than one is answered "c."
[✓ The wetland provides *habitat for some species* if:]	Answers do not satisfy the above- or below-listed criteria.
The wetland's wildlife habitat function is *lost or not present* if:	All questions are answered "c."

Fish Habitat (FH)

Part A - Streams

1. What percentage of the stream is shaded by stream-side (riparian) vegetation?
    a. More than 75% [✓ b]. Between 50 and 75% c. Less than 50%

2. What is the physical character of the stream channel?
    a. The stream is in a natural channel, or modified portions of the stream are returning to a natural channel
    [✓ b]. Only portions of the stream channel are modified
    c. The stream is extensively modified or confined in a non-vegetated channel or pipe

3. What percentage of the entire stream contains instream structures such as large woody debris, floating submerged vegetation, large rocks or boulders?
    a. More than 25% [✓ b]. Between 10 and 25% c. Less than 10%

4. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
    [✓ a]. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
    b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
    c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants

5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
    a. Exclusive Forest Use or Open Space b. Agriculture [✓ c]. Developed uses

6. Are fish present in a stream, lake or pond associated with the wetland?
    a. Salmon, trout or sensitive species are present at some time during the year
    b. Species not covered in "a" are present at some time during the year
    [✓ c.] No species are present at any time during the year

Part B - Lakes and Ponds

1. Does the lake or pond contain areas of both deep and shallow water?
    a. Yes b. Cannot be determined. c. No

2. What percentage of the wetland complex contains cover objects such as submerged logs, floating or submerged vegetation, large rocks or boulders?
    a. More than 25% b. Between 10 and 75% c. Less than 10%

3. What percentage of the shoreline is shaded at the water's edge by forested or scrub-shrub vegetation?
    a. 60% or more b. Between 20 and 59% c. Less than 20%

4 What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
    a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
    b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
    c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants

5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
    a. Exclusive Forest Use or Open Space b. Agriculture c. Developed uses

6. Are fish in a stream, lake or pond associated with the wetland?
    a. Salmon, trout or sensitive species are present at some time during the year
    b. Species not covered in "a" are present at some time during the year

c. No species are present at any time during the year

Fish Habitat Assessment Criteria

The wetland's fish habitat function is *intact* if:	Three or more questions are answered "a," and no more than one is answered "c."
The wetlands's fish habitat function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
The wetlands's fish habitat function is *lost or not present* if:	All questions are answered "c."

Water Quality (Pollutant Removal; WQ)

1. What is the wetland's primary source of water?
   [✓ a. Surface flow, including streams and ditches] b. Precipitation or sheet flow
   c. Groundwater, including seeps and springs
2. Is there evidence of flooding or ponding during a portion of the growing season?
   [✓ a. Yes] b. Unable to determine or not applicable c. No
3. What is the degree of wetland vegetation cover?
   [✓ a. High (>60%; OW<40%)] b. Moderate (~60%; OW=40%) c. Low (<60%; OW>40%)
4. What is the wetland's area in acres?
   a. >5 acres
   [✓ b. Between 0.5 acre and 5 acres; or <0.5 acres and the wetland is connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake]
   c. <0.5 acre, and the wetland is not connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake
5. What is the dominant, existing land use within 500 feet of the wetland's edge (opposite WH8)?
   [✓ a. Developed uses] b. Agriculture c. Exclusive Forest Use or Open Space
6. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (opposite WH7)?
   a. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   [✓ c. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants]

Water Quality Assessment Criteria

A wetland's water-quality function is *intact* if:	Four or more questions are answered "a."
A wetland's water-quality function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
A wetlands's water-quality function is *lost or not present* if:	Four or more questions are answered "c."

Hydrologic Control (Flood Control & Water Supply; HC)

1. Is all or part of the wetland located within the 100-year floodplain or within an enclosed basin?
    a. Yes b. [✓ No]
2. Is there evidence of flooding or ponding during a portion of the growing season?
    [✓ a.] Yes b. Unable to determine or not applicable c. No
3. What is the wetland's area in acres?
    a. >5 acres b. Between 0.5 and 5 acres [✓ c.] <0.5 acre
4. Is waterflow out of the wetland restricted (eg., beaver dam, concrete structure, undersized culvert)?
    a. Yes, the outlet is restricted or the wetland has not outlet
    [✓ b.] Minor restrictions slow down the water (i.e., undersized culvert)
    c. No the outlet has unrestricted flow
5. What is the dominant wetland vegetation cover type (=WH2)?
    [✓ a.] Woody vegetation
    b. Emergent vegetation and ponding, or open water only
    c. Emergent vegetation or wet meadow
6. What is the dominant existing land use within 500 feet of the wetland <u>on the downstream or down-slope edge of the wetland</u>?
    [✓ a]. Developed uses b. Agriculture c. Exclusive Forest Use or Open Space
7. What is the dominant land use in the watershed upstream from the assessment area?
    a. Urban or Urbanizing b. Agriculture [✓ c]. Forested or Natural Area

Hydrologic Control Assessment Criteria	
A wetland's hydrologic control function is *intact* if:	Four or more questions are answered “a.”
[✓ A wetland’s hydrologic control function is *impacted of degraded* if:]	Answers do not satisfy the above- or below-listed criteria.
A wetland’s hydrologic control function is *lost or not present* if:	Four or more questions are answered “c.”

OFWAM FUNCTION SUMMARY

WH: Some habitat

FH: Impacted or degraded

WQ: Intact

HC: Impacted or degraded

OREGON FRESHWATER WETLAND ASSESSMENT METHODOLOGY (OFWAM)
ASSESSMENT QUESTIONS

Wetland 2

Wildlife Habitat (WH)

1. How many Cowardin wetland classes are present (include vertical strata ≥20% cover)?
   [✓ a.] 2 or more b. 1 with >5 plant species c. 1 w/ ≤5 plant species
2. What is the dominant wetland vegetation cover type?
   [✓ a.] Woody vegetation b. Emergent vegetation and ponding, or open water only
   c. Emergent vegetation or wet meadow
3. What is the degree of Cowardin class interspersion for the wetland being observed (Fig. 3)?
   a. High b. Moderate [✓ c.] Low
4. How many acres of unvegetated open water are present?
   a. More than 1 acre b. Between 0.5 and 1 acre [✓ c.] Less than 0.5 acre
5. How is the wetland connected to another body of water, such as a stream, lake or pond (F. 2)?
   a. The wetland is connected by surface water to another body of water
   [✓ b.] No surface water connection exists, but other bodies of water lie within 1 mile
   c. No surface water connection exits, and no other bodies of water lie within 1 mile
6. How is the wetland connected to other wetlands?
   a. Connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, culvert, canal or lake
   [✓ b.] Not connected by surface water, but other unconnected wetlands lie within a 3-mile radius
   c. Not connected to other wetlands by surface waters, and no other unconnected wetlands lie within a 3-mile radius
7. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland?
   [✓ a.] No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
8. What is the dominant existing land use within 500 feet of the wetland's edge?
   a. Exclusive Forest Use or Open Space b. Agriculture [✓ c.] Developed uses

9b. What percent of the wetland's edge is bordered by a vegetative buffer at least 25 feet wide?
   [✓ a.] Greater than 40% b. Between 10 and 40% c. Less than 10%
   Is it 50 feet wide or wider? [✓ yes]___ no___ notes:

Wildlife Habitat Assessment Criteria	
The wetland provides *diverse* wildlife habitat if:	At least four questions are answered "a," and no more than one is answered "c."
The wetland provides *habitat for some species* if:	Answers do not satisfy the above- or below-listed criteria.
The wetland's wildlife habitat function is *lost or not present* if:	All questions are answered "c."

Fish Habitat (FH)

Part A - Streams

1. What percentage of the stream is shaded by stream-side (riparian) vegetation?
   a. More than 75% b. Between 50 and 75% c. Less than 50%
2. What is the physical character of the stream channel?
   a. The stream is in a natural channel, or modified portions of the stream are returning to a natural channel
   b. Only portions of the stream channel are modified
   c. The stream is extensively modified or confined in a non-vegetated channel or pipe
3. What percentage of the entire stream contains instream structures such as large woody debris, floating submerged vegetation, large rocks or boulders?
   a. More than 25% b. Between 10 and 25% c. Less than 10%
4. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
   a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
   a. Exclusive Forest Use or Open Space b. Agriculture c. Developed uses
6. Are fish present in a stream, lake or pond associated with the wetland?
   a. Salmon, trout or sensitive species are present at some time during the year
   b. Species not covered in "a" are present at some time during the year
   c. No species are present at any time during the year

Part B - Lakes and Ponds

1. Does the lake or pond contain areas of both deep and shallow water?
   a. Yes b. Cannot be determined. c. No
2. What percentage of the wetland complex contains cover objects such as submerged logs, floating or submerged vegetation, large rocks or boulders?
   a. More than 25% b. Between 10 and 75% c. Less than 10%
3. What percentage of the shoreline is shaded at the water's edge by forested or scrub-shrub vegetation?
   a. 60% or more b. Between 20 and 59% c. Less than 20%

4 What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
   a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants

5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
   a. Exclusive Forest Use or Open Space b. Agriculture c. Developed uses
6. Are fish in a stream, lake or pond associated with the wetland?
   a. Salmon, trout or sensitive species are present at some time during the year
   b. Species not covered in "a" are present at some time during the year

c. No species are present at any time during the year

Fish Habitat Assessment Criteria

The wetland's fish habitat function is *intact* if:	Three or more questions are answered “a,” and no more than one is answered “c.”
The wetlands's fish habitat function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
The wetlands's fish habitat function is *lost or not present* if:	All questions are answered “c.”

Water Quality (Pollutant Removal; WQ)

1. What is the wetland's primary source of water?
   - a. Surface flow, including streams and ditches   b. Precipitation or sheet flow
   - [✓ c.] Groundwater, including seeps and springs
2. Is there evidence of flooding or ponding during a portion of the growing season?
   - a. Yes   b. Unable to determine or not applicable   [✓ c.] No
3. What is the degree of wetland vegetation cover?
   - a. High (>60%; OW<40%)   b. Moderate (~60%; OW=40%)   [✓ c.] Low (<60%; OW>40%)
4. What is the wetland's area in acres?
   - a. >5 acres
   - b. Between 0.5 acre and 5 acres; or <0.5 acres and the wetland is connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake
   - [✓ c.] <0.5 acre, and the wetland is not connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake
5. What is the dominant, existing land use within 500 feet of the wetland's edge (opposite WH8)?
   - [✓ a.] Developed uses   b. Agriculture   c. Exclusive Forest Use or Open Space
6. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (opposite WH7)?
   - a. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
   - b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   - [✓ c.] No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants

Water Quality Assessment Criteria

A wetland's water-quality function is *intact* if:	Four or more questions are answered “a.”
A wetland’s water-quality function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
A wetlands's water-quality function is *lost or not present* if:	Four or more questions are answered “c.”

Hydrologic Control (Flood Control & Water Supply; HC)

1. Is all or part of the wetland located within the 100-year floodplain or within an enclosed basin?
   a. Yes b. [✓ No]
2. Is there evidence of flooding or ponding during a portion of the growing season?
   a. Yes b. Unable to determine or not applicable [✓ c. No]
3. What is the wetland's area in acres?
   a. >5 acres b. Between 0.5 and 5 acres [✓ c. <0.5 acre]
4. Is waterflow out of the wetland restricted (eg., beaver dam, concrete structure, undersized culvert)?
   [✓ a. Yes, the outlet is restricted or the wetland has not outlet]
   b. Minor restrictions slow down the water (i.e., undersized culvert)
   c. No the outlet has unrestricted flow
5. What is the dominant wetland vegetation cover type (=WH2)?
   [✓ a. Woody vegetation]
   b. Emergent vegetation and ponding, or open water only
   c. Emergent vegetation or wet meadow
6. What is the dominant existing land use within 500 feet of the wetland <u>on the downstream or down-slope edge of the wetland</u>?
   [✓ a. Developed uses] b. Agriculture c. Exclusive Forest Use or Open Space
7. What is the dominant land use in the watershed upstream from the assessment area?
   a. Urban or Urbanizing b. Agriculture [✓ c. Forested or Natural Area]

Hydrologic Control Assessment Criteria	
A wetland's hydrologic control function is *intact* if:	Four or more questions are answered “a.”
[✓ A wetland’s hydrologic control function is *impacted of degraded* if:]	Answers do not satisfy the above- or below-listed criteria.
A wetland’s hydrologic control function is *lost or not present* if:	Four or more questions are answered “c.”

OFWAM FUNCTION SUMMARY

WH: Some habitat

FH: Not present

WQ: Lost

HC: Impacted or degraded

OREGON FRESHWATER WETLAND ASSESSMENT METHODOLOGY (OFWAM) ASSESSMENT QUESTIONS

Wetland Tapman Creek

Wildlife Habitat (WH)

1. How many Cowardin wetland classes are present (include vertical strata ≥20% cover)?
   a. 2 or more b. 1 with >5 plant species [✓ c. 1 w/ ≤5 plant species]
2. What is the dominant wetland vegetation cover type?
   a. Woody vegetation b. Emergent vegetation and ponding, or open water only
   [✓ c. Emergent vegetation or wet meadow]
3. What is the degree of Cowardin class interspersion for the wetland being observed (Fig. 3)?
   a. High b. Moderate [✓ c. Low]
4. How many acres of unvegetated open water are present?
   a. More than 1 acre b. Between 0.5 and 1 acre [✓ c. Less than 0.5 acre]
5. How is the wetland connected to another body of water, such as a stream, lake or pond (F. 2)?
   a. The wetland is connected by surface water to another body of water
   [✓ b. No surface water connection exists, but other bodies of water lie within 1 mile]
   c. No surface water connection exits, and no other bodies of water lie within 1 mile
6. How is the wetland connected to other wetlands?
   [✓ a. Connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, culvert, canal or lake]
   b. Not connected by surface water, but other unconnected wetlands lie within a 3-mile radius
   c. Not connected to other wetlands by surface waters, and no other unconnected wetlands lie within a 3-mile radius
7. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland?
   [✓ a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants]
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
8. What is the dominant existing land use within 500 feet of the wetland's edge?
   a. Exclusive Forest Use or Open Space b. Agriculture [✓ c. Developed uses]

9b. What percent of the wetland's edge is bordered by a vegetative buffer at least 25 feet wide?
   [✓ a. Greater than 40%] b. Between 10 and 40% c. Less than 10%
   Is it 50 feet wide or wider? [✓ yes]__ no___ notes:

Wildlife Habitat Assessment Criteria	
The wetland provides *diverse* wildlife habitat if:	At least four questions are answered “a,” and no more than one is answered “c.”
[✓ The wetland provides *habitat for some species* if:]	Answers do not satisfy the above- or below-listed criteria.
The wetland’s wildlife habitat function is *lost or not present* if:	All questions are answered “c.”

Fish Habitat (FH)

Part A - Streams

1. What percentage of the stream is shaded by stream-side (riparian) vegetation?
   a. More than 75%   [✓ b. Between 50 and 75%]   c. Less than 50%
2. What is the physical character of the stream channel?
   a. The stream is in a natural channel, or modified portions of the stream are returning to a natural channel
   [✓ b. Only portions of the stream channel are modified]
   c. The stream is extensively modified or confined in a non-vegetated channel or pipe
3. What percentage of the entire stream contains instream structures such as large woody debris, floating submerged vegetation, large rocks or boulders?
   a. More than 25%   b. Between 10 and 25%   [✓ c. Less than 10%]
4. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
   [✓ a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants]
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
   a. Exclusive Forest Use or Open Space   b. Agriculture   [✓ c. Developed uses]
6. Are fish present in a stream, lake or pond associated with the wetland?
   a. Salmon, trout or sensitive species are present at some time during the year
   b. Species not covered in "a" are present at some time during the year
   [✓ c. No species are present at any time during the year]

Part B - Lakes and Ponds

1. Does the lake or pond contain areas of both deep and shallow water?
   a. Yes   b. Cannot be determined.   c. No
2. What percentage of the wetland complex contains cover objects such as submerged logs, floating or submerged vegetation, large rocks or boulders?
   a. More than 25%   b. Between 10 and 75%   c. Less than 10%
3. What percentage of the shoreline is shaded at the water's edge by forested or scrub-shrub vegetation?
   a. 60% or more   b. Between 20 and 59%   c. Less than 20%

4 What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (= WH7)?
   a. No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants
   b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
   c. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants

5. What is the dominant existing land use within 500 feet of the wetland's edge (= WH8)?
   a. Exclusive Forest Use or Open Space   b. Agriculture   c. Developed uses
6. Are fish in a stream, lake or pond associated with the wetland?
   a. Salmon, trout or sensitive species are present at some time during the year
   b. Species not covered in "a" are present at some time during the year

c. No species are present at any time during the year

Fish Habitat Assessment Criteria	
The wetland's fish habitat function is *intact* if:	Three or more questions are answered “a,” and no more than one is answered “c.”
The wetlands's fish habitat function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
The wetlands's fish habitat function is *lost or not present* if:	All questions are answered “c.”

Water Quality (Pollutant Removal; WQ)

1. What is the wetland's primary source of water?
    [✓ a.] Surface flow, including streams and ditches   b. Precipitation or sheet flow
    c. Groundwater, including seeps and springs
2. Is there evidence of flooding or ponding during a portion of the growing season?
    [✓ a.] Yes   b. Unable to determine or not applicable   c. No
3. What is the degree of wetland vegetation cover?
    [✓ a.] High (>60%; OW<40%)   b. Moderate (~60%; OW=40%)   c. Low (<60%; OW>40%)
4. What is the wetland's area in acres?
    a. >5 acres
    [✓ b.] Between 0.5 acre and 5 acres; or <0.5 acres and the wetland is connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake
    c. <0.5 acre, and the wetland is not connected to other wetlands within a 3-mile radius by a perennial or intermittent stream, irrigation or drainage ditch, canal or lake
5. What is the dominant, existing land use within 500 feet of the wetland's edge (opposite WH8)?
    [✓ a.] Developed uses   b. Agriculture   c. Exclusive Forest Use or Open Space
6. What is the water quality condition of stream reaches in the watershed upstream of the wetland or adjacent to the wetland (opposite WH7)?
    a. One or more upstream or adjacent reaches are listed as *water quality limited* or in *severe* water quality condition for nonpoint source pollutants
    b. One or more upstream or adjacent reaches are listed in *moderate* water quality condition for nonpoint source pollutants
    [✓ c.] No upstream or adjacent reached are listed as *water quality limited*, and all upstream or adjacent reaches are listed as *no problem* (or no data available) for nonpoint source pollutants

Water Quality Assessment Criteria	
A wetland's water-quality function is *intact* if:	Four or more questions are answered “a.”
A wetland’s water-quality function is *impacted or degraded* if:	Answers do not satisfy the above- or below-listed criteria.
A wetlands's water-quality function is *lost or not present* if:	Four or more questions are answered “c.”

Hydrologic Control (Flood Control & Water Supply; HC)

1. Is all or part of the wetland located within the 100-year floodplain or within an enclosed basin?
   a. Yes b. [✓ No]
2. Is there evidence of flooding or ponding during a portion of the growing season?
   [✓ a. Yes] b. Unable to determine or not applicable c. No
3. What is the wetland's area in acres?
   a. >5 acres b. Between 0.5 and 5 acres [✓ c. <0.5 acre]
4. Is waterflow out of the wetland restricted (eg., beaver dam, concrete structure, undersized culvert)?
   [✓ a. Yes, the outlet is restricted or the wetland has not outlet]
   b. Minor restrictions slow down the water (i.e., undersized culvert)
   c. No the outlet has unrestricted flow
5. What is the dominant wetland vegetation cover type (=WH2)?
   a. Woody vegetation
   b. Emergent vegetation and ponding, or open water only
   [✓ c. Emergent vegetation or wet meadow]
6. What is the dominant existing land use within 500 feet of the wetland <u>on the downstream or down-slope edge of the wetland</u>?
   [✓ a. Developed uses] b. Agriculture c. Exclusive Forest Use or Open Space
7. What is the dominant land use in the watershed upstream from the assessment area?
   a. Urban or Urbanizing b. Agriculture [✓ c. Forested or Natural Area]

Hydrologic Control Assessment Criteria	
A wetland's hydrologic control function is *intact* if:	Four or more questions are answered “a.”
A wetland’s hydrologic control function is *impacted of degraded* if:	Answers do not satisfy the above- or below-listed criteria.
A wetland’s hydrologic control function is *lost or not present* if:	Four or more questions are answered “c.”

OFWAM FUNCTION SUMMARY

WH: Some habitat

FH: Not present

WQ: Lost

HC: Impacted or degraded

APPENDIX G. HABITAT ASSESSMENT FORM

Component		**Degree**	**Score**	**Comments**
WATER	**Quantity and Seasonality**	None Seasonal Perennial 0…………………4……………………8	4	Small seasonal wetland/streams present
	Quality	Stagnant Seasonally Flushed Continually Flushed 0…………………3……………………6	3	Wetlands seasonally inundated and sloped
	Proximity to Cover	None Nearby Immediately adjacent 0…………………3……………………6	4	Dense blackberry thicket proximal to wetland. Cover for small wildlife only
	Diversity (Streams, Ponds, Wetlands)	One Two Three 2…………………4……………………8	4	2 water types present
	WATER TOTAL		15	
FOOD	**Variety**	Low Medium High 0…………………4……………………8	2	Blackberry and hawthorn berries only major food source
	Quality and Seasonality	None Limited Year around 0…………………4……………………8	2	Short berry season
	Proximity to Cover	None Nearby Immediately adjacent 0…………………4……………………8	6	Blackberry thicket provides cover for small wildlife only. Forest cover nearby offers cover for larger
	FOOD TOTAL		10	
COVER	**Structural Diversity**	Low Medium High 0…………………4……………………8	4	Mostly shrub, some trees
	Variety	Low Medium High 0…………………4……………………8	4	Mostly shrub, some trees
	Nesting	Low Medium High 0…………………2……………………4	2	
	Escape	Low Medium High 0…………………2……………………4	2	
	Seasonality	None Limited Year around 0…………………2……………………4	2	
	COVER TOTAL		14	

ADDITIONAL VALUE				
DISTURBANCE	PHYSICAL	Permanent Temporary Undisturbed 0………………….2…………………….4	1	invasive species dominant, little natural tree cover
	HUMAN	High Medium Low 0………………….2…………………….4	2	Surrounded by developed uses
HABITAT INTERSPERSION		Low Medium High 0………………….3…………………….6	3	
UNIQUE FEATURES 0-4		Wildlife ________ Rarity of Habitat _______ Flora __________ Type_________________ Scenic _________ Educational ___________ Potential _______ Potential _____________	0	none

APPENDIX H: DSL CONCURRENCE LETTER: WD2021-0556

Oregon
Kate Brown, Governor

Department of State Lands
775 Summer Street NE, Suite 100
Salem, OR 97301-1279
(503) 986-5200
FAX (503) 378-4844
www.oregon.gov/dsl

State Land Board

Kate Brown
Governor

Shemia Fagan
Secretary of State

Tobias Read
State Treasurer

December 2, 2021

Delta Logistics, Inc.
Attn: Vladimir Tkach
9835 SW Commerce Circle
Wilsonville, OR 97070

Re: WD # 2021-0556 **Approved**
Wetland Delineation Report for SW Day Road
Washington County; T3S R1W S02B TLs 600 and 601; RGL # 1793
City of Sherwood Local Wetlands Inventory Wetland 3.03

Dear Vladimir Tkach:

The Department of State Lands has reviewed the wetland delineation report prepared by Schott and Associates for the site referenced above. Based upon the information presented in the report, and additional information submitted upon request, we concur with the wetland and waterway boundaries as mapped in Figures 6A and 6B of the report. Please replace all copies of the preliminary wetland maps with these final Department-approved maps.

Within the study area, 2 wetlands (Wetland 1 and 2, totaling approximately 0.33 acres) and Tapman Creek were identified. The wetlands and creek are subject to the permit requirements of the state Removal-Fill Law. Normally, a state permit is required for cumulative fill or annual excavation of 50 cubic yards or more in wetlands or below the ordinary high-water line (OHWL) of the waterway (or the 2-year recurrence interval flood elevation if OHWL cannot be determined). However, Wetland 1 is a compensatory wetland mitigation (CWM) area (RGL # 1793). Any impact within a CWM area may require a state permit.

This concurrence is for purposes of the state Removal-Fill Law only. We recommend that you attach a copy of this concurrence letter to any subsequent state permit application to speed application review. Federal, other state agencies or local permit requirements may apply as well. The U.S. Army Corps of Engineers will determine jurisdiction under the Clean Water Act, which may require submittal of a complete Wetland Delineation Report.

Please be advised that state law establishes a preference for avoidance of wetland impacts. Because measures to avoid and minimize wetland impacts may include reconfiguring parcel layout and size or development design, we recommend that you work with Department staff on appropriate site design before completing the city or county land use approval process.

This concurrence is based on information provided to the agency. The jurisdictional determination is valid for five years from the date of this letter unless new information necessitates a revision. Circumstances under which the Department may change a determination are found in OAR 141-090-0045 (available on our web site or upon request). In addition, laws enacted by the legislature and/or rules adopted by the Department may result in a change in jurisdiction; individuals and applicants are subject to the regulations that are in effect at the time of the removal-fill activity or complete permit application. The applicant, landowner, or agent may submit a request for reconsideration of this determination in writing within six months of the date of this letter.

Thank you for having the site evaluated. If you have any questions, please contact the Jurisdiction Coordinator for Washington County, Chris Stevenson, PWS, at (503) 986-5246.

Sincerely,

Pete Ryan

Peter Ryan, SPWS
Aquatic Resource Specialist

Enclosures

ec: Kim Biafora, Schott and Associates
City of Sherwood Planning Department
Danielle Erb, Corps of Engineers
Michael De Blasi, DSL
Lindsey Obermiller, Clean Water Services

WETLAND DELINEATION / DETERMINATION REPORT COVER FORM

Fully completed and signed report cover forms and applicable fees are required before report review timelines are initiated by the Department of State Lands. Make checks payable to the Oregon Department of State Lands. To pay fees by credit card, go online at: https://apps.oregon.gov/DSL/EPS/program?key=4.

Attach this completed and signed form to the front of an unbound report or include a hard copy with a digital version (single PDF file of the report cover form and report, minimum 300 dpi resolution) and submit to: **Oregon Department of State Lands, 775 Summer Street NE, Suite 100, Salem, OR 97301-1279.** A single PDF of the completed cover from and report may be e-mailed to: **Wetland_Delineation@dsl.state.or.us**. For submittal of PDF files larger than 10 MB, e-mail DSL instructions on how to access the file from your ftp or other file sharing website.

Contact and Authorization Information

☐ Applicant ☒ Owner Name, Firm and Address:

Vladimir Tkach/ Delta Logistics, Inc.
9835 SW Commerce Cir,
Wilsonville, OR 97070

Business phone # 800-595-3077
Mobile phone # (optional)
E-mail: Vlad@deltagov.com

☐ Authorized Legal Agent, Name and Address (if different):

Business phone #
Mobile phone # (optional)
E-mail:

I either own the property described below or I have legal authority to allow access to the property. I authorize the Department to access the property for the purpose of confirming the information in the report, after prior notification to the primary contact.

Typed/Printed Name: Vladimir Tkach **Signature:**

Date: 09/27/2021 Special instructions regarding site access: ____

Project and Site Information

Project Name: SW Day Road

Latitude: 45.339611° Longitude: -122.778340°
decimal degree - centroid of site or start & end points of linear project

Proposed Use:
Trailer parking/storage

Tax Map # 3S102B
Tax Lot(s) 600, 601

Tax Map #
Tax Lot(s)

Project Street Address (or other descriptive location):
9710 SW Day Rd

Township 3S Range 1W Section 2B QQ NW/SE
Use separate sheet for additional tax and location information

City: Wilsonville County: Washington

Waterway: Tapman Creek River Mile: 6

Wetland Delineation Information

Wetland Consultant Name, Firm and Address:

Kim Biafora
Schott & Associates
PO Box 589
Aurora, OR 97002

Phone # (503) 678-6028
Mobile phone # (if applicable)
E-mail: kim@schottandassociates.com

The information and conclusions on this form and in the attached report are true and correct to the best of my knowledge.

Consultant Signature: Kim Biafora | Date: 10/7/2021

Primary Contact for report review and site access is ☐ Consultant ☐ Applicant/Owner ☐ Authorized Agent

Wetland/Waters Present? ☒ Yes ☐ No | Study Area size: 9.13 Total Wetland Acreage: 0.33

Check Applicable Boxes Below

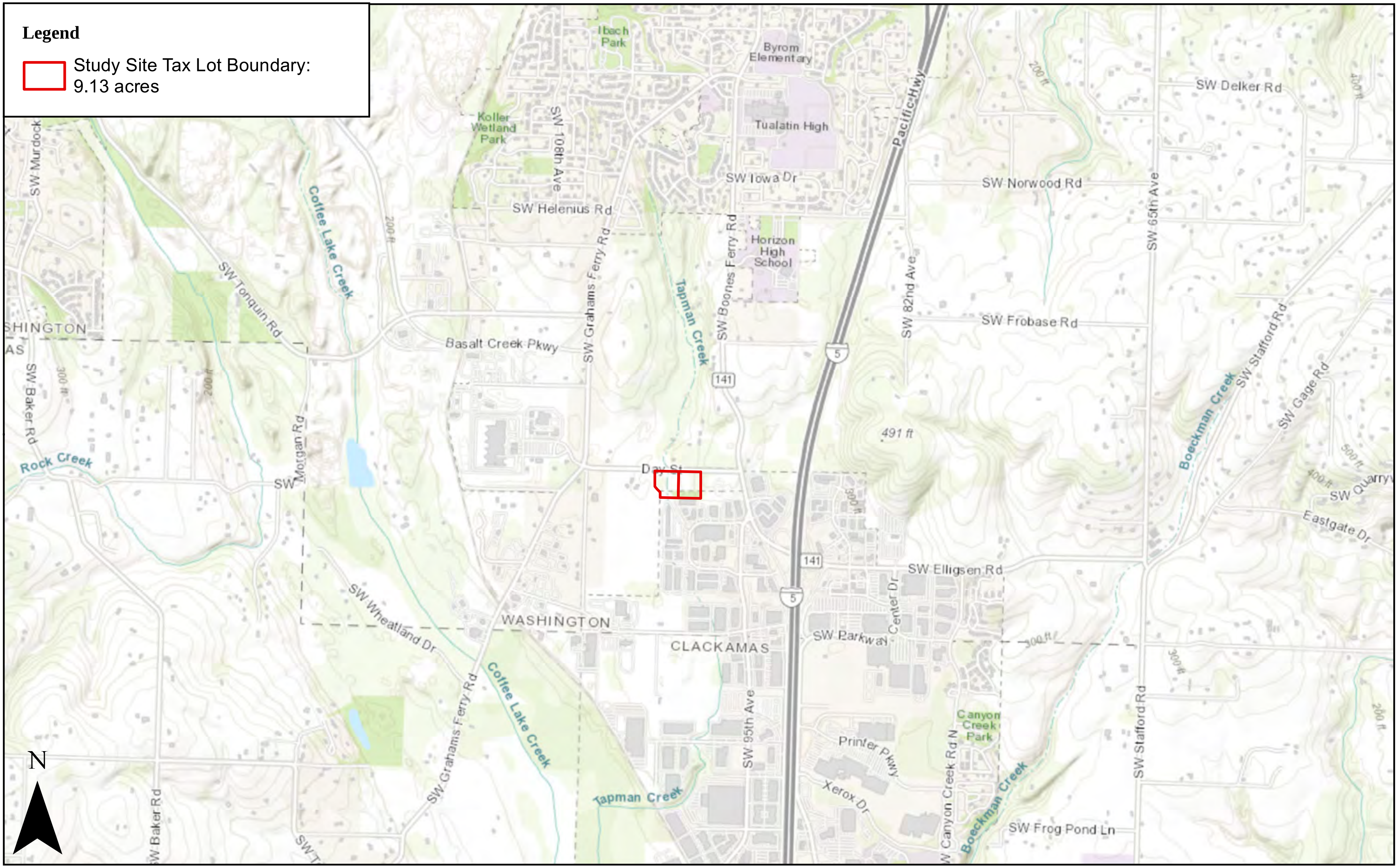
☐ R-F permit application submitted
☒ Mitigation bank site
☐ EFSC/ODOE Proj. Mgr: ☐
☐ Wetland restoration/enhancement project (not mitigation)
☒ Previous delineation/application on parcel
If known, previous DSL # 25201-FP

☐ Fee payment submitted $ _____
☐ Resubmittal of rejected report ($100)
☐ Request for Reissuance. See eligibility criteria. (no fee)
DSL # _____ Expiration date_____
☐ LWI shows wetlands or waters on parcel
Wetland ID code _____

For Office Use Only

DSL Reviewer: ______________ Fee Paid Date: ____/____/____ DSL WD # ______________

Date Delineation Received: ___/___/___ Scanned: ☐ Electronic: ☐ DSL App.# ______________



Date: 9/9/2021

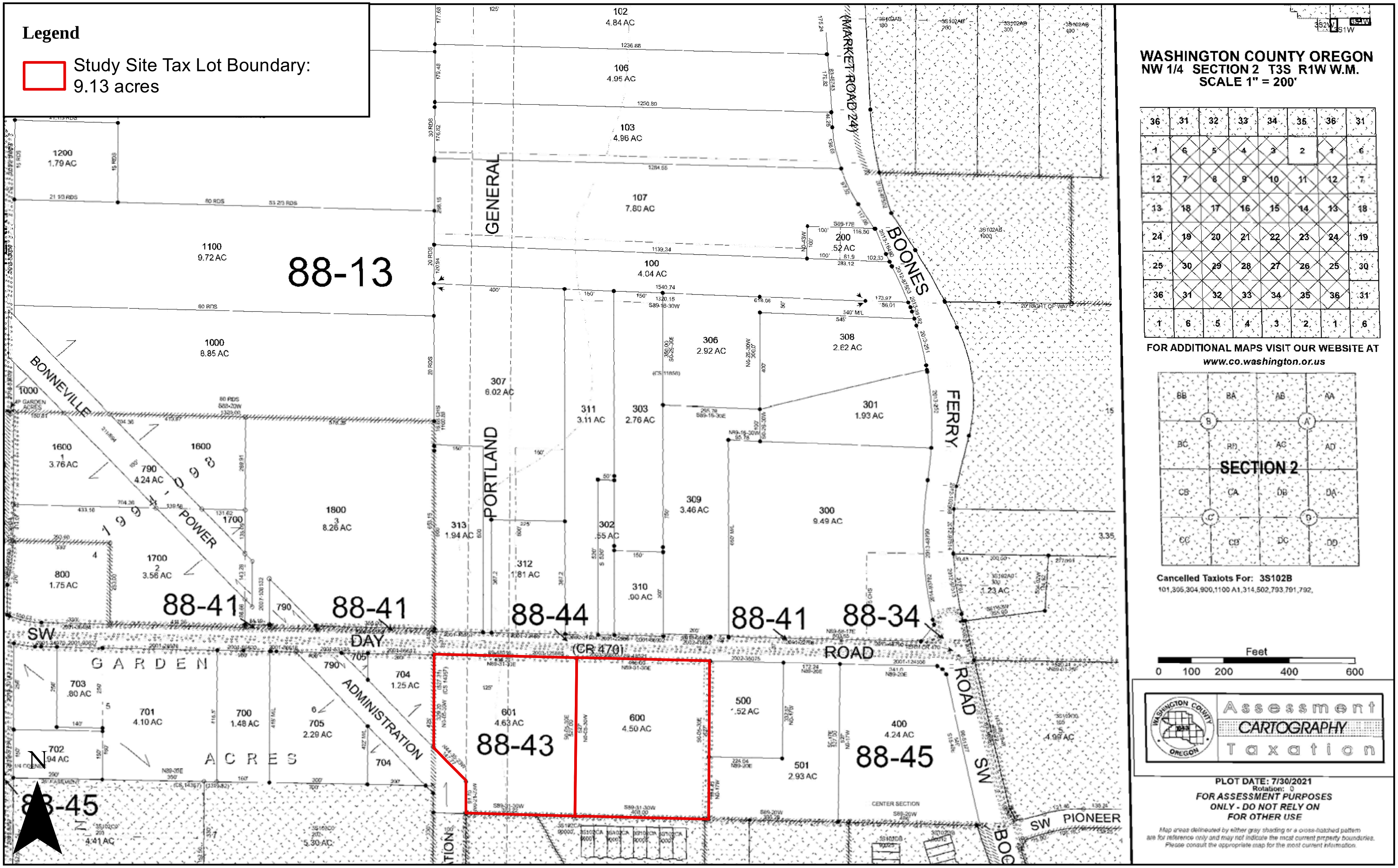
Data Source: ESRI, 2021; Washington County Intermap, 2021

Figure 1. Location Map

SW Day Road Project Site: S&A #2739

0 1,000 2,000 4,000 Feet

SCHOTT & ASSOCIATES, Inc.



Date: 9/9/2021

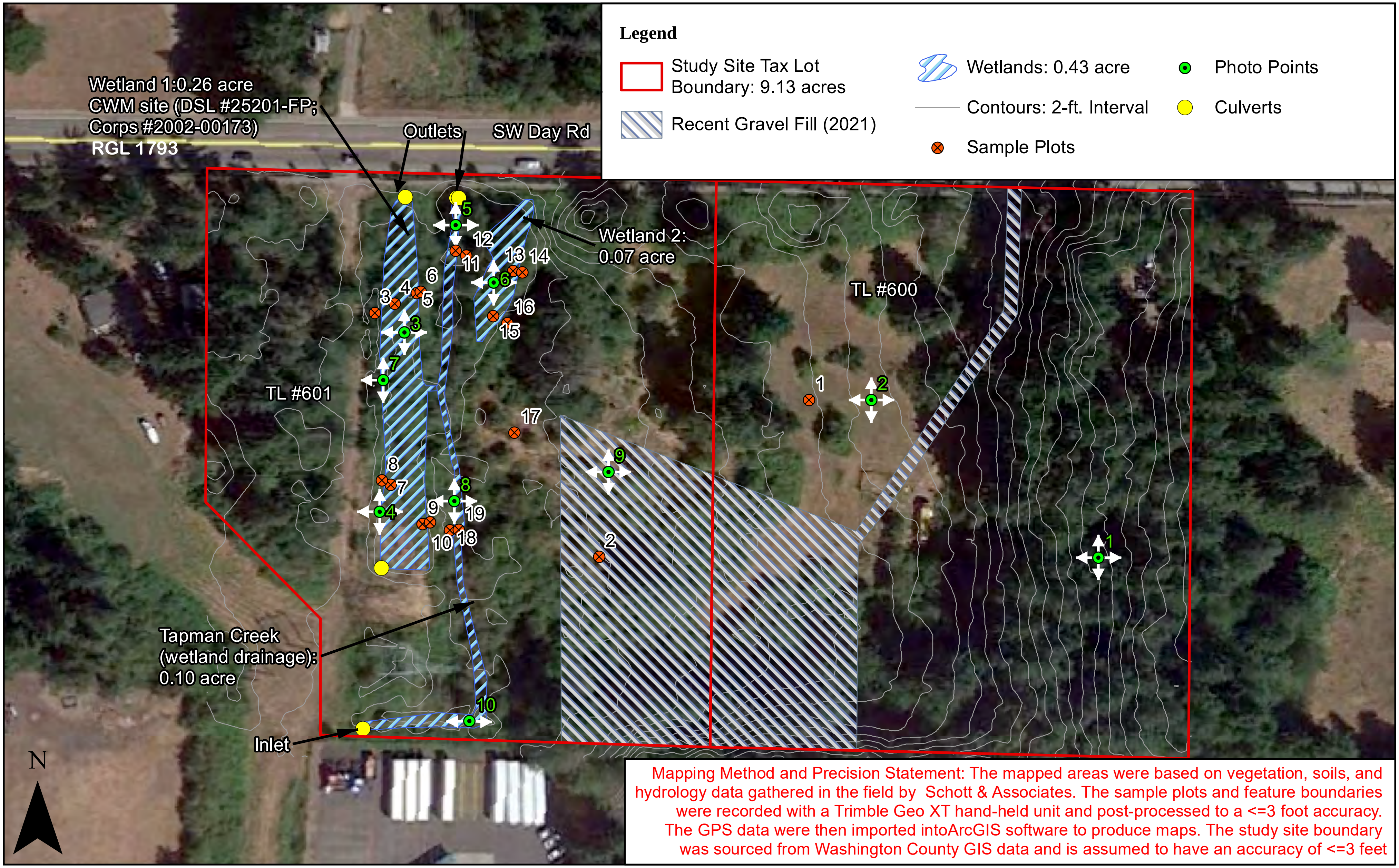
Data Source: Washington County Intermap, 2021

Figure 2. Washington County Tax Map-3S102B

SW Day Road Project Site: S&A #2739

0 200 400 800 Feet

SCHOTT & ASSOCIATES, Inc.



Mapping Method and Precision Statement: The mapped areas were based on vegetation, soils, and hydrology data gathered in the field by Schott & Associates. The sample plots and feature boundaries were recorded with a Trimble Geo XT hand-held unit and post-processed to a <=3 foot accuracy. The GPS data were then imported intoArcGIS software to produce maps. The study site boundary was sourced from Washington County GIS data and is assumed to have an accuracy of <=3 feet

Date: 11/29/2021

Data Source: ESRI, 2021; Washington County Intermap, 2021; DOGAMI, 2014

DSL WD # 2021-0556
Approval Issued 12/2/2021
Approval Expires 12/2/2026

Figure 6a. Wetland Delineation Map - Overview

SCHOTT & ASSOCIATES, Inc.

SW Day Road Road Project Site: S&A #2739

0 50 100 200 Feet

Mapping Method and Precision Statement: The mapped areas were recorded utilizing a Trimble Geo 7X hand-held unit and post-processed to a <= 3 foot accuracy. The GPS data were then imported into ArcGIS software to produce maps. The study site boundary was sourced from the Washington County GIS Department and is assumed to have an accuracy of <=3 feet.

Date: 11/29/2021

Data Source: ESRI, 2021; Marion County GIS Dept, 2021; DOGAMI, 2014

DSL WD # 2021-0556
Approval Issued 12/2/2021
Approval Expires 12/2/2026

Figure 6b. Wetland Delineation Map - Detail

SW Day Road Project Site: S&A # 2739

0 30 60 120 Feet

SCHOTT & ASSOCIATES, Inc.

APPENDIX G

GEOTECHNICAL REPORT

REPORT OF GEOTECHNICAL ENGINEERING SERVICES

Delta Logistics Day Road Annex
SW Day Road
Wilsonville, Oregon

For
Delta Logistics, Inc.
June 30, 2021

Project: DeltaLog-1-01

June 30, 2021

Delta Logistics, Inc.
9835 Commerce Circle
Wilsonville, OR 97070

Attention: Igor Nichiporchik

Report of Geotechnical Engineering Services
Delta Logistics Day Road Annex
SW Day Road
Wilsonville, Oregon
Project: DeltaLog-1-01

NV5 is pleased to present this report of geotechnical engineering services for the proposed Delta Logistics Day Road Annex project located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. Our services were provided in general conformance with our proposal dated May 17, 2021.

We appreciate the opportunity to be of continued service to you. Please call if you have questions regarding this report.

Sincerely,

NV5

Brett A. Shipton, P.E., G.E.
Principal Engineer

cc: Lee Leighton, Mackenzie (via email only)

BAS:kt
Attachments
One copy submitted (via email only)
Document ID: DeltaLog-1-01-063021-geor.docx

EXECUTIVE SUMMARY

- Shallow basalt bedrock was encountered in the explorations, which will be difficult to excavate. Specialized excavation techniques such as controlled blasting and ripping may be required to make the planned site cuts
- The proposed building can be supported on spread footings that bear on basalt or the native soil.
- The silt overburden soil will require moisture conditioning if it is to be used as structural fill.
- Measured infiltration rates are extremely low and on-site stormwater infiltration is not feasible.
- Seismic forces on the building can be computed assuming seismic Site Class B as described in the SOSSC.
- The excavated basalt bedrock can be crushed and processed and re-used as structural fill or aggregate base if it meets gradation requirements.

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APPENDIX

ACRONYMS AND ABBREVIATIONS

AC	asphalt concrete
ACP	asphalt concrete pavement
ASTM	American Society for Testing and Materials
BGS	below ground surface
CRB	Columbia River Basalt
FHWA	Federal Highway Administration
g	gravitational acceleration (32.2 feet/second^2)
H:V	horizontal to vertical
MCE	maximum considered earthquake
OSHA	Occupational Safety and Health Administration
OSSC	Oregon Standard Specifications for Construction (2021)
pcf	pounds per cubic foot
PG	performance grade
psf	pounds per square foot
psi	pounds per square inch
RQD	rock quality designation
SOSSC	State of Oregon Structural Specialty Code
SPT	standard penetration test
USGS	U.S. Geological Survey

1.0 INTRODUCTION

NV5 is pleased to submit this report of geotechnical engineering services for the proposed Delta Logistics Day Road Annex project. The site is located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. The subject property includes Tax Lots 600 and 601 of Washington County Tax Map 3S102B, which collectively encompass 9.13 acres.

The site location is shown relative to surrounding features on Figure 1. Existing conditions and the proposed site layout (overlay) are shown on Figure 2. Acronyms and abbreviations used herein are defined above, immediately following the Table of Contents.

2.0 PROJECT UNDERSTANDING

The proposed development includes construction of a new logistics center with a building footprint of 57,300 square feet on the eastern portion of the site. We understand the new building will be of concrete tilt-up construction. A concrete loading dock apron is planned along the western perimeter of the proposed building. The center portion of the site will be paved with AC for drive lanes and parking spaces. A detached parking lot located on the western portion of the site is also being considered at this time. A 125-foot-wide drainage easement runs north to south through the property with its centerline approximately 150 feet from the western property boundary.

Foundation loads of the proposed building were not provided at the time of this report. Based on our experience with similar structures, we anticipate maximum column and wall loads will be less than 200 kips and 5 kips per lineal foot, respectively. In addition, we have assumed maximum floor loads of 300 psf. Cuts and fills are expected to be 18 and 5 feet, respectively. An approximately 18-foot-tall retaining wall will support a cut along the site's eastern perimeter and an approximately 5-foot-tall retaining wall will support fill along a storm drainage easement in the western portion of the site.

3.0 PURPOSE AND SCOPE

The purpose of our services was to provide geotechnical engineering recommendations for use in design and construction of the proposed logistics center. Specifically, we completed the following scope of services:

- Reviewed readily available, published geologic data and our in-house files for existing information on subsurface conditions in the site vicinity.
- Coordinated and managed the field explorations, including private and public utility locates and scheduling subcontractors and NV5 staff.
- Conducted a geotechnical subsurface investigation at the site that included the following:
  - Three borings to depths between 15 and 22.5 feet BGS
  - Nine test pits to depths of between 3 and 12 feet BGS
- Conducted two infiltration tests in a test pit at depths of 2 and 3.5 feet BGS.
- Conducted two dynamic cone penetrometer tests in test pits for use in pavement design.

- Collected geotechnical soil samples from the explorations for laboratory testing and maintained a log of encountered soil, rock, and groundwater conditions in the explorations.
- Conducted a laboratory testing program, including the following tests:
    - Four moisture content determinations in general accordance with ASTM D2216
    - One particle-size analyses in general accordance with ASTM D1140
    - Three unconfined compression tests in general accordance with ASTM D2166
- Provided recommendations for site preparation, grading and drainage, stripping depths, fill type for imported material, compaction criteria, trench excavation and backfill, use of on-site soil, and wet weather earthwork.
- Provided recommendations for design and construction of shallow spread foundations, including allowable design bearing pressure, minimum footing depth and width, passive resistance capacity, and coefficient of friction.
- Provided recommendations for preparation of floor slab subgrade.
- Provided design criteria recommendations for retaining walls, including lateral earth pressures, backfill, compaction, and drainage.
- Evaluated the rippability of the basalt bedrock encountered in the explorations.
- Provided recommendations for managing groundwater conditions that may affect the performance of structures.
- Provided recommendations for the construction of AC pavement for on-site access roads and parking areas, including subbase, base course, and AC paving thickness.
- Provided recommendations for subsurface drainage of foundations and roadways, as necessary.
- Provided seismic coefficients in accordance with the SOSSC.
- Documented our findings, conclusions, and recommendations in this report.

4.0 SITE CONDITIONS

4.1 GEOLOGIC CONDITIONS

The site is located in the Tualatin Basin of the Puget Sound-Willamette Valley physiographic province, a tectonically active lowland located along the convergent Cascadia margin. The Tualatin Basin is formed between the uplifted Coast Ranges to the west, the Chehalem Mountains to the south, and the Tualatin Mountains to the north and east. The Tualatin Mountains have been uplifted along northwesterly oriented faults, including the steeply dipping Portland Hills fault located along the eastern flank of the mountains.

The near-surface geologic unit mapped at the site is the fine-grained facies of the Missoula flood deposits. The unit consists of unconsolidated silt and sand deposited by catastrophic floods associated with the sudden release of waters from glacial Lake Missoula during the late Pleistocene (15,500 and 12,500 years ago) (Madin, 1990).

Underlying the Quaternary flood deposits, we encountered basalt bedrock representing the Miocene CRBs, emplaced approximately 17 million to 6 million years ago in the Portland area (Madin, 1990). The CRBs consist of thick flows of basalt and are exposed in the Tualatin Mountains and in the mountains southwest of the site, including Cooper Mountain and Bull Mountain.

4.2 SURFACE CONDITIONS

The site is located along SW Day Road between SW Grahams Ferry Road and SW Boones Ferry Road in Wilsonville, Oregon. The subject property includes Tax Lots 600 and 601 of Washington County Tax Map 3S102B, which collectively encompass 9.13 acres. The site is undeveloped, except for a residence located on the northeastern property corner. The site slopes down from east to west, with the eastern end of the site at an elevation of 285 feet and the western end at an elevation of approximately 240 feet. The slope is steeper toward the east with a gradient of between 10 and 15 percent. Vegetation at the site includes grass, shrubbery, and trees.

4.3 SUBSURFACE CONDITIONS

Subsurface conditions were explored by drilling three borings (B-1 through B-3) to depths between 15 and 22.5 feet BGS and excavating nine test pits (TP-1 through TP-9) to depths between 3 and 12 feet BGS. The locations of the explorations are shown on Figure 2. The exploration logs and laboratory test results are presented in the Appendix.

Subsurface conditions encountered in our explorations consists of a thin mantle of silt underlain by basalt bedrock to the maximum depth explored. The following sections provide a detailed description of the geologic units encountered.

4.3.1 Silt

In general, we observed a mantel of medium stiff to stiff silt with varying proportions of sand that extends to depths between approximately 1 foot and 7 feet BGS, except boring B-2 where silt was not observed. Laboratory testing indicates that the silt had moisture contents ranging from 21 to 26 percent at the time of our explorations.

4.3.2 Weathered Basalt

Weathered basalt that consists of clayey and silty gravel, cobbles, and boulders underlies the silt at depths between 1 foot and 7 feet BGS. All of the test pits were terminated in this unit where they encountered practical refusal. Laboratory testing indicates that the weathered basalt layer had a moisture content of 11 percent at the time of our explorations.

4.3.3 Basalt

Competent basalt was encountered to the maximum depths explored in borings B-2 and B-3. In general, the basalt consists of soft (R2) to hard (R4) basalt. The basalt exhibits varying degrees of weathering from fresh to decomposed. A siltstone interflow was encountered in boring B-3 between depths of 14.6 and 15.6 feet BGS. The siltstone interflow is very soft (R1) and moderately weathered.

4.3.4 Groundwater

Groundwater was not encountered during our explorations, except for moderate seepage in TP-8 at a depth of 8 feet BGS. Groundwater may perch on the basalt bedrock during the wet season or prolonged periods of wet weather. The depth to groundwater may fluctuate in response to seasonal changes, prolonged rainfall, changes in surface topography, and other factors not observed in this study.

4.4 INFILTRATION TESTING

We conducted two infiltration tests in test pit TP-5 at depths of 2 and 3.5 feet BGS. The infiltration testing procedures are described in the Appendix, and the results of the infiltration testing are presented in Table 1.

Table 1. Infiltration Testing Summary

Location	Depth (feet BGS)	Observed Infiltration Rate[1] (inches per hour)	Test Method	Soil Type at Test Depth
TP-5	2	1.5	Standpipe	Silt
TP-5	3.5	0	Open Pit	Weathered Basalt

1. Infiltration rate measured in the field

4.5 GEOLOGIC HAZARDS

4.5.1 Liquefaction

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Silty soil with low plasticity is moderately susceptible to liquefaction under relatively higher levels of ground shaking. Based on the subsurface conditions encountered in the explorations, liquefaction is not a hazard at the site.

4.5.2 Lateral Spreading

Lateral spreading is a liquefaction-related seismic hazard. Areas subject to lateral spreading are typically gently sloping or flat sites underlain by liquefiable sediment adjacent to an open face, such as a riverbank. Since liquefaction is not a hazard at the site, lateral spreading is also not considered a site hazard.

4.5.3 Fault Surface Rupture

There are no mapped faults reported beneath this site by the USGS Quaternary Fault and Fold Database of the United States. Consequently, it is our opinion that the probability of surface fault rupture beneath the site is low.

5.0 DESIGN RECOMMENDATIONS

5.1 GENERAL

The following sections provide our design recommendations for the project. All site preparation and structural fill should be prepared as recommended in the "Construction" section.

5.2 SHALLOW FOUNDATIONS

In our opinion, the proposed building can be supported on conventional spread footings founded on the basalt bedrock or native silt.

5.2.1 Bearing Capacity

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. The bottom of exterior footings should be at least 18 inches below the lowest adjacent exterior grade. The bottom of interior footings should be established at least 12 inches below the base of the slab.

Footings bearing on basalt bedrock can be sized assuming an allowable bearing pressure of 15,000 psf. Footings bearing on the overburden fine-grained soil should be sized assuming an allowable bearing pressure equal to 3,000 psf. These are net values; the weight of the footing and overlying backfill can be ignored in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads and may be increased by one-third for short-term loads such as those resulting from wind or seismic forces.

5.2.2 Resistance to Sliding

Lateral loads on footings can be resisted by passive earth pressure on the sides of structures and by friction on the base of footings. Our analysis indicates the available passive earth pressure for footings confined by native soil or structural fill is 350 pcf modeled as an equivalent fluid pressure. If the footings are confined by basalt bedrock, this value can be increase to 750 pcf. Adjacent floor slabs, pavement, or the upper 12-inch depth of adjacent, unpaved areas should not be considered when calculating passive resistance. To rely on passive resistance, a minimum of 10 feet of horizontal clearance must exist between the face of the footings and any adjacent down slopes. For footings that bear on granular pads as described above, a coefficient of friction equal to 0.5 may be used when calculating resistance to sliding for footings bearing on basalt or crushed rock; this should be reduced to 0.35 for footings bearing on the native silt.

5.2.3 Settlement

Total foundation settlement should be less than 0.25 inch; a differential settlement of 0.25 inch should be assumed between similarly loaded footings. A total settlement of 1 inch should be assumed for footings that bear on silt, with a differential of 0.5 inch between similarly loaded footings.

5.2.4 Subgrade Observation

All footing and floor slab subgrade should be observed by a representative of NV5 to evaluate the bearing conditions. Observations should also confirm that all loose or soft material, organic material, unsuitable fill, prior topsoil zones, and softened subgrades (if present) have been removed. Localized over-excavation of footing subgrade may be required to remove deleterious material.

5.3 SEISMIC DESIGN CONSIDERATIONS

5.3.1 Seismic Design Parameters

Based on the results of our subsurface explorations, the seismic design coefficients consistent with Site Class B can be used for design. These coefficients are presented in Table 2.

Table 2. Seismic Design Parameters

Seismic Design Parameter	Short Period (T_s = 0.2 second)	1 Second Period (T_1 = 1.0 second)
MCE Spectral Acceleration	S_s = 0.827 g	S_1 = 0.385 g
Site Class	B	
Site Coefficient	F_a = 0.9	F_v = 0.8
Adjusted Spectral Acceleration	S_{MS} = 0.744 g	S_{M1} = 0.308 g
Design Spectral Response Acceleration Parameters	S_{DS} = 0.496 g	S_{D1} = 0.205 g

5.4 FLOOR SLABS

Slabs should be reinforced according to their proposed use and per the structural engineer's recommendations. Slabs on grade may be designed assuming a modulus of subgrade reaction, k, of 600 psi per inch, if they bear on basalt. This value should be decreased 150 psi per inch if the floor slab bears on the overburden silty soil. To aid as a capillary break, we recommend a 6-inch-thick layer of floor slab base rock be placed and compacted over the prepared subgrade. The floor slab base rock should meet the requirements in the "Structural Fill" section and be compacted to at least 95 percent of ASTM D1557.

The near-surface native soil is primarily fine grained and will tend to maintain a high moisture content. In areas where moisture-sensitive floor slab and flooring will be installed, installation of a vapor barrier is warranted in order to reduce the potential for moisture transmission through and efflorescence growth on the slab and flooring. In addition, flooring manufacturers often require vapor barriers to protect flooring and flooring adhesives and will warrant their product only if a vapor barrier is installed according to their recommendations. Selection and design of an appropriate vapor barrier should be a collaborative effort with members of the design team.

5.5 RETAINING WALLS

We have provided recommendations for retaining walls that retain soil and basalt bedrock. Our recommendations are based on the following assumptions: (1) the walls are less than 20 feet in height, (2) adequate drainage is provided behind the retaining wall to prevent lateral earth pressures from developing, and (3) the ground surface behind the retaining wall is flatter than 4H:1V. Re-evaluation of our recommendations will be required if the retaining wall design criteria for the project varies from these assumptions.

Lateral earth pressures can be computed using Figure 3. Seismic earth pressures can be calculated assuming a uniformly distributed load equal to force equal to 7H pounds per linear foot of wall where the wall retains soil, where H is the wall height. The seismic force should be applied as a distributed load with the centroid located at 0.6H from the wall base. Footings for retaining walls should be designed as recommended for shallow foundations.

If other surcharges are located within a horizontal distance of twice the height of the wall from the back of the wall, additional pressures will need to be incorporated in the wall design. Figure 4 can be used to compute surcharge induced lateral earth pressures.

5.6 DRAINAGE

5.6.1 Temporary

During mass grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface. During rough and finished grading of the site, the contractor should keep all pads and subgrade free of ponding water.

5.6.2 Surface

Where possible, the finished ground surface around the building should be sloped away from the structure at a minimum 2 percent gradient for a distance of at least 5 feet. Downspouts or roof scuppers should discharge into a storm drain system that carries the collected water to an appropriate stormwater system. Trapped planter areas should not be created adjacent to the building without providing means for positive drainage (e.g., swales or catch basins).

5.6.3 Subsurface

Assuming the site grades around the building will be sloped as discussed previously, it is our opinion that perimeter footing drains will not be required around the proposed building.

5.6.4 Infiltration

In our opinion, infiltration of stormwater is not feasible due the shallow impermeable bedrock.

5.7 PAVEMENT

5.7.1 Pavement Design

Pavement should be installed on competent subgrade or new engineered fills prepared in conformance with the recommendation in this report. Our pavement recommendations are based on the following assumptions:

- Reliability of 80 percent and standard deviation of 0.45
- Pavement design life of 20 years
- Initial and terminal serviceability indices of 4.2 and 2.5, respectively
- Structural coefficients of 0.42 and 0.10 for new AC and new base rock, respectively
- Subgrade resilient modulus of 3,500 psi for silt and 45,000 psi for basalt
- New base rock resilient modulus of 20,000 psi
- New base rock drainage coefficient of 1.0
- The subgrade below pavement areas is evaluated by proof rolling and prepared as recommended in this report

We do not have specific information on the frequency of vehicles expected at the site; however, we have assumed a breakdown on the type of vehicles likely to be used. We have assumed traffic will consist of passenger cars in light traffic areas and a mixture of cars and trucks elsewhere. The truck traffic is assumed to be single tractor-trailers evenly distributed between FHWA Classes 8, 9, and 10.

If any of these assumptions are incorrect, our office should be contacted with the appropriate information so that the pavement designs can be revised.

Our pavement design recommendations assuming between 0 and 50 trucks per day are presented in Tables 3 and 4. If projected truck traffic exceeds 50 or truck axle weights are projected to exceed street legal values, our office should be contacted to provide revised pavement design thicknesses.

Table 3. Recommended Pavement Sections on Bedrock

Traffic Levels	Trucks per Day	ESALs	AC (inches)	Base Rock (inches)
Car Traffic Only	0	10,000	2.5	4.0
Truck Area	10	100,000	3.0	4.0
Truck Area	25	240,000	3.5	4.0
Truck Area	50	475,000	4.0	4.0

Table 4. Recommended Pavement Sections on Soil Subgrade

Traffic Levels	Trucks per Day	ESALs	AC (inches)	Base Rock (inches)
Car Traffic Only	0	10,000	2.5	8.0
Truck Area	10	100,000	4.0	13.5
Truck Area	25	240,000	4.5	16.0
Truck Area	50	475,000	5.0	18.0

All thicknesses in Tables 3 and 4 are intended to be the minimum acceptable. Design of the recommended pavement section is based on the assumption that construction will be completed during an extended period of dry weather. Wet weather construction could require an increased thickness of base rock where the pavement is constructed on soil subgrade.

Construction traffic should be limited to non-building, unpaved portions of the site or haul roads. Construction traffic should not be allowed on new pavement. If construction traffic is to be allowed on newly constructed road sections, an allowance for this additional traffic will need to be made in the design pavement section.

6.0 CONSTRUCTION

6.1 SITE PREPARATION

6.1.1 Demolition

Demolition includes complete removal of the existing buildings, retaining walls, pavement, concrete curbs, abandoned utilities, and any subsurface elements within 5 feet of areas to receive new pavement, buildings, retaining walls, or engineered fills. Demolished material should be transported off site for disposal. In general, this material will not be suitable for re-use as engineered fill. However, concrete, pavement, and base rock material may be recycled in accordance with the requirements set forth by the project jurisdiction and the recommendations provided in the “Structural Fill” section.

Excavations remaining from removing basements, foundations, utilities, and other subsurface elements should be backfilled with structural fill where these are below planned site grades. The base of the excavations should be excavated to expose firm subgrade before filling. The sides of the excavations should be cut into firm material and sloped a minimum of 1½H:1V. Utility lines abandoned under new structural components should be completely removed and backfilled with structural fill or grouted full if left in place. Soft or disturbed soil encountered during demolition should be removed and replaced with structural fill.

Considerable subgrade damage can occur during demolition activities and we recommend that the subgrade protection measures discussed in the “Construction Considerations” section be implemented.

6.1.2 Grubbing and Stripping

Trees and shrubs should be removed from fill areas. In addition, root balls should be grubbed out to the depth of the roots, which could exceed 3 feet BGS. Depending on the methods used to remove root balls, considerable disturbance and loosening of the subgrade could occur during site grubbing. We recommend that soil disturbed during grubbing operations be removed to expose firm, undisturbed subgrade. The resulting excavations should be backfilled with structural fill.

The existing root zone in landscaped areas should be stripped and removed from all fill areas. The actual stripping depth should be based on field observations at the time of construction. Stripped material should be transported off site for disposal or used in landscaped areas.

6.1.3 Subgrade Evaluation

Upon completion of stripping and subgrade stabilization, and prior to the placement of fill or pavement, the exposed subgrade should be evaluated by proof rolling. The subgrade should be proof rolled with a fully loaded dump truck or similarly heavy, rubber tire construction equipment to identify soft, loose, or unsuitable areas. A member of our geotechnical staff should observe proof rolling to evaluate yielding of the ground surface. During wet weather, subgrade evaluation should be performed by probing with a foundation probe rather than proof rolling. Areas that appear soft or loose should be improved in accordance with subsequent sections.

6.2 CONSTRUCTION CONSIDERATIONS

The fine-grained soil present on this site is easily disturbed, but the bedrock is less sensitive to disturbance. Where the subgrade consists of soil, site preparation, utility trench work, and excavation can create extensive soft areas and significant repair costs can result. Earthwork planning, regardless of the time of year, should include considerations for minimizing subgrade disturbance.

6.3 PERMANENT SLOPES

Permanent cut and fill slopes should not exceed 2H:1V in soil and ¾H:1H in competent bedrock. The face of bedrock slopes should be scaled to remove loose rock fragments from the face. Access roads and pavement should be located at least 5 feet from the top of cut and fill slopes. The setback should be increased to 10 feet for buildings. The slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

6.4 EXCAVATION

6.4.1 Excavation and Shoring

The site soil should be readily excavatable with conventional grading equipment. Bedrock may require ripping and or blasting. Temporary excavation sidewalls should stand vertical to a depth of approximately 4 feet, provided groundwater seepage does not occur. Deeper excavations will require shoring or need to be sloped. Shoring will still be required in bedrock to protect worker safety from rockfall. Temporary soil slopes should be no steeper than 1.5H:1V and rock slopes no steeper than ¾H:1V. All loose rock fragments should be removed from the excavation sidewalls before workers are allowed to enter the excavation.

6.4.2 Trench Dewatering

Based on the results of our explorations, major dewatering is not anticipated for the project. If perched groundwater is present, dewatering may be required to maintain dry working conditions. Pumping from sumps located within the trench will likely be effective in removing water resulting from seepage.

6.4.3 Safety

All excavations should be made in accordance with applicable OSHA requirements and regulations of the state, county, and local jurisdiction. While this report describes certain approaches to excavation and dewatering, the contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety, and providing shoring (as required) to protect personnel and adjacent structural elements.

6.5 MATERIALS

6.5.1 Structural Fill

6.5.1.1 General

Fill should be placed on subgrade that has been prepared in conformance with the “Site Preparation” section. A variety of material may be used as structural fill at the site. However, all material used as structural fill should be free of organic material or other unsuitable material. A brief characterization of some of the acceptable materials and our recommendations for their use as structural fill are provided below.

6.5.1.2 On-Site Material

Basalt excavated from the site can be processed and re-used as structural fill. The gradation and compaction requirements will depend on its and intended use. The soil at the site should be suitable for use as general structural fill, provided it is properly moisture conditioned and free of debris, organic material, and particles over 6 inches in diameter. Moisture conditioning (drying) will likely be required to use on-site fine-grained soil for structural fill. Accordingly, extended dry weather will be required to adequately condition and place the soil as structural fill and, given the site constraints, will possibly not be feasible. It will be difficult, if not impossible, to adequately compact on-site soil during the rainy season or during prolonged periods of rainfall. When used as structural fill, native soil should be placed in lifts with a maximum uncompacted thickness of 8 inches and compacted to not less than 92 percent of the maximum dry density, as determined by ASTM D1557.

6.5.1.3 Processed Native and Imported Granular Material

Processed native basalt and imported granular material used as structural fill should be pit- or quarry-run rock, crushed rock, or crushed gravel and sand. The imported granular material should also be angular and fairly well graded between coarse and fine material, should have less than 5 percent fines by dry weight passing the U.S. Standard No. 200 sieve, and should have at least two mechanically fractured faces. Imported granular material should be placed in lifts with a maximum uncompacted thickness of 12 inches and compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557. During the wet season or when wet subgrade conditions exists, the initial lift should be approximately 18 inches in uncompacted thickness and should be compacted by rolling with a smooth-drum roller without using vibratory action.

6.5.1.4 Stabilization Material

Stabilization material used in staging or haul road areas or in trenches should consist of 4- or 6-inch-minus pit- or quarry-run rock, crushed rock, or crushed gravel and sand. The material should have a maximum particle size of 6 inches, should have less than 5 percent by dry weight passing the U.S. Standard No. 4 sieve, and should have at least two mechanically fractured faces. The material should be free of organic material and other deleterious material. Stabilization material should be placed in lifts between 12 and 24 inches thick and compacted to a firm condition.

6.5.1.5 Trench Backfill

Trench backfill placed beneath, adjacent to, and for at least 12 inches above utility lines (i.e., the pipe zone) should consist of durable, well-graded granular material with a maximum particle size of 1½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. The pipe zone backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

Within roadway alignments, the remainder of the trench backfill up to the subgrade elevation should consist of durable, well-graded granular material with a maximum particle size of 2½ inches, should have less than 7 percent fines by dry weight, and should have at least two mechanically fractured faces. This material should be compacted to at least 92 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department. The upper 3 feet of the trench backfill should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone may consist of general fill material that is free of organic material and material over 6 inches in diameter. This general trench backfill should be compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557, or as required by the pipe manufacturer or local building department.

6.5.1.6 Drain Rock

Drain rock should consist of angular, granular material with a maximum particle size of 2 inches. The material should be free of roots, organic material, and other unsuitable material; should have less than 2 percent by dry weight passing the U.S. Standard No. 200 sieve (washed analysis); and should have at least two mechanically fractured faces. Drain rock should be compacted to a well-keyed, firm condition.

6.5.1.7 Aggregate Base Rock

Imported granular material used as base rock for building floor slabs and pavement should consist of ¾- or 1½-inch-minus material (depending on the application). In addition, the aggregate should have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve and have at least two mechanically fractured faces. The aggregate base should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.1.8 Retaining Wall Select Backfill

Backfill material placed behind retaining walls and extending a horizontal distance of ½H, where H is the height of the retaining wall, should consist of imported granular material as described above and should have less than 7 percent fines by dry weight and have at least two mechanically fractured faces. We recommend the wall backfill be separated from general fill, native soil, and/or topsoil using a geotextile fabric that meets the specifications provided below for drainage geotextiles.

The wall backfill should be compacted to a minimum of 95 percent of the maximum dry density, as determined by ASTM D1557. However, backfill located within a horizontal distance of 3 feet from a retaining wall should only be compacted to approximately 90 percent of the maximum dry density, as determined by ASTM D1557. Backfill placed within 3 feet of the wall should be compacted in lifts less than 6 inches thick using hand-operated tamping equipment (such as a jumping jack or vibratory plate compactor). If flatwork (sidewalks or pavement) will be placed atop the wall backfill, we recommend the upper 2 feet of material be compacted to 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.2 Geotextile Fabric

6.5.2.1 Subgrade Geotextile

Subgrade geotextile should conform to OSSC Table 02320-4 and OSSC 00350 (Geosynthetic Installation). A minimum initial aggregate base lift of 6 inches is required over geotextiles. All drainage aggregate and stabilization material should be underlain by a subgrade geotextile.

6.5.2.2 Drainage Geotextile

Drainage geotextile should conform to Type 2 material of OSSC Table 02320-1 and OSSC 00350 (Geosynthetic Installation). A minimum initial aggregate base lift of 6 inches is required over geotextiles.

6.5.3 Conventional Pavement Material Requirements

The AC should be Level 3, ½-inch, dense ACP as described in OSSC 00744 (Asphalt Concrete Pavement) and compacted to 91 percent of the specific gravity of the mix, as determined by ASTM D2041. Minimum and maximum lift thicknesses for ½-inch, dense ACP are 2 and 3 inches, respectively. ACP should be placed at the minimum ground surface temperatures described in OSSC 00744.40 (Season and Temperature Limitations). Asphalt binder should be performance graded and conform to PG 64-22.

The crushed base rock should consist of ¾- or 1½-inch-minus material meeting the requirements in OSSC 00641 (Aggregate Subbase, Base, and Shoulders), with the exception that the crushed base rock should have less than 5 percent by dry weight passing the U.S. Standard No. 200 sieve. The crushed base rock should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557.

6.5.3.1 Cold Weather Paving Considerations

In general, AC paving is not recommended during the cold weather (temperatures less than 40 degrees Fahrenheit). Compacting under these conditions can result in low compaction and premature pavement distress.

Each AC mix design has a recommended compaction temperature range that is specific for the particular AC binder used. In colder temperatures, it is more difficult to maintain the temperature of the AC mix as it can lose heat while stored in the delivery truck, as it is placed, and in the time between placement and compaction. In Oregon, the AC surface temperature during paving should be at least 40 degrees Fahrenheit for lift thickness greater than 2.5 inches and at least 50 degrees Fahrenheit for lift thickness between 2 and 2.5 inches.

If paving activities must take place during cold-weather construction as defined above, the project team should be consulted and a site meeting should be held to discuss ways to lessen low compaction risks.

6.6 EROSION CONTROL

The site soil is susceptible to erosion; therefore, erosion control measures should be carefully planned and in place before construction begins. Surface water runoff should be collected and directed away from slopes to prevent water from running down the slope face. Erosion control measures (such as straw bales, sediment fences, and temporary detention and settling basins) should be used in accordance with local and state ordinances.

7.0 OBSERVATION OF CONSTRUCTION

Satisfactory foundation and earthwork performance depends to a large degree on quality of construction. Sufficient observation of the contractor's activities is a key part of determining that the work is completed in accordance with the construction drawings and specifications. Subsurface conditions observed during construction should be compared with those encountered during the subsurface exploration. Recognition of changed conditions often requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect if subsurface conditions change significantly from those anticipated.

We recommend NV5 be retained to observe earthwork activities, including stripping, proof rolling of the subgrade and repair of soft areas, footing subgrade and granular pad preparation, final proof rolling of the pavement subgrade and base rock, and AC placement and compaction, and performing laboratory compaction and field moisture-density tests.

8.0 LIMITATIONS

We have prepared this report for use by Delta Logistics, Inc. and members of the design and construction team for the proposed development. The data and report can be used for estimating purposes, but our report, conclusions, and interpretations should not be construed as a warranty of the subsurface conditions and are not applicable to other sites.

Soil explorations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during the course of excavation and construction, re-evaluation will be necessary.

The site development plans and design details were conceptual at the time this report was prepared. When the design has been finalized and if there are changes in the site grades or location, configuration, design loads, or type of construction, the conclusions and recommendations presented may not be applicable. If design changes are made, we should be retained to review our conclusions and recommendations and to provide a written evaluation or modification.

The scope of our services does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in this report for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

◆ ◆ ◆

We appreciate the opportunity to be of continued service to you. Please call if you have questions concerning this report or if we can provide additional services.

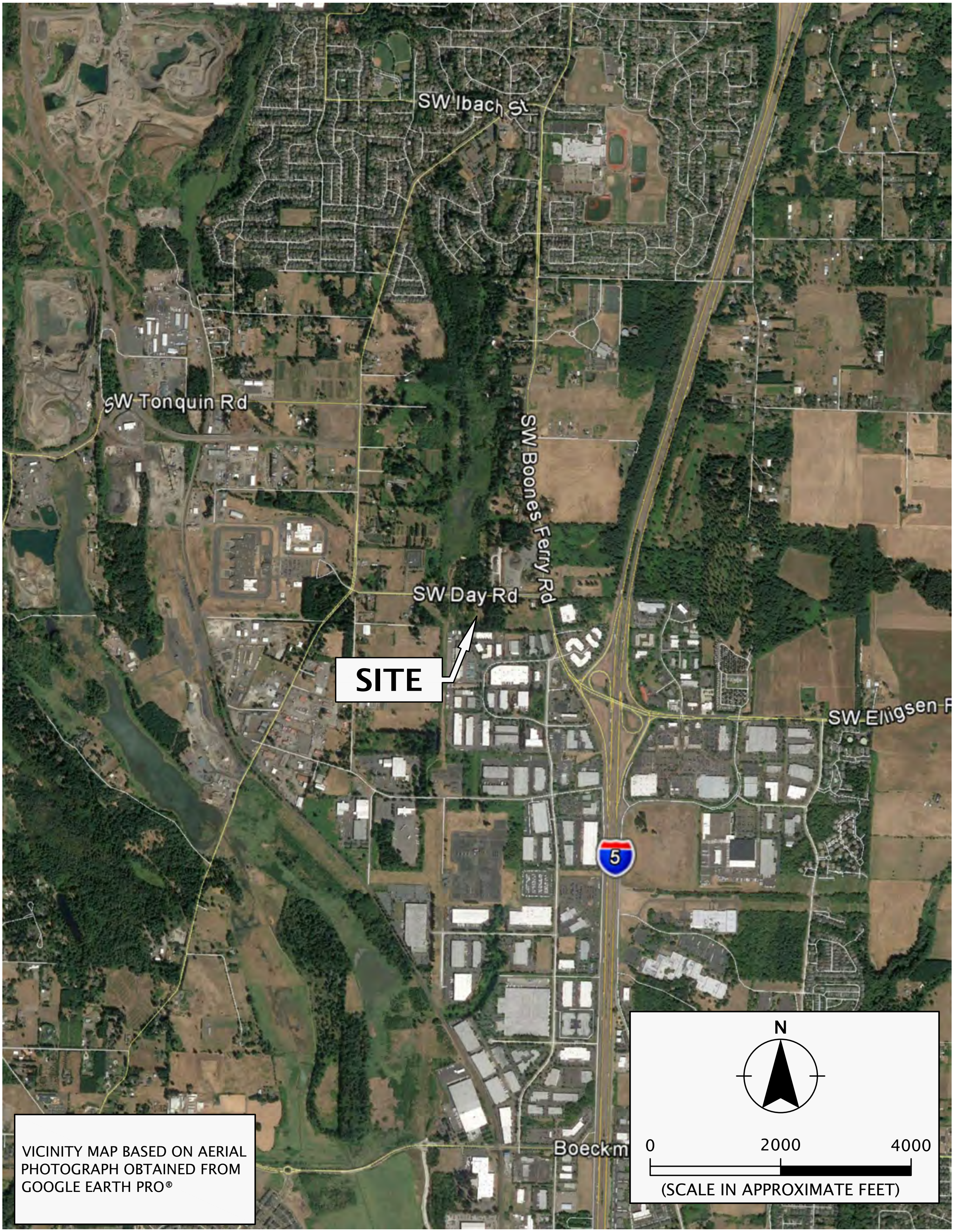
Sincerely,

NV5

Brett A. Shipton, P.E., G.E.
Principal Engineer

REGISTERED PROFESSIONAL
ENGINEER
56207
OREGON
July 11, 2000
BRETT A. SHIPTON
EXPIRES: 6/30/22

FIGURES



VICINITY MAP BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®

NV5	DELTALOG-1-01	**VICINITY MAP**	
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE 1**

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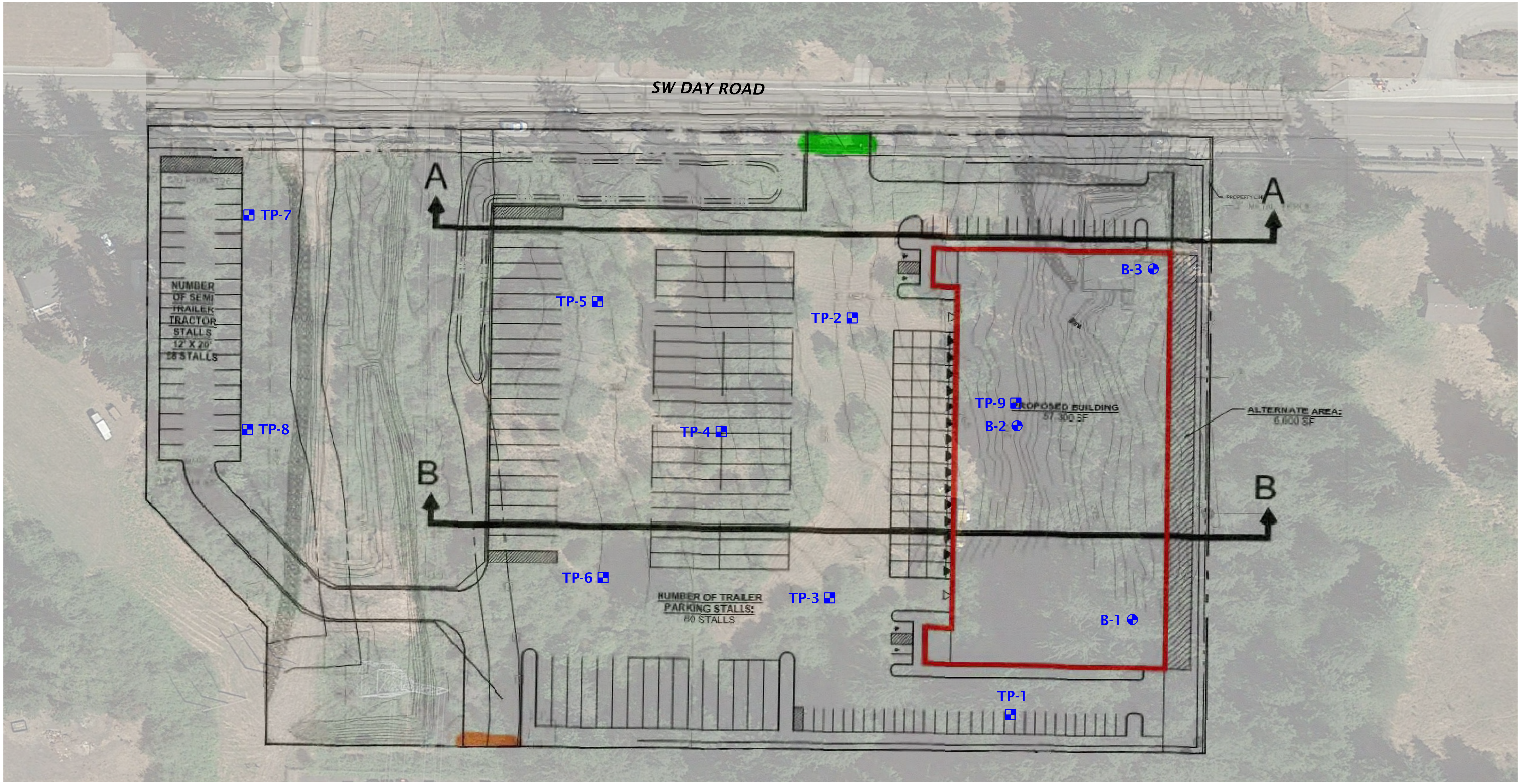
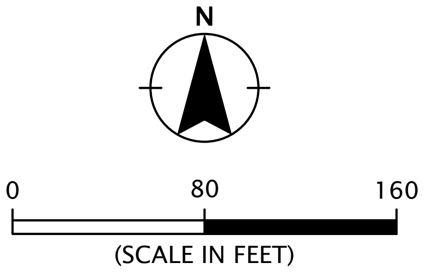
File Name: J:\A-D\DeltaLog\DeltaLog-1\DeltaLog-1-01\Figures\CAD\DeltaLog-1-01-VM01.dwg | Layout: FIGURE 1



LEGEND:

B-1 ◕ BORING

TP-1 ▣ TEST PIT



NOTES:

1. SITE PLAN BASED ON IMAGE OF SHEET SITE PLAN - OPTION 3B DATED MARCH 15, 2021 PREPARED BY MACKENZIE.
2. AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO JUNE 21, 2021.

FIGURE 2

SITE PLAN

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

DELTALOG-1-01

JUNE 2021

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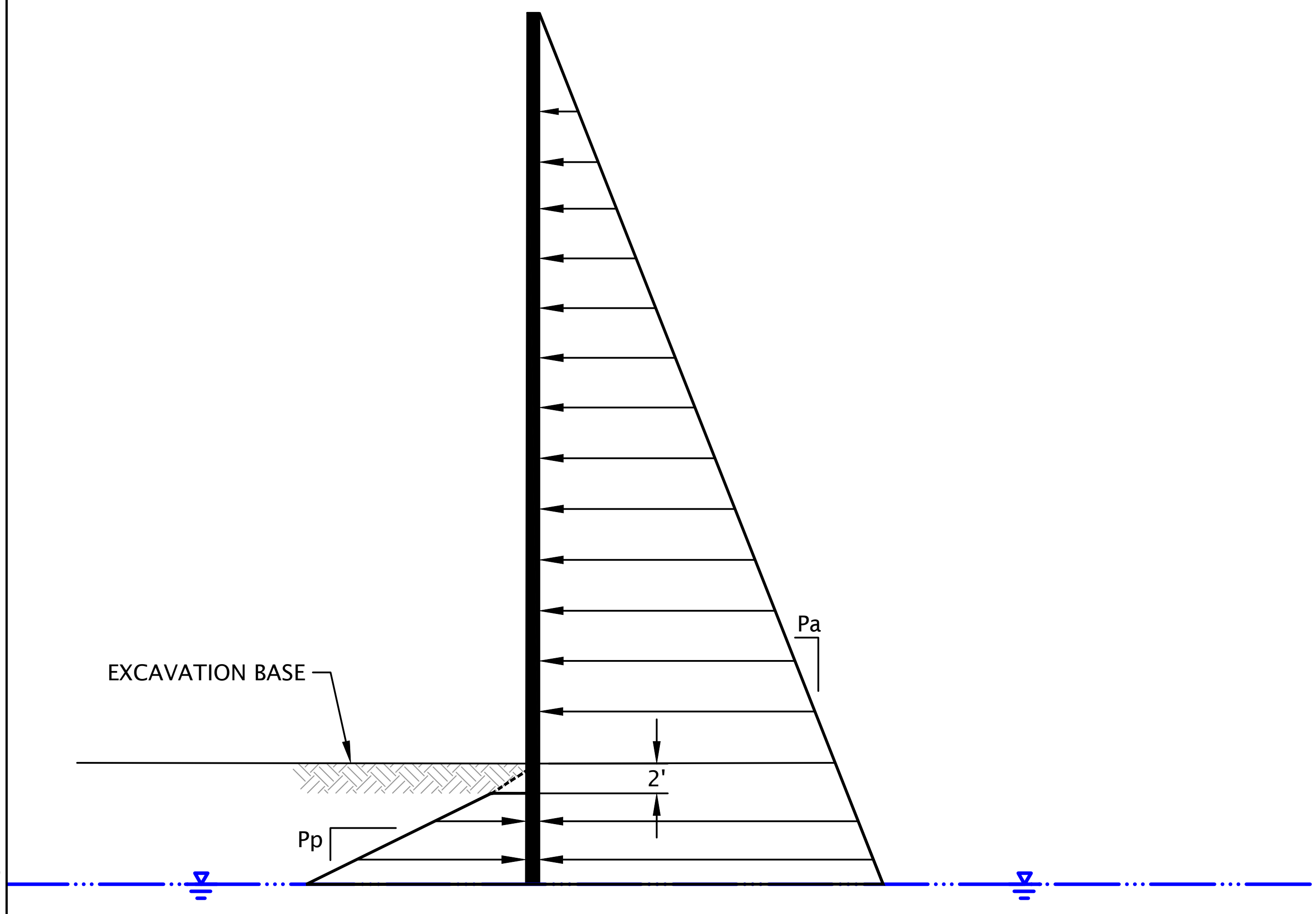
DRAFT

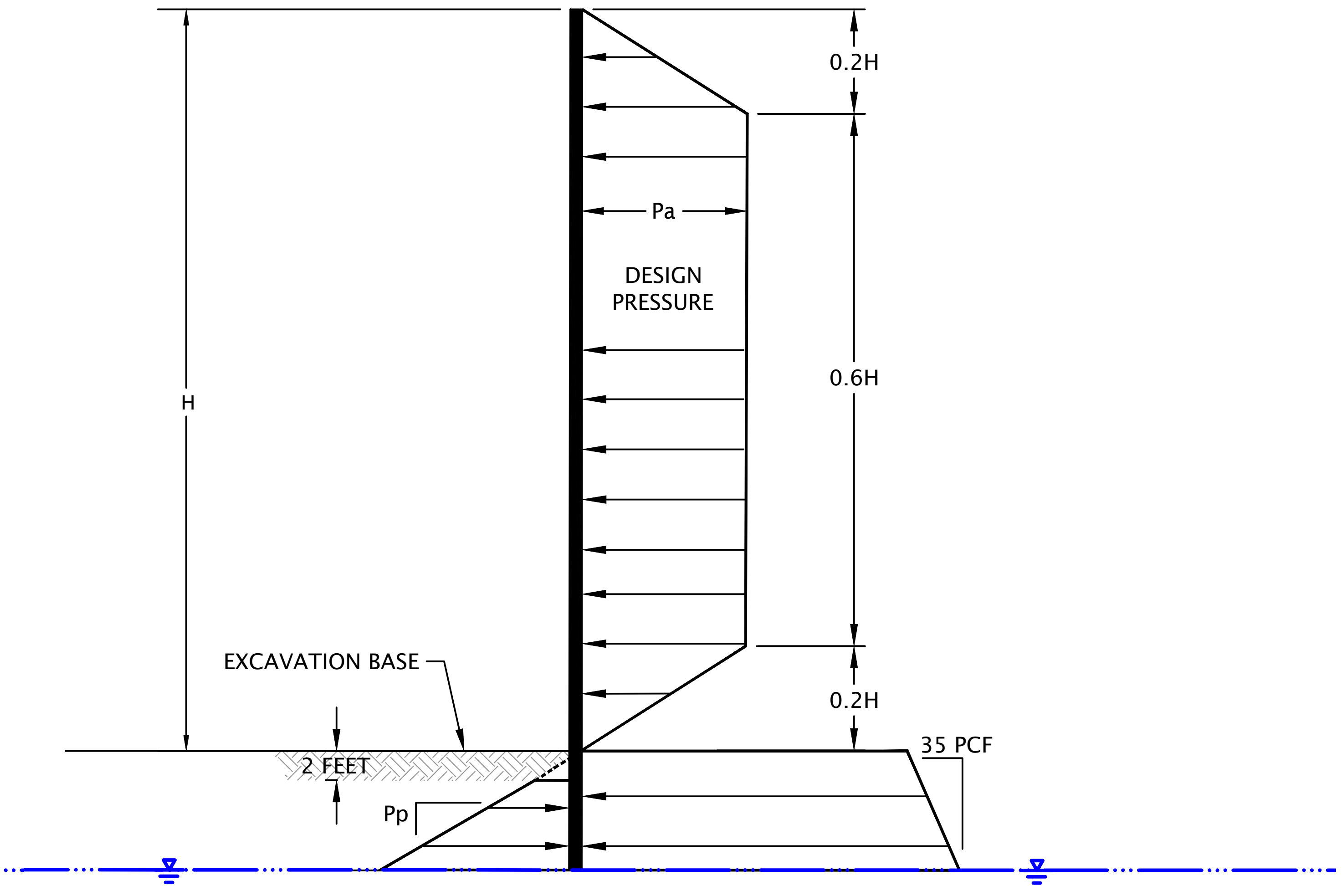
RECOMMENDED DESIGN PARAMETERS FOR CANTILEVERED WALL



EXPLANATION:
Pa = 35 PCF FOR SOIL OR STRUCTURAL FILL ABOVE WATER TABLE
Pa = 15 PCF FOR BASALT ABOVE WATER TABLE
Pp = 350 PCF FOR SOIL ABOVE WATER TABLE
Pp = 850 PCF FOR BASALT ABOVE WATER TABLE

NOTES:
1. FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
2. LATERAL EARTH PRESSURE ASSUMES WATER WILL BE MAINTAINED BELOW THE BASE OF THE EXCAVATION.
3. THE LATERAL EARTH PRESSURES ARE UNFACTORED.
4. PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
5. REFER TO THE GEOTECHNICAL REPORT FOR APPROPRIATE GROUNDWATER ELEVATION.
6. ACTIVE EARTH PRESSURE ASSUMES RETAINING WALL IS FREE TO ROTATE SLIGHTLY AROUND THE BASE.

RECOMMENDED DESIGN PARAMETERS FOR BRACED WALL



EXPLANATION:
Pa = 25 PCF FOR SOIL OR STRUCTURAL FILL ABOVE WATER TABLE
Pa = 12 PCF FOR BASALT ABOVE WATER TABLE
Pp = 350 PCF FOR SOIL ABOVE WATER TABLE
Pp = 850 PCF FOR BASALT ABOVE WATER TABLE

NOTES:
1. FIGURE DOES NOT INCLUDE SURCHARGE OR SEISMIC LOADS.
2. TIEBACKS SHOULD BE LOCKED OFF AT 100 PERCENT OF DESIGN LOAD.
3. THE LATERAL EARTH PRESSURES ARE UNFACTORED.
4. PASSIVE PRESSURE RESISTANCE SHOULD BE NEGLECTED 2 FEET BELOW THE BOTTOM OF THE EXCAVATION.
5. REFER TO THE GEOTECHNICAL REPORT FOR APPROPRIATE GROUNDWATER ELEVATION.
6. ASSUMES RETAINING WALL IS BRACED AT MORE THAN ONE LOCATION.

CANTILEVERED AND BRACED WALLS DESIGN CRITERIA

FIGURE 3

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

DELTALOG-1-01

JUNE 2021

NV5

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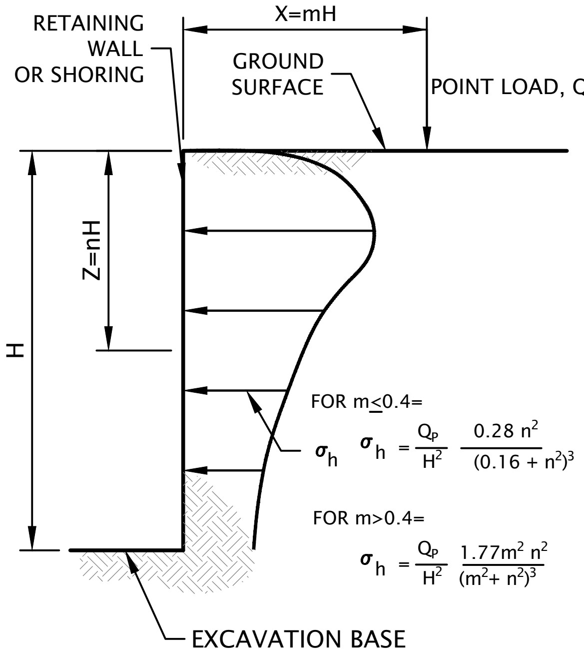
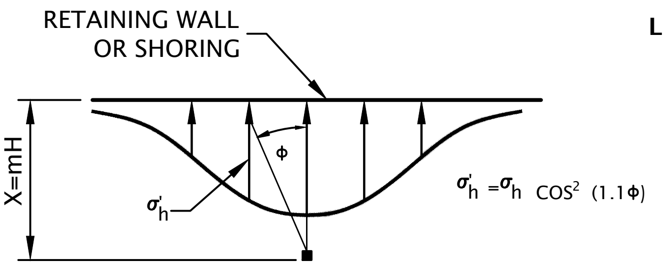
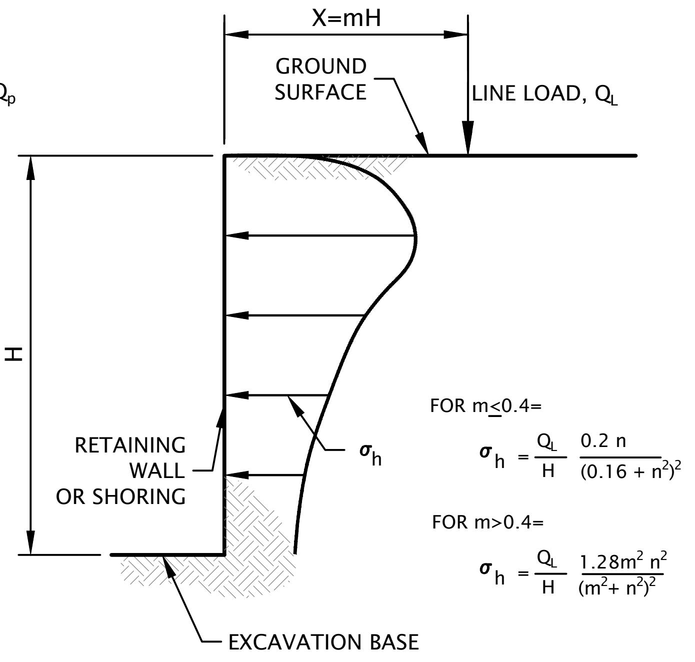


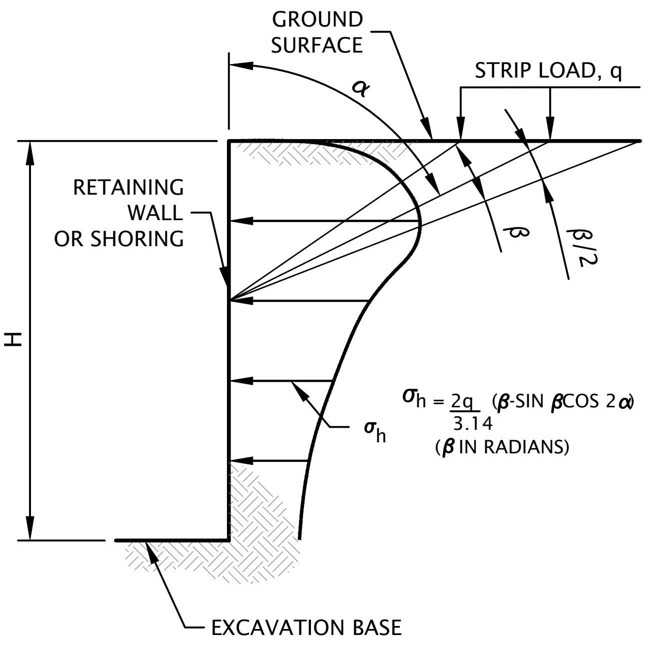


DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD



LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL

NOT TO SCALE

NOTES:

1. FIGURE SHOULD BE USED IN CONJUNCTION WITH REPORT TEXT.
2. THESE GUIDELINES APPLY TO RIGID WALLS WITH POISSON'S RATIO ASSUMED TO BE 0.5 FOR BACKFILL MATERIALS.
3. LATERAL PRESSURES FROM ANY COMBINATION OF ABOVE LOADS MAY BE DETERMINED BY THE PRINCIPLE OF SUPERPOSITION.

NV5

DELTALOG-1-01

JUNE 2021

SURCHARGE-INDUCED LATERAL EARTH PRESSURES

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE 4

APPENDIX

APPENDIX

FIELD EXPLORATIONS

GENERAL

Subsurface conditions were explored by drilling three borings (B-1 through B-3) to depths between 15 and 22.5 feet BGS and excavating nine test pits (TP-1 through TP-9). Drilling services were provided by Western States Soil Conservation, Inc. of Hubbard, Oregon, using mud rotary drilling methods and HQ core drilling techniques. Excavation services were provided by Dan J. Fischer Excavating, Inc. of Forest Grove, Oregon. All explorations were observed by a qualified member of NV5's staff. The approximate exploration locations are shown on Figure 2.

The exploration locations were determined by pacing from existing site features and should be considered accurate to the degree implied by the methods used.

SOIL AND ROCK SAMPLING

We collected representative samples of the various soils encountered during drilling for geotechnical laboratory testing. Samples were collected from the borings using 1½-inch-inside-diameter, split-spoon SPT samplers in general accordance with ASTM D1586. The samplers were driven into the soil with a 140-pound automatic trip hammer free-falling 30 inches. The samplers were driven a total distance of 18 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the exploration logs, unless otherwise noted. The average efficiency of the automatic SPT hammer used by Western States Soil Conservation, Inc. was 82.2 percent. The calibration testing results are presented at the end of this appendix.

Rock was cored continuously using HQ core drilling methods in general accordance with ASTM D2113-99. Percent core recovery and RQD are noted on the exploration logs. The RQD is defined as the total length of all the intact core sections over 4 inches in length divided by the total length of the core run.

Representative grab samples of the soil observed in the test pits were collected from the walls or base of the test pits using the excavator bucket.

Sampling methods and intervals are shown on the exploration logs.

SOIL AND ROCK CLASSIFICATION

The soil and rock samples were classified in the field in accordance with the "Exploration Key" (Table A-1), "Soil Classification System" (Table A-2), and "Rock Classification System" (Table A-3), which are presented in this appendix. The exploration logs indicate the depths at which the soil characteristics change, although the change could be gradual. If the change occurred between sample locations, the depth was interpreted. Classifications are shown on the exploration logs.

INFILTRATION TESTING

Infiltration testing was conducted test pit TP-5 at depths of 2 and 3.5 feet BGS. The infiltration test at a depth of 2 feet BGS was conducted using the falling head method in a 6-inch-diameter standpipe under a head of approximately 14 inches. An open pit technique was used to conduct the test at a depth of 3.5 feet BGS under a head of 14 inches.

LABORATORY TESTING

We visually examined soil samples collected from the explorations to confirm field classifications. We also performed the following laboratory tests to evaluate the engineering properties of the soil.

MOISTURE CONTENT

We tested the natural moisture content of select soil samples in general accordance with ASTM D2216. The test results are presented in this appendix.

PARTICLE-SIZE ANALYSIS

We determined the fines content of a select soil sample in general accordance with ASTM D1140. The test results are presented in this appendix.

UNCONFINED COMPRESSION TESTS

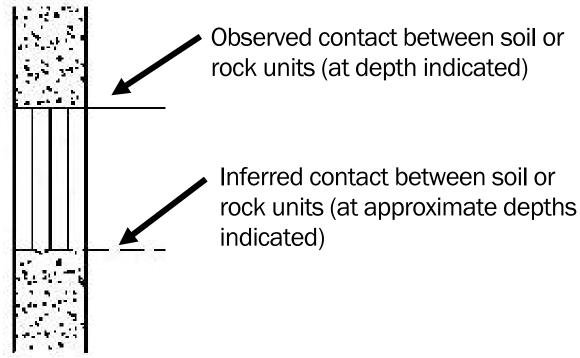
Unconfined compressive strength testing was conducted on several samples from the rock cores. The testing was completed in accordance with ASTM D2938 The test results are summarized in the table below.

Unconfined Compression Test Results

Boring	Depth (feet BGS)	Unconfined Compressive Strength (psi)
B-2	9.6	12,722
B-3	6.3	11,818
B-3	21	7,898

SYMBOL	SAMPLING DESCRIPTION
▯	Location of sample collected in general accordance with ASTM D1586 using Standard Penetration Test (SPT) with recovery
▮	Location of sample collected using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D1587 with recovery
▥	Location of sample collected using Dames & Moore sampler and 300-pound hammer or pushed with recovery
▤	Location of sample collected using Dames & Moore sampler and 140-pound hammer or pushed with recovery
◩	Location of sample collected using 3-inch-outside diameter California split-spoon sampler and 140-pound hammer with recovery
⊠	Location of grab sample
▒	Rock coring interval
▽	Water level during drilling
▼	Water level taken on date shown

Graphic Log of Soil and Rock Types



Observed contact between soil or rock units (at depth indicated)

Inferred contact between soil or rock units (at approximate depths indicated)

GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density		
DS	Direct Shear	RES	Resilient Modulus
HYD	Hydrometer Gradation	SIEV	Sieve Gradation
MC	Moisture Content	TOR	Torvane
MD	Moisture-Density Relationship	UC	Unconfined Compressive Strength
NP	Non-Plastic	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen

EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOIL

Relative Density	Standard Penetration Test (SPT) Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very loose	0 – 4	0 – 11	0 – 4
Loose	4 – 10	11 – 26	4 – 10
Medium dense	10 – 30	26 – 74	10 – 30
Dense	30 – 50	74 – 120	30 – 47
Very dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOIL

Consistency	Standard Penetration Test (SPT) Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 – 4	3 – 6	2 – 5	0.25 – 0.50
Medium stiff	4 – 8	6 – 12	5 – 9	0.50 – 1.0
Stiff	8 – 15	12 – 25	9 – 19	1.0 – 2.0
Very stiff	15 – 30	25 – 65	19 – 31	2.0 – 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOIL (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVEL WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SAND (<5% fines)	SW or SP	SAND
		SAND WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SAND WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOIL (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOIL			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.

Percent	Silt and Clay In:		Percent	Sand and Gravel In:	
	Fine-Grained Soil	Coarse-Grained Soil		Fine-Grained Soil	Coarse-Grained Soil
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
			> 30	sandy/gravelly	Indicate %

NV5

SOIL CLASSIFICATION SYSTEM

TABLE A-2

HARDNESS	DESCRIPTION
Extremely soft (R0)	Indented by thumbnail
Very soft (R1)	Can be peeled by pocket knife or scratched with finger nail
Soft (R2)	Can be peeled by a pocket knife with difficulty
Medium hard (R3)	Can be scratched by knife or pick
Hard (R4)	Can be scratched with knife or pick only with difficulty
Very hard (R5)	Cannot be scratched with knife or sharp pick

WEATHERING	DESCRIPTION
Decomposed	Rock mass is completely decomposed
Predominantly decomposed	Rock mass is more than 50% decomposed
Moderately weathered	Rock mass is decomposed locally
Slightly weathered	Rock mass is generally fresh
Fresh	No discoloration in rock fabric

JOINT SPACING	DESCRIPTION
Very close	Less than 2 inches
Close	2 inches to 1 foot
Moderate close	1 foot to 3 feet
Wide	3 feet to 10 feet
Very wide	Greater than 10 feet

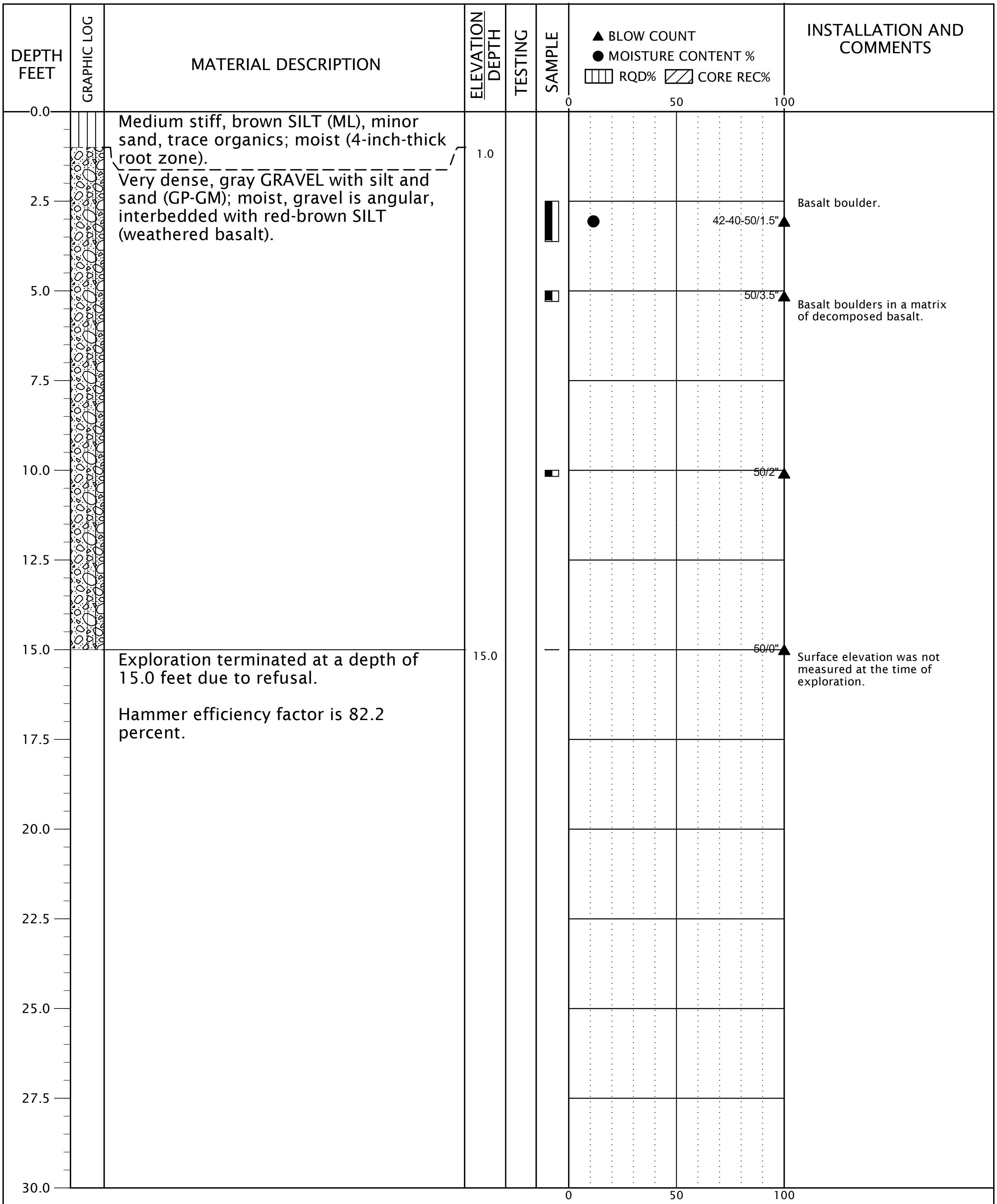
FRACTURING	FRACTURE SPACING
Very intensely fractured	Chips and fragments with a few scattered short core lengths
Intensely fractured	0.1 foot to 0.3 foot with scattered fragments intervals
Moderately fractured	0.3 foot to 1 foot with most lengths 0.6 foot
Slightly fractured	1 foot to 3 feet
Very slightly fractured	Greater than 3 feet
Unfractured	No fractures

HEALING	DESCRIPTION
Not healed	Discontinuity surface, fractured zone, sheared material or filling not re-cemented
Partly healed	Less than 50% of fractured or sheared material
Moderately healed	Greater than 50% of fractured or sheared material
Totally healed	All fragments bonded

NV5

ROCK CLASSIFICATION SYSTEM

TABLE A-3



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH
0.0	Medium stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).	1.0
	Very dense, gray GRAVEL with silt and sand (GP-GM); moist, gravel is angular, interbedded with red-brown SILT (weathered basalt).	15.0
15.0	Exploration terminated at a depth of 15.0 feet due to refusal. Hammer efficiency factor is 82.2 percent.	

BLOW COUNT	INSTALLATION AND COMMENTS
42-40-50/1.5"	Basalt boulder.
50/3.5"	Basalt boulders in a matrix of decomposed basalt.
50/2"	
50/0"	Surface elevation was not measured at the time of exploration.

DRILLED BY: Western States Soil Conservation, Inc.
LOGGED BY: J. Pence
COMPLETED: 06/08/21

BORING METHOD: mud rotary (see document text)
BORING BIT DIAMETER: 4 7/8 inches

NV5

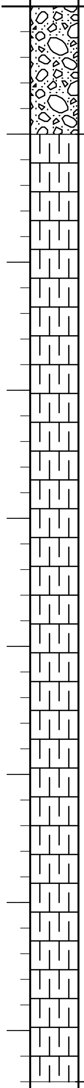
DELTALOG-1-01

JUNE 2021

BORING B-1

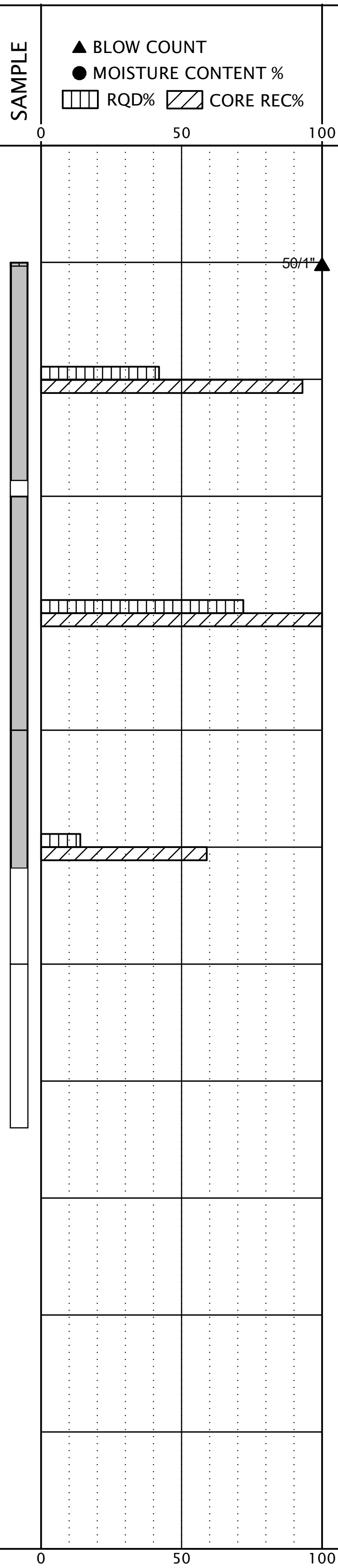
DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-1



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0.0	Very dense, gray GRAVEL with sand (GP); moist, gravel is angular.			
2.5	Medium hard (R3), light orange-gray BASALT; moderately weathered, intensely fractured [joint, 5-30˚, 70-90˚, narrow, decomposed rock infill (clay), planar, smooth to rough, partly healed], aphanitic, moist. hard (R4), light gray; [joint, 0-20˚, extremely narrow, surface staining/decomposed, not healed] at 5.5 feet	2.5		Switch to HQ rock drilling at 2.5 feet.
10.0			UC	UC = 12,722 psi
	medium hard (R3); [joint, 0-80˚, very narrow] at 10.8 feet			
	soft (R2); slightly weathered [fracture zone] at 14.0 feet			
21.0	Exploration completed at a depth of 21.0 feet. Hammer efficiency factor is 82.2 percent.	21.0		Surface elevation was not measured at the time of exploration.

Depth scale (feet): 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27.5, 30.0



DRILLED BY: Western States Soil Conservation, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/08/21

BORING METHOD: mud rotary and HQ core drilling (see document text)

BORING BIT DIAMETER: 4 7/8 inches

NV5

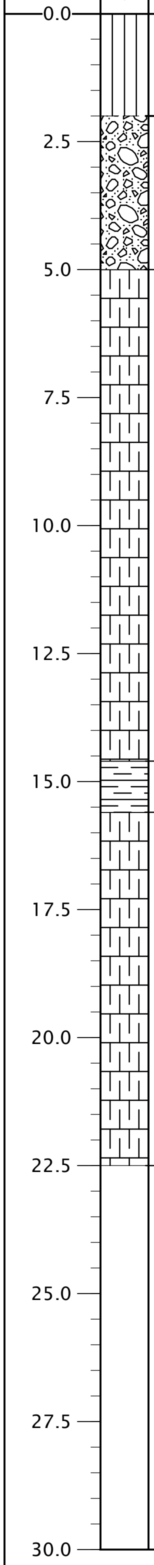
DELTALOG-1-01

JUNE 2021

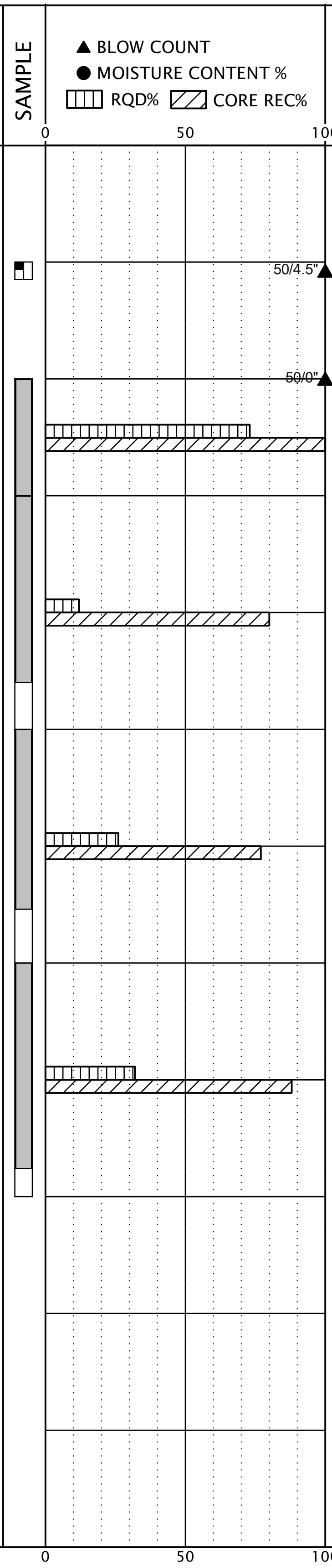
BORING B-2

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-2



MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
Medium stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).			
Very dense, gray-brown GRAVEL with sand (GP); moist, gravel is angular.	2.0		
Hard (R4), light gray BASALT; moderately weathered, moderately fractured [joint, 10-45°, narrow, decomposed rock infill (clay), planar, smooth to rough, partly healed], aphanitic, moist. light gray; intensely fractured [joint, 0-30°] at 8.0 feet	5.0	UC	Switch to HQ rock drilling at 5.0 feet. UC = 11,818 psi
Very soft (R1), gray-brown SILTSTONE; slightly weathered, moderately fractured [bedding joint, narrow, planar, smooth to rough], silt, laminated, cemented, fissile (interflow deposit).	14.6		
Hard (R4), gray BASALT; slightly weathered, moderately fractured [joint, 0-15°, surface staining, planar, not healed], vuggy.	15.6	UC	UC = 7,898 psi
Exploration completed at a depth of 22.5 feet. Hammer efficiency factor is 82.2 percent.	22.5		Surface elevation was not measured at the time of exploration.



DRILLED BY: Western States Soil Conservation, Inc.
LOGGED BY: J. Pence
COMPLETED: 06/08/21

BORING METHOD: mud rotary and HQ core drilling (see document text)
BORING BIT DIAMETER: 4 7/8 inches

NV5

DELTALOG-1-01

JUNE 2021

BORING B-3

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-3

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % (0 50 100)	COMMENTS
0.0		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics (roots, rootlets); moist (4-inch-thick root zone). without roots at 1.0 foot					
				PP	☒	●	PP = 1.0 tsf
2.5							
5.0							
					☒		
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	7.0				
7.5							
					☒		
10.0							
		intact basalt at 12.0 feet Exploration terminated at a depth of 12.0 feet due to refusal.	12.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
12.5							
15.0							

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-1

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-4

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics; moist, sand is fine (4-inch-thick root zone).					
2.5							
				PP	☒		PP = 1.5 tsf
5.0		intact gray basalt at 5.0 feet	5.0				
		Exploration terminated at a depth of 5.0 feet due to refusal.					No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

DELTALOG-1-01

JUNE 2021

TEST PIT TP-2

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-5

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics; moist (3-inch-thick root zone).					
				PP	☒		PP = 13.5 tsf
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular (weathered basalt).	2.0				
2.5							
					☒		
		intact gray basalt at 4.0 feet Exploration terminated at a depth of 4.0 feet due to refusal.	4.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-3

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-6

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).					
				PP	☒		PP = 1.0 tsf
2.5		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	2.0				Basalt becomes more intact with depth.
5.0		Exploration terminated at a depth of 5.0 feet due to refusal.	5.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Pence
COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

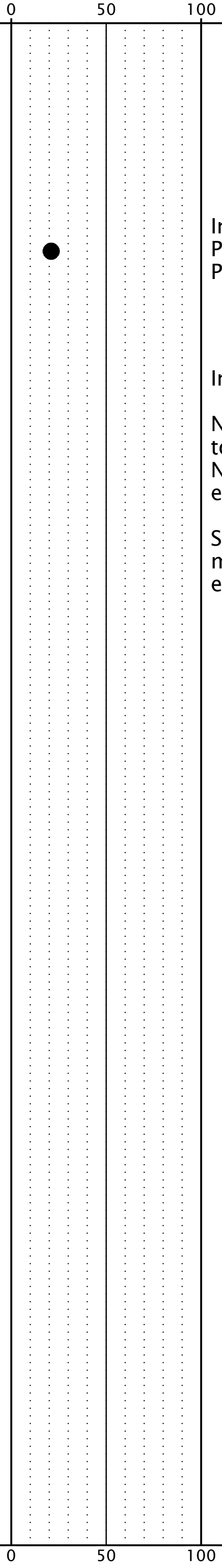
TEST PIT TP-4

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-7

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT %	COMMENTS
0.0		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics; moist (4-inch-thick root zone).					
2.5				P200 PP	☒	●	Infiltration test at 2.0 feet. P200 = 86% PP = 1.0 tsf
		Medium dense to dense, red-brown, clayey GRAVEL (GC); moist, gravel is angular and vesicular (weathered basalt).	3.0		☒		Infiltration test at 3.5 feet.
		Exploration terminated at a depth of 3.5 feet due to refusal.	3.5				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0							



EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-5

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-8

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		GRAVEL - **FILL**.					
		Medium stiff to stiff, brown SILT (ML), minor sand, trace organics (roots); moist. without roots at 1.0 foot	0.5	PP	☒		PP = 1.0 tsf
2.5							
		Medium dense to dense, gray GRAVEL with sand (GP); dry to moist, gravel is angular (weathered basalt). intact gray basalt at 4.0 feet	3.0		☒		
		Exploration terminated at a depth of 3.5 feet due to refusal.	3.5				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

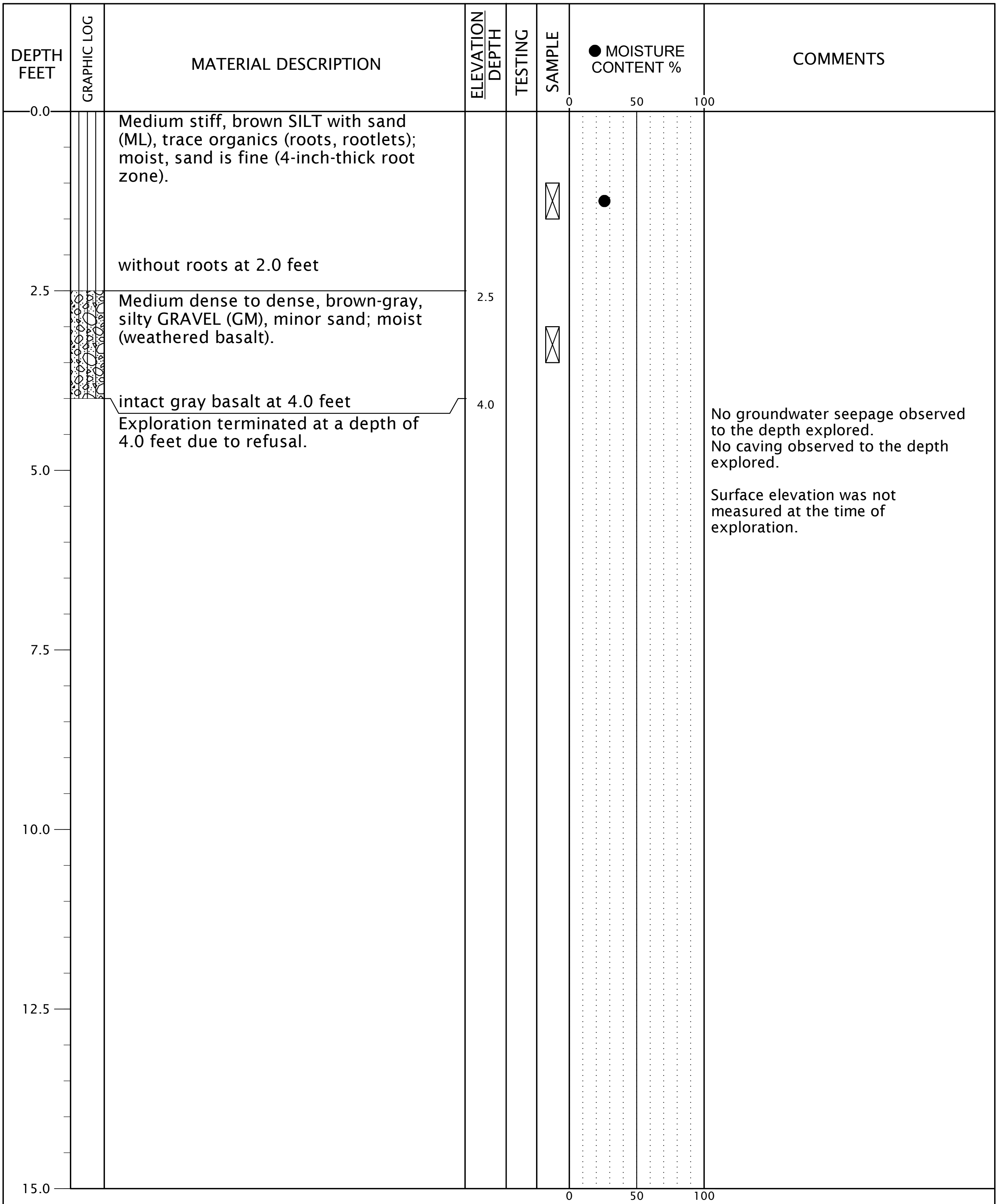
DELTALOG-1-01

JUNE 2021

TEST PIT TP-6

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-9



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT %	COMMENTS
0.0	Medium stiff, brown SILT with sand (ML), trace organics (roots, rootlets); moist, sand is fine (4-inch-thick root zone). without roots at 2.0 feet			☒	●	
2.5	Medium dense to dense, brown-gray, silty GRAVEL (GM), minor sand; moist (weathered basalt).	2.5		☒		
	intact gray basalt at 4.0 feet Exploration terminated at a depth of 4.0 feet due to refusal.	4.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.

EXCAVATED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Pence
COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

DELTALOG-1-01

JUNE 2021

TEST PIT TP-7

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-10

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

TEST PIT TP-8

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0	Medium stiff, brown SILT (ML), minor sand, trace organics (roots); moist (4-inch-thick root zone).					
			PP	☒		PP = 0.75 tsf
	without roots at 2.0 feet					
2.5						
			PP	☒		PP = 1.5 tsf
	Dense, red-brown, silty GRAVEL (GM), minor sand; moist, gravel is angular (weathered basalt).	4.0				
5.0						
	Dense, gray GRAVEL (GP), minor sand, trace silt; moist, gravel is angular (weathered basalt).	6.0				
7.5						
						Moderate groundwater seepage observed at 8.0 feet.
	intact gray basalt at 8.5 feet Exploration terminated at a depth of 8.5 feet due to refusal.	8.5				No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
10.0						
12.5						
15.0					0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-11

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

DEPTH FEET	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION / DEPTH	TESTING	SAMPLE	● MOISTURE CONTENT % 0 50 100	COMMENTS
0.0		Medium stiff, brown SILT (ML), minor sand, trace organics (roots, rootlets); moist (4-inch-thick root zone).					
2.5							
		basalt at 3.0 feet Exploration terminated at a depth of 3.0 feet due to refusal.	3.0				No groundwater seepage observed to the depth explored. No caving observed to the depth explored. Surface elevation was not measured at the time of exploration.
5.0							
7.5							
10.0							
12.5							
15.0						0 50 100	

EXCAVATED BY: Dan J. Fischer Excavating, Inc.

LOGGED BY: J. Pence

COMPLETED: 06/07/21

EXCAVATION METHOD: backhoe (see document text)

NV5

DELTALOG-1-01

JUNE 2021

TEST PIT TP-9

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-12

TEST PIT LOG - NV5 - 1 PER PAGE DELTALOG-1-01-B1_3-TP1_9.GPJ GDI_NV5.GDT PRINT DATE: 6/30/21:KT

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	2.5		11							
TP-1	1.5		21							
TP-5	2.0		21				86			
TP-7	1.0		26							

NV5

DELTALOG-1-01

JUNE 2021

SUMMARY OF LABORATORY DATA

DELTA LOGISTICS DAY ROAD ANNEX
WILSONVILLE, OR

FIGURE A-13

BORING B-2, CORE RUN 1, 2.5 TO 7.5 FEET BGS.

BORING B-2, CORE RUN 2, 7.5 TO 12.5 FEET BGS.

NV5	DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-14**

BORING B-2, CORE RUN 3, 12.5 TO 17.5 FEET BGS.

BORING B-3, CORE RUN 1, 5 TO 7.5 FEET BGS.

NV5	DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-15**

BORING B-3, CORE RUN 2, 7.5 TO 12.5 FEET BGS.

BORING B-3, CORE RUN 3, 12.5 TO 17.5 FEET BGS.

NV5	DELTALOG-1-01	**ROCK CORE PHOTOGRAPHS**	
	JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-16**

BORING B-3, CORE RUN 4, 17.5 TO 22.5 FEET BGS.

DELTALOG-1-01	ROCK CORE PHOTOGRAPHS	
JUNE 2021	DELTA LOGISTICS DAY ROAD ANNEX WILSONVILLE, OR	**FIGURE A-17**

Summary of SPT Test Results

Project: WSSC-8-05, Test Date: 4/13/2020

EMX: Maximum Energy

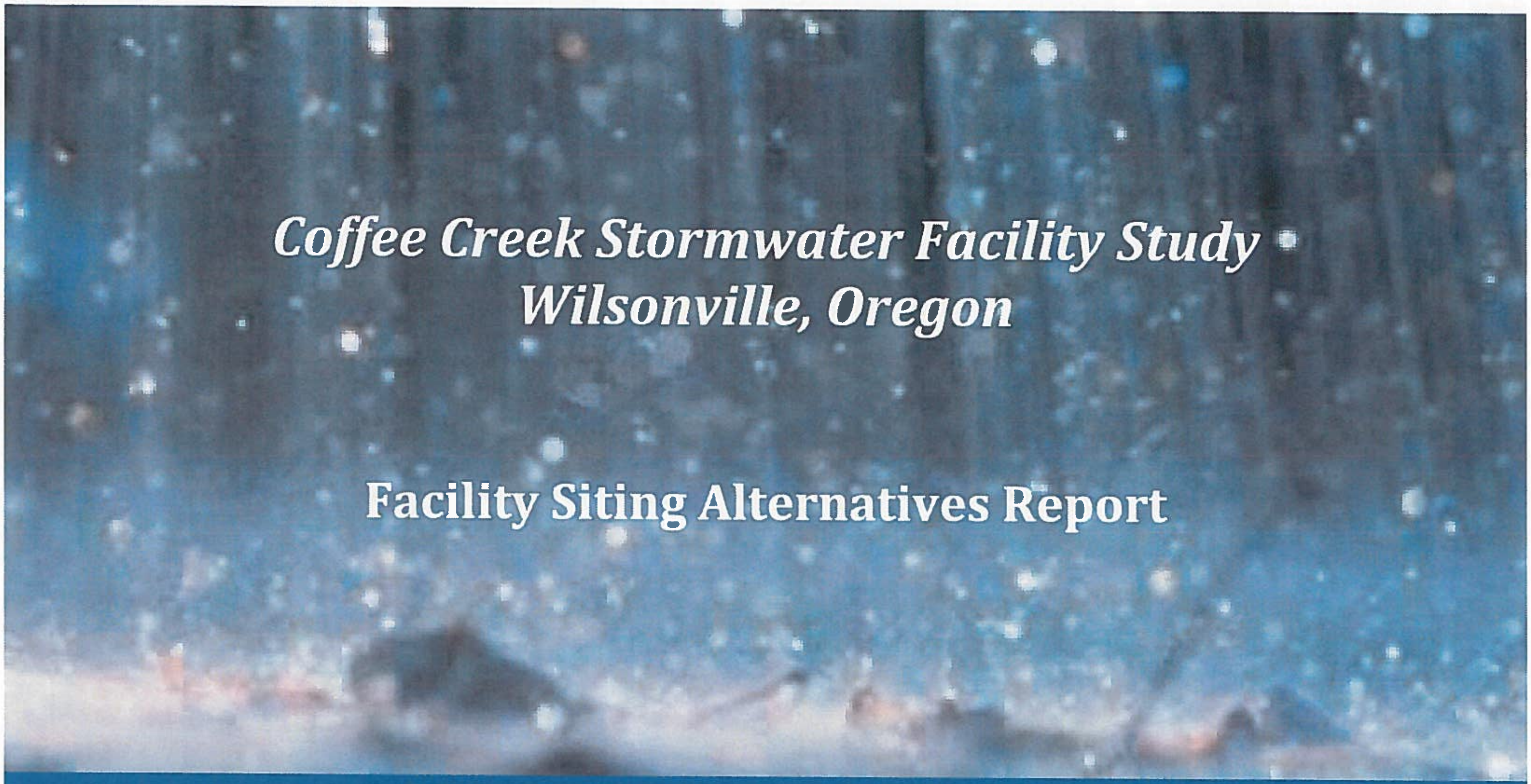
ETR: Energy Transfer Ratio - Rated

Start Depth ft	Final Depth ft	**N Value**	**N60 Value**	Average EMX ft-lb	Average ETR %
15.00	16.50	**8**	**10**	291.65	83.3
17.50	19.00	**15**	**20**	278.80	79.7
20.00	21.50	**18**	**24**	290.63	83.0
22.50	24.00	**15**	**20**	304.84	87.1
25.00	26.50	**11**	**15**	269.66	77.0
			Overall Average Values:	287.84	82.2
			Standard Deviation:	38.44	11.0
			Overall Maximum Value:	327.58	93.6
			Overall Minimum Value:	0.10	0.0

N|V|5 Delivering Solutions
Improving Lives

APPENDIX H

COFFEE CREEK
STROMWATER STUDY
(JUNE 2019)



Coffee Creek Stormwater Facility Study
Wilsonville, Oregon

Facility Siting Alternatives Report

Date: June 2019

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Facility Siting Alternatives Report

COFFEE CREEK STORMWATER FACILITY STUDY

WILSONVILLE, OREGON

1.0 Introduction

The City of Wilsonville's 2012 Stormwater Master Plan (SWMP) identifies the Coffee Creek Industrial Area as an existing problem area due to its poor drainage and its tendency to flood during moderate storm events. Basalt Creek (also referred to as Tapman Creek), which has been constructed into channels and culverts, overtops its banks and floods the adjacent parking area on the west side of the Commerce Circle Business Park, beginning at the 2-year, 24-hour storm event. The creek has negative slopes in this area that contribute to flooding while also preventing flooding from occurring downstream (2012 SWMP 6.6.1).

Commerce Circle was identified in the 2012 SWMP as one of four general areas to experience flooding. The 2012 SWMP states that the area "is known to flood, and the parking lots in the development were originally designed to flood and provide additional detention volume. Therefore, some flooding is to be expected in this area. Portions of the open channel system have a reverse slope, contributing to the predicted and observed flooding. The reverse slope has not been removed so as to avoid moving the flooding to a downstream location."

The Coffee Creek Regional Stormwater Facility Project (Project) is intended to meet the following goals for this portion of Basalt Creek:

1. Functional
2. Maintainable
3. Uplifted habitat

The 2012 SWMP includes the capital improvement project (CIP) Channel Project – Commerce Circle (CLC-3) as a recommended project, which is the basis of design for this project. More information about the basis of design can be found in the Basis of Design Report included as Supplemental Information to this report.

This report summarizes and describes the tasks completed for the pre-design effort for this project.

2.0 Project Location

This project is located to the west and south of the Commerce Circle industrial area and follows Basalt Creek in a straightened, incised channel between SW Day Road to the north, and SW Ridder Road to the south. Approximately 1,050 acres of surrounding drainage area contributes stormwater runoff to the system. This drainage area is shown on Figure 2 in the Basis of Design Report, included as Supplemental Information to this report.

3.0 Data Gathering and Concept Development

3.1 DOCUMENT REVIEW

To get an accurate understanding of the existing site conditions, AKS first reviewed relevant documents provided by the City, including the 2007 Coffee Creek Master Plan; 2012 SWMP; the documents used in the creation of the 2012 SWMP such as the CIP CLC-3 and InfoSWMM model; and the 2018 Draft Basalt Creek Concept Plan. A more detailed review of these documents can be found in the attached Basis of Design Report included as Supplemental Information to this report.

AKS analyzed the drainage basin and subbasins contributing stormwater runoff to the project site using DOGAMI LIDAR topography and stormwater GIS data provided by the City. This phase also included site visits by AKS' engineering team, natural resources team, and survey team, as well as Shannon & Wilson's geotechnical and environmental teams and Willamette Cultural Resources Associates.

In January 2019, AKS utilized drone technology to collect high-resolution imagery of the project area. This imagery was processed with survey-grade ground control to create an orthomosaic and elevation data of the site. This was especially useful for confirming areas of suspected ponding and digitally locating utility poles, as they were not a part of the preliminary topographic survey. While the resolution and accuracy of the data is quite high, there are inherent limitations to a photogrammetric workflow. Heavy shadowing, dense vegetation and surface water obstruct the visibility of the terrain in the imagery and therefore impede the creation of any derived elevation data. To confirm accuracy and reliability, the AKS drone topography was cross-referenced with the DOGAMI LIDAR and was found to be precise.

In addition to the drone survey and DOGAMI LIDAR analysis, a preliminary topographic survey took place in January 2019. The preliminary topographic survey included only critical elements, such as the culvert inlets and select channel cross-sections, to supplement the DOGAMI LIDAR. This survey effort was limited to the level of detail needed to validate the viability of CIP CLC-3. A more comprehensive topographic survey, including a tree survey, will need to be completed for construction-level drawings.

3.2 NATURAL RESOURCES DESKTOP REVIEW

As part of the Wetlands/Waters Desktop Review, AKS' natural resources department reviewed previous wetland delineation concurrences and visited the site in February 2019 to confirm the presence and absence of wetland conditions in the study area. The study confirmed that much of the project area is wetlands and/or jurisdictional waters.

The complete Wetlands/Waters Desktop Review is included as Supplemental Information to this report.

3.3 GEOTECHNICAL DESKTOP INVESTIGATION

Shannon & Wilson provided preliminary geotechnical services for this project. They reviewed borehole logs in the vicinity of the project and recommended that no excavation be proposed within 15 feet of any existing utility poles. Shannon & Wilson also noted that the Bonneville Power Administration (BPA) will need to be asked to review any proposed work in the vicinity and that the BPA should be the ultimate authority on proposed excavations adjacent to their utility poles.

More detailed information about the geotechnical study can be found in the Preliminary Geotechnical Desktop Study included as Supplemental Information to this report.

3.4 HAZARDOUS MATERIALS CORRIDOR ASSESSMENT (HMCA)

Shannon & Wilson provided the HMCA for this project. They found four Environmental Conditions (ECs) that exist for the Project Corridor and recommend a Phase II ESA be performed along the proposed channel alignment.

More detailed information about the Environmental Conditions and Shannon & Wilson's recommendations can be found in the HMCA included as Supplemental Information to this report.

3.5 CULTURAL RESOURCES DESKTOP REVIEW

Willamette Cultural Resources Associates provided cultural resources services for this project and identified the undeveloped portions of the study area as having a moderate to high probability for precontact archaeological resources based on proximity to Tapman Creek. Willamette Cultural Resources Associates recommends these areas receive a systematic pedestrian survey and shovel probing.

More detailed information about the cultural resources study can be found in the Cultural Resources Reconnaissance Survey included as Supplemental Information to this report.

3.6 LAND USE

The project limits extend through properties located within and outside of the Wilsonville City limits. For the segments outside city limits, Washington County is the authority having jurisdiction on land use matters. Construction of the improvements would require either annexation of the affected properties into Wilsonville or obtaining land use approval from Washington County. Given that the project could potentially affect five properties outside of City limits, pursuing land use approval for the improvements under County review, rather than annexation, is likely the most efficient path for permitting. All affected properties are zoned Future Development 20-acre District (FD-20) as defined by the Washington County Community Development Code. The project would likely be reviewed under a Type III procedure as a Public Utility in accordance with Section 308-4.8 of the Washington County CDC. If the City wishes to obtain fee simple ownership of the land within the open channel portions of the project, then a series of property line adjustments and partitions may be required. Land use requirements for properties within City limits should be reviewed internally with City of Wilsonville Planning staff. Each of the proposed channel improvement options will require similar procedures for land use entitlement; therefore, land use process is not considered a factor in the siting study.

3.7 SITE CONSTRAINTS

Several constraints were noted during the data gathering and concept development stage that guided the final conceptual plans. These constraints are described below.

3.7.1 Utility Poles and Towers

The project area runs north to south, mostly along a BPA easement, and includes areas along a Portland General Electric (PGE) easement. As such, there are many utility poles and towers along the project corridor.

The BPA utility poles have an excavation setback that is described in Shannon & Wilson's Preliminary Geotechnical Desktop Study, attached to this report. There is currently maintenance access to these poles along a dirt and gravel road, and access to these poles must remain.

The new channel design must take into consideration the access road and utility pole/tower setbacks.

3.7.2 Limited Pipe Capacity

Just north of SW Ridder Road, Basalt Creek (Tapman Creek) enters two 36-inch stormwater pipes that run beneath the access drive and parking lot for Tax Lot 500, Tax Map 3S102CD. These two 36-inch stormwater pipes have limited capacity and are a constraint on the system.

3.7.3 Reverse Slope and Flat Topography

Some sections of Basalt Creek (Tapman Creek) have reverse slope in the project area, as shown in the existing profile attached in an appendix to this report. For the purposes of this analysis, the reverse slope is proposed to be corrected.

The channel restoration is proposed to extend approximately 3,300-linear feet between the southern outlet of the SW Day Road culverts and the 36-inch pipes beneath the parking area of Tax Lot 500, Tax Map 3S102CD. The elevation difference through this segment is only ±1.1 feet with a slope of 0.0003 (0.03%). Correcting the reverse grade in this area creates a nearly flat creek channel and floodplain.

3.7.4 The Willamette Water Supply Program:

Section PLM_1.3 of the Willamette Water Supply Program is proposed within SW Ridder Road. Construction is currently estimated to occur between 2020 and 2022. Coordination with the entities involved in this project may be required if improvements within SW Ridder Road are selected (e.g. Option B).

3.7.5 New Kinsman Road Extension

The Coffee Creek Industrial Area Infrastructure Analysis, dated 2011, indicates plans for a new road directly adjacent to the project site.

Originally this was considered a potential constraint that would need to be taken into consideration during final design of the new channel. After discussions with the City, it was determined that this planned roadway is no longer being considered for construction and is no longer a potential constraint.

3.8 HYDROLOGIC AND HYDRAULIC MODEL

Once data was sufficiently gathered and analyzed, AKS adjusted the City’s existing InfoSWMM model to estimate the capacity that proposed design elements of CLC-3 would have on the system. Modeling the 25-year storm, it was apparent that the proposed design of CLC-3 was incapable of reducing flood levels in the channel and that more would need to be done to reduce flooding within the industrial area.

The Facility Siting Concepts were developed with the goal of maximizing conveyance and capacity while considering the project constraints.

4.0 Facility Siting Concepts: Option A and Option B

The designs for Options A and B are described in this section. Plans, profiles, and cross-sections are attached to this report.

4.1 OPTION A AND OPTION B

Beginning in the north at SW Day Road (STA 44+00), Option A and Option B are identical up to the point that they veer apart at approximately station 14+50, at which point Option A continues east, along the existing channel, while Option B splits to the south. These differences will be described below.

To maximize conveyance, both options include removing negative slopes and culverts that are constraints on the system. The slope is limited to about 0.03%, with the vertical elevation fall, from the SW Day Road culvert to the stormwater pipes beneath Tax Lot 500, Tax Map 3S102CD, only being ±1.1 foot, over a horizontal distance of ±3,000 feet.

The primary channel is designed with a 5-foot wide bottom that is 1-foot to 6-feet deep, on average. To maximize storage and capacity, the channel is widened at elevation 223.0 to create a floodplain, where feasible. Side slopes are designed at 2:1 to minimize the excavation footprint. In some locations, structural earth walls (see detail, Sheet 7 of the Facility Siting Concepts) are proposed to further minimize the project footprint and to avoid constraints such as existing utility poles.

Open-bottom or box culverts are proposed to provide access to the existing utility poles while also maximizing conveyance. The existing maintenance road will be relocated to allow for the excavation of the channel and floodplain.

In two locations, there is not enough width in the original project area to construct a new channel while also meeting the excavation setbacks. In these locations, the restored channel is proposed on neighboring agricultural properties to the west. To limit the disturbance footprint in these areas, structural earth walls are proposed, similar to the detail on Sheet 7 of the Facility Siting Concepts sheets attached to this report. These walls will be vegetated.

Maintenance access will be preserved by relocating a gravel access road and utilizing open-bottom or box culverts for channel crossings.

Both options include a detention pond for additional storage capacity on Tax Lots 704 and 790, Tax Map 3S102B, adjacent to SW Day Road. The bottom elevation of this pond is designed at 223.0, equal to the floodplain designed in the channel portion of the project. The side slopes are designed at 4:1. The detention pond will be connected to the existing detention pond and channel with an open-bottom or box culvert beneath the existing maintenance road.

4.2 OPTION A

Option A continues east at approximately station 14+50, through an existing wetland. To minimize the excavation footprint in this area, from approximately station 14+50 through station 12+50, structural earth walls are proposed to allow for steeper slopes, designed at 0.25:1.

The channel will continue to the two existing 36-inch stormwater pipes that are located beneath the parking lot of Tax Lot 500, Tax Map 3S102CD, within a City stormwater easement. To increase conveyance, a third 36-inch stormwater pipe is proposed to be constructed parallel to the two existing pipes, within the existing parking lot. If space allows, the existing easement will be used although it is likely that the City will require an easement extension.

4.3 OPTION B

Option B veers south from Option A at approximately station 14+50, through a proposed channel on Tax Lot 600, Tax Map 3S102CD. To minimize the footprint necessary to create a positive slope to SW Ridder Road, the channel does not include floodplain. The channel side slopes are designed at 2:1.

At the southern terminus of this channel, the creek will be piped in two parallel 42-inch stormwater pipes installed in the north lane of SW Ridder Road. Two 42-inch pipes were chosen to convey the same amount of water as the potential three 36-inch pipes proposed in Option A. These pipes will connect to the existing western 48-inch culvert beneath SW Ridder Road. A concrete vault is proposed to make this connection. The existing 12-inch stormwater pipe and existing manholes in SW Ridder Road will be removed.

The two existing 36-inch stormwater pipes that are located beneath the parking lot of Tax Lot 500, Tax Map 3S102CD, will remain in place to convey stormwater from Commerce Circle.

As stated earlier in this report, the future Willamette Water Supply Program is proposed to be installed in SW Ridder Road. Coordination with the entities involved with this pipeline project will be necessary.

4.4 OPTIONAL DESIGN ELEMENTS

For modeling and cost estimating purposes, Options A and B were broken down further to allow a more detailed look at the effects of some of the design elements, notably the detention pond and the additional 36-inch pipe beneath Tax Lot 500, Tax Map 3S102CD. Breaking these options down to smaller elements allowed for a better understanding of where the costs were receiving the most benefits for the project goals.

The model for Option A was evaluated with: neither the detention pond nor the additional 36-inch pipe (A-1); with one of each of those elements separately (A-2 and A-3); and with both the detention pond and the additional 36-inch pipe included (A-4).

The model for Option B was evaluated without the detention pond (B-1), and with the detention pond (B-2).

These six options are summarized in the table below.

Table 1: Summary of Options and Design Elements

Option	Additional 36-inch Pipe	Detention Pond
A-1	No	No
A-2	No	Yes
A-3	Yes	No
A-4	Yes	Yes
B-1	n/a	No
B-2	n/a	Yes

4.5 MODELING RESULTS

The elevation of the parking lot on the west side of Tax Lot 400, Tax Map 3S102CA was used as a baseline flood elevation for the modeling study. This elevation was determined to be 226.5 and the peak hydraulic grade line (HGL) of the adjacent proposed channel improvements was used as a determining factor in the final recommendations.

More information about the HGL can be found in the attached Preliminary Stormwater Report.

4.6 100-YEAR STORM

4.6.1 Modeling Update

The Facility Siting Concepts, modeling results, and recommendations were presented to the City in May 2019. The City requested AKS to add the 100-yr storm to the modeling to determine how adjacent properties would be affected by the channel improvements.

The cross-sections of each modeled conduit were refined and expanded to include a wider surface area for more accurate modeling results. The model was then run for the 100-year storm model under existing development conditions and calculated the HGL along each conduit for Options A-3 and B-1. Option A-4 was run only to determine an estimated HGL for the detention pond.

Finished floor elevations (FFE) were estimated using DOGAMI Bare Earth LIDAR topography (2014), aerial photography, and photographs from AKS site visits. Loading docks were estimated at 4.0 feet above existing ground, where applicable.

Once the HGL of each conduit was determined by the updated model, the Facility Siting Concepts (Appendix A) were updated to include the 100-year and 25-year flood storage areas.

4.6.2 Results

Both Options A-3 and B-1 were studied and compared. Both options result in flooding on private properties during the 100-year storm, with the HGL for Option B-1 between 0.3 and 0.5 feet lower than the HGL for Option A-3.

The results of the modeling updates indicate that in a few locations the 100-year storm event will have flood waters abutting existing buildings. However, due to the locations of loading docks, the HGL of the 100-year storm did not rise to the level of the FFEs of the existing buildings. In the worst-case scenario, the HGL rises to approximately 2.4 feet below FFE. This scenario occurs on Tax Lot 500, Tax Map 3S102CD at 9685 SW Ridder Road. A cross-section (Cross-Section F) in this location can be found on Sheet 14 of the Facility Siting Concepts (Appendix A).

As part of this analysis, the existing detention pond adjacent to SW Ridder Road, on the north side, was also analyzed. The results indicate that the existing culverts beneath SW Ridder Road are adequately sized to convey the 100-year storm and dissipate any ponding of water in the detention pond.

4.7 LONG-TERM MAINTENANCE CONSIDERATIONS

The long-term maintenance of the new channel, culverts, and stormwater pipes would be mostly limited to the City's regular maintenance of the stormwater system. Visual inspections of the creek channel and culverts are recommended to determine if there is any erosion of the channel or blockages. Planting maintenance will be ongoing for the first few years.

5.0 Cost Estimates

Cost estimates have been prepared for both Concepts Option A and Option B and the additional elements (detention pond and additional 36-inch stormwater pipe). These are included as an attachment to this report and summarized in the table below. Note: Property acquisition is not included.

Table 2: Engineers Estimate Total

Facility Siting Concept	Estimate
A-1	$3.0 million
A-2	$5.2 million
A-3	$3.2 million
A-4	$5.4 million
B-1	$4.4 million
B-2	$6.5 million

6.0 Evaluation of Alternatives

In addition to cost, we analyzed six non-financial criteria to determine the recommended option: property impacts, public impacts, environmental impacts, risk/constructability, operations and maintenance, and conveyance improvement. The criteria can be described as follows:

Property Impacts

The anticipated impact to private property, including requiring easements or property acquisition, and construction impacts.

Public Impacts

The anticipated disruption to traffic on neighboring streets during construction.

Environmental Impacts

The anticipated amount of work in environmental, cultural resource, or hazardous materials areas that could impact project schedule or cost, and the potential for impacts to the land use permitting schedule and costs.

Risk/Constructability

The difficulty level of construction and anticipated risk of discovering unknowns. The depth and/or difficulty of excavations, haul-off, construction access, dewatering, proximity to adjacent utilities, and road/sidewalk repair were all taken into consideration.

Operations and Maintenance

The anticipated operations and maintenance that will be required, including access to manholes, pipes, and the proposed channel, as well as the level of planting maintenance that will be required.

Conveyance Improvement

The anticipated improvement the proposed elements will have on conveyance and reduced flood risk.

Cost

In addition to the non-financial criteria, the estimated costs were weighed against the anticipated benefit to the project goals.

7.0 Conclusion and Recommendations

Option A-3

Based on the studies of the six different options (A-1, A-2, A-3, A-4, B-1, and B-2) described earlier in this report, AKS recommends Option A-3 for further consideration.

In addition to the channel improvements, Option A-3 includes the additional 36” pipe beneath Tax Lot 500, Tax Map 3S102CD but does not include the detention pond.

This option maximizes conveyance while minimizing cost and non-financial impacts. It is anticipated to convey the existing 25-year event when analyzing the hydraulic grade line adjacent to the industrial area parking lot (Tax Lot 400, Tax Map 3S102CA).

Additional 36” Pipe beneath Tax Lot 500, Tax Map 3S102CD

We recommend including this element in the design due to the relatively low cost and large positive impact on conveyance. The two existing 36” stormwater pipes are constraints on the system and are anticipated to cause flooding even with the reverse grade of the existing channel removed.

Detention Pond

The detention pond would be more efficiently sited as part of CLC-1, north of SW Day Road. In its currently proposed location, the amount of excavation needed to obtain the depth required is much larger than the estimated capacity of the pond. Specifically, it would require over 36,000 cubic yards of excavation and haul-off, while only providing approximately 7,500 cubic yards of storage. This is caused by the higher elevations in the western portion of the site, where there is almost 15 feet of cut required to construct the facility.

Options B-1 and B-2

While Options B-1 and B-2 would provide greater conveyance and lessen the flood risk, these options may be too costly considering the property acquisition through BPA property, as well as coordination with the entities responsible for the Willamette Water Supply Program proposed in SW Ridder Road.

Facility Siting Alternatives Report, Appendix A:

Facility Siting Concepts

FACILITY SITING CONCEPTS NARRATIVE DESCRIPTION

THE GOAL OF THIS PROJECT IS TO ADDRESS FLOODING THAT OCCURS DURING EXISTING STORM EVENTS AND IS PREDICTED DURING FUTURE STORM EVENTS (BEGINNING AT THE 2-YEAR, 24-HOUR STORM EVENT), AND TO RESTORE AND ENHANCE AN EXISTING STRAIGHTENED, INCISED CHANNEL. THE CHANNEL HAS NEGATIVE SLOPES IN SOME AREAS WHICH CONTRIBUTE TO FLOODING.

THIS PLAN SET AND NARRATIVE DESCRIBES TWO OPTIONS THAT ARE DESIGNED TO MAXIMIZE CONVEYANCE AND CAPACITY WITHIN THE PROJECT AREA: OPTION A, AND OPTION B.

OPTION A AND OPTION B

BEGINNING IN THE NORTH AT SW DAY ROAD (STA 44+00), OPTION A AND OPTION B ARE IDENTICAL UP TO THE POINT THAT THEY VEER APART AT APPROXIMATELY STATION 14+50, AT WHICH POINT OPTION A CONTINUES EAST, ALONG THE EXISTING CHANNEL, WHILE OPTION B SPLITS TO THE SOUTH. THESE DIFFERENCES WILL BE DESCRIBED BELOW.

TO MAXIMIZE CONVEYANCE, BOTH OPTIONS INCLUDE REMOVING NEGATIVE SLOPES AND CULVERTS THAT ARE CONSTRAINTS ON THE SYSTEM. THE SLOPE IS LIMITED TO ABOUT 0.03%, WITH THE VERTICAL ELEVATION FALL, FROM THE SW DAY ROAD CULVERT TO THE STORMWATER PIPES BENEATH TAXLOT 3S102CD00400, ONLY BEING ±1.1 FOOT, OVER A HORIZONTAL DISTANCE OF ±3,000 FEET.

TO MAXIMIZE STORAGE AND CAPACITY, THE CHANNEL IS WIDENED AT ELEVATION 223.0 TO CREATE A FLOODPLAIN. SIDE SLOPES ARE DESIGNED AT 2:1 TO MINIMIZE THE EXCAVATION FOOTPRINT. IN SOME LOCATIONS, STRUCTURED EARTH WALLS ARE PROPOSED TO FURTHER MINIMIZE THE PROJECT FOOTPRINT AND TO AVOID CONSTRAINTS SUCH AS EXISTING UTILITY POLES.

BOX CULVERTS ARE PROPOSED TO PROVIDE ACCESS TO THE EXISTING UTILITY POLES WHILE ALSO MAXIMIZING CONVEYANCE. THE EXISTING MAINTENANCE ROAD WILL BE RELOCATED TO ALLOW FOR THE EXCAVATION OF THE CHANNEL AND FLOODPLAIN.

BOTH OPTIONS INCLUDE A DETENTION POND ON TAXLOTS 3S102B000704 AND 3S102B000790, ADJACENT TO SW DAY ROAD, FOR ADDITIONAL STORAGE CAPACITY. THE BOTTOM ELEVATION OF THIS POND IS DESIGNED AT 223.0, EQUAL TO THE FLOODPLAIN DESIGNED IN THE CHANNEL PORTION OF THE PROJECT. THE SIDE SLOPES ARE DESIGNED AT 4:1. THE DETENTION POND WILL BE CONNECTED TO THE EXISTING DETENTION POND AND CHANNEL WITH A BOX CULVERT BENEATH THE EXISTING MAINTENANCE ROAD.

OPTION A

OPTION A CONTINUES EAST AT APPROXIMATELY STATION 14+50, THROUGH AN EXISTING WETLAND. TO MINIMIZE THE EXCAVATION FOOTPRINT IN THIS AREA, STRUCTURAL EARTH WALLS ARE PROPOSED TO ALLOW FOR STEEPER SLOPES, DESIGNED AT 0.25:1.

THE CHANNEL WILL CONTINUE TO TWO EXISTING 36" STORM PIPES THAT ARE INSTALLED BENEATH THE PARKING LOT OF TAXLOT 3S102CD00500. TO INCREASE CONVEYANCE, A THIRD 36" STORM PIPE IS PROPOSED TO BE CONSTRUCTED PARALLEL TO THE TWO EXISTING PIPES, WITHIN THE EXISTING PARKING LOT.

OPTION B

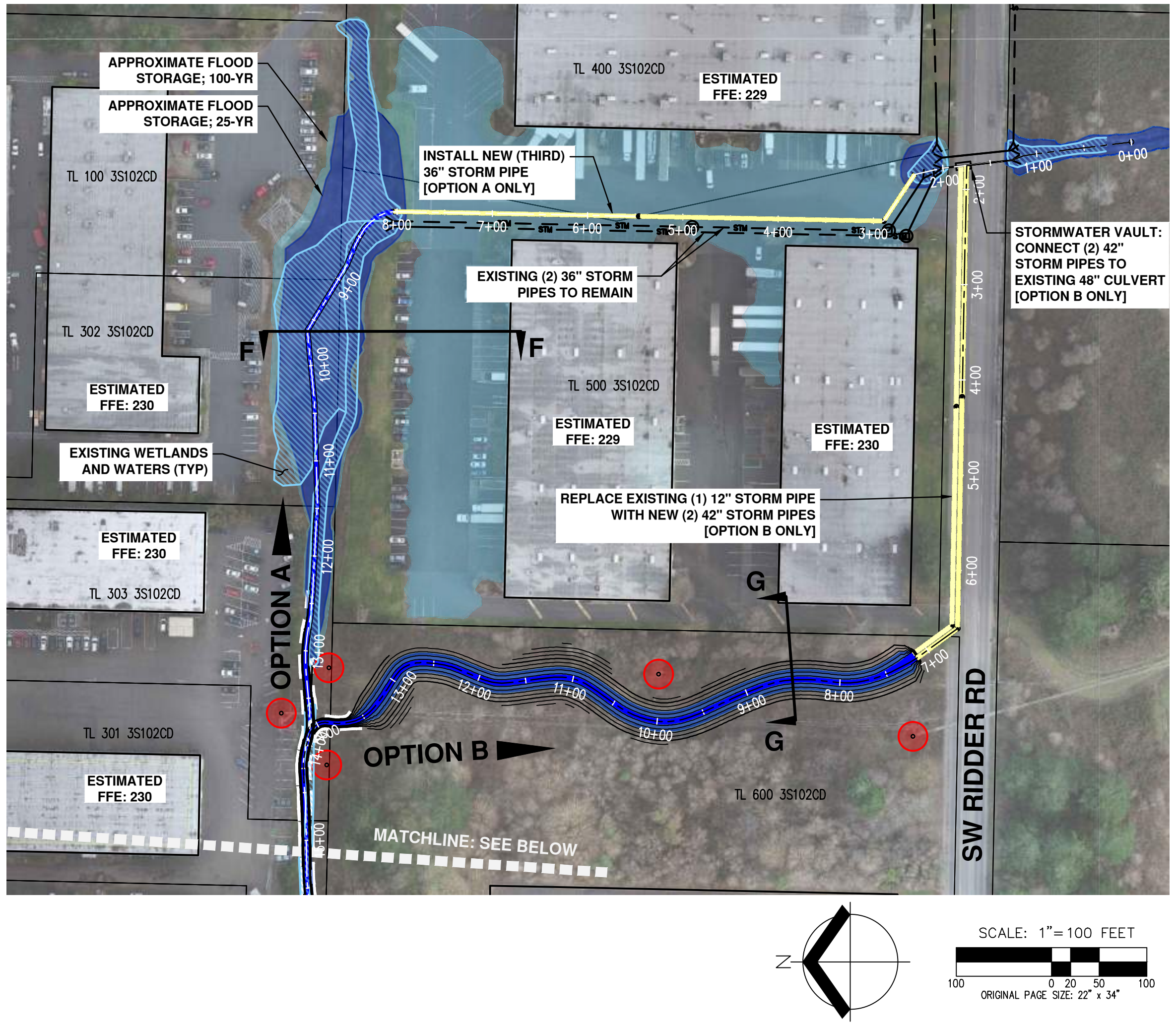
OPTION B VEERS SOUTH FROM OPTION A AT APPROXIMATELY STATION 14+50, THROUGH A PROPOSED CHANNEL ON TAXLOT 3S102CD00600. TO MINIMIZE THE FOOTPRINT NECESSARY TO CREATE A POSITIVE SLOPE TO SW RIDDER ROAD, THE CHANNEL DOES NOT INCLUDE FLOODPLAIN. THE CHANNEL SIDE SLOPES ARE DESIGNED AT 2:1.

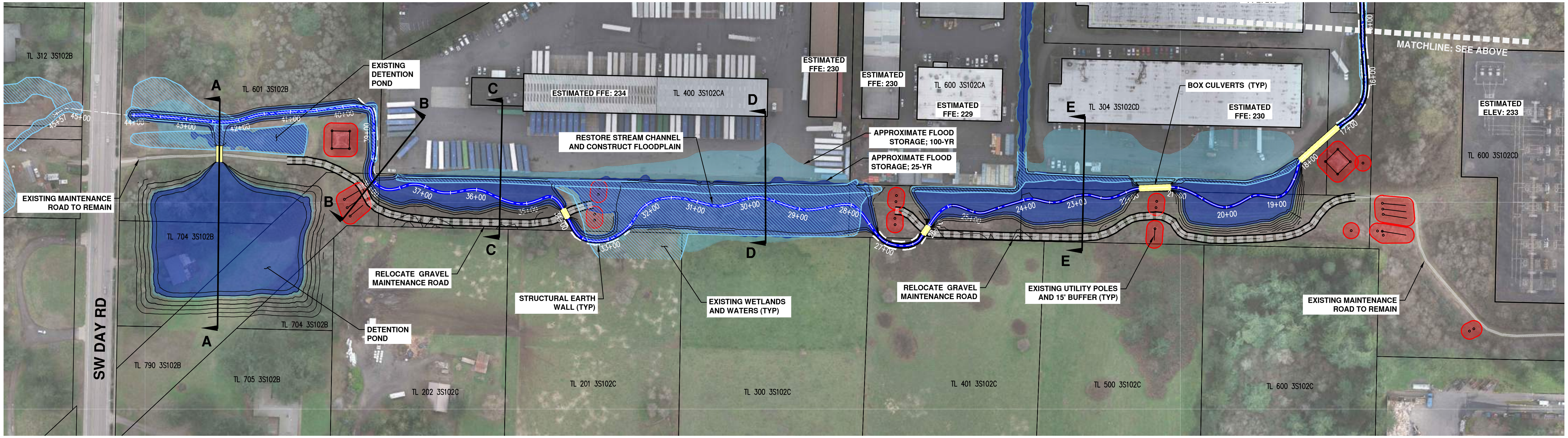
AT THE SOUTHERN TERMINUS OF THIS CHANNEL, THE CREEK WILL BE PIPED IN TWO PARALLEL 42" STORM PIPES INSTALLED IN THE NORTH LANE OF SW RIDDER ROAD. THESE PIPES WILL CONNECT TO THE EXISTING WESTERN 48" CULVERT BENEATH SW RIDDER ROAD. A CONCRETE VAULT IS PROPOSED TO MAKE THIS CONNECTION. THE EXISTING 12" STORM PIPE AND EXISTING MANHOLES IN SW RIDDER ROAD WILL BE REMOVED.

THE FUTURE WILLAMETTE WATER SUPPLY PROGRAM PIPELINE IS PROPOSED TO BE INSTALLED IN SW RIDDER ROAD. COORDINATION WITH THE ENTITIES INVOLVED WITH THIS PIPELINE PROJECT WILL BE NECESSARY.

NOTES:

1. FLOOD STORAGE ELEVATIONS FOR THE 25-YR AND 100-YR STORMS ARE BASED ON MODELING RESULTS FOR OPTIONS A-3 AND B-1, DESCRIBED IN THE FACILITY SITING ALTERNATIVES REPORT NARRATIVE.
2. DETENTION POND FLOOD STORAGE ELEVATIONS FOR THE 25-YR AND 100-YR STORMS ARE BASED ON MODELING RESULTS FOR OPTION A-4, DESCRIBED IN THE FACILITY SITING ALTERNATIVES REPORT NARRATIVE.





AKS DRONE AERIAL
JANUARY, 2019

AKS DRAWING FILE: 7076 A & B OVERVIEW.DWG | LAYOUT: OVERVIEW

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COFFEE CREEK STORMWATER FACILITY

WILSONVILLE OREGON

FACILITY SITING CONCEPTS OPTIONS A & B OVERVIEW

DESIGNED BY: SRR
DRAWN BY: SRR
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

NOT FOR CONSTRUCTION

REVISIONS

JOB NUMBER
7076

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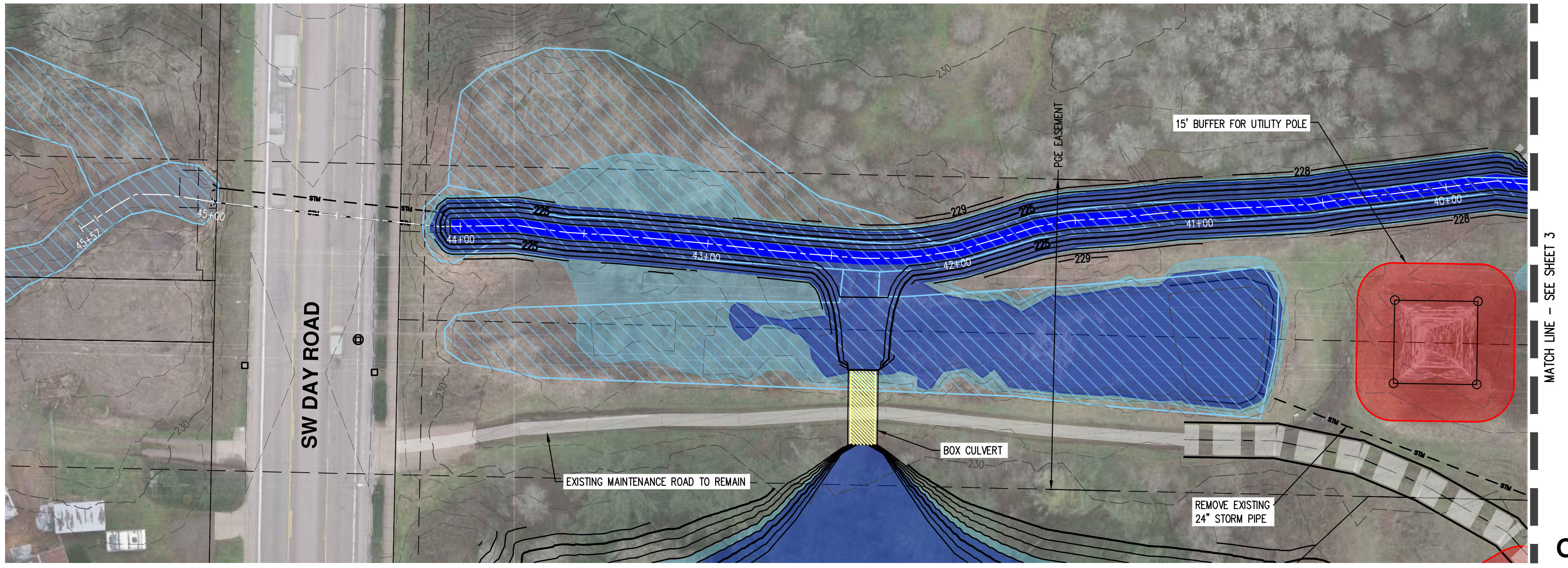
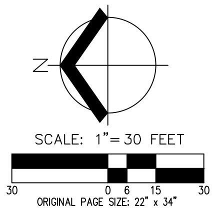
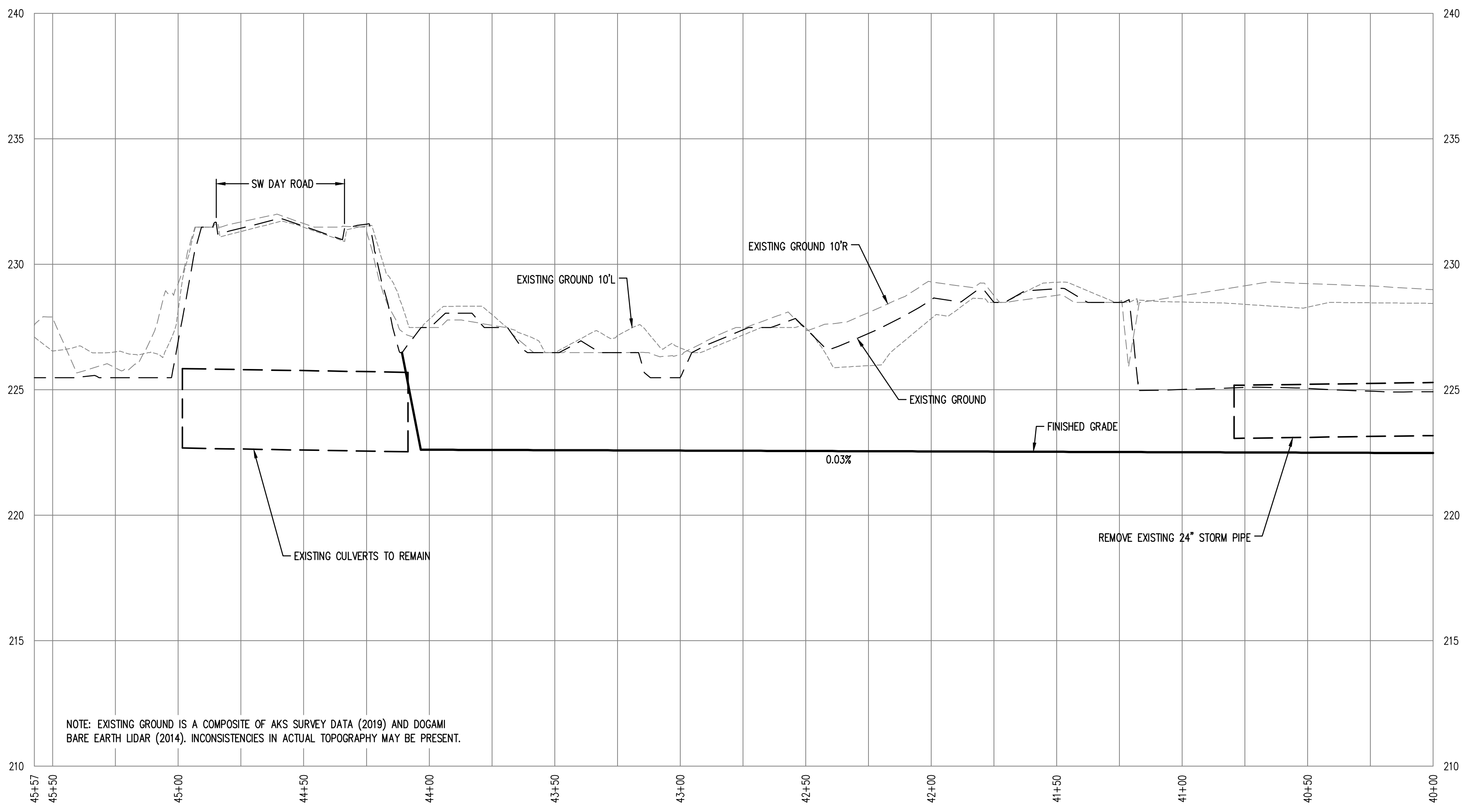




OPTIONS A & B

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	—— 170 ——
FINISHED GROUND CONTOUR (5')	—— 170 ——
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	■■■■■■■■■■
EXISTING UTILITY POLES AND 15' BUFFER	🟥



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A & B PROFILE 40+00 – 45+57.32

HOR: 1"= 30'

VERT: 1"= 3'

AKS DRAWING FILE: 7076 PLAN & PROFILE A ALIGNMENT.DWG | LAYOUT: SHEET 2

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WILSONVILLE OREGON

FACILITY SITING CONCEPTS
PLAN AND PROFILE
STA 40+00 - 45.57.32

DESIGNED BY: SRR
DRAWN BY: GMB
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

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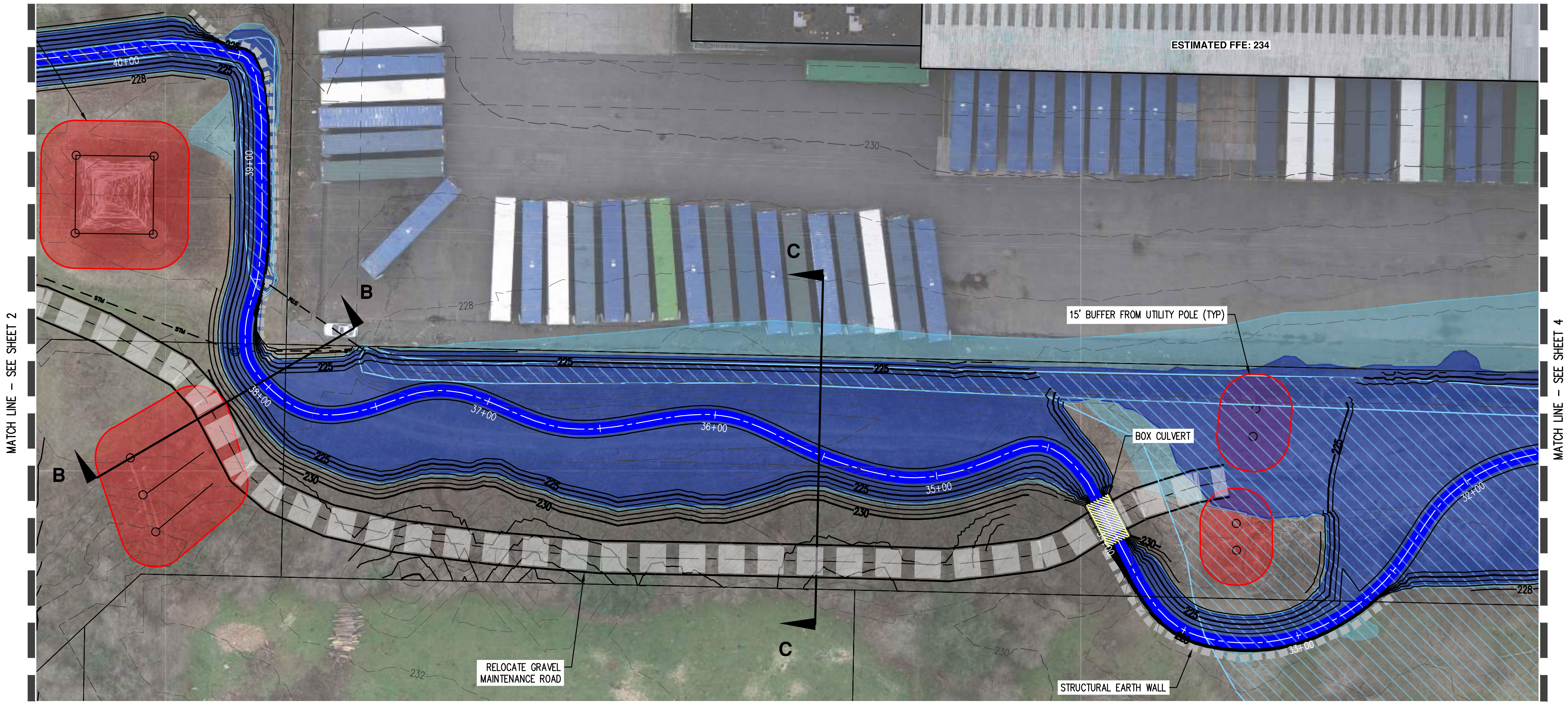
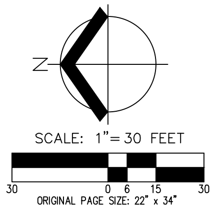
SHEET
2





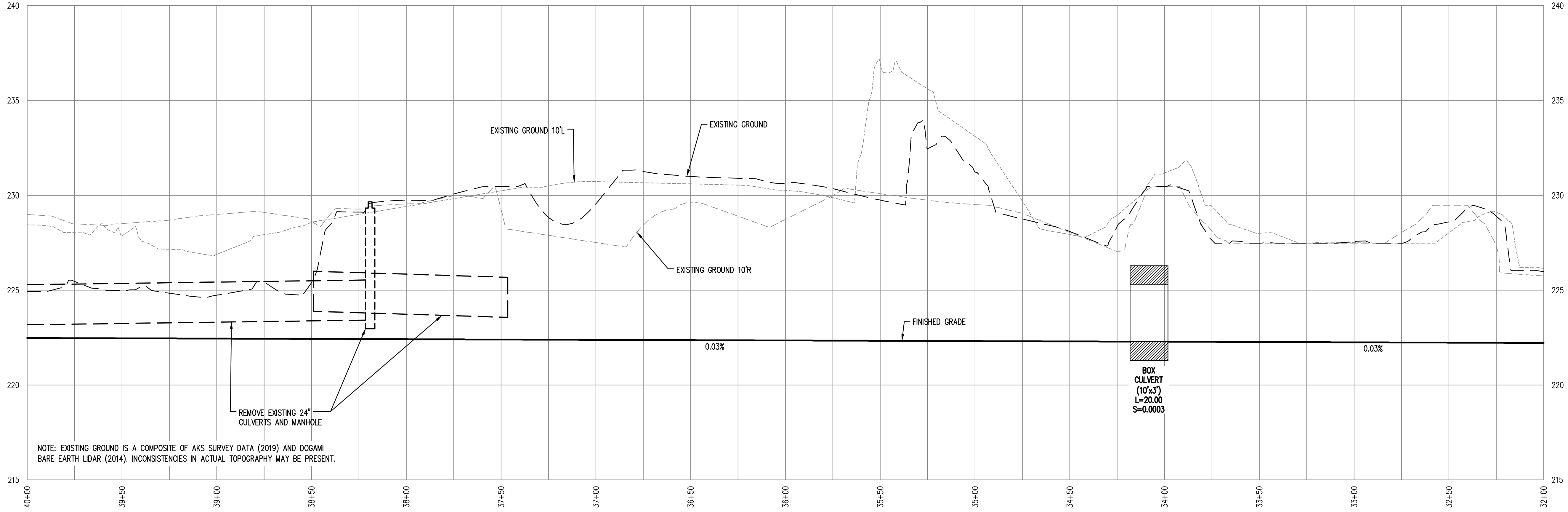
SCALE: 1"= 30 FEET

ORIGINAL PAGE SIZE: 22" x 34"

OPTIONS A & B

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	—— 170 ——
FINISHED GROUND CONTOUR (5')	—— 170 ——
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	🟥



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A & B PROFILE 32+00 - 40+00

HOR: 1"= 30'
VERT: 1"= 3'

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PLAN AND PROFILE
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3

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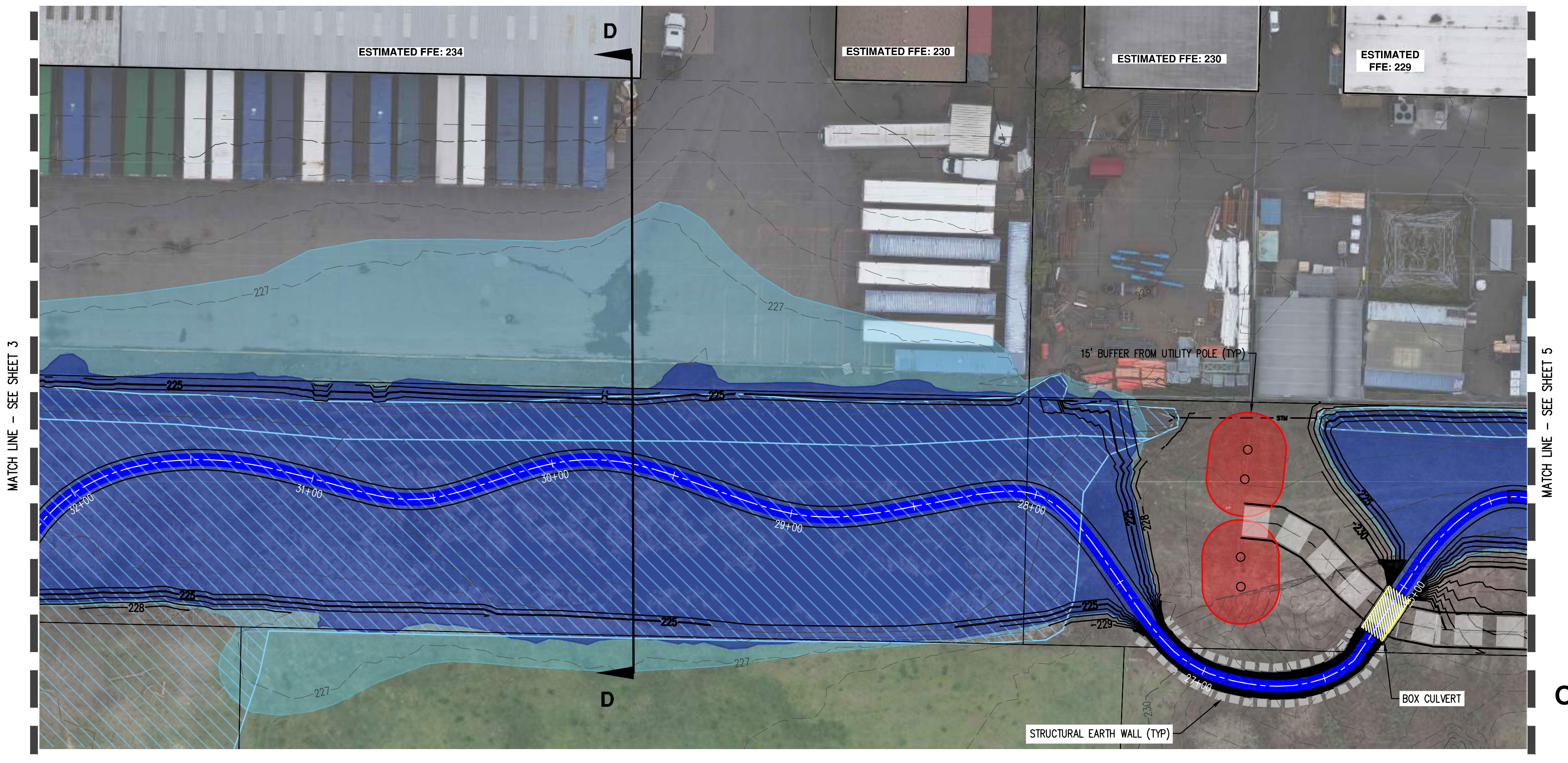
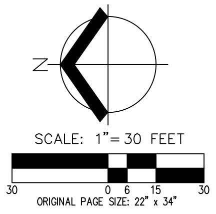
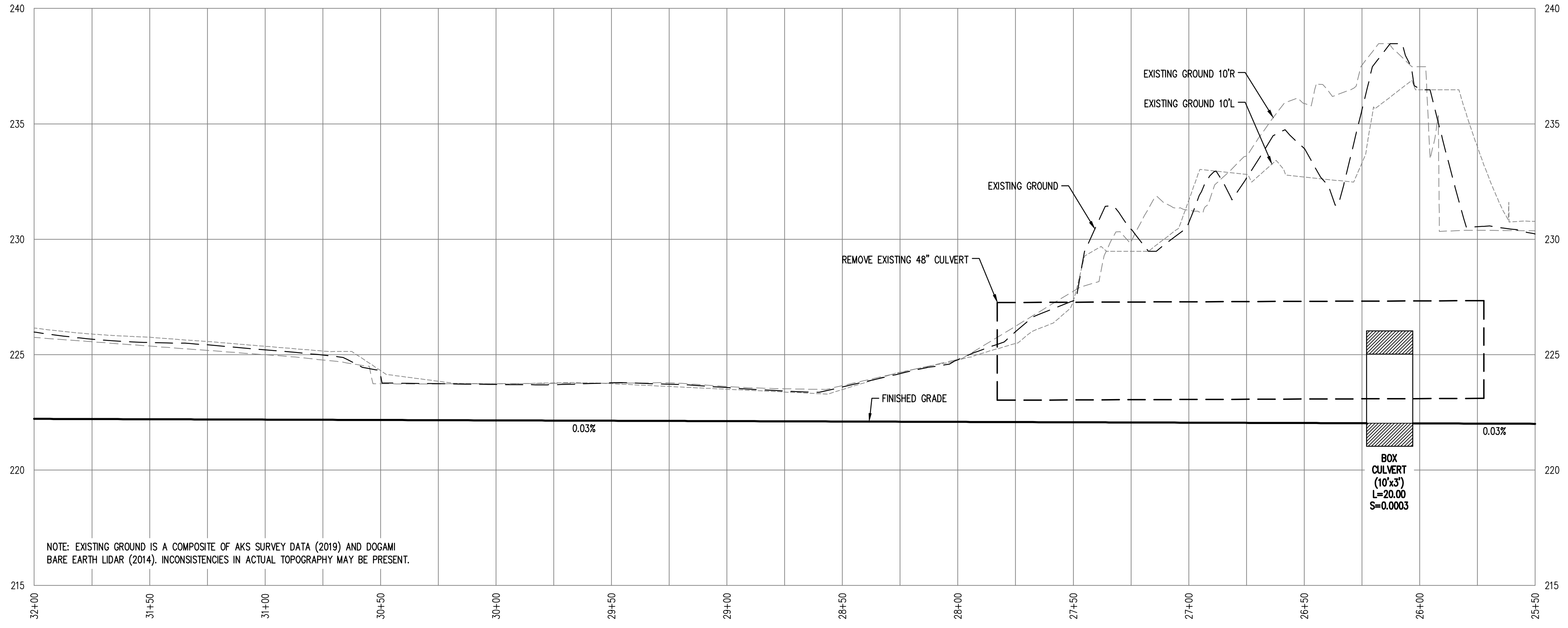




OPTIONS A & B

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	— 170 —
FINISHED GROUND CONTOUR (5')	— 170 —
EXISTING GROUND CONTOUR (1')	– – 170 – –
EXISTING GROUND CONTOUR (5')	– – 170 – –
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25–YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100–YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	○ ○



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A & B PROFILE 25+50 – 32+00
HOR: 1"= 30'
VERT: 1"= 3'

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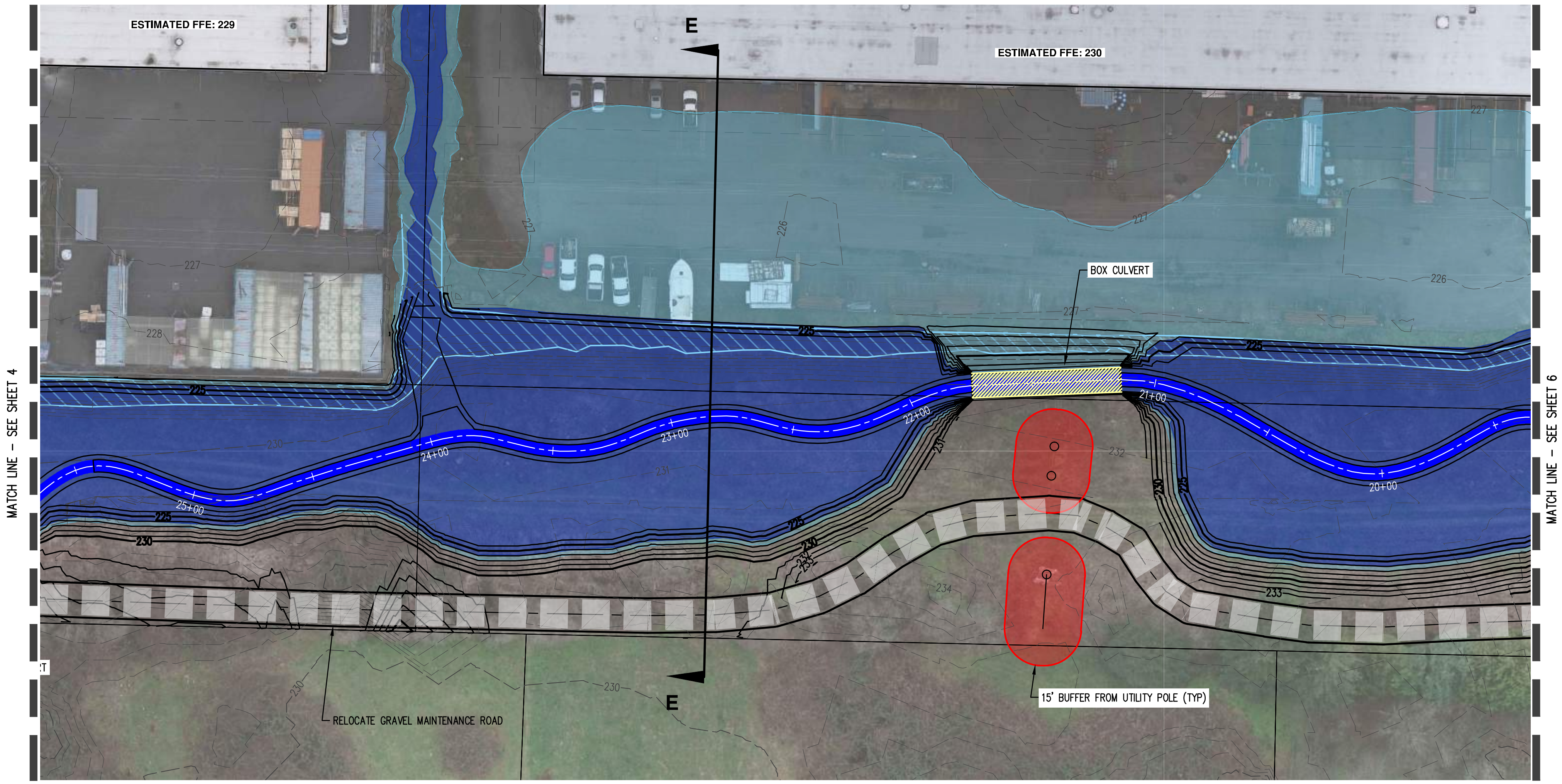
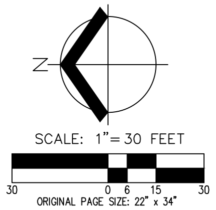
SHEET
4

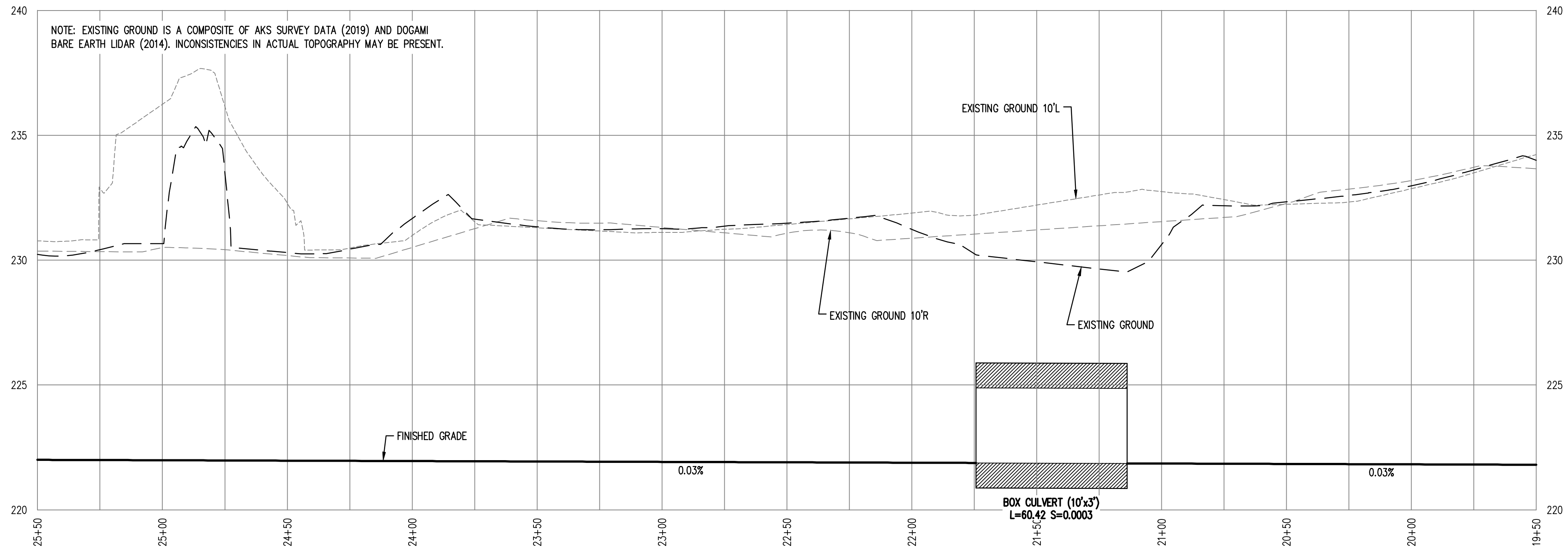




OPTIONS A & B

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	— 170 —
FINISHED GROUND CONTOUR (5')	— **170** —
EXISTING GROUND CONTOUR (1')	– – 170 – –
EXISTING GROUND CONTOUR (5')	– – 170 – –
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	▪▪▪▪▪▪▪▪▪▪
EXISTING UTILITY POLES AND 15' BUFFER	🟥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ALIGNMENT A & B PROFILE 19+50 – 25+50

HOR: 1"= 30'

VERT: 1"= 3'

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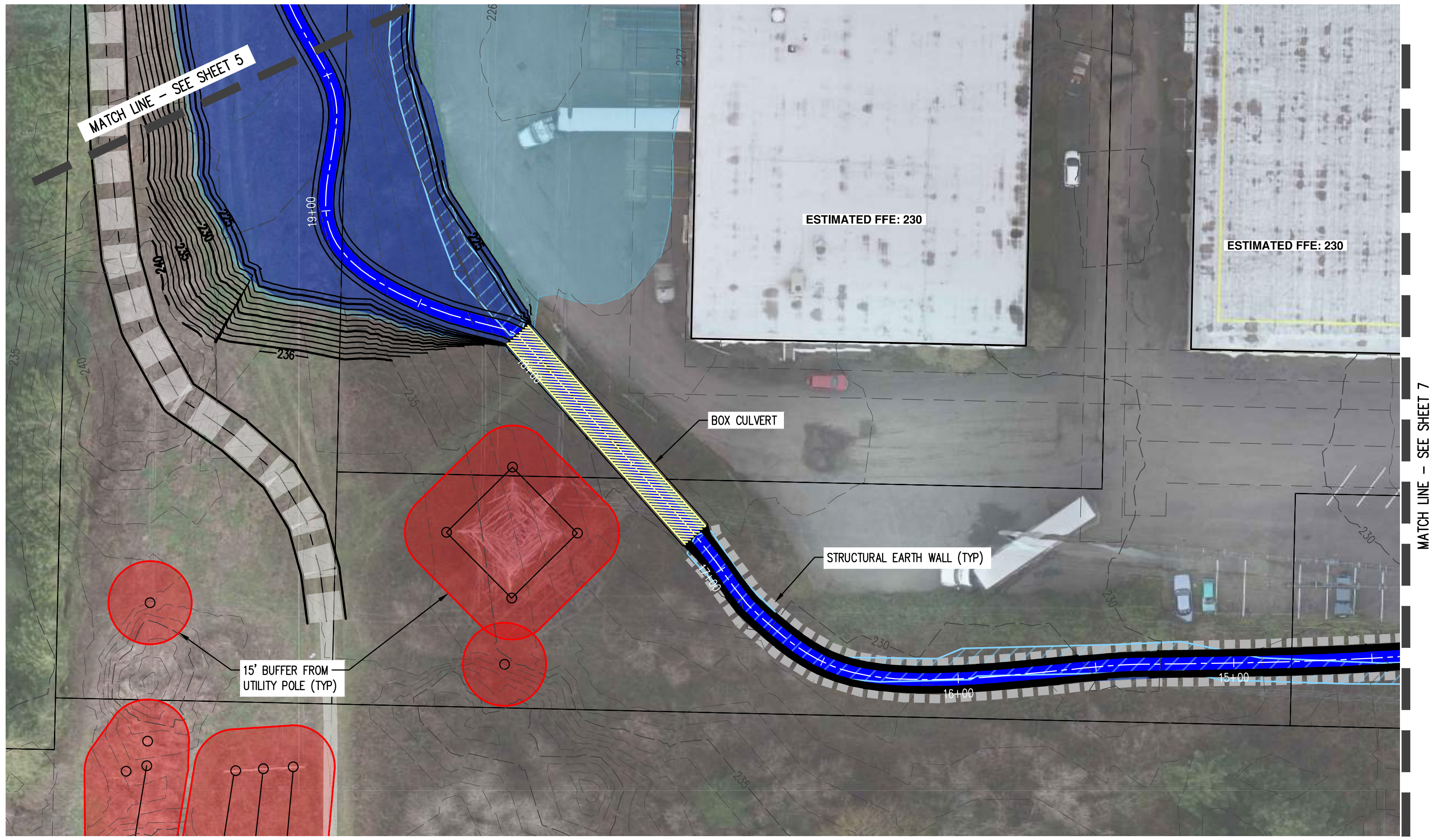
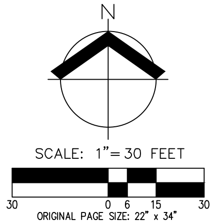
SHEET
5

AKS DRAWING FILE: 7076 PLAN & PROFILE A ALIGNMENT.DWG | LAYOUT: SHEET 5

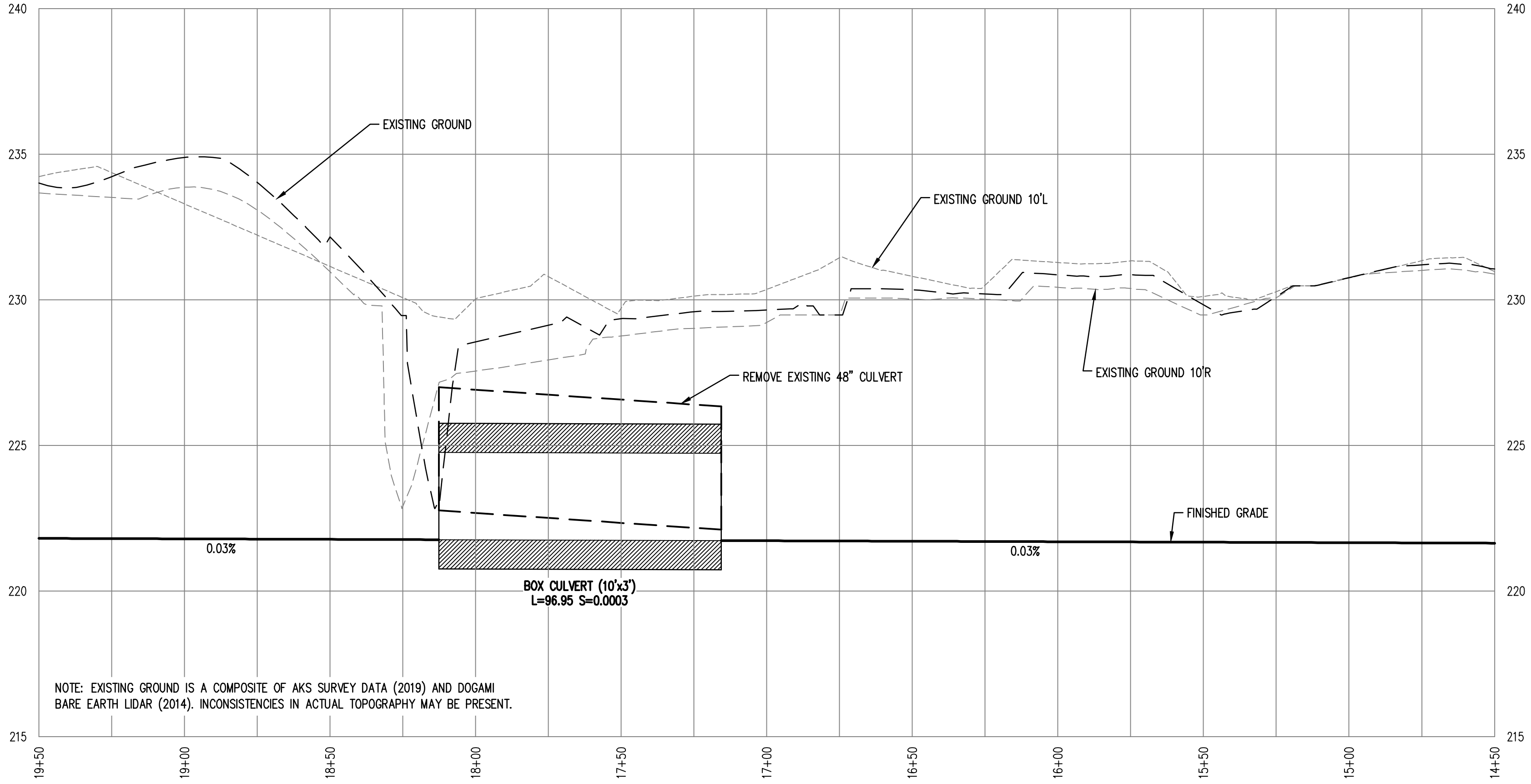


LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	— 170 —
FINISHED GROUND CONTOUR (5')	— **170** —
EXISTING GROUND CONTOUR (1')	– – 170 – –
EXISTING GROUND CONTOUR (5')	– – 170 – –
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25–YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100–YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	○ ○



OPTIONS A & B



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A & B PROFILE 14+50 – 19+50
HOR: 1"= 30'
VERT: 1"= 3'

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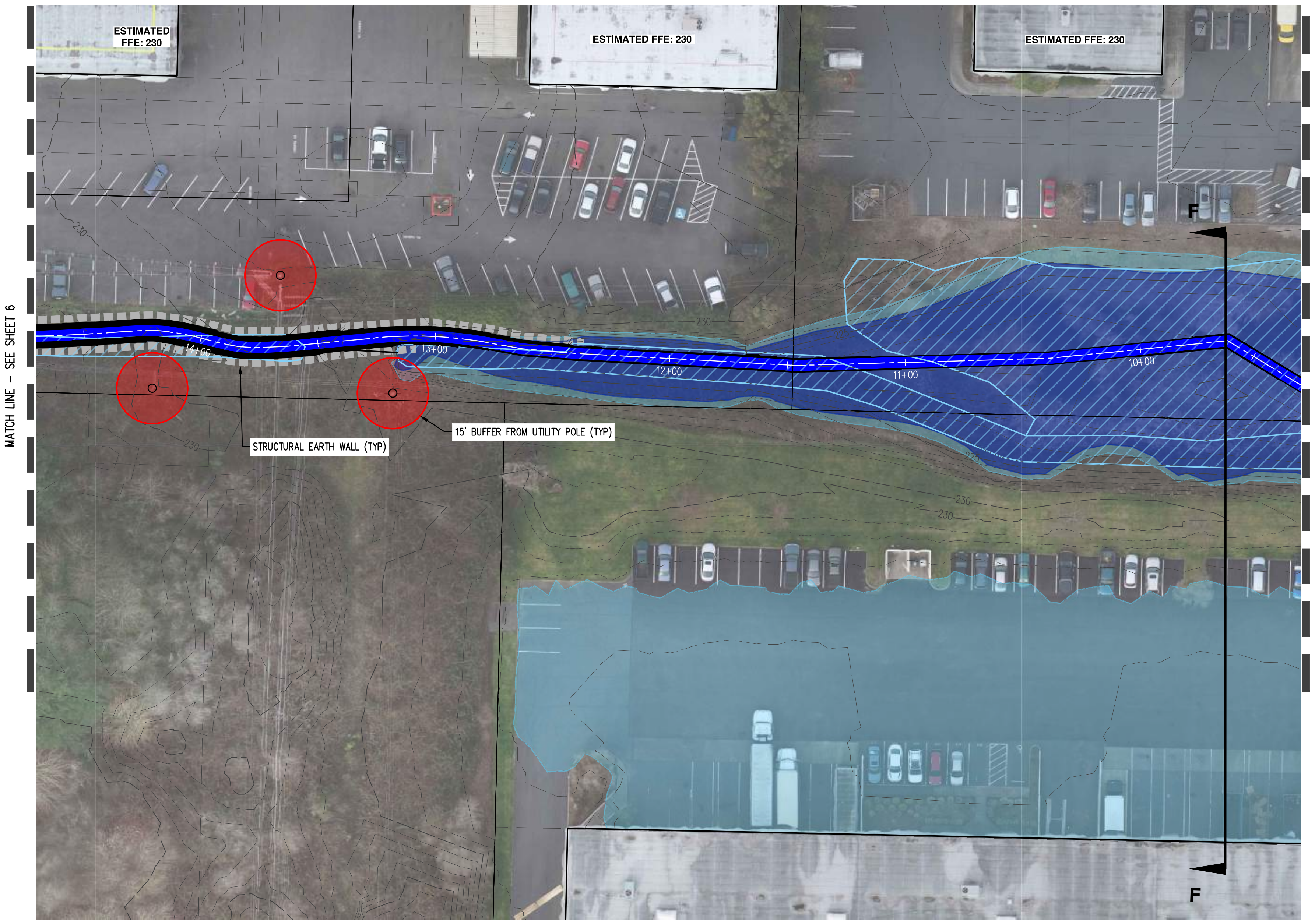
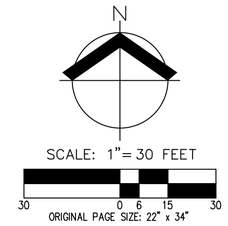
SHEET
6

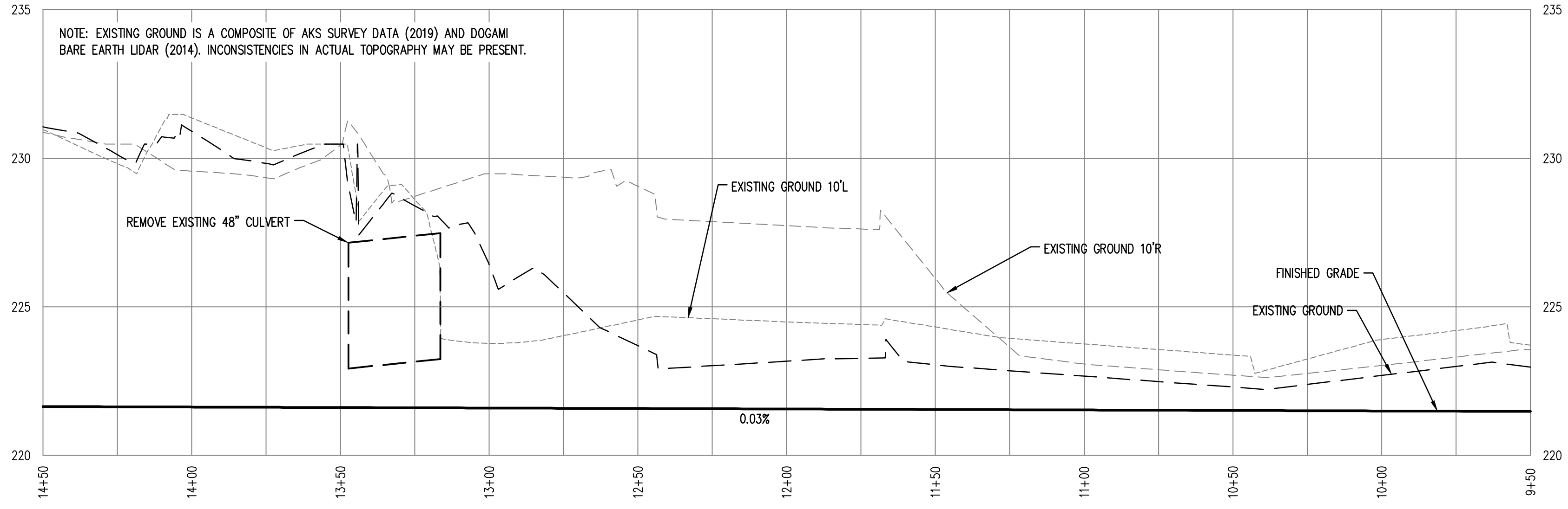




OPTION A

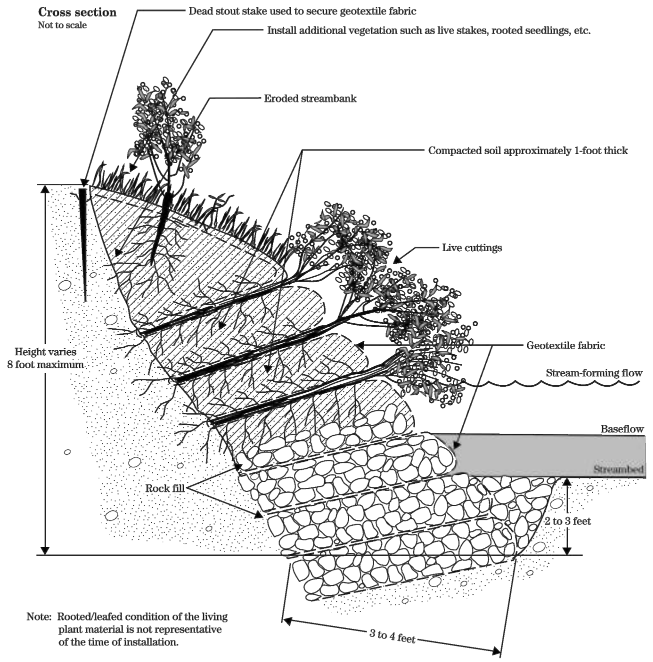
LEGEND

EXISTING STORM LINE	— — STM — —
FINISHED GOUND CONTOUR (1')	170
FINISHED GROUND CONTOUR (5')	**170**
EXISTING GROUND CONTOUR (1')	170
EXISTING GROUND CONTOUR (5')	170
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	▬
APPROXIMATE FLOOD STORAGE; 25-YR STORM	■
APPROXIMATE FLOOD STORAGE; 100-YR	■
STRUCTURAL EARTH WALL	▪▪▪▪▪▪
EXISTING UTILITY POLES AND 15' BUFFER	●



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A PROFILE 9+50 – 14+50
HOR: 1"= 30'
VERT: 1"= 3'



Note: Rooted/leafed condition of the living plant material is not representative of the time of installation.

STRUCTURAL EARTH WALL
N.T.S.

SOURCE:
TUTTLE, RONALD W. AND RICHARD D. WENBERG. ENGINEERING FIELD HANDBOOK; CHAPTER 16, STREAMBANK AND SHORELINE PROTECTION. WASHINGTON, D.C.: U.S. DEPT. OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE, 1996.
HTTPS: //DIRECTIVES.SC.EGOV.USDA.GOV/OPENNONWEBCONTENT.ASPX?CONTENT=17553.WBA

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SHEET
7

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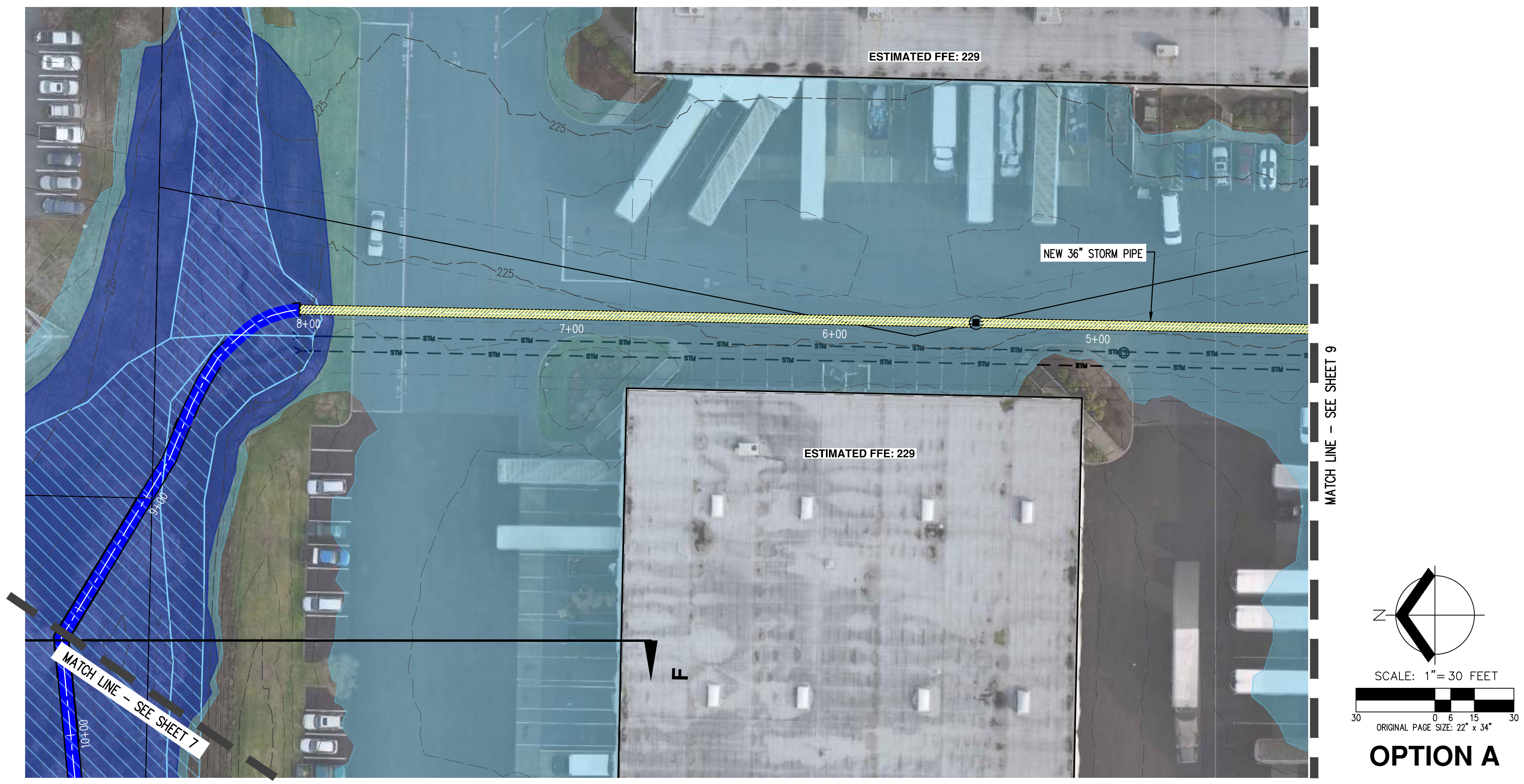
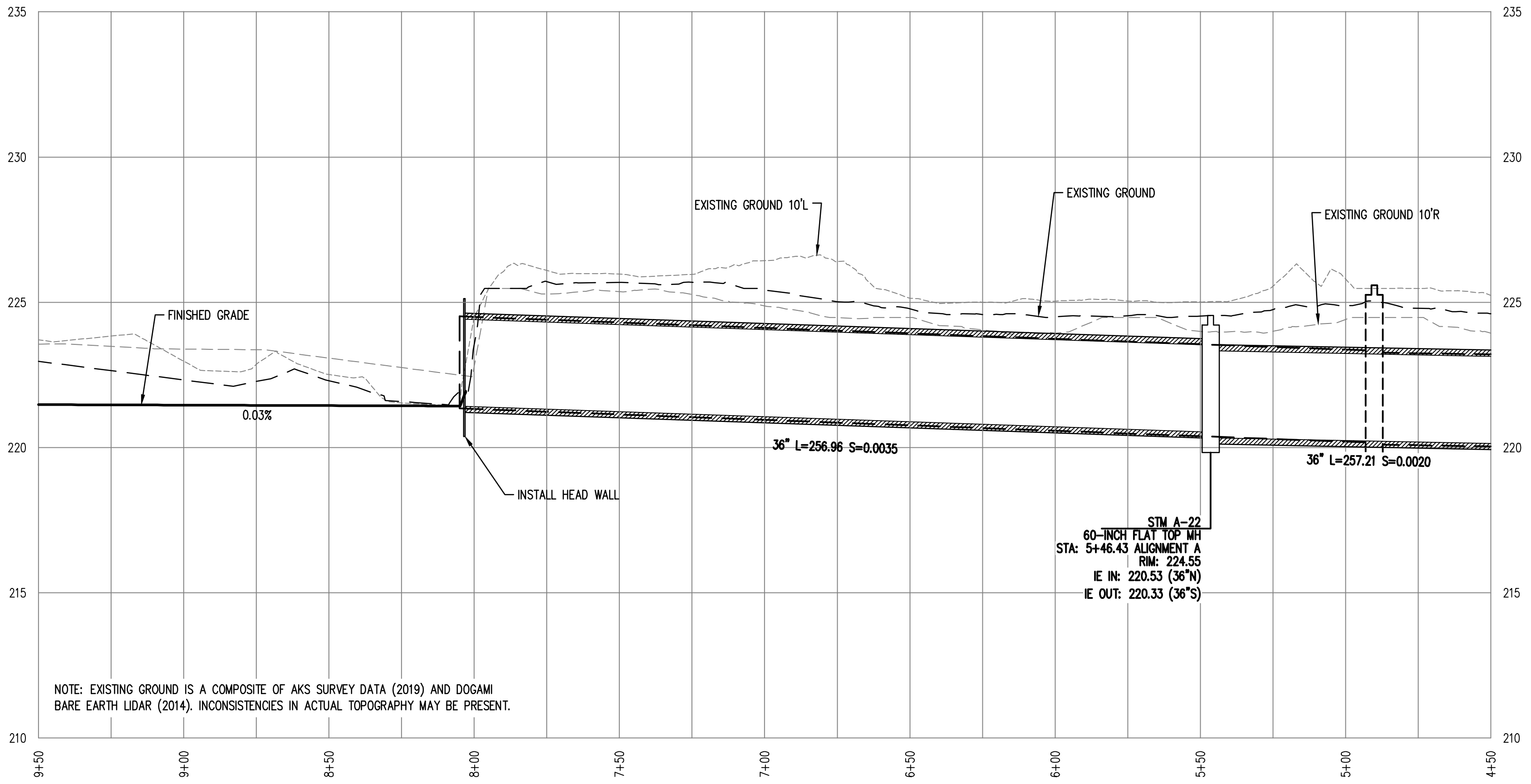


OPTION A

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	— 170 —
FINISHED GROUND CONTOUR (5')	— 170 —
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25–YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100–YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	○ ○



STM A–22
60–INCH FLAT TOP MH
STA: 5+46.43 ALIGNMENT A
RIM: 224.55
IE IN: 220.53 (36"N)
IE OUT: 220.33 (36"S)

NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A PROFILE 4+50 – 9+50
HOR: 1"= 30'
VERT: 1"= 3'

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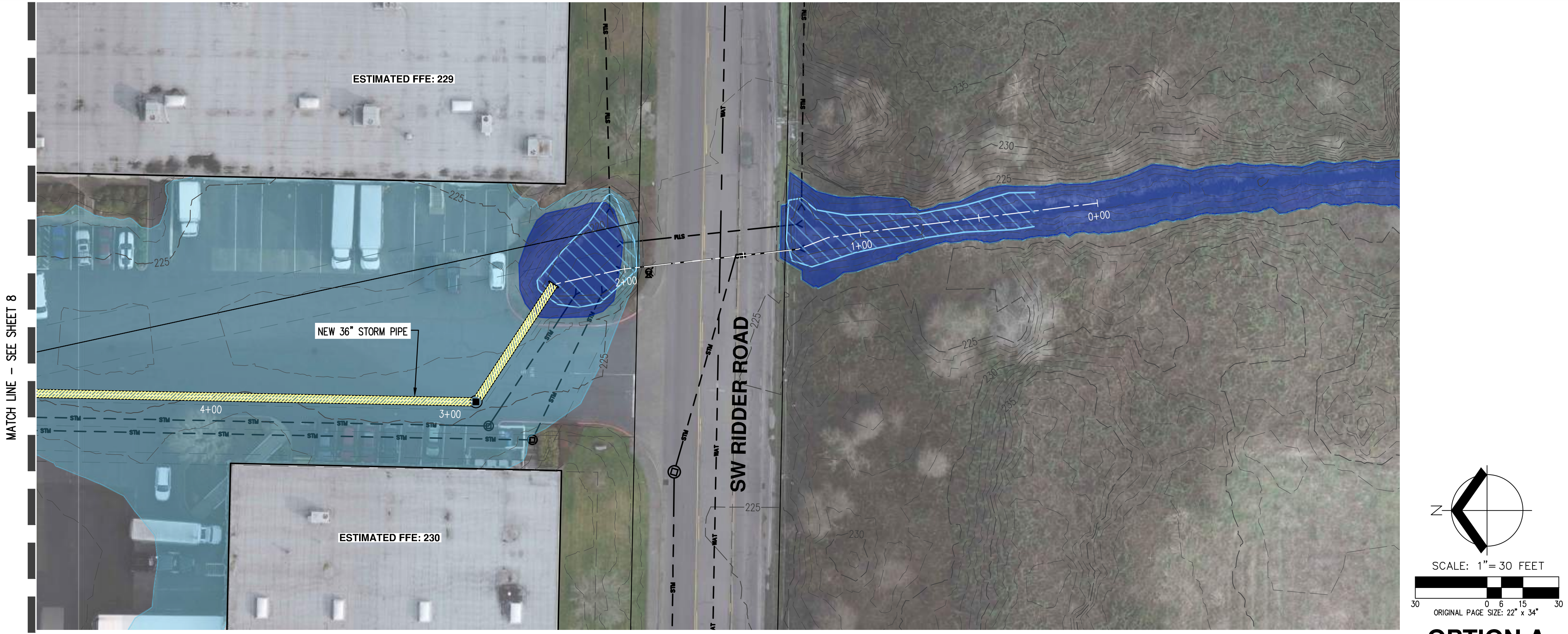
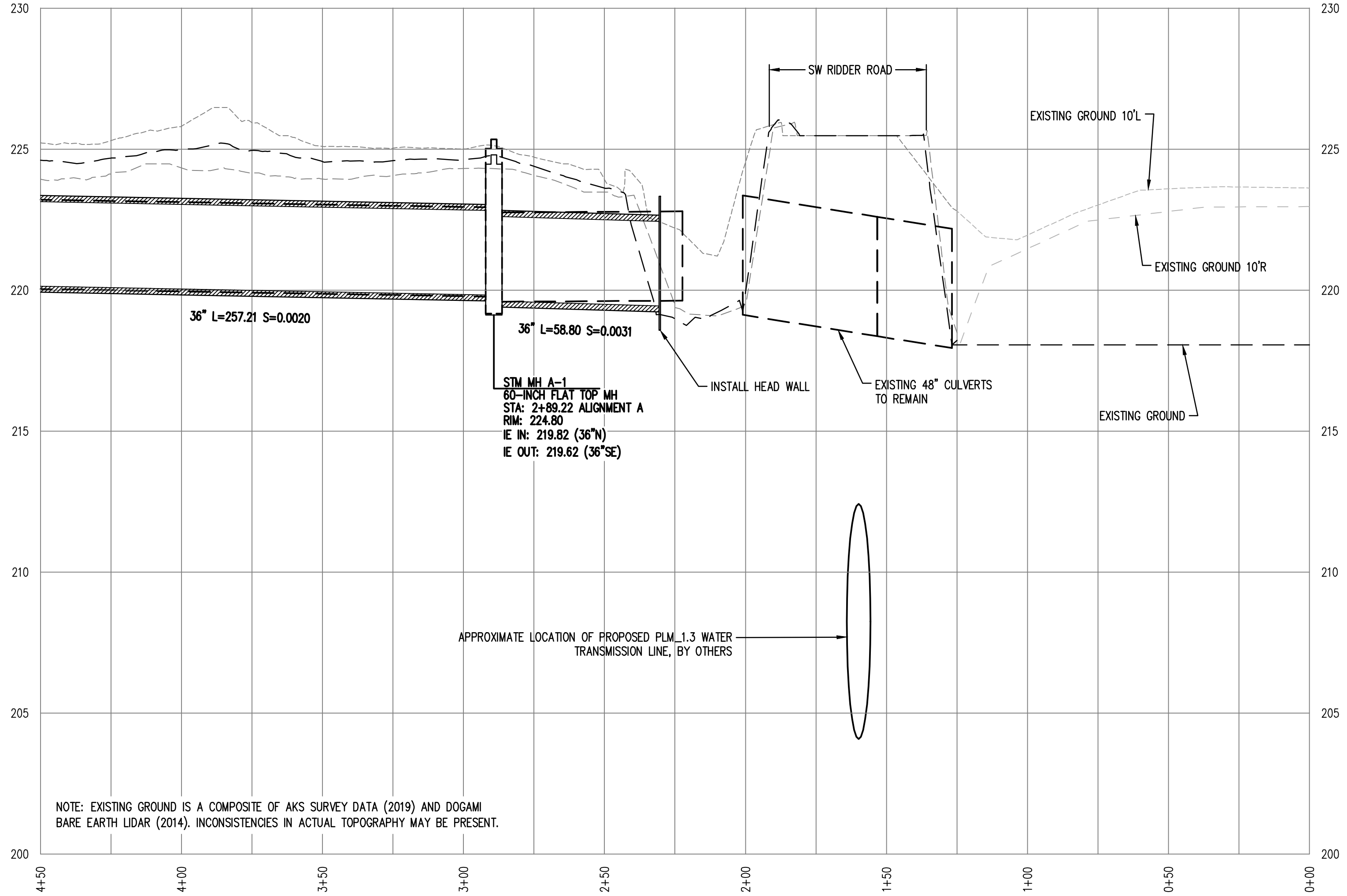
SHEET
8



OPTION A

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	— 170 —
FINISHED GROUND CONTOUR (5')	— 170 —
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	○ ○



STM MH A-1
60-INCH FLAT TOP MH
STA: 2+89.22 ALIGNMENT A
RIM: 224.80
IE IN: 219.82 (36"N)
IE OUT: 219.62 (36"SE)

APPROXIMATE LOCATION OF PROPOSED PLM_1.3 WATER TRANSMISSION LINE, BY OTHERS

NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES IN ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT A PROFILE 0+00 - 4+50
HOR: 1"= 30'
VERT: 1"= 3'

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9

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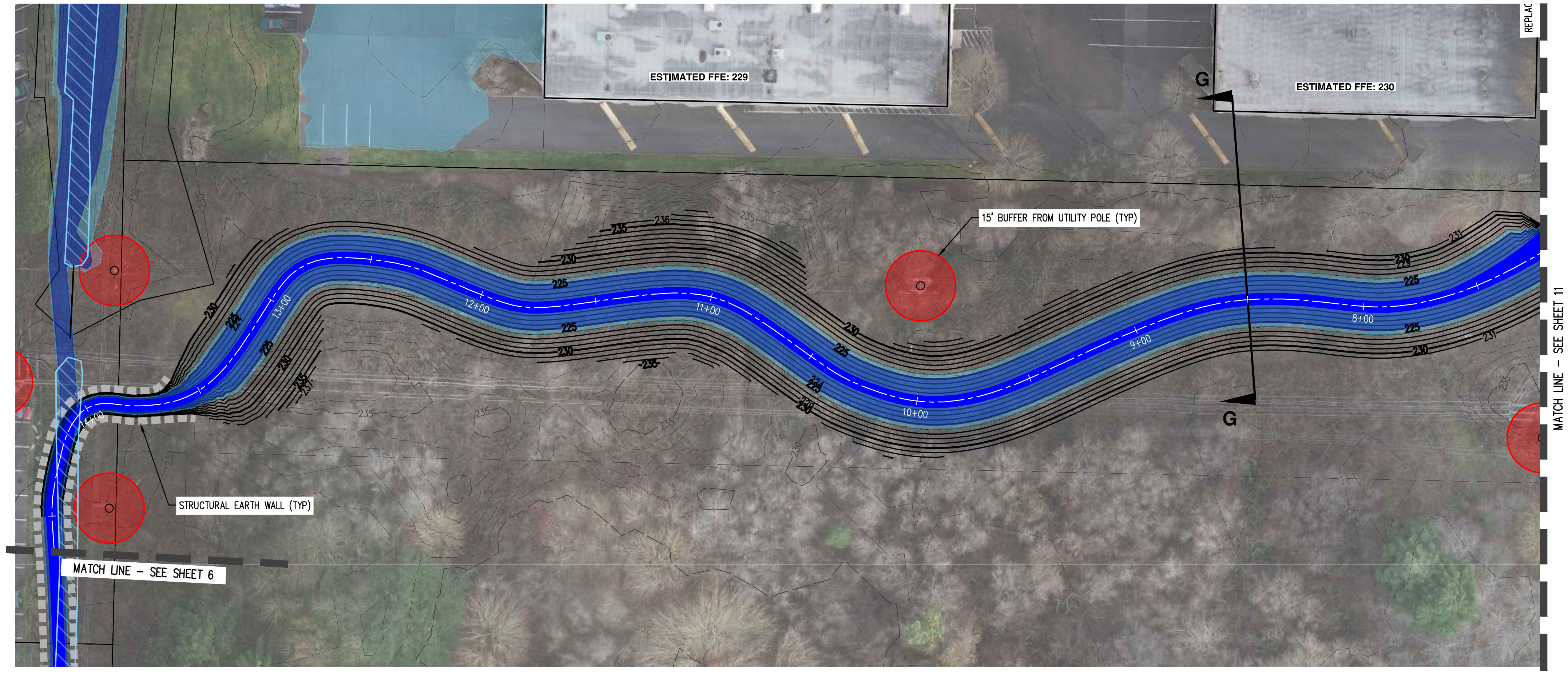
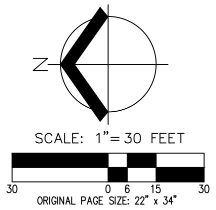
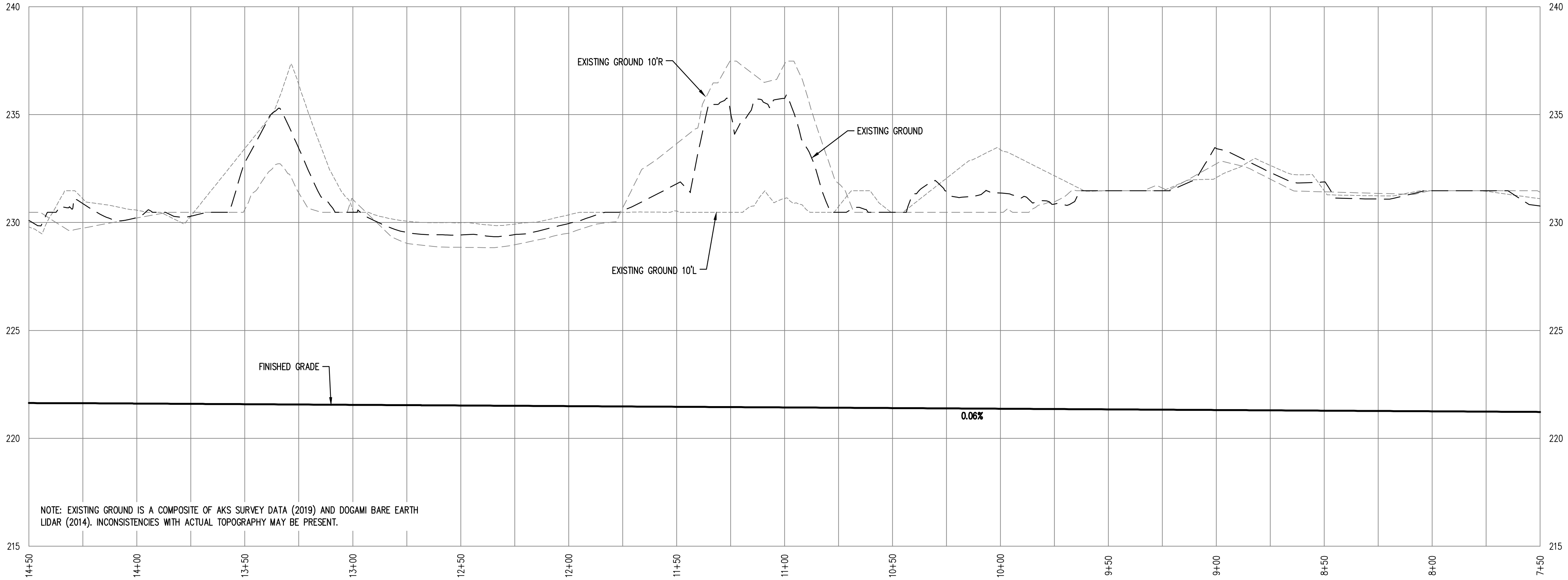


LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	—— 170 ——
FINISHED GROUND CONTOUR (5')	—— 170 ——
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	■
APPROXIMATE FLOOD STORAGE; 25-YR STORM	■
APPROXIMATE FLOOD STORAGE; 100-YR	■
STRUCTURAL EARTH WALL	■■■■■■■■■■
EXISTING UTILITY POLES AND 15' BUFFER	●



OPTION B



NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES WITH ACTUAL TOPOGRAPHY MAY BE PRESENT.

ALIGNMENT B PROFILE 7+50 – 14+50
HOR: 1"= 30'
VERT: 1"= 3'

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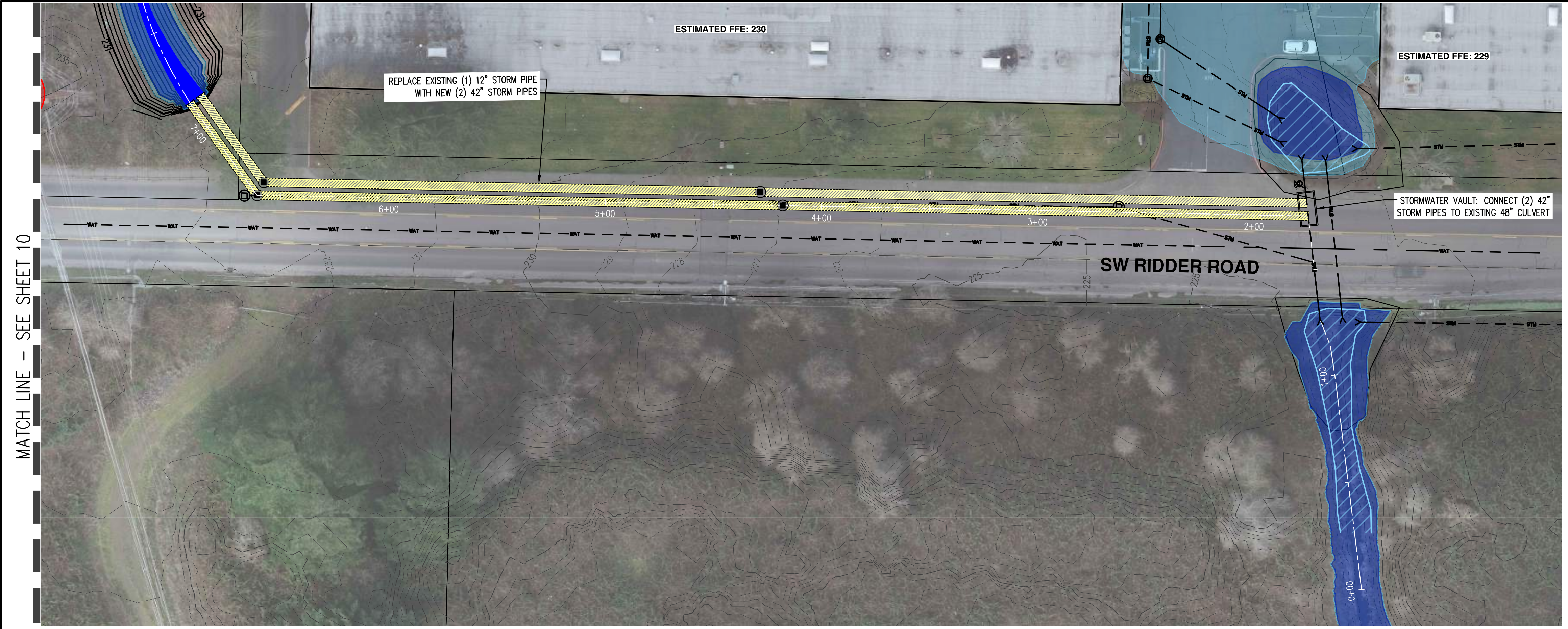
SHEET
10



LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	—— 170 ——
FINISHED GROUND CONTOUR (5')	—— **170** ——
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	🟥

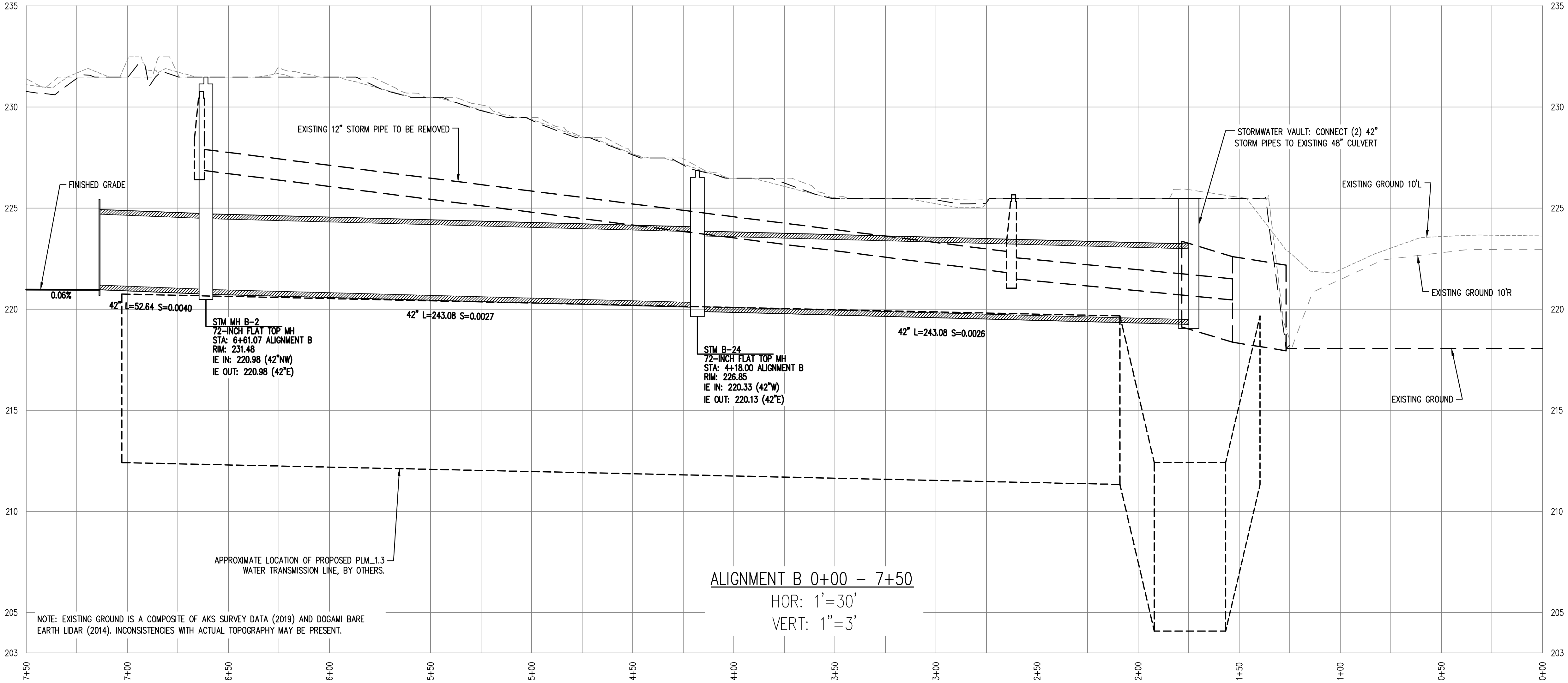
N

SCALE: 1"=30 FEET

30 0 6 15 30

ORIGINAL PAGE SIZE: 22" x 34"

OPTION B



ALIGNMENT B 0+00 – 7+50

HOR: 1'=30'

VERT: 1"=3'

NOTE: EXISTING GROUND IS A COMPOSITE OF AKS SURVEY DATA (2019) AND DOGAMI BARE EARTH LIDAR (2014). INCONSISTENCIES WITH ACTUAL TOPOGRAPHY MAY BE PRESENT.

AKS DRAWING FILE: 7076 PLAN & PROFILE B ALIGNMENT.DWG | LAYOUT: SHEET 11

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COFFEE CREEK STORMWATER FACILITY

WILSONVILLE OREGON

FACILITY SITING CONCEPTS PLAN AND PROFILE STA 0+00 - 7+50

DESIGNED BY: SRR
DRAWN BY: GMB
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

NOT FOR CONSTRUCTION

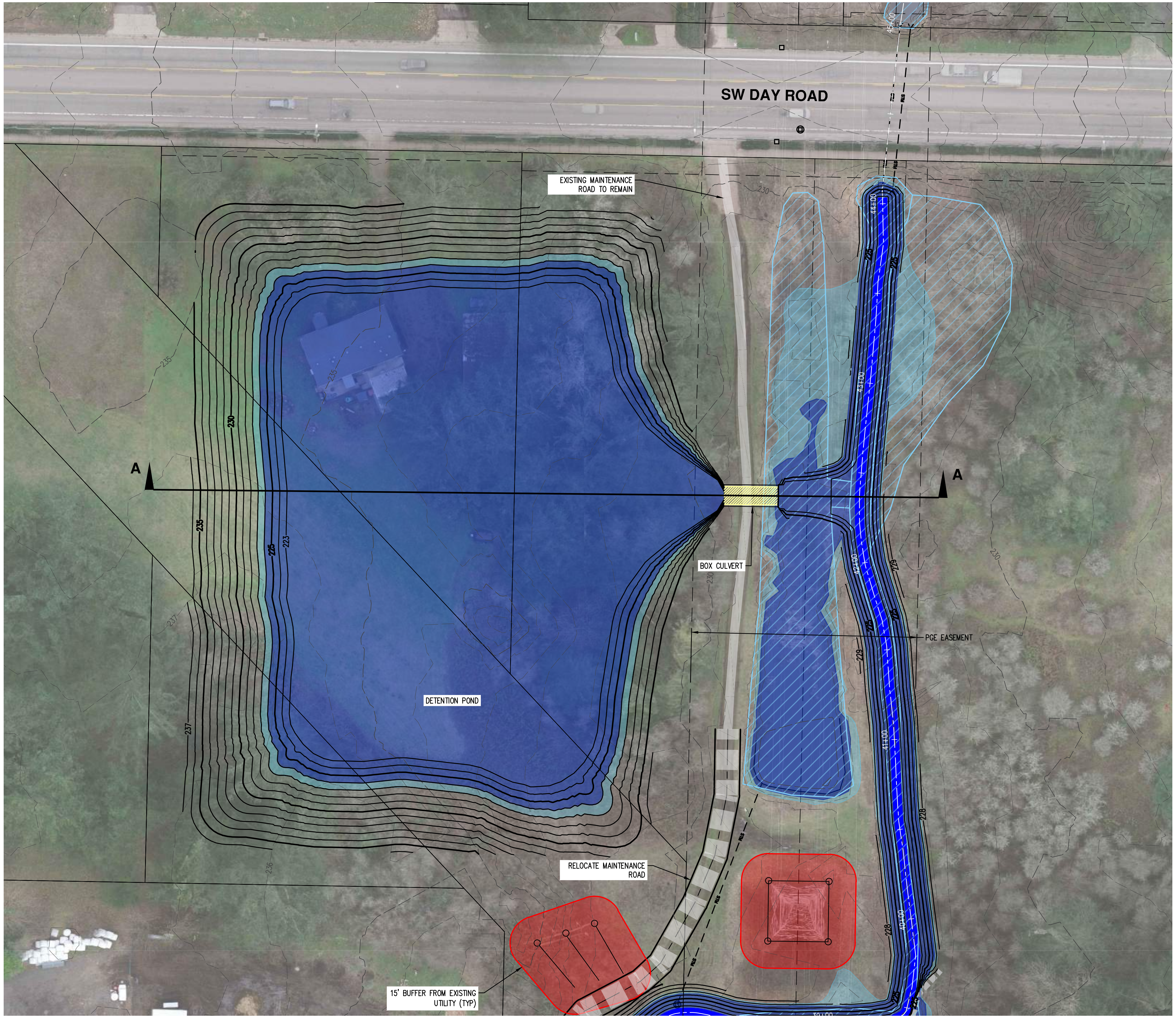
REVISIONS

JOB NUMBER
7076

SHEET
11

LEGEND

EXISTING STORM LINE	— — — STM —
FINISHED GOUND CONTOUR (1')	—— 170 ——
FINISHED GROUND CONTOUR (5')	**—— 170 ——**
EXISTING GROUND CONTOUR (1')	— — 170 — —
EXISTING GROUND CONTOUR (5')	— — 170 — —
PROPOSED STORM LINE/CULVERT	▨
EXISTING WETLANDS AND WATERS	▨
PROPOSED CHANNEL	🟦
APPROXIMATE FLOOD STORAGE; 25-YR STORM	🟦
APPROXIMATE FLOOD STORAGE; 100-YR	🟦
STRUCTURAL EARTH WALL	■ ■ ■ ■ ■ ■ ■ ■ ■ ■
EXISTING UTILITY POLES AND 15' BUFFER	🟥



OPTIONS A & B

SCALE: 1"= 30 FEET
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ORIGINAL PAGE SIZE: 22" x 34"

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COFFEE CREEK
STORMWATER FACILITY
WILSONVILLE OREGON

FACILITY SITING CONCEPTS
DETENTION POND

DESIGNED BY: SRR
DRAWN BY: GMB
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

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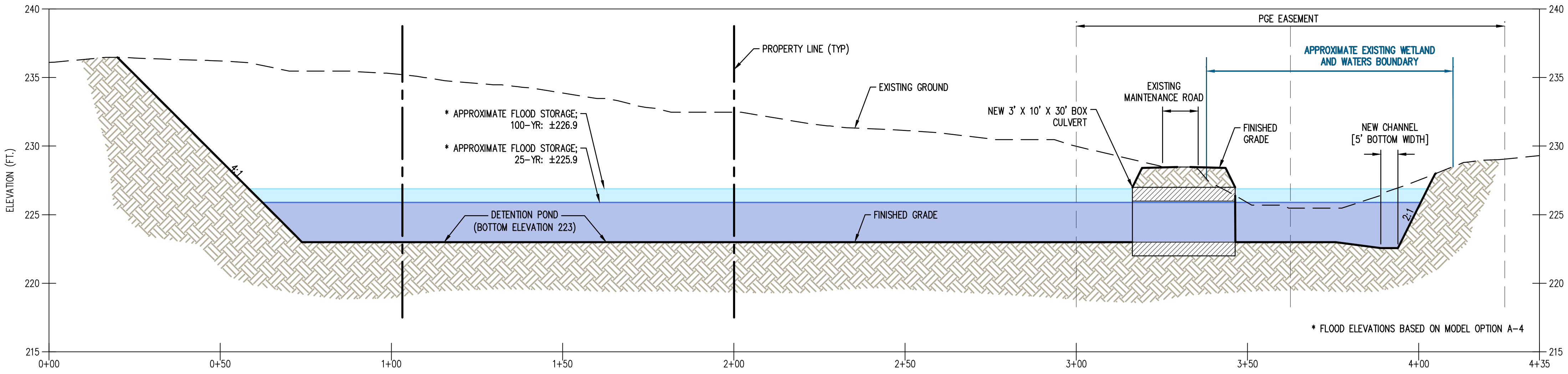
REVISIONS

JOB NUMBER
7076

SHEET
12

AKS DRAWING FILE: 7076 PLAN & PROFILE A ALIGNMENT.DWG | LAYOUT: SHEET 12



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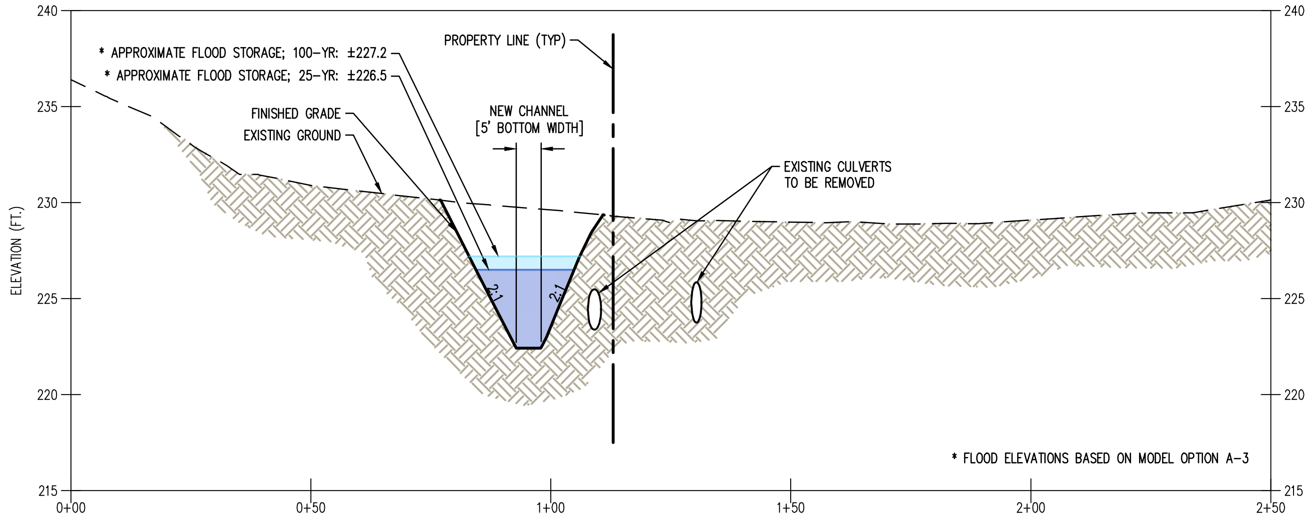

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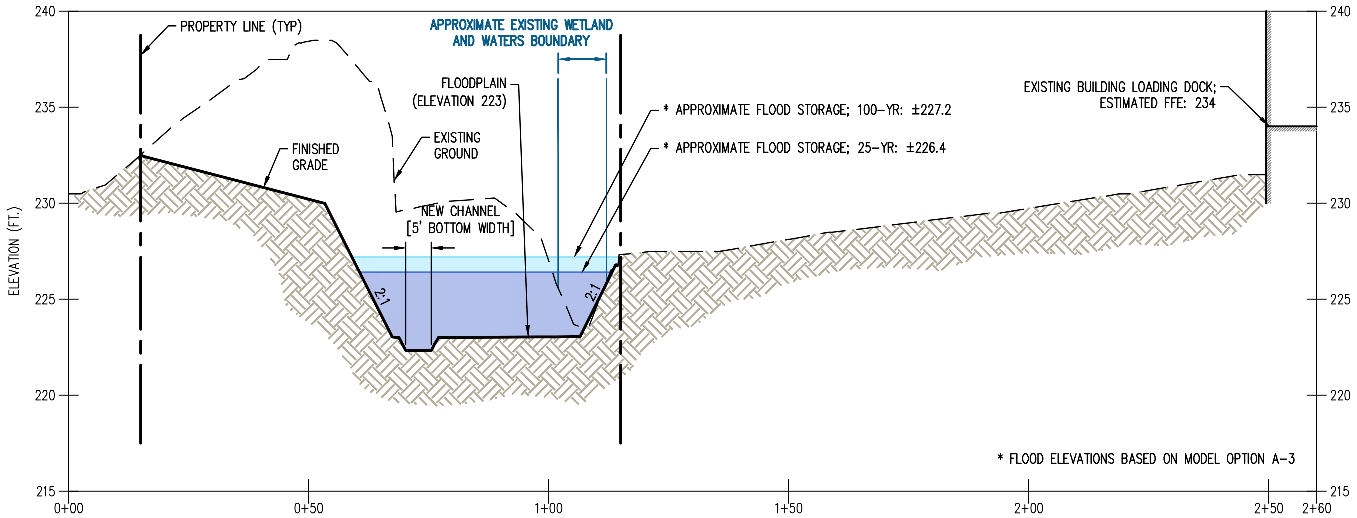

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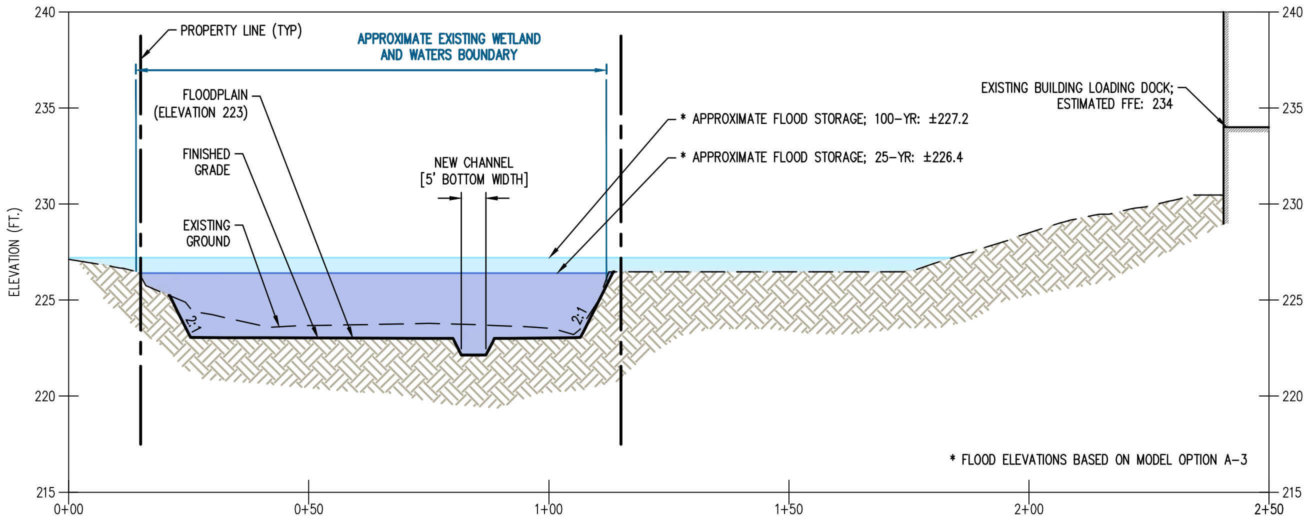

CROSS-SECTION D
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Vert. Scale: 1"= 5'

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COFFEE CREEK STORMWATER FACILITY

WILSONVILLE OREGON

FACILITY SITING CONCEPTS CROSS-SECTIONS

DESIGNED BY: SRR
DRAWN BY: SRR
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

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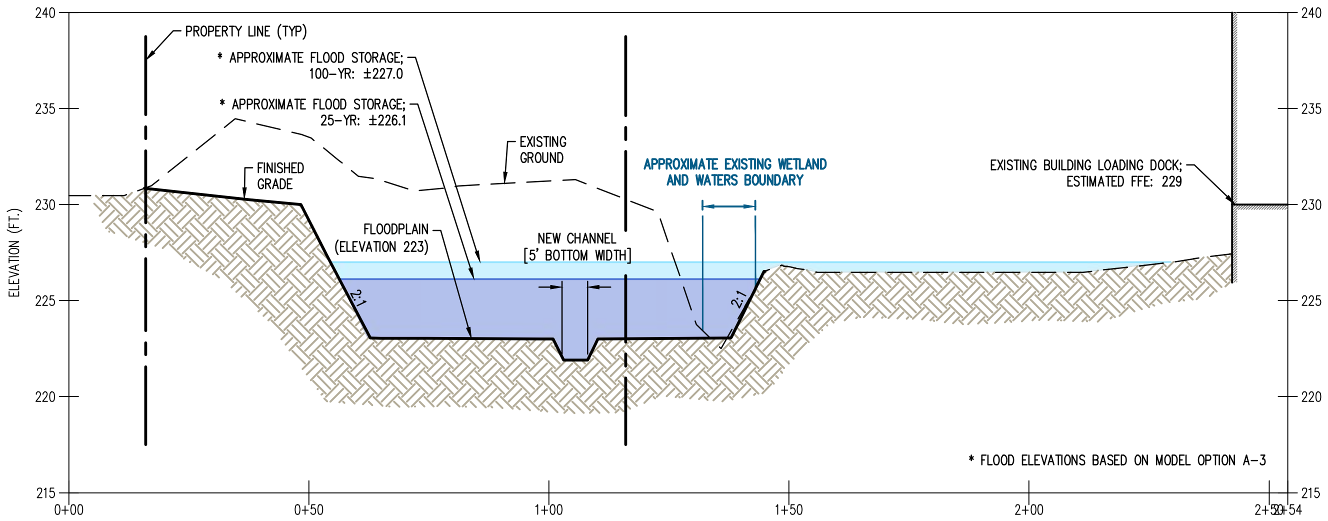
REVISIONS

JOB NUMBER
7076

SHEET
13

AKS DRAWING FILE: 7076 XSEC.DWG | LAYOUT: SHEET 13 - SECTIONS 20 SCALE



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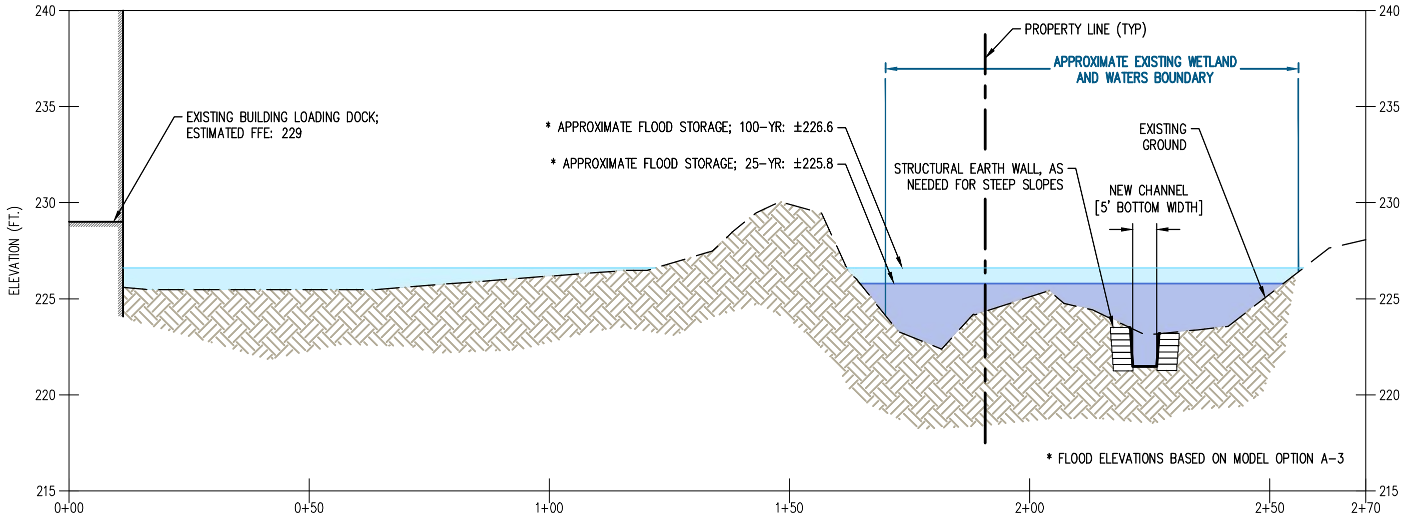

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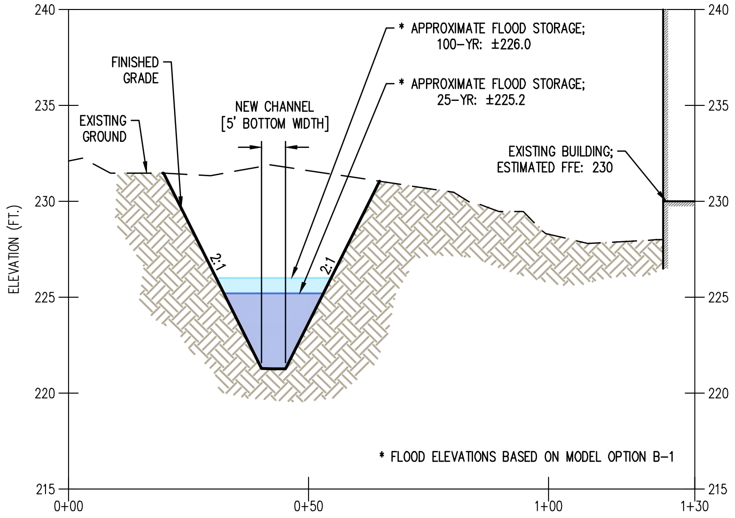

CROSS-SECTION G
Hor. Scale: 1"= 20'
Vert. Scale: 1"= 5'

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COFFEE CREEK STORMWATER FACILITY
WILSONVILLE OREGON

FACILITY SITING CONCEPTS CROSS-SECTIONS

DESIGNED BY: SRR
DRAWN BY: SRR
MANAGED BY: JPC
CHECKED BY: JPC
DATE: 06/20/19

NOT FOR CONSTRUCTION

REVISIONS

JOB NUMBER
7076

SHEET
14

AKS DRAWING FILE: 7076 XSEC.DWG | LAYOUT: SHEET 14 - SECTIONS 20 SCALE

Facility Siting Alternatives Report, Appendix B:
Cost Estimates

Coffee Creek Stormwater Facility Study

Engineer's Estimate - Siting Concept

Est By: SRR
Checked: JPC

OPTION A - Channel

Item No.	Spec. Section	Description	Unit	Unit Price	Qty	Total
1		Mobilization	LS	$177,000	1	$177,000
2		Erosion And Sediment Control	ACRE	$12,000	5.7	$68,400
3		Removal of Structures and Obstructions	LS	$20,000	1	$20,000
4		Clearing and Grubbing	ACRE	$5,000	5.7	$28,500
5		General Excavation	CY	$10	26,500	$265,000
6		Haul-off	CY	$20	26,500	$530,000
7		Fine Grading	SQYD	$1	27,600	$27,600
8		Structural Earth Wall	SQFT	$10	16,900	$169,000
9		Jute Mat	SQYD	$1	4,950	$4,950
10		Streambed Cobble	TON	$70	900	$63,000
11		Loose Riprap, Class 50	CY	$120	125	$15,000
13		Planting and Seeding	ACRE	$100,000	3.2	$320,000
14		Plant Establishment Period	ACRE	$6,500	3.2	$20,800
15		Temporary Irrigation System	ACRE	$13,000	3.2	$41,600
16		Aggregate Base and Shoulders (3/4" minus) [Maintenance Road, 8" Thick]	TON	$46	1,100	$50,600
17		Open Bottom Culvert (10x3)	LF	$2,600.00	200	$520,000
					Subtotal =	**$2,321,450**
					Contingency (30%) =	**$696,435**
					OPTION A - Channel TOTAL =	**$3,017,885**

OPTION A - Pipe

Item No.	Spec. Section	Description	Unit	Unit Price	Qty	Total
1		Sawcut	LF	$1	1,070	$1,070
2		36" Storm Pipe	LF	$190	575	$109,250
3		60" Flat Top Manhole	EA	$15,000	2	$30,000
4		Riprap Outfall	EA	$1,500	1	$1,500
5		Trench Patch (4" thick)	SY	$70	475	$33,250
					Subtotal =	**$175,070**
					Contingency (30%) =	**$52,521**
					OPTION A - Pipe TOTAL =	**$227,591**

Pond

Item No.	Spec. Section	Description	Unit	Unit Price	Qty	Total
1		Mobilization	LS	$145,000	1	$145,000
2		Erosion And Sediment Control	ACRE	$12,000	2.8	$33,600
3		Clearing and Grubbing	ACRE	$10,000	2.8	$28,000
4		General Excavation	CY	$10	36,100	$361,000
5		Haul-off	CY	$20	36,100	$722,000
6		Fine Grading	SQYD	$1	10,700	$10,700
7		Loose Riprap, Class 50	CY	$120	40	$4,800
8		Planting and Seeding	ACRE	$100,000	2.2	$220,000
9		Plant Establishment Period	ACRE	$6,500	2.2	$14,300
10		Temporary Irrigation	ACRE	$13,000	2.2	$28,600
11		Open Bottom Culvert (10x3)	LF	$2,600	30	$78,000
					Subtotal =	**$1,646,000**
					Contingency (30%) =	**$493,800**
					Pond TOTAL =	**$2,139,800**

Engineer's Estimate
Estimate By: SRR
Checked By: JPC

Date: 04/26/2019

OPTION B - Channel/Pipe

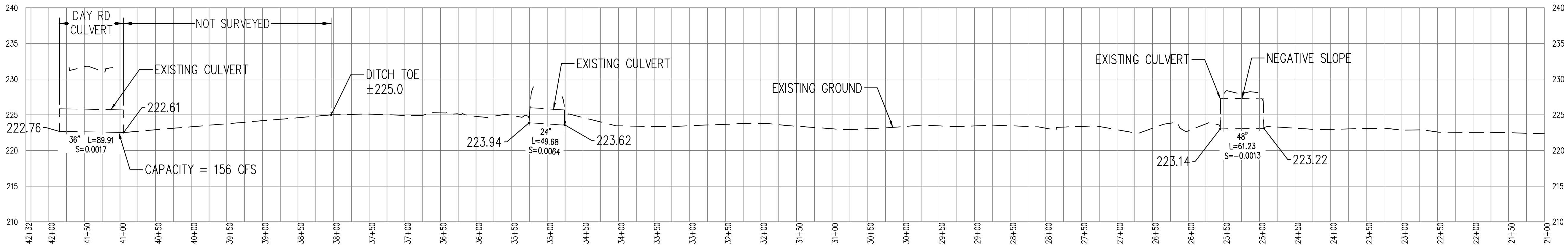
Item No.	Spec. Section	Description	Unit	Unit Price	Qty	Total
1		Mobilization	LS	$274,000	1	$274,000
2		Erosion And Sediment Control	ACRE	$12,000	6.5	$78,000
3		Removal of Structures and Obstructions	LS	$30,000	1	$30,000
4		Clearing and Grubbing	ACRE	$5,000	6.5	$32,500
5		General Excavation	CY	$10	33,000	$330,000
6		Haul-off	CY	$20	33,000	$660,000
7		Fine Grading	SQYD	$1	31,500	$31,500
8		Structural Earth Wall	SQFT	$10	15,000	$150,000
9		Jute Mat	SQYD	$1	7,850	$7,850
10		Streambed Cobble	TON	$70	930	$65,100
11		Loose Riprap, Class 50	CY	$120	145	$17,400
12		Planting and Seeding	ACRE	$100,000	3.8	$380,000
13		Plant Establishment Period	ACRE	$6,500	3.8	$24,700
14		Temporary Irrigation System	ACRE	$13,000	3.8	$49,400
15		Sawcut	LF	$1	1,030	$1,030
16		42" Storm Pipe	LF	$452	1,080	$488,160
17		72" Flat Top Manhole	EA	$18,000	4	$72,000
18		Tie into Existing Culvert (SW Ridder Road)	LS	$15,000	1	$15,000
19		Pre-cast Stormwater Vault	EA	$25,000	1	$25,000
20		Trench Patch (8" thick)	SY	$110	700	$77,000
21		Aggregate Base and Shoulders (3/4" minus) [Maintenance Road, 8" Thick]	TON	$46	1,100	$50,600
22		Open Bottom Culvert (10x3)	LF	$2,600	200	$520,000
					Subtotal =	**$3,379,240**
					Contingency (30%) =	**$1,013,772**
					OPTION B - Channel TOTAL =	**$4,393,012**

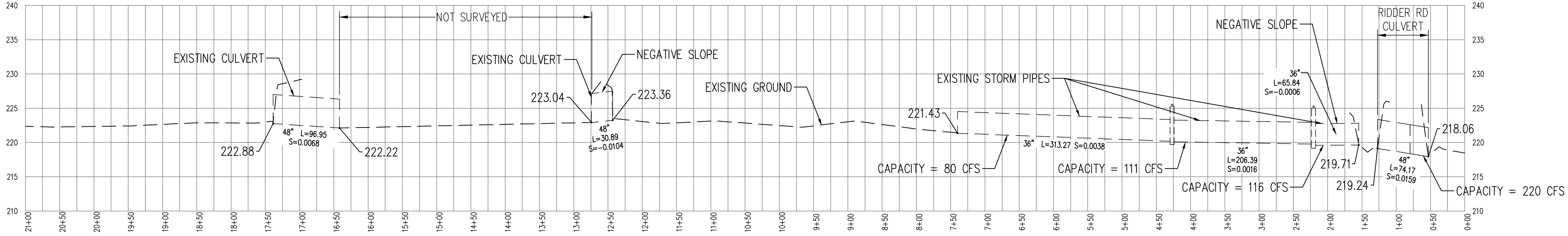
Assumptions

1. This estimate was developed for the purpose of comparing two design alternatives and may not be inclusive of all work necessary to install the improvements.
2. The unit prices shown are based on engineering experience and do not represent actual contractor bids. Actual contractor bids may vary significantly.
3. Units that are in L.F., S.F., or S.Y. are based on 1-dimensional (linear) or 2-dimensional (horizontal plan) measurements. Units are not 3-dimensional (slope) measurements.
4. This estimate does not include:
    - City, County, State, or Federal Permit Fees
    - Consulting Services
    - Hard Rock/Boulder Excavation
5. Volumes and quantities listed are approximate.
6. This estimate does not include items not specifically listed.
7. This estimate is based on Concept Level Plans (Not Final Approved Construction Plans).
8. All items, quantities, volumes, etc. listed are based on “in-place” measurements.
9. All items listed include materials and installation.
10. Estimate is based on 2019 dry weather construction.
11. Grading volumes and quantities shown in this estimate are subject to significant change pending final engineering design requirements.
12. Estimates are intended for Client’s general project feasibility purposes only. Actual contractor bids may vary significantly.
13. All costs assume dry weather construction.

Facility Siting Alternatives Report, Appendix C:

Profile Along Existing Channel





PROFILE ALONG EXISTING CHANNEL

HOR: 1"=200'
VERT: 1"=20'

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BEND, OR 97703
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COFFEE CREEK STORMWATER FACILITY

WILSONVILLE OREGON

PROFILE ALONG EXISTING CHANNEL

DESIGNED BY:	SRR
DRAWN BY:	GMB
MANAGED BY:	JPC
CHECKED BY:	JPC

DATE: 04/23/19

REVISIONS

JOB NUMBER
7076

SHEET

AKS DRAWING FILE: 7076 CPIPES.DWG | LAYOUT: LAYOUT2

Facility Siting Alternatives Report, Appendix D:
Preliminary Stormwater Report

Coffee Creek Stormwater Facility Study
Wilsonville, Oregon

Preliminary Stormwater Report

Date:	June 2019
Client:	City of Wilsonville – Engineering Division 29799 SW Town Center Loop East Wilsonville, OR 97070
Engineering Contact:	John Christiansen, PE (503) 563-6151 | johnc@aks-eng.com
Engineering Firm:	AKS Engineering & Forestry, LLC 12965 SW Herman Road Suite 100 Tualatin, OR 97062
AKS Job Number:	7076

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Tables

Appendices

Preliminary Stormwater Report

COFFEE CREEK STORMWATER FACILITY STUDY
WILSONVILLE, OREGON

1.0 Purpose of Report

This report advances the design of capital improvement project (CIP) *CLC-3: Channel Project – Commerce Circle* using the parameters set forth in the Basis of Design Report, dated March 2019.

The purpose of this report is to analyze the effects of the design concepts developed during the Stormwater Analysis phase of the project on the existing stormwater conveyance system; document the criteria, methodology, and informational sources used to design the stormwater improvements; and present the results of the preliminary hydraulic analysis.

2.0 Project Location/Description

This project is located to the west and south of the Commerce Circle industrial area and follows Basalt Creek in a straightened, incised channel between SW Day Road to the north, and SW Ridder Road to the south. Approximately 1,050 acres of surrounding drainage area contributes stormwater runoff to the system. This drainage area is shown on Figure 2 in the Basis of Design Report.

The goal of the project is to address flooding that occurs during existing storm events and that is predicted during future storm events (beginning at the 2-year, 24-hour storm event), and to restore and enhance an existing straightened, incised channel. The channel has negative slopes in some areas which contribute to flooding.

3.0 Regulatory Design Criteria

3.1 STORMWATER QUANTITY

This project is intended to address a conveyance and capacity constraint and does not specifically address water quantity management for future development.

3.2 STORMWATER QUALITY

This project is intended to address a conveyance and capacity constraint and does not specifically address water quality management. The conveyance improvements may have water quality benefits.

4.0 Design Methodology

As described in the 2012 Stormwater Management Plan (SWMP), the Green-Ampt method was used to estimate runoff and infiltration in the InfoSWMM model. The Green-Ampt method calculates infiltration of stormwater into soils using antecedent moisture conditions (initial moisture deficit), water depth, and the hydraulic conductivity of the soil. The values of these three parameters were based on soil types in the City of Wilsonville. A more detailed description of this methodology, as well as a table of Green-Ampt Infiltration Parameters by Soil Type, can be found in the Basis of Design Report.

AKS ran the model using the infiltration parameters matching those from the 2012 SWMP InfoSWMM model.

5.0 Design Parameters

For input and analysis purposes, the following hydrologic parameters were included for each subbasin in the InfoSWMM model:

- Subbasin name or number
- Subbasin (acres)
- Impervious surface percentage (percent)
- Average ground slope (percent)
- Subbasin width (feet)
- Manning's roughness coefficient for impervious areas
- Manning's roughness coefficient for pervious areas
- Depression storage for impervious areas (inches)
- Depression storage for pervious areas (inches)
- Green-Ampt soil infiltration parameters: initial moisture deficit of soil, hydraulic conductivity of soil, and suction head at the wetting front

The 2012 SWMP provides a description for each user-defined hydrologic parameter entered into the InfoSWMM model. These parameters were used for scenarios modeled for this project as well. Detailed descriptions can be found in the Basis of Design Report.

5.1 DESIGN STORMS

The 2012 SWMP lists rainfall in inches for the 24-hour design storms. These rainfall amounts are listed in *Table 1* and were used for the models developed in this project.

Table 1: 24-Hour Design Storms for the City of Wilsonville

Storm Event	Rainfall (inches)
2-year	2.50
5-year	3.00
10-year	3.45
25-year	3.90
50-year	4.25
100-year	4.50

6.0 Stormwater Analyses

6.1 PROPOSED STORMWATER CONDUIT SIZING

The proposed stormwater system will be sized using Manning's equation to maximize conveyance of the peak flows from the 25-year storm event under the existing site constraints.

6.2 ELEVATION OF ADJACENT INDUSTRIAL AREA PARKING LOT

As one of the goals of the project is to address flooding that occurs in the Commerce Circle Industrial Area, the elevation of flooding needed to be determined. Based on LIDAR topography and the preliminary topographic survey conducted by AKS, the lowest elevation adjacent to the project site is approximately 226.50 feet. This elevation was used a baseline flood elevation to determine the effectiveness of the conceptual designs. The industrial area parking lot on Tax Lot 400, Tax Map 3S102CA was studied specifically.

6.3 MODEL RESULTS

The model results can be summarized by studying the hydraulic grade line (HGL) of the system, specifically in the area adjacent to the parking lot that has seen the most flooding, along the west side of Tax Lot 400, Tax Map 3S102CA. The model was run for the existing 10-year, 25-year, and 50-year events, and the HGL elevations of the adjacent channel section were calculated for each of the six conceptual designs described in the Facility Siting Alternatives Report. The HGL elevations were then compared with elevation 226.50 and plotted on the graph below.

For reference, the Summary of Options and Design Elements is provided below. See the Facility Siting Alternatives Report for more detail about the six design options.

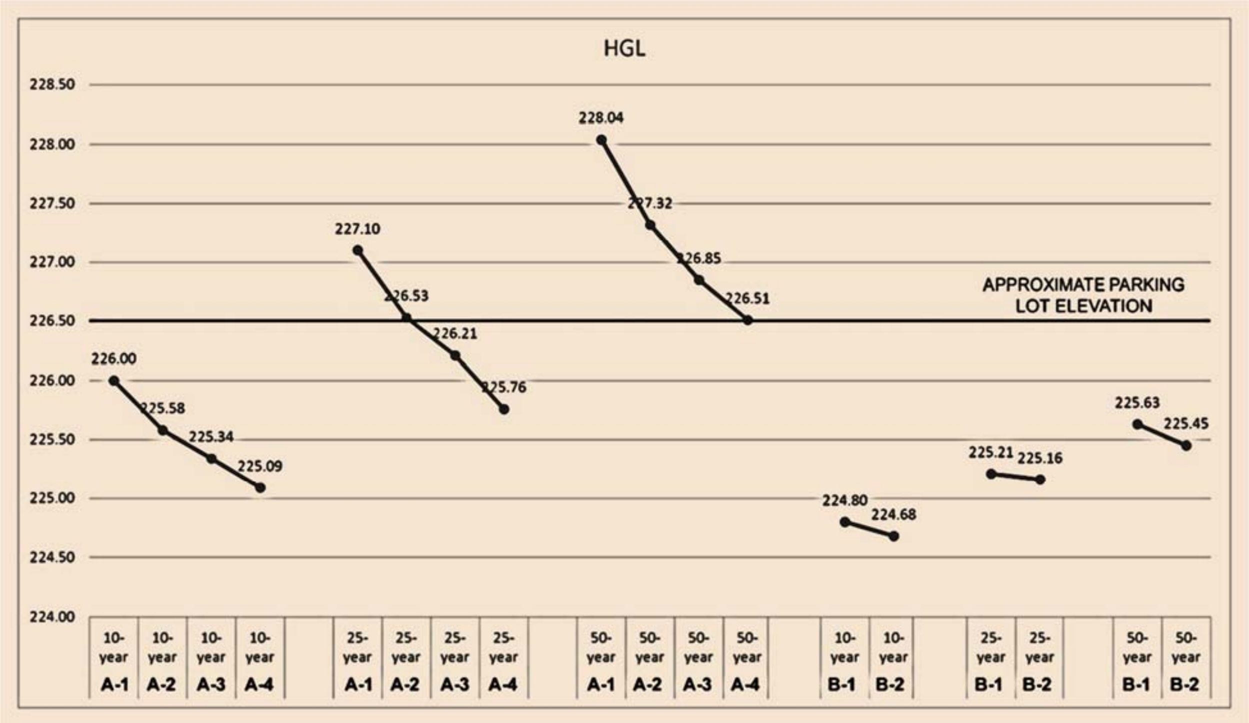


Table 2: Summary of Options and Design Elements

Option	Additional 36-inch Pipe	Detention Pond
A-1	No	No
A-2	No	Yes
A-3	Yes	No
A-4	Yes	Yes
B-1	n/a	No
B-2	n/a	Yes

6.4 HYDRAULIC GRADE LINE PROFILES

The full HGL Profiles were run for the 25-year storm event and each of the six options, beginning upstream at SW Day Road and ending at the channel south of SW Ridder Road. These are provided as an attachment to this report.

Following the presentation of the Facility Siting Concepts, modeling results, and recommendations to the City in May 2019, AKS updated the model to include wider conduit cross-sections that represent existing flood plain above the proposed channel improvements. This approach allowed a more realistic look at the potential effects on existing buildings a 100-year storm would have. The 100-year storm HGL Profiles are provided in the appendix of this report.

6.5 DOWNSTREAM IMPACTS

As described in the Basis of Design Report, the intent of this project is to increase conveyance capacity and provide storage of stormwater runoff, reducing the flooding that occurs in the Commerce Circle Industrial Area. As stated in the 2012 SWMP, the current conveyance channel has negative slopes that prevent the occurrence of flooding downstream. The 2012 SWMP states that this reverse slope has not been removed in order to avoid moving the flooding to a downstream location (2012 SWMP 6.6.1).

Modeling results for the existing City model and Option A-3 were compared downstream from SW Ridder Road to the Coffee Lake Wetlands to determine if the channel improvements would result in increased flooding potential downstream of SW Ridder Road. The modeling shows that immediately south of SW Ridder Road, the HGL raises approximately 1.2 feet post-improvements; however, this flood level remains within the defined channel south of SW Ridder Road.

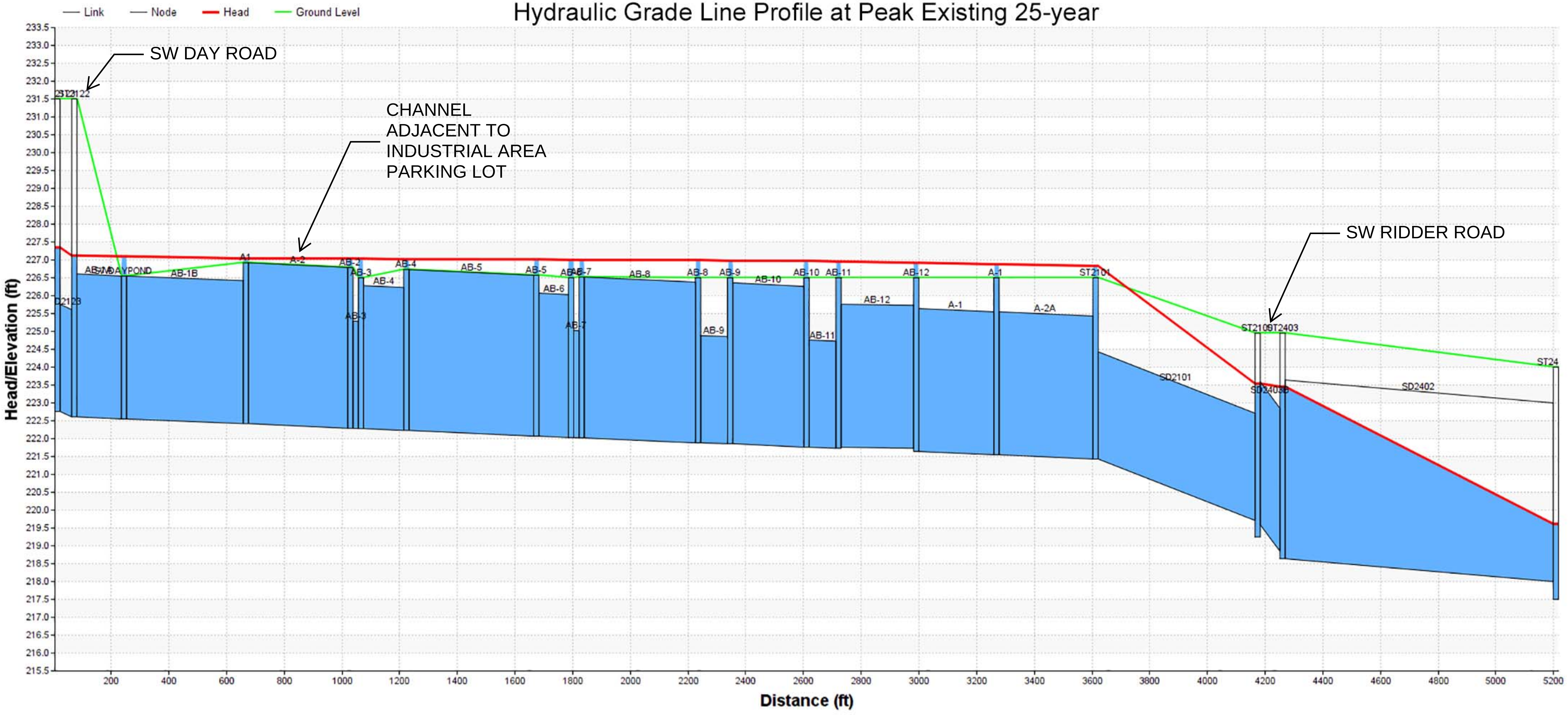
Further downstream, the HGL is lower post-improvements than existing conditions by approximately 0.1-0.2 feet. This remains consistent in both the 25-year storm and 100-year storm scenarios.

The final design recommendations for this project include removing the reverse grade and providing storage capacity.

Appendix A: Hydraulic Grade Line Profiles at Peak Existing 25-year

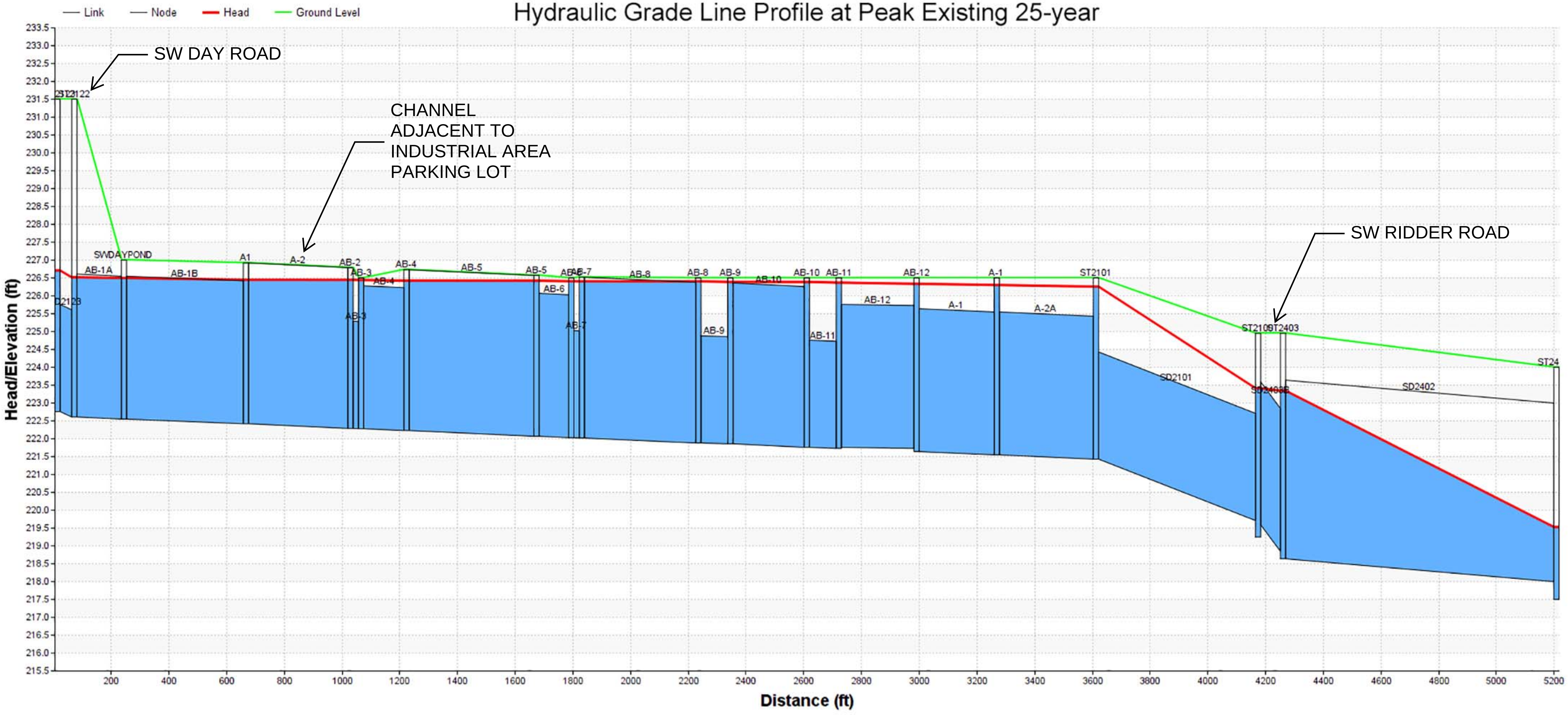
Option A-1

Hydraulic Grade Line Profile at Peak Existing 25-year



Option A-2

Hydraulic Grade Line Profile at Peak Existing 25-year



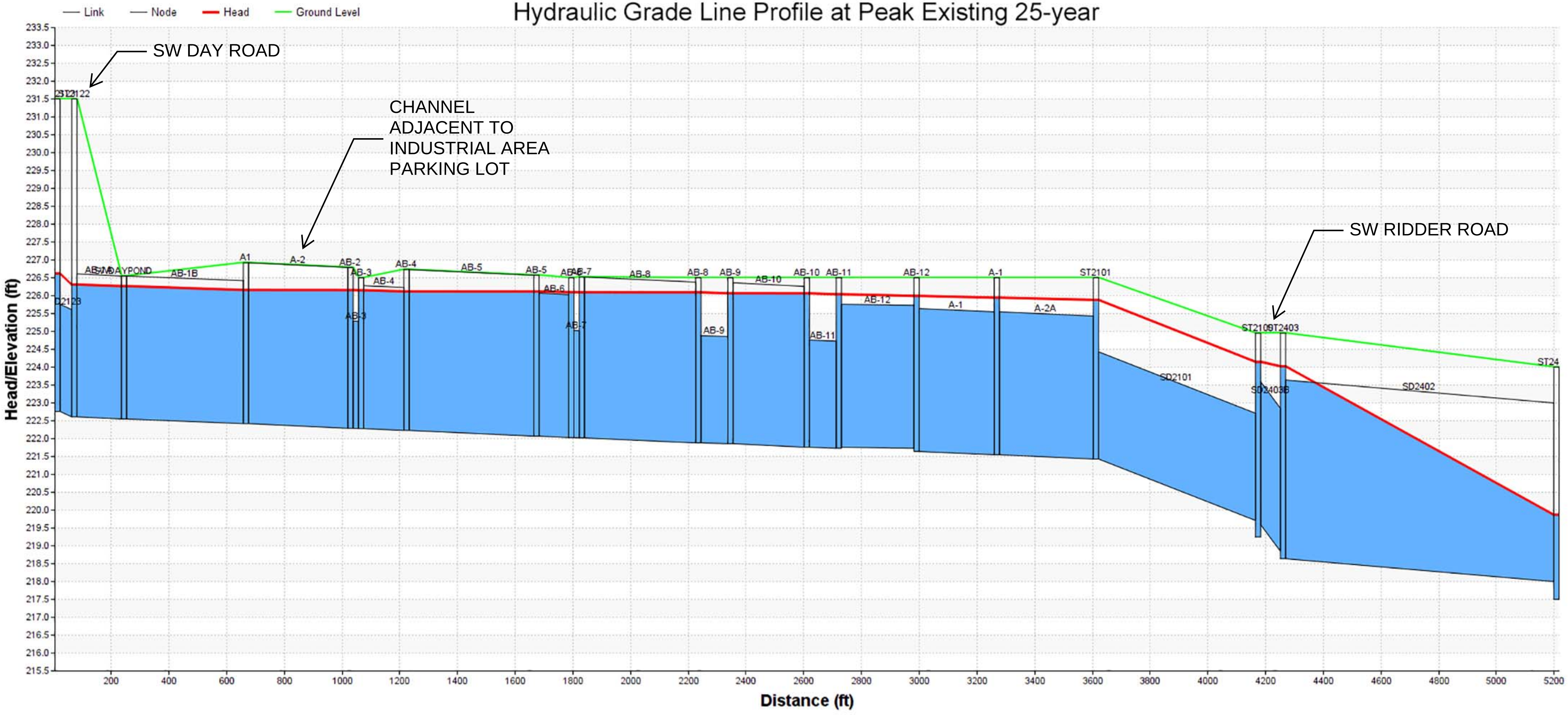
SW DAY ROAD

CHANNEL ADJACENT TO INDUSTRIAL AREA PARKING LOT

SW RIDDER ROAD

Option A-3

Hydraulic Grade Line Profile at Peak Existing 25-year



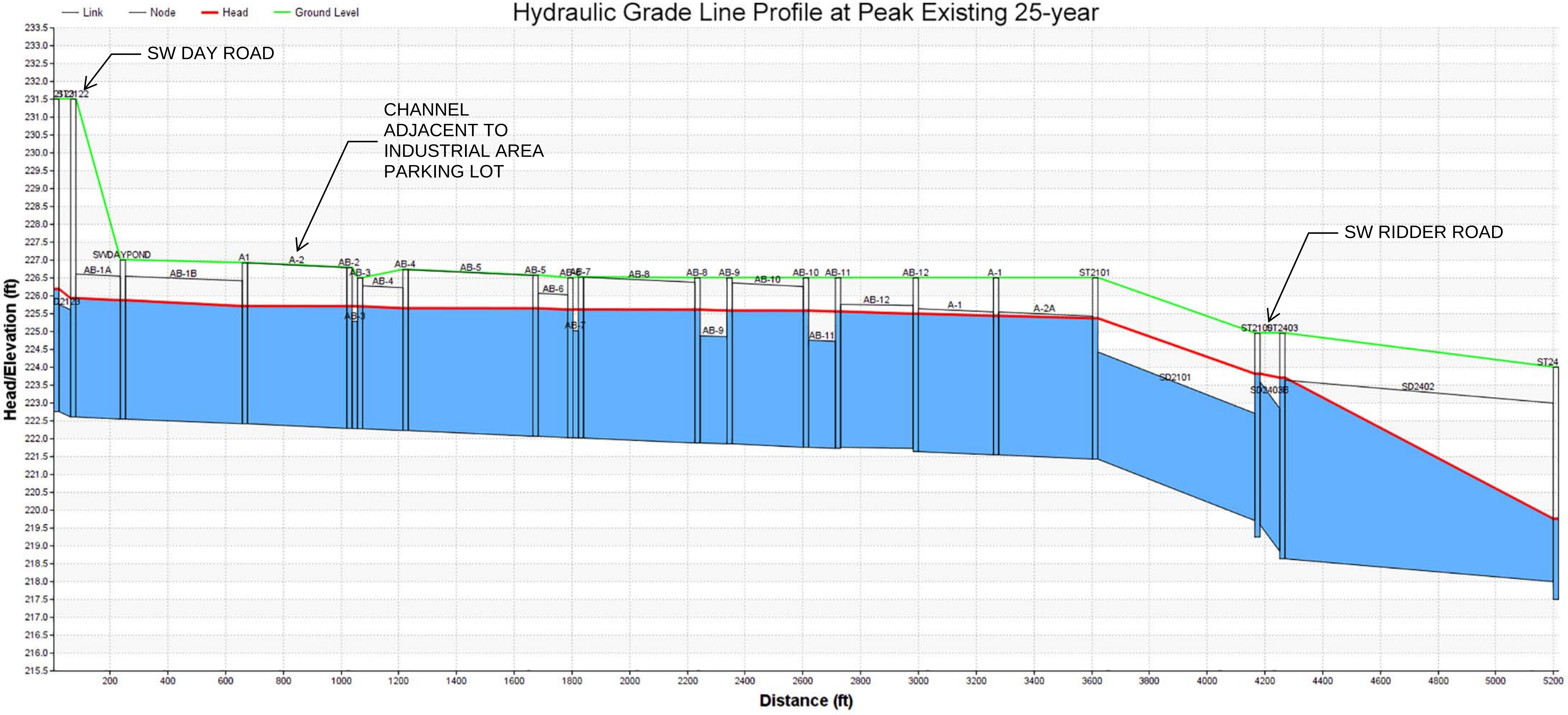
SW DAY ROAD

CHANNEL
ADJACENT TO
INDUSTRIAL AREA
PARKING LOT

SW RIDDER ROAD

Option A-4

Hydraulic Grade Line Profile at Peak Existing 25-year



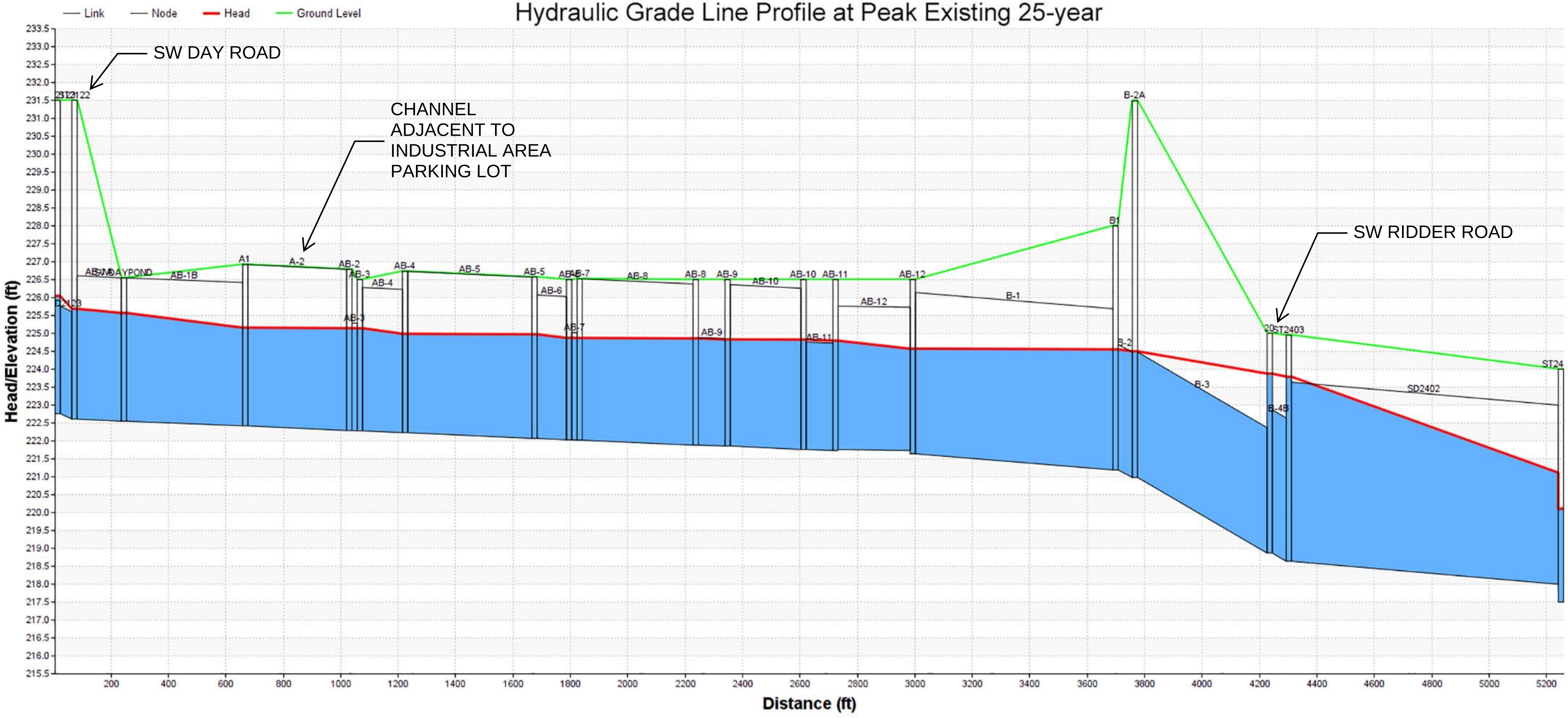
SW DAY ROAD

CHANNEL ADJACENT TO INDUSTRIAL AREA PARKING LOT

SW RIDDER ROAD

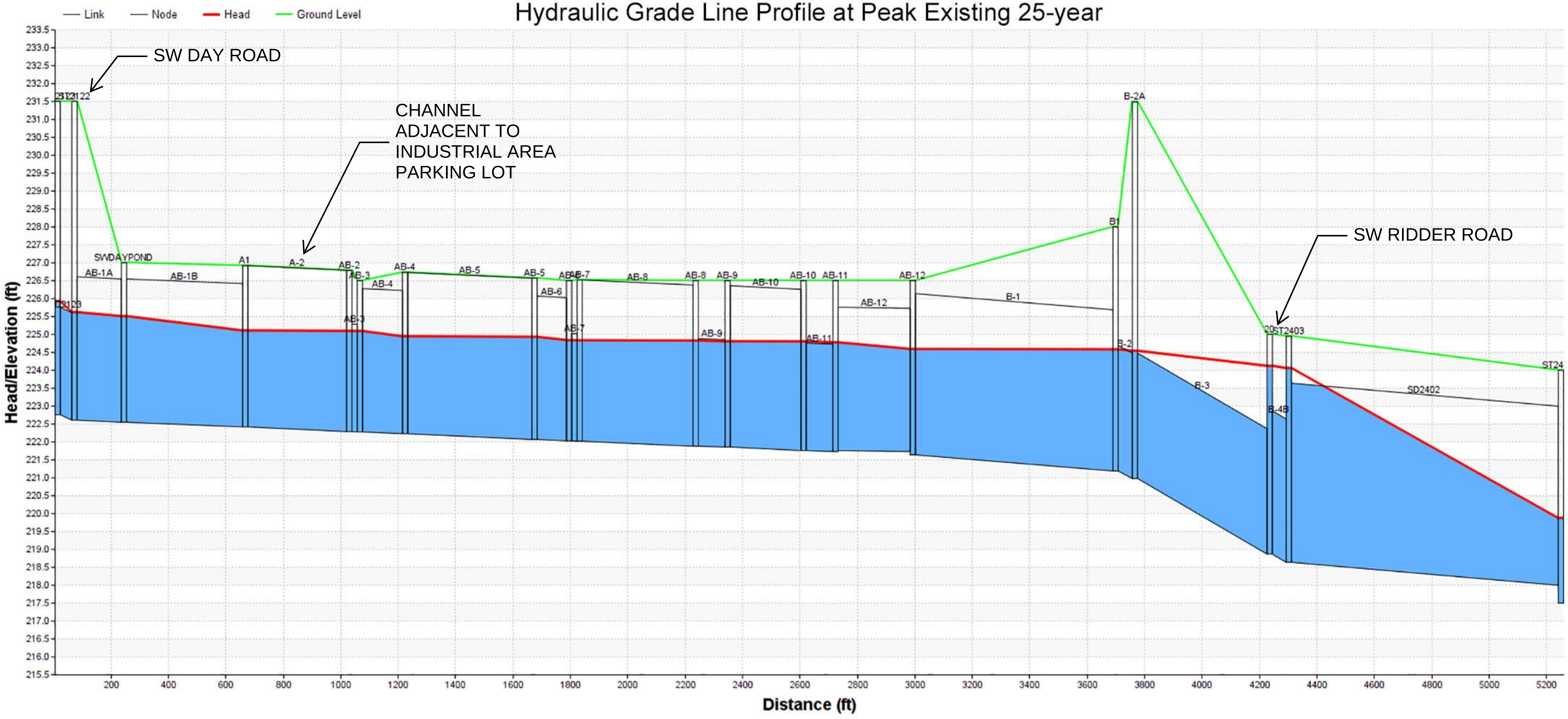
Option B-1

Hydraulic Grade Line Profile at Peak Existing 25-year



Option B-2

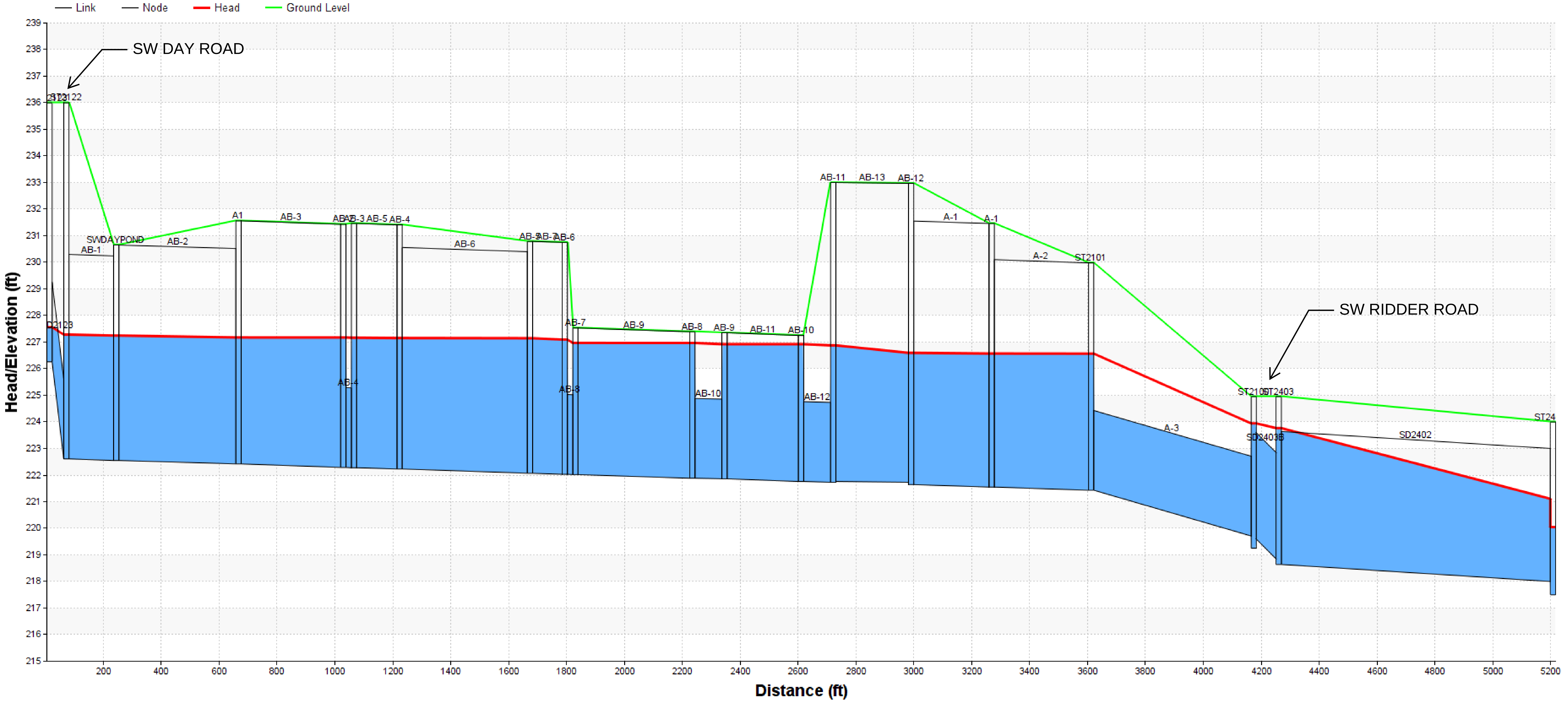
Hydraulic Grade Line Profile at Peak Existing 25-year



Appendix B: Hydraulic Grade Line Profiles at Peak Existing 100-year (Options A-3 & B-1)

Option A-3

Hydraulic Grade Line Profile at Peak Existing 100-Year



Option B-1

Hydraulic Grade Line Profile at Peak Existing 100-Year