Tillamook County

DEPARTMENT OF COMMUNITY DEVELOPMENT
BUILDING, PLANNING & ON-SITE SANITATION SECTIONS

1510 – B Third Street
Tillamook, Oregon 97141
www.tillamook.or.us

Building (503) 842-3407
Planning (503) 842-3408
On-Site Sanitation (503) 842-3409
FAX (503) 842-1819
Toll Free 1 (800) 488-8280

Land of Cheese, Trees and Ocean Breeze

MEMO

Date: October 15, 2021
To: Tillamook County Board of Commissioners
From: Melissa Jenck, CFM, Land Use Planner II
Subject: October 22, 2021 BOCC Appeal Hearing for - #851-21-000309-PLNG: Appeal of Planning Commissions decision to deny a Subdivision preliminary plat and Geologic Hazard Report for "Second Addition to Avalon Heights"

Included with this memorandum is testimony received on the record for the above-mentioned Appeal for the Subdivision preliminary plat for the "Second Addition to Avalon Heights" #851-21-000095-PLNG, together with Geologic Hazard Report Review #851-21-000202-PLNG.

This is the second appeal hearing with the Board of County Commissioners for this appeal request, to occur on October 22, 2021, at 2:00pm. The first appeal hearing occurred August 30, 2021, at 9:00am. The oral and written record remained opening following the August 30th hearing.

Testimony received on the record included materials provided by the Applicants/Appellants, and have been summarized as follows:

- An updated Geotechnical Engineering Report prepared by Strata Design with a revision date of October 12, 2021.
- A Preliminary Stormwater Report prepared by Firwood Design Group dated October 11, 2021.
    - This report appears to be a revision of the March 31, 2021 Preliminary Stormwater Report prepared by Firwood Design Group and was included in the original subdivision review materials.
    - This report provides information relating to the revised storm water system, including several infiltration drywells.
- Revised plat sets were provided, with a revision date of October 11, 2021.
    - Applicant states lot dimensions remain unchanged compared to the previously submitted plats.
- A revised Transportation Impact Study dated October 14, 2021 prepared by Lancaster Mobley.
    - Lancaster Mobley states the revision is to address traffic conditions, trip generation and safety concern as requested by the BOCC.

Staff will provide an assessment of the updated materials at the BOCC hearing on October 22, 2021.

If you have any questions regarding the information received, please do not hesitate to contact me at 503-842-3408x3301, email: mjenck@co.tillamook.or.us or email Allison Hinderer, Office Specialist 2, at ahindere@co.tillamook.or.us.

Sincerely,

Melissa Jenck, CFM, Land Use Planner II

Melissa Jenck

From: eh@firwooddesign.com
Sent: Tuesday, October 12, 2021 2:12 PM
To: Melissa Jenck; 'Bill Hughes'; 'Skip Urling'
Cc: Sarah Absher; Isabel Gilda; Kelly Fulton; Chris Laity; 'Ty K. Wyman'
Subject: EXTERNAL: RE: EXTERNAL: RE: Avalon Heights Subdivision Appeal

Melissa,
At the request and direction of the Board of Commissioners and staff, we have revised and updated several documents that formed the basis for the application for preliminary plat approval for the Second Addition to Avalon Heights.

Below is link where you may download the documents:
https://www.dropbox.com/sh/khgc5blobn5amd4/AABpUTIEuQDKmkyK5XHXPStha?dl=0

- The storm water system has been revised. Two 30-foot infiltration drywells will be installed above the detention pond and three 30-foot drywells are proposed along Grand Avenue in the middle of the subdivision. These new improvements will reduce the volume of stormwater flowing to the pond and allow its footprint and depth to be reduced in order to provide additional distance between the edges of the pond and future construction of dwellings on the adjacent lots. The slope of the pond walls also will be sloped shallower.

- The Geotechnical Engineering Report and Executive Summary were updated to include review of the changes in the revised storm water plan and associated grading. It concludes in summary, that the proposed mass grading for the subdivision is feasible from a geotechnical standpoint, provided out recommendations and conclusions as presented in the Report are incorporated in conjunction with all applicable development codes.

Lot dimensions remain unchanged from the last preliminary plat we previously submitted.

A revised Addendum to the Traffic Impact Study addressing items requested by the Commissioners will be provided hopefully in the next few days as soon as it is available. We are currently addressing review comments from ODOT.

Also, please note that we chose not to address all the items already listed in conditions of approval or recommendations already made by County staff (i.e. a new name for Grand Ave, the offsite improvements, etc.) as we thought it would be simpler and avoid staff having to re-write all their comments or conditions.

We appreciate the input and feedback from the Board and staff and believe the revised documents address the questions and concerns raised and will allow the approval of the preliminary plat. Should you have any questions or wish to discuss the aspects of the revised documents, please contact us.

Erik Hoovestol, P.E.

FIRWOOD DESIGN GROUP

359 E. Historic Columbia River Highway
Troutdale, OR 97060

P:503-668-3737

C:503-706-6557

Date: August 12, 2021

From: Randall Goode, PE - Geotechnical Engineer

To: Erik Hoovestol, P.E.
E-mail: eh@firwooddesign.com

RE: Executive Summary – Geotechnical Report
Avalon Heights Subdivision, Oceanside, Oregon
STRATA Project: 21-0375

In accordance with our review of the updated civil site development plan set, Strata Design LLC (STRATA) has prepared the attached updated Geotechnical Engineering Report ("Report") for you use with the subdivision package submittal.

In summary, the proposed mass grading for the subdivision is feasible from a geotechnical standpoint, provided out recommendations and conclusions as presented in the Report are incorporated in conjunction with all applicable development codes.

The key geotechnical consideration will be to institute tight quality control throughout the earthwork construction quality control to permit the geotechnical engineer to document that all subgrade preparation, drainage measures, and mass fill placement is completed per the recommendations spelled out.

At this time, our Report is intended to assess the overall mass grading elements, and does not address the analysis of proposed individual home lots. STRATA should be consulted in the future for analysis and geotechnical development protocols for individual lots.

Attachment

GEOTECHNICAL ENGINEERING REPORT

Avalon Heights LLC
Residential Subdivision
Highland Drive, Oceanside, Oregon

PREPARED FOR:

Bill Hughes
Avalon Heights LLC
41901 Old Highway 30
Astoria, Oregon 97103

Original: August 20, 2021
Updated: October 12, 2021

STRATA Project No. 21-0375

Prepared by:
Strata Design LLC

Cory Van Fosson, EIT
Project Manager

Reviewed by:
Strata Design LLC

REGISTERED PROFESSIONAL
ENGINEER
OREGON
AUGUST 17, 1993
RANDALL S. GOODE

Randall S. Goode, PE
Principal Geotechnical Engineer

STRATA DESIGN

2117 NE OREGON STREET, SUITE 502
PORTLAND, OREGON 97232
503.248.1939 MAIN
STRATA-DESIGN.COM

TABLE OF CONTENTS

SUPPORTING DATA

FIGURES

APPENDICES

APPENDIX A: Field Explorations

APPENDIX B: Laboratory Testing

1.0 INTRODUCTION

1.1 General

This report presents the results of STRATA Design LLC (STRATA) geotechnical engineering services for the proposed Avalon Heights Subdivision at Highland Drive in Oceanside, Oregon. The general site location is shown on the Vicinity Map, Figure 1. The subject property is identified as Tax Lot 200 on Tax Map 01S10W30DC. The currently proposed 58 lot subdivision project would be developed in three phases, as indicated on Figure 2.

1.2 Purpose and Scope

The purpose of STRATA's services was to develop geotechnical design and construction recommendations for the proposed Avalon Heights Subdivision. This Geotechnical Engineering Report summarizes the results of our explorations, testing, and analyses, including information relating to the following:

- Review of published geologic/hazard maps of the area for information regarding geologic conditions and hazards at or near the site
- Field exploration logs and site plan showing approximate exploration locations
- Laboratory test results
- Groundwater considerations
- Shallow foundation design recommendations:
  - Minimum embedment
  - Allowable bearing pressure
  - Estimated settlement
  - Sliding coefficient
- Construction considerations
  - Earthwork and grading, cut, and fill recommendations
  - Structural fill materials and preparation, and reuse of on-site soils
  - Wet weather considerations
  - Utility trench excavation and backfill requirements
  - Soil parameters for use in temporary/permanent excavation shoring
- Seismic design criteria in accordance with the current Oregon Structural Specialty Code (OSSC)
- Recommended asphalt concrete (AC) pavement sections

1.3 Field Exploration

Locations of STRATA's exploration in relation to the existing and proposed site features is shown on the Site Plan, Figure 2. Two borings were advanced to a depth of 51.5 feet below the existing ground surface (bgs) within the development footprint. The boring was logged and representative soil samples collected by a member of the STRATA geotechnical engineering staff. The approximate boring location is shown on the Site Plan, Figure 2. The interpreted boring log is presented in Appendix A, Field Explorations.

STRATA excavated 10 test pits within the proposed development to depths of up to 8.5 feet below the existing ground surface (bgs). The test pits were logged and representative soil samples collected by qualified geotechnical staff. Interpreted test pit logs are included in Appendix A, Field Explorations.

1.4 Soils Testing

Soil samples were returned to our laboratory and classified in general accordance with the Unified Soil Classification System, Visual-Manual Procedure. Laboratory tests included natural moisture contents. Laboratory test results are listed on the boring logs in Appendix A (Field Explorations) and result sheets attached in Appendix B (Laboratory Testing).

1.5 Geotechnical Engineering Analysis

Data collected during the subsurface exploration, literature research, and testing were used to develop site-specific geotechnical design parameters and construction recommendations. While STRATA also analyzed stability of most likely slope configurations, as presented in the preliminary civil site grading plans[1], it is recommended (consistent with Tillamook County conditions of approval) that all individual lots which will contain steep slope grades be subject to site specific geotechnical analysis during the building permitting process. At that future time, the home placement and elevation configurations will be clearly understood.

2.0 SITE CONDITIONS

2.1 Project Understanding

Based on the information provided to us, STRATA is providing geotechnical design service and construction recommendations for the proposed Avalon Heights Subdivision in Oceanside, Oregon. The Subdivision is proposed for the entire site. Per Tillamook County code, there was a Geological Hazard Report (GHR) submitted in 2018[2] associated with the concept plan application. In the GHR, it was reported that the generally 1 to 2 feet of fine sandy loam and then transitioning to native dune sand deposits. It should be realized that depths and frequency of subsurface exploration (test pits) was limited in comparison to this current 2021 Geotechnical Report.

The study site is located within an area zoned as geologic hazard (landslide topography). Thus, the County has recommended a Condition of Approval requirement for a geotechnical professional to provide future site-specific slope stability analysis associated with applicable individual lot building permitting in accordance with TCLUO Section 4.130. STRATA has provided preliminary stability analysis discussion in Section 3.1 of this Report.

2.2 Surface Description

As shown in Figure 2, the proposed development area is roughly rectangular shaped with some vegetation brush and grasses, along with occasional mature trees in the steeper section of the site. The site was timber harvested earlier during 2021, or thereabouts. The site is divided from north to south by a seasonal drainageway. It is understood that the drainage draw will be backfilled with engineered structural fill to thickness up to approximately 30-feet. Existing single-family residences now border the site's western side. Areas to the north and east are primarily undeveloped forested lands. Based on available topographic data, the site slopes to the ground surface elevations ranging from about 300 to 430 feet above mean sea level (AMSL). Maximum slopes (naturally occurring) across the site are on the order of 45 to 60 percent.

1 Firwood Design Group, Inc.; Civil – Grading Plans for Second Avalon Heights Subdivision; October 11, 2021.
2 Geohazard Report, April 2018, Proposed Avalon Heights Subdivision, Oceanside, Tillamook County, Oregon, T: 1S,R: 10W, Sec: 30, TL:200; by Environmental Management Systems, Inc.

2.3 Geologic Setting

The site and project area are located on the south flank of a massive coastal headland of Miocene age Grande Ronde basalt flows that juts into the Pacific Ocean west of Tillamook Bay. Maxwell Point, Cape Mears, and other rocky headlands extend into the ocean with dramatic vertical relief in this area. Three Arch Rocks, and other offshore rocks are also mapped as Grand Ronde basalt. We interpret these basalt headlands and stacks as erosional remnants of basalt flows that entered the Pacific Ocean as a series of intra-canyon flows about 16 million years ago. Local pillow lava textures exposed in road cuts in the immediate site vicinity suggest that molten lava entered the water at this location. Geologic research suggests that basalt flows also intruded or were injected into soft marine sediment. This basalt has the same chemical composition as massive flood basalt flows that covered much of northeastern and north central Oregon, and that also covered numerous upland areas in what is now the Willamette Valley.

2.4 Slope Stability and Geologic Publications

Review of the Oregon Department of Geology and Mineral Industries (DOGAMI) Statewide Landslide Information Layer of Oregon (SLIDO[3]) indicates the presence of a mapped landslide across this area of Oceanside. The inventory is generated primarily from LiDAR imagery and published geology mapping, as well as maps and local documentation of known landslides. DOGAMI created the maps as a planning tool and to prompt site-specific geologic hazard evaluation to determine if features are in fact landslide related and if mitigation measures are needed to guide safe stewardship of the land. Very little in terms of specifics were included in DOGAMI GIS publication on this particular Landslide feature, other than to describe it as deeply seated, complex rock and debris flow, and pre-historic (>150 years in age). Overall, based on our own review of LiDAR imagery, there does not appear to be any evidence of prior slope instability. Observed site slopes are generally smooth and uniform, consistent with stable slope conditions.

As recommended by the GHR study, the purpose of this Geotechnical Report is to provide more in-depth and extensive subsurface soils and slope stability profiling than was scoped in the GHR. Our geotechnical investigation included machine borehole tests to depths of 50 feet below grade. This was necessary to begin quantitative analysis of slope stability scenarios with respect to the more current civil site development plans, with respect to findings of subsurface soils, groundwater and quantitative slope stability.

For reference material on the regional geologic hazard studies of the past, STRATA reviewed geologic mapping of the area (Schlicker and Deacon, 1972, Bulletin 74) and also Bulletin 79 of the Oregon Department of Geology and Mineral Industries (DOGAMI), and found that the site location is not within an overlay zone of active or inactive landslides, or general landslide topography and mass movement topography. Intrusive basalt of the younger Grande Ronde Basalt (part of the Columbia River Basalt Group; middle Miocene age) also occurs in the region. The bedrock was subject to uplift, folding, and faulting.

From our own general observations of site slope and subsurface soils within the test pits and borings, we confirm the presence of fairly consistent deposition of dune sand. During our reconnaissance of the site slope settings, we did not observe geomorphic landforms typical of slope instability, such as headscarps, open ground cracks,

[3] SLIDO, maintained by the Oregon Department of Geology and Mineral Industries: http://www.gis.dogami.oregon.gov/maps/slido

fissures, spring activity, irregular accumulations of disturbed mixtures of soil and/or rock and irregular orientation of mature conifer trees. Slope stability analysis is further discussed below in Section 3.1. Where standards of care for geotechnical engineering and construction practices are instituted, as described in this Report, the grading work would be unlikely to cause slope destabilization.

Stormwater engineering design and construction is key to achievement of site slope stability. We understand that a portion of runoff will be collected via stormwater ditching, and then disposed of in drywell(s) that will be deeply embedded in the native or compacted reused sand soils. At the lower reach of the property, a stormwater pond facility is proposed for stormwater retention and infiltration. The pond has been designed with maximum 4:1 (horiz:vert) slopes, consistent with ODOT standard design guidance for such facilities. In addition, the pond location proposed rests in a low gradient area of the property, and is buffered a reasonable distance from offsite, descending slope grades.

Overall, STRATA believes the planned stormwater treatment and disposal systems should be feasible, provided construction quality is assured along with long term maintenance protocols. Based on infiltration testing performed in the past, onsite disposal of stormwater can be facilitated by the sand soil. It is understood that the stormwater pond has been sized to accommodate 100-year rainfall events without overflow. Even so, to avoid potential adverse future impact to properties downgradient of the stormwater pond, some consideration should be given to incorporating overflow water to discharge into a deep drywell, or by way of a conveyance pipe to a suitable established and maintain discharge location in a public right-of-way.

2.5 Groundwater and Seepage

Static groundwater, seepage or perched water levels were not encountered or identified during our exploration. The seasonal stream ravine (so designated by GIS mapping), was dry during our site visit. The low depression in the mid-portion of the site where the ravine flows through, displayed no wetland types of vegetation, most likely indicating that the ravine is naturally infiltrating faster rather than accumulating as surface water for extended periods.

Based on a review of regional groundwater logs provided by the Oregon Water Resources Department (OWRD), we anticipate that the static groundwater level is present at a depths greater than 50-feet below ground surface (bgs)[4]. Please note that groundwater levels can fluctuate during the year depending on climate, irrigation season, extended periods of precipitation, drought, and other factors.

2.6 Subsurface Conditions

During our site reconnaissance visit of March 17, 2021, subsurface soils were profiled by excavating ten test pits, designated TP-1 through TP-10, to depths of up to 9 feet bgs. The property owner (William Hughes) completed the excavation of the test pits using a tracked backhoe equipped with a 36-inch-wide toothed bucket. In addition, two borings designated B-1 and B-2 were drilled to a depth of approximately 50 feet bgs. The drilling was carried out using solid stem auger drilling techniques, performed by Dan Fischer Drilling LLC. Sampling in the borings was carried out in conjunction with Standard Penetration Testing (SPT) at 2.5-foot intervals to 10

4 Oregon Water Resources Department Well Report Query; https://apps.wrd.state.or.us/apps/gw/well_log/Default.aspx

feet depth and 10-foot intervals after that. The soils obtained were described in the field then transported to our soils laboratory for further confirmation. Detailed summary logs for the test pits and boreholes are attached as Attachment A to this report.

STRATA has summarized the subsurface units as follows:

SILTY SAND/ SANDY SILT: Silty Sand was encountered just below the ground surface, with amounts of fine-grained sand was encountered below the silt in borings and test pits. The sand content varied throughout but tended to increase with depth, grading to silty sand at approximately 1 to 2 feet bgs. This layer was generally brown, soft to medium stiff or loose to medium dense, with low plasticity.

SAND: Below the silt or sandy silt/silty sand in all borings, poorly-graded sand was encountered. The sand was generally brown-gray and fine- to medium-grained or fine- to coarse-grained. This deposit extended to the termination depth in all the explorations and generally increased in relative density with increasing depth, from medium dense to very dense.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Design Considerations

For our site investigation and Report, STRATA has carefully studied the site grading plan and lot layout from Firwood Design Group (FDG), dated October 11, 2021. Where civil/stormwater plans change substantially from this version, STRATA should be engaged to review the project plans and update our recommendations if necessary.

The predominant subsurface condition identified at the site was dune sand. As detailed in Figure 3 (attached), the steepest finish slope grades exist along the eastern boundary of the site, which range from 47 to 57 percent grade, most generally descending from west to east. With respect to overall slope morphology characteristics, we did not observe clear indications of local slope instability. Recent logging has been completed to harvest most of the trees and understory along the eastern most slope. While no significant erosive patterns along the logged slopes were noted at the time of our March, 2021 site visit, STRATA would recommend that all bare soils, gullies, or like disturbances that often result with freshly occurring logging practices be treated with best management erosion control practice.

Criterion for slope-to-structure and/or grading buffers may be established based on degree of slope, vegetation, and other factors. Along the crest of the east facing slope, we understand there will be scenarios of setbacks of less than 30 feet from steep slopes. For purposes of this Report discussion, STRATA defines steep slopes as containing greater than 33 percent grades.

For preliminary slope stability analysis using the soil properties identified, we modeled the scenario of a 20 foot slope setback (measured from bottom of footing to face of descending slope). From this assumption, we were able to check that slope stability analysis can achieve factors of safety in excess of building code criteria, with properly designed stormwater management and earthwork quality control and execution, which are both described in recommendations below.

3.2 Foundations

The soils encountered tend to increase in relative density with depth. As a general guidance criterion, if structures are buffered by 30 feet or more from steep slopes, the native soils will normally be conducive for designing structures with shallow, spread foundations. Native subgrades must be prepared to firm and unyielding condition, as confirmed by the geotechnical professional, and provided all other recommendations in this report are adhered. Footings should not be supported on non-structurally placed fill.

When structures are planned to be located less than a criteria of 30 feet for slope setback (measured horizontally between face of slope and base depth of footing) we recommend that pile supported foundations be carefully considered for deeper support of foundations, and to relieve additional loading placed along steep slopes by residential structures. Specific recommendations and engineering analysis of pile-supported foundations is considered beyond the scope of this current Report. More specific, detailed analysis should be conducted in conjunction with individual building permit applications which would occur at future dates.

3.2.1 Minimum Footing Widths / Design Bearing Pressure

Continuous wall and isolated spread footings should be at least 18 and 24 inches wide, respectively. Footings should be sized using a maximum allowable bearing pressure of 1,500 pounds per square foot (psf). This is a net bearing pressure, and the weight of the footing and overlying backfill can be disregarded in calculating footing sizes. The recommended allowable bearing pressure applies to the total of dead plus long-term live loads. Allowable bearing pressures may be increased by one-third for seismic and wind loads.

Footings will settle in response to column and wall loads. Based on our evaluation of the subsurface conditions and our analysis, we estimate post-construction settlement will be less than 1 inch for the column and perimeter foundation loads. Differential settlement will be on the order of one-half of the total settlement.

3.2.2 Footing Embedment Depths

STRATA recommends that all footings be founded a minimum of 18 inches below the lowest adjacent grade. The footings should be founded below an imaginary line projecting upward at a 1H:1V (horizontal to vertical) slope from the base of any adjacent, parallel utility trenches or deeper excavations.

3.2.3 Footing Preparation

Excavations for footings should be carefully prepared to a neat and undisturbed state. A representative from STRATA should confirm suitable bearing conditions and evaluate all exposed footing subgrades. Observations should also confirm that loose or soft materials have been removed from new footing excavations and concrete slab-on-grade areas. Localized deepening of footing excavations may be required to penetrate loose, wet, or deleterious materials.

STRATA recommends a layer of compacted, crushed rock be placed over the footing subgrades to help protect them from disturbance due to foot traffic and the elements. Placement of this rock is the prerogative of the contractor; regardless, the footing subgrade should be in a dense or stiff condition prior to pouring concrete. Based on our experience, approximately 4 inches of compacted crushed rock will be suitable beneath the footings.

3.2.4 Lateral Resistance

Lateral loads can be resisted by passive earth pressure on the sides of footings and grade beams, and by friction at the base of the footings. A passive earth pressure of 300 pounds per cubic foot (pcf) may be used for footings confined by native gravels and new structural fills. The allowable passive pressure has been reduced by a factor of two to account for the large amount of deformation required to mobilize full passive resistance. Adjacent floor slabs, pavements, or the upper 12-inch depth of adjacent unpaved areas should not be considered when calculating passive resistance. For footings supported on native gravels or new structural fills, use a coefficient of friction equal to 0.4 when calculating resistance to sliding. These values do not include a factor of safety (FS).

3.3 Retaining Walls

The proposed new development may include retaining walls. The following recommendations are based on the assumption of flat conditions in front of and behind the wall and fully drained backfill. For unrestrained walls allowed to rotate at least 0.005H about the base, where H is the height of the wall, we recommend using an active earth pressure of 35 psf. Where walls are constrained against rotation, we recommend using an at-rest earth pressure equal to 55 psf. We recommend any retaining walls founded on native soil or compacted structural fill be provided with adequate drainage and backfilled with clean, angular, crushed rock fill, in accordance with the recommendations provided in section 4.3.

For seismic loading, we recommend using an inverted triangular distribution (seismic surcharge) equivalent to [9H] psf. Walls should be designed by applying the active earth pressure plus the seismic loading, or at-rest earth pressures, whichever is greater. If vertical surcharge loads, q, are present within 0.5H of the wall, a lateral surcharge of [0.3q] (for walls allowed to rotate) and [0.5q] (for restrained walls) should be applied as a uniform horizontal surcharge active over the full height of the wall. These values assume that the wall is vertical and the backfill behind the wall is horizontal. Seismic lateral earth pressures were computed using the Mononobe-Okabe equation. Recommended lateral earth pressure distributions are shown on Figure 4, Retaining Wall Earth Pressure Diagram. Additional lateral pressures due to surcharge loads can be estimated using the guidelines shown on Figure 5, Lateral Surcharge Detail. Lateral loads can also be resisted by a passive resistance of 250 psf acting against [retaining/embedded] walls and foundations, and by friction acting on the base of spread footings or mats using a friction coefficient of 0.35. Recommended lateral earth pressures assume that walls are fully drained and no hydrostatic pressures develop.

3.4 Site Stormwater Management

For stormwater runoff management, the current civil design outlines that drywells and infiltration ponds/swales, will be utilized. In addition, local stormwater ponds or treatment swale facilities will be proposed. Stormwater disposal/infiltration devices will typically need to be registered with the Department of Environmental Quality

(DEQ) as Underground Injection and Control (UIC) facilities. Stormwater disposal systems shall be designed per jurisdictional requirements.

The perimeter ground surface and hard-scaping should be sloped to drain away from all structures. Gutters should be tight-lined to a suitable discharge and maintained as dispersed, free flowing condition, and/or connected to a stormwater pipe system. Cut or fill slopes shall be prepared and maintained to control erosion in accordance with area requirements and the civil site plans.

3.5 Seismic Design Considerations

The contribution of potential earthquake-induced ground motion from all known sources are included in probabilistic ground motion maps developed by the USGS and adopted by ASCE 7-16 code. Based on site explorations and geologic mapping, the site falls into Site Class D for seismic design. Seismic design parameters for the Site are provided in the following table.

ASCE 7-16 (2019 IBC CODE) BASED RESPONSE SPECTRUM MCER GROUND MOTION - 5% DAMPING 1% IN 50 YEARS PROBABILITY OF COLLAPSE			
LAT	45.691	LON	-123.191
S_S		1.30 g	
S_1		0.68 g	
MAPPED MAXIMUM CONSIDERED EARTHQUAKE SPECTRAL RESPONSE ACCELERATION PARAMETER (SITE CLASS D)			
F_A		1.00	
F_V		SEE ASCE 7-16 SECTION 11.4.8*	
S_{MS}		1.30 g	
S_{M1}		SEE ASCE 7-16 SECTION 11.4.8*	
DESIGN SPECTRAL RESPONSE ACCELERATION PARAMETER			
S_{DS}		0.71 g	
S_{D1}		SEE ASCE 7-16 SECTION 11.4.8*	

* Factors dependent on structural design.

3.5.1 Liquefaction Potential

Based on a review of the Oregon Statewide Geohazard Viewer (HazVu)[5], the site is not located in a liquefaction hazard area. Liquefaction is defined as a decrease in the shear resistance of loose, saturated, cohesionless soil (e.g., sand) or low plasticity silt soils, due to the buildup of excess pore pressures generated during an earthquake. This results in a temporary transformation of the soil deposit into a viscous fluid. Liquefaction can result in ground settlement, foundation bearing capacity failure, and lateral spreading of ground.

[5] Oregon HazVu: Statewide Geohazards Viewer https://gis.dogami.oregon.gov/maps/hazvu/

3.6 Ground Moisture

The perimeter ground surface and hard-scape should be sloped to drain away from all structures and away from adjacent slopes. Gutters should be tight-lined to a suitable discharge and maintained as free-flowing. All crawl spaces should be adequately ventilated and sloped to drain to a suitable exterior discharge.

3.7 Pavement Design

The provided pavement recommendations were developed using the American Association of State Highway and Transportation Officials (AASHTO) design methods and references the associated Oregon Department of Transportation (ODOT) specifications for construction. Our evaluation considered a maximum of two trucks per day for a 20-year design life.

The minimum recommended pavement section thicknesses are provided in Table 2. Depending on weather conditions at the time of construction, a thicker aggregate base course section could be required to support construction traffic during the preparation and placement of the pavement section.

Table 2. Minimum AC Pavement Sections

Traffic Loading	AC (inches)	Base Course (inches)	Subgrade
Residential Access Drives	3	10	Stiff subgrade as verified by STRATA personnel*
Collectors	4	10	

* Subgrade must pass proof roll

The asphalt cement binder should be selected following ODOT SS 00744.11 – Asphalt Cement and Additives. The AC should consist of ½-inch hot mix asphalt concrete (HMAC) with a maximum lift thickness of 3 inches. The AC should conform to ODOT SS 00744.13 and 00744.14 and be compacted to 91 percent of the maximum theoretical density (Rice value) of the mix, as determined in accordance with ASTM D2041.

Heavy construction traffic on new pavements or partial pavement sections (such as base course over the prepared subgrade) will likely exceed the design loads and could potentially damage or shorten the pavement life; therefore, we recommend construction traffic not be allowed on new pavements, or that the contractor take appropriate precautions to protect the subgrade and pavement during construction.
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.

4.0 CONSTRUCTION RECOMMENDATIONS

4.1 Site Preparation

Demolition should include removal of existing pavement, utilities, etc., throughout the development. The voids resulting from the removal of loose soil should be backfilled with compacted structural fill. The base of these excavations should be excavated to firm native subgrade before filling, with sides sloped at a minimum of 1H:1V to allow for uniform compaction. Materials generated during demolition should be transported off-site or stockpiled in areas designated by the owner's representative.

4.1.1 Proof Rolling/Subgrade Verification

Following site preparation and prior to placing aggregate base for [the shallow foundations, building pad, slab subgrade sections, or pavement sections,] the exposed subgrade should be evaluated either by proofrolling or another method of subgrade verification. The subgrade should be proofrolled with a fully loaded dump truck or similar heavy, rubber-tire construction equipment to identify unsuitable areas. If evaluation of the subgrades occurs during wet conditions, or if proofrolling the subgrades will result in disturbance, they should be evaluated by STRATA using a steel foundation probe. We recommend that STRATA be retained to observe the proofrolling and perform the subgrade verifications. Unsuitable areas identified during the field evaluation should be compacted to a firm condition or be excavated and replaced with structural fill.

4.1.2 Wet/Freezing Weather and Wet Soil Conditions

Due to the presence of fine-grained silt and sands in the near-surface materials at the site, construction equipment may have difficulty operating on the near-surface soils when the moisture content of the surface soil is more than a few percentage points above the optimum moisture required for compaction. Soils disturbed during site preparation activities, or unsuitable areas identified during proofrolling or probing, should be removed and replaced with compacted structural fill.

Site earthwork and subgrade preparation should not be completed during freezing conditions, except for mass excavation to the subgrade design elevations.

Protection of the subgrade is the responsibility of the contractor. Construction of granular haul roads to the project site entrance may help reduce further damage to the pavement and disturbance of site soils. The actual thickness of haul roads and staging areas should be based on the contractors' approach to site development, and the amount and type of construction traffic. The imported granular material should be placed in one lift over the prepared undisturbed subgrade and compacted using a smooth-drum, non-vibratory roller. A geotextile fabric should be used to separate the subgrade from the imported granular material in areas of repeated construction traffic. The geotextile should meet the specifications of ODOT SS Section 2320.10 and SS 02320.20, Table 02320-1 for soil separation. The geotextile should be installed in conformance with ODOT SS 0350.00 – Geosynthetic Installation.

4.2 Excavation

The near-surface soils at the site can be excavated with conventional earthwork equipment. Sloughing and caving should be anticipated. All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor is solely responsible for adherence to the OSHA requirements. Trench cuts should stand relatively vertical to a depth of approximately 4 feet bgs, provided no groundwater seepage is present in the trench walls. Open excavation techniques may be used provided the excavation is configured in accordance with the OSHA requirements, groundwater seepage is not present, and with the understanding that some sloughing may occur. Trenches/excavations should be flattened if sloughing occurs or seepage is present. Use of a trench shield or other approved temporary shoring is recommended if vertical walls are desired for cuts deeper than 4 feet bgs. If dewatering is used, we recommend that the type and design of the dewatering system be the responsibility of the contractor, who is in the best position to choose systems that fit the overall plan of operation.

4.3 Mass Grading Cut and Fill

From our review of preliminary site grading plans, the primary grading will involve essentially balancing cuts and fills such that the north-south ridges are excavated to lower elevation, while the natural drainage ravine receive structural fill of up to 30 feet. Structural fill involving reuse of onsite soils should be placed over subgrade that has been prepared in conformance with the Site Preparation and Wet/Freezing Weather sections of this report. The mass grading structural fill material may consist of the native sandy soil, free of organic material and debris. The bottom of the ravine should be cleared of all organics, followed by benching that progresses with elevation. We recommend at least 4 feet of an angular stabilization material (approximately 2" – 4" crushed rock) to provide a drainage blanket. If fill and excavated material will be placed on slopes steeper than 5H:1V, these must be keyed/benched into the existing slopes and installed in horizontal lifts. Vertical steps between benches should be approximately 2 feet. To mitigate subgrade fill pumping that occurs as fill is placed, some consideration should be given to geogrid reinforcement as the fill is brought up to grade.

The suitability of soil for use as compacted structural fill will depend on the gradation and moisture content of the soil when it is placed. As the amount of fines (material finer than the US Standard No. 200 Sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and compaction becomes more difficult to achieve. Soils containing more than about 5 percent fines cannot consistently be compacted to a dense, non-yielding condition when the water content is significantly greater (or significantly less) than optimum.

4.3.1 On-Site Soil

On-site soils encountered in our explorations are generally suitable for placement as structural fill during moderate, dry weather when moisture content can be maintained by air drying and/or addition of water. The fine-grained fraction of the site soils are moisture sensitive, and during wet weather, may become unworkable because of excess moisture content. In order to reduce moisture content, some aerating and drying of fine-grained soils may be required. The material should be placed in uniform lifts with a maximum uncompacted thickness of approximately 10 inches and compacted to at least 95 percent of the maximum dry density (MDD), as determined by ASTM D698 (standard proctor).

4.3.2 Borrow Material

Borrow material for general structural fill construction should meet the requirements set forth in ODOT SS 00330.12 – Borrow Material. When used as structural fill, borrow material should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches (variable with compaction means and methods, and verified in the field by the engineer) and compacted to not less than 95 percent of MDD, as determined by ASTM D698.

4.3.3 Select Granular Fill

Selected granular backfill used during periods of wet weather for structural fill construction should meet the specifications provided in ODOT SS 00330.14 – Selected Granular Backfill. The imported granular material should be uniformly moisture conditioned to within about 2 percent of the optimum moisture content and compacted in relatively thin lifts using suitable mechanical compaction equipment. Selected granular backfill should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and be compacted to not less than 95 percent of MDD, as determined by ASTM D698.

4.3.4 Crushed Aggregate Base

Crushed aggregate base course below floor slabs, spread footings, and asphalt concrete pavements should be clean crushed rock or crushed gravel that contains no deleterious materials and meets the specifications provided in ODOT SS 02630.10 – Dense-Graded Aggregate, and has less than 5 percent by dry weight passing the US Standard No. 200 Sieve. The crushed aggregate base course should be placed in lifts with a maximum uncompacted thickness of 8 to 12 inches and be compacted to at least 95 percent MDD, as determined by ASTM D698.

4.3.5 Utility Trench Backfill

Pipe bedding placed to uniformly support the barrel of pipe should meet specifications provided in ODOT SS 00405.12 – Pipe Zone Bedding. The pipe zone that extends from the top of the bedding to at least 8 inches above utility lines should consist of material prescribed by ODOT SS 00405.13 – Pipe Zone Material. The pipe zone material should be compacted to at least 95 percent MDD (ASTM D698), or as required by the pipe manufacturer.

Under pavements, paths, slabs, or beneath building pads, the remainder of the trench backfill should consist of well-graded granular material with less than 10 percent by dry weight passing the US Standard No. 200 Sieve, and should meet standards prescribed by ODOT SS 00405.14 – Trench Backfill, Class B or D. This material should be compacted to at least 95 percent MDD, as determined by ASTM D698 or as required by the pipe manufacturer. The upper 2 feet of the trench backfill should be compacted to at least 95 percent of MDD (ASTM D698). Controlled low-strength material (CLSM), ODOT SS 00405.14 – Trench Backfill, Class E, can be used as an alternative.

Outside of structural improvement areas (e.g., pavements, sidewalks, or building pads), trench material placed above the pipe zone may consist of general structural fill materials that are free of organics and meet ODOT SS 00405.14 – Trench Backfill, Class A. This general trench backfill should be compacted to at least 92 percent of MDD (ASTM D698), or as required by the pipe manufacturer or local jurisdictions.

4.3.6 Stabilization Material

Stabilization rock should consist of pit or quarry run rock that is well-graded, angular, crushed rock consisting of 4- or 6-inch-minus material with less than 5 percent passing the US Standard No. 4 Sieve. The material should be free of organic matter and other deleterious material. ODOT SS 00330.16 – Stone Embankment Material can be used as a general specification for this material with the stipulation of limiting the maximum size to 6 inches.

5.0 ADDITIONAL SERVICES AND CONSTRUCTION OBSERVATIONS

In most cases, other services beyond completion of a final geotechnical engineering report are necessary or desirable to complete the project. Occasionally, conditions or circumstances arise that require additional work that was not anticipated when the geotechnical report was written. STRATA offers a range of environmental, geological, geotechnical, and construction services to suit the varying needs of our clients.

STRATA should be retained to review the plans and specifications for this project before they are finalized. Such a review allows us to verify that our recommendations and concerns have been adequately addressed in the design.

Satisfactory earthwork performance depends on the 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. We recommend that STRATA be retained to observe general excavation, stripping, fill placement, footing subgrades, and/or pile installation. Subsurface conditions observed during construction should be compared with those encountered during the subsurface explorations. Recognition of changed conditions requires experience; therefore, qualified personnel should visit the site with sufficient frequency to detect whether subsurface conditions change significantly from those anticipated.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the addressee, and their architects and engineers, for aiding in the design and construction of the proposed development and is not to be relied upon by other parties. It is not to be photographed, photocopied, or similarly reproduced, in total or in part, without the express written consent of the client and STRATA. It is the addressee's responsibility to provide this report to the appropriate design professionals, building officials, and contractors to ensure the correct implementation of the recommendations.

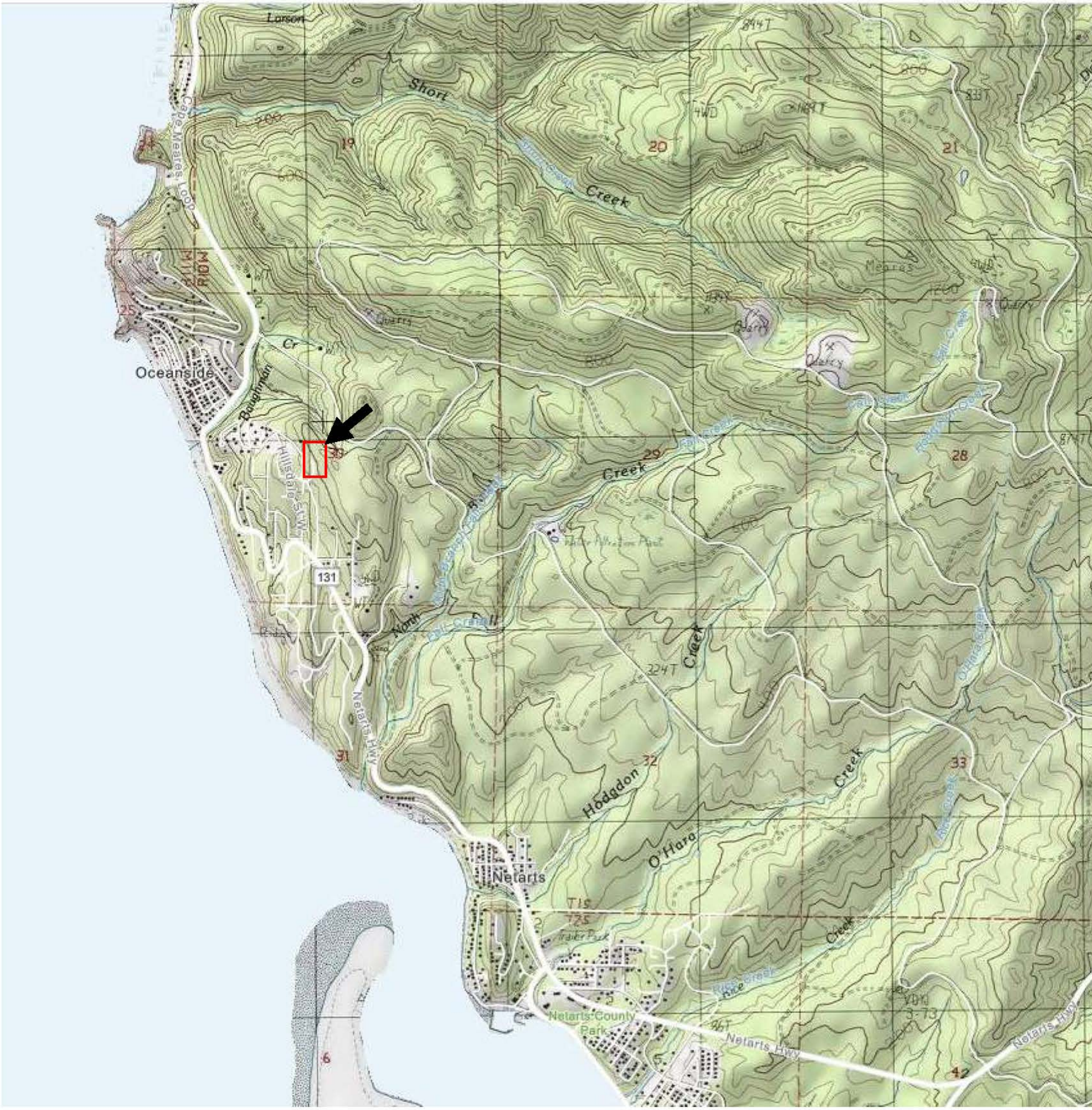
The opinions, comments, and conclusions presented in this report are based upon information derived from our literature review, field explorations, laboratory testing, and engineering analyses. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If soil, rock, or groundwater conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that STRATA is notified immediately so that we may reevaluate the recommendations of this report.

Unanticipated fill, soil and rock conditions, and seasonal soil moisture and groundwater variations are commonly encountered and cannot be fully determined by merely taking soil samples or completing explorations such as soil borings or test pits. Such variations may result in changes to our recommendations and may require additional funds for expenses to attain a properly constructed project; therefore, we recommend a contingency fund to accommodate such potential extra costs.

The scope of work for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, this report should be reviewed to determine the applicability of the conclusions and recommendations presented herein. Land use, site conditions (both on and off-site), or other factors may change over time and could materially affect our findings; therefore, this report should not be relied upon after three years from its issue or in the event that the site conditions change.

FIGURES

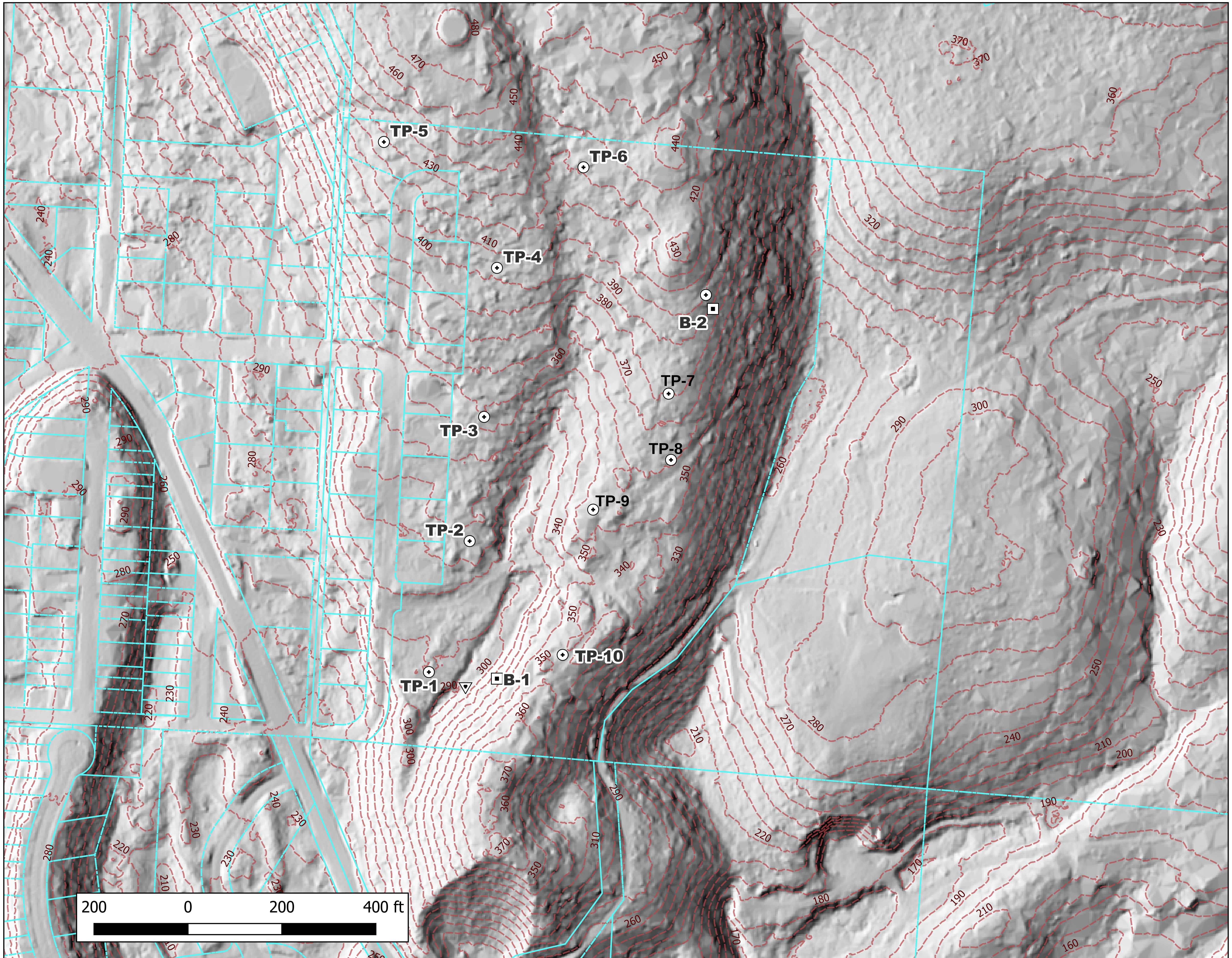


STRATADESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

SITE VICINITY MAP
AVALON HEIGHTS SUBDIVISION
OCEANSIDE, OR

FIGURE

1



SITE EXPLORATION PLAN

TOPOGRAPHIC MAP

AVALON HEIGHTS
HIGHLAND DR

Contours derived from 2009 LiDAR (OR-DOGAMI)

10-foot Contour Intervals

STRATA DESIGN

Legend

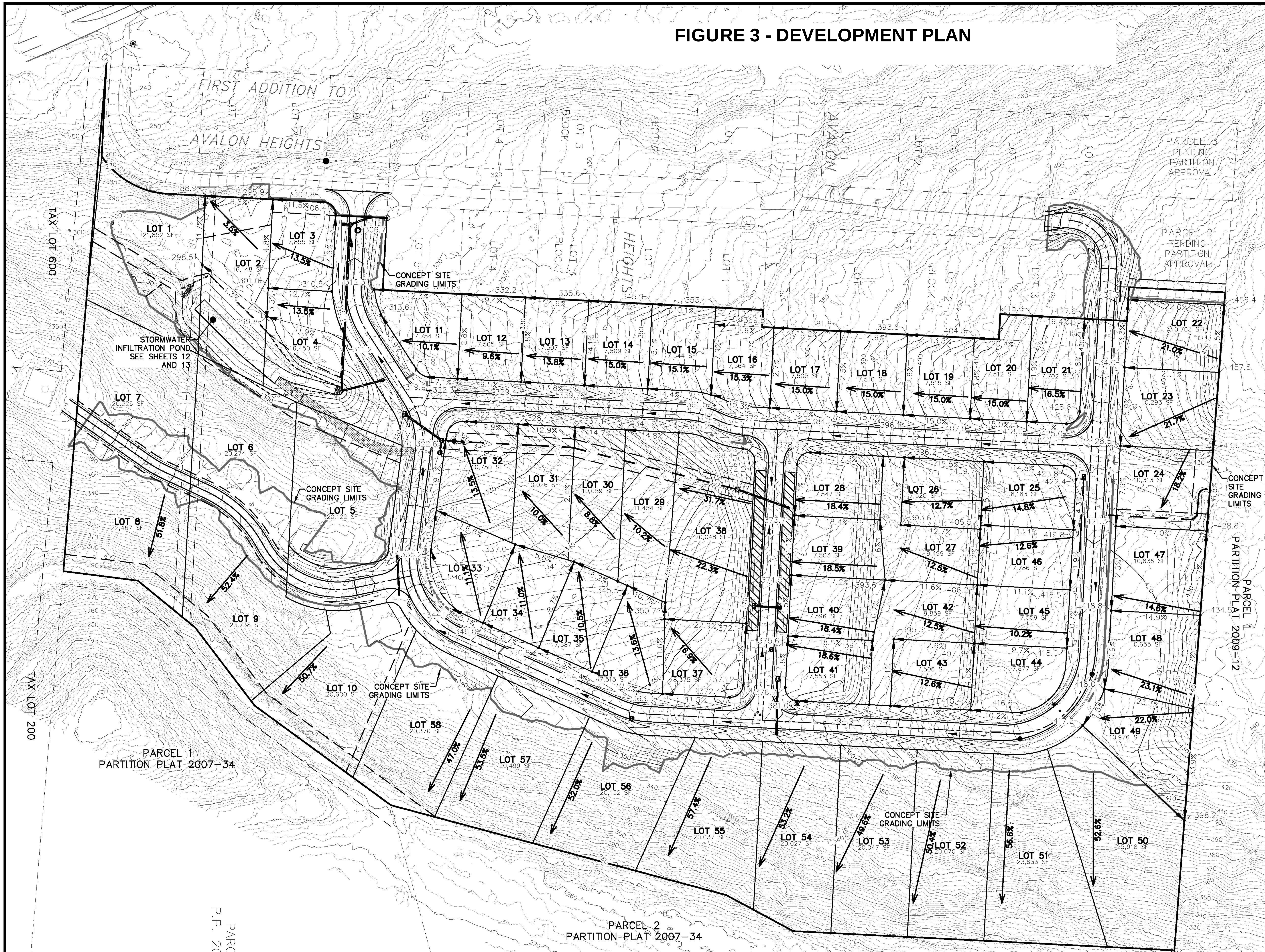
▽ Infiltration Locations
▣ Bore Locations
⊙ Test Pit Locations

Job #21-0375

Lot lines shown are from Tillamook County GIS

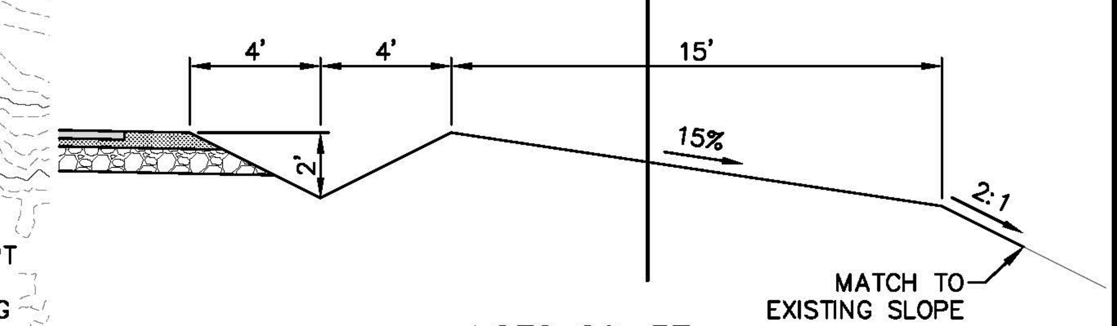
Figure 2

FIGURE 3 - DEVELOPMENT PLAN



SLOPE LABEL LEGEND

X.X%	REPRESENTATIVE LOT SLOPE
X.X%	LOT LINE SLOPE



LOTS 29-37
SCALE: N.T.S.

TCLUO 3.310 MINIMUM LOT SIZE

WHERE SLOPE AVERAGES LESS THAN 19%: 7,500 SF
WHERE SLOPE AVERAGES FROM 19% TO 29%: 10,000 SF
WHERE SLOPE AVERAGES GREATER THAN 29%: 20,000 SF

DETAILED LOT SLOPE DATA NOT PROVIDED ON THIS PLAN FOR LOTS OVER 20,000 SF

NOTES

1. PER TILLAMOOK COUNTY, THE PROJECT IS WITHIN AN AREA OF GEOLOGIC HAZARD. A GEOLOGIC HAZARD REPORT IS REQUIRED.
2. REFER TO THE GEOLOGIC HAZARD REPORT INCLUDED WITH THE LAND USE SUBMITTAL DOCUMENTS: "GEOHAZARD REPORT, PROPOSED AVALON HEIGHTS SUBDIVISION, OCEANSIDE, TILLAMOOK COUNTY, OREGON, T:1S, R:10W, SEC:30, TL:200. PREPARED BY ENVIRONMENTAL MANAGEMENT SYSTEMS, INC DATED APRIL 12, 2018.
3. BUILDING FOUNDATIONS WITHIN GEO-HAZARD AREA TO BE CONSTRUCTED PER GEOTECHNICAL ENGINEERING RECOMMENDATIONS.

W S N E

0 60 120
SCALE IN FEET

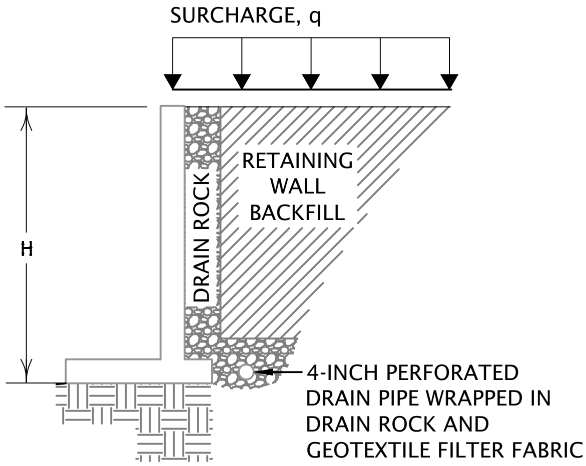
DATE:	NO.	REVISION
10/7/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

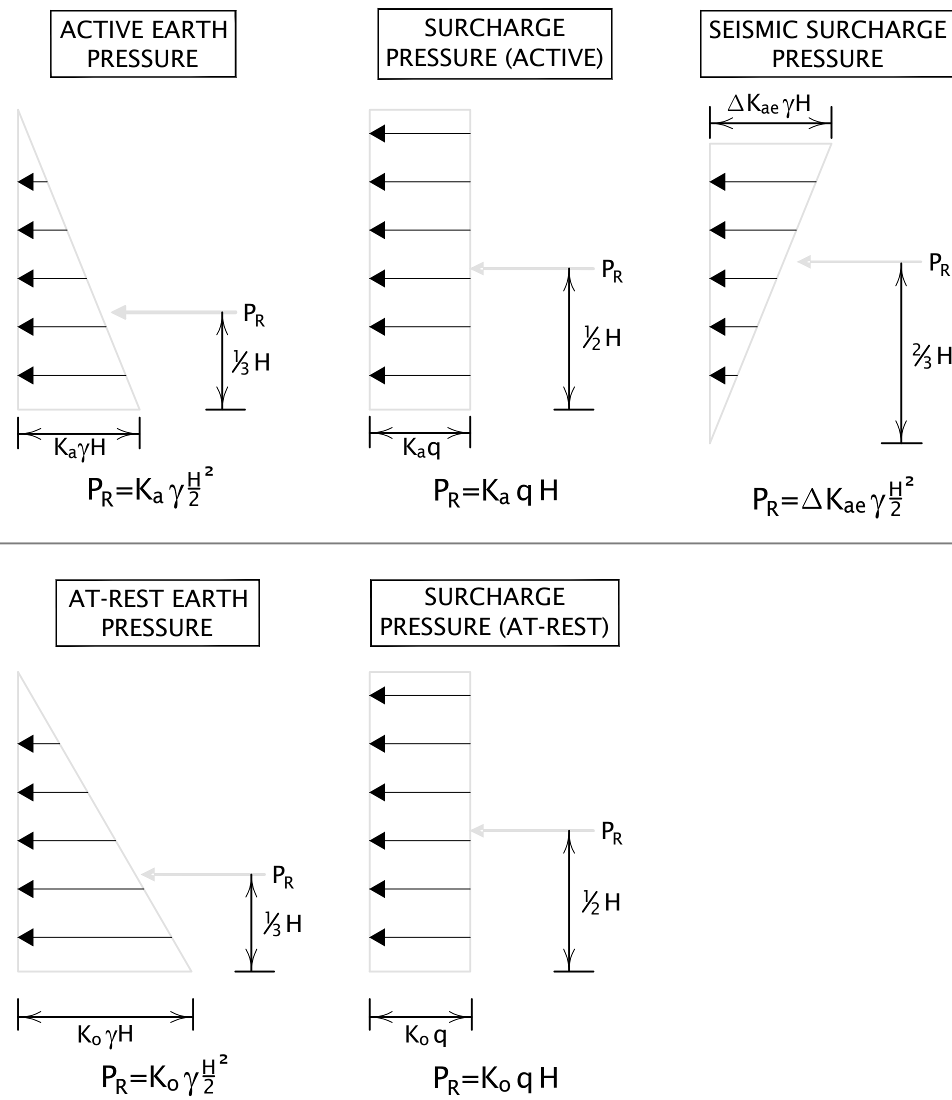
FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

CONCEPT GRADING & LOT SLOPE ANALYSIS
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS



PARAMETER	VALUE
K_a	0.33
K_o	0.47
ΔK_{ae}	0.53
γ	115 pcf



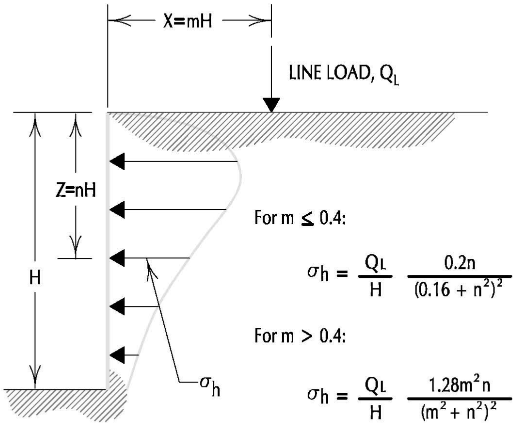
STRATA DESIGN

RETAINING WALL EARTH PRESSURE DIAGRAM

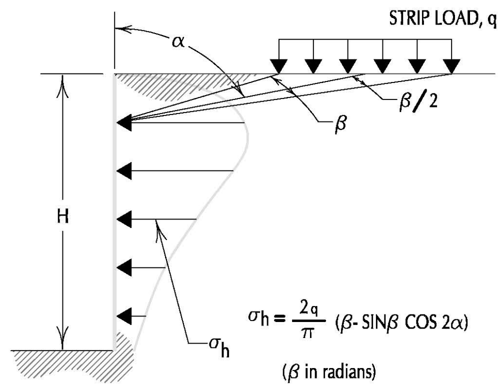
AVALON HEIGHTS 41901, OLD HIGHWAY 30
OCEANSIDE, OREGON

JUNE 2021
21-0375

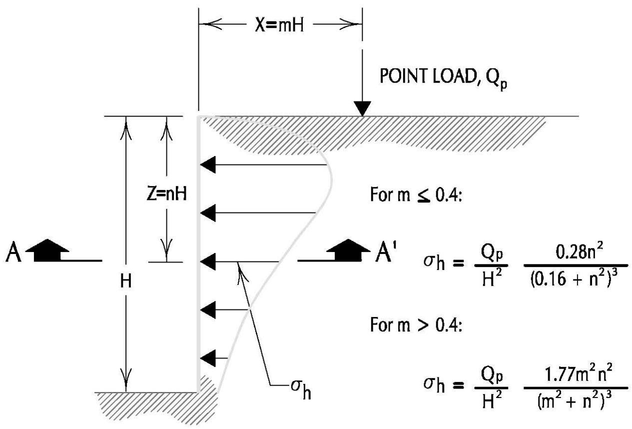
FIGURE
4

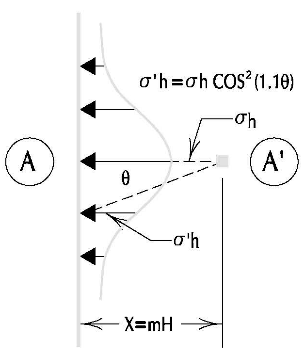


LINE LOAD PARALLEL TO WALL



STRIP LOAD PARALLEL TO WALL





DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

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

STRATA DESIGN

LATERAL SURCHARGE DETAIL

AVALON HEIGHTS 41901, OLD HIGHWAY 30
OCEANSIDE, OREGON

JUNE 2021
21-0375
FIGURE
5

APPENDIX A

Field Explorations

2117 NE OREGON STREET, SUITE 502

PORTLAND, OREGON 97232

503.248.1939 MAIN

STRATA-DESIGN.COM

BORING AND TEST PIT LOGS

DISTINCTION BETWEEN FIELD LOGS AND FINAL LOGS

A field log is prepared for exploration by our field representative. The log contains information concerning soil and groundwater encountered, sampling depths, sampler types used and identification of samples selected for laboratory analysis. The final logs presented in this report represent our interpretation of subsurface conditions based on the contents of the field logs, observations made during explorations, and the results of laboratory testing. Our recommendations are based on the contents of the final logs and the information contained therein, and not on the field logs.

SOIL CLASSIFICATION SYSTEM

Soil samples are classified in the field in general accordance with the United Soil Classification System (USCS) presented in ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." Final logs reflect field soil classifications and laboratory testing results. A summary of the USCS is provided on page 3. Classifications and sampling intervals are shown in the logs.

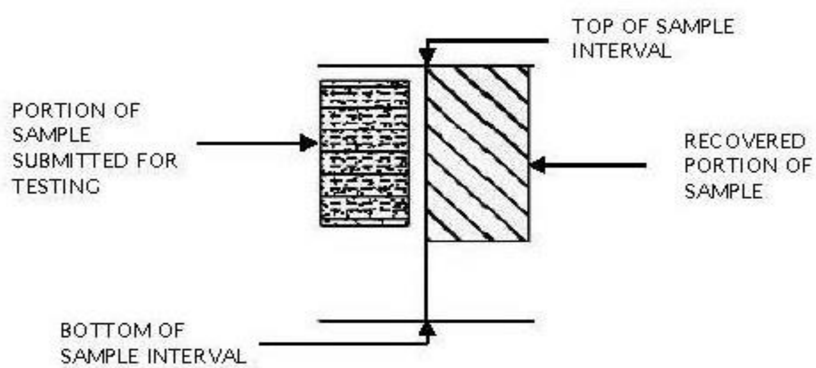
VARIATION OF SOIL BETWEEN EXPLORATIONS

The final logs and related information depict subsurface conditions only at the specific location and on the date(s) indicated. Those using the information contained herein should be aware that soil conditions at other locations or on other dates may differ.

TRANSITION BETWEEN SOIL AND ROCK CLASSIFICATIONS

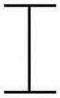
The lines designating the interface between soil, fill, or rock on the final logs and on the subsurface profiles presented in the report are determined by interpolation and are, therefore, approximate. The transition between the materials may be abrupt or gradual. Only at specific exploration locations should profiles be considered as reasonably accurate and then only to the degree implied by the notes.

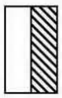
BORING LOG SAMPLES



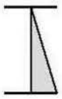
	2019	**KEY TO BORING AND TEST PIT LOGS**	
2839 SE Milwaukie Avenue Portland, OR 97202	Drawn By: GCN	**GENERAL INFORMATION**	**1/5**

EXPLORATION LOG SYMBOLS


Sample Location with No Sample Recovery


Sample Location Using Direct Push Sampler (ASTM D 6282)


Sample Location Using Ring-Lined Barrel Sampler (ASTM D 3550)

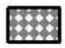

Sample Location Using Split-Barrel Sampler (ASTM D 1586)

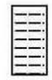

Sample Location Using Thin-Walled Tube Sampler (ASTM D 1587)


Rock Core Interval


Grab Sample Location


Soil Sample Submitted for Chemical Testing


Soil Sample Submitted for Physical Property Testing


Water Sample Screened Interval


Water Sample Submitted for Chemical Testing


Water Sample Tested in the Field


Groundwater Level Encountered While Drilling


Static Groundwater Level


Perched Groundwater


Groundwater Level at Time of Sampling

SOIL CHARACTER

Granular Soil		Cohesive Soil		
Density	Standard Penetration Test *	Consistency	Standard Penetration Test*	Unconfined Compressive Strength (tsf)
Very Loose	0 - 4	Very Soft	Less Than 2	Less Than 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.5
Medium Dense	10 - 30	Medium Stiff	4 - 8	0.50 - 1.0
Dense	30 - 50	Stiff	8 - 16	1.0 - 2.0
Very Dense	Greater Than 50	Very Stiff	16 - 32	2.0 - 4.0
Blows Required to Drive a Split-Barrel Sampler 12 inches		Hard	Greater Than 32	Greater Than 4.0

DEFINITIONS AND ABBREVIATIONS

AT	ATTERBERG LIMITS TEST	ND	NON DETECT	PPB	PARTS PER BILLION
BGS	BELOW GROUND SURFACE	NEG	NEGATIVE RESULT	PPM	PARTS PER MILLION
CO	CONSOLIDATION TEST	NS	NO VISIBLE SHEEN	PSF	POUNDS PER SQUARE FOOT
DS	DIRECT SHEAR TEST	OC	ORGANIC CONTENT	RS	SOIL RESISTIVITY TEST
DW	DRY UNIT WEIGHT	P	PUSHED SAMPLE	S4	SUDAN IV SOIL TEST
GS	MECHANICAL GRAIN SIZE TEST	P200	P200 FINES CONTENT TEST	SG	SPECIFIC GRAVITY TEST
HS	HEAVY SHEEN	PCF	POUNDS PER CUBIC FOOT	SPT	STD. PENETRATION TEST
HYD	HYDROMETER TEST	PH	SOIL pH	SS	SLIGHT SHEEN
MC	MOISTURE CONTENT	PID	PHOTOIONIZATION DETECTOR	TO	TOREVANE
MG/KG	MILLIGRAMS PER KILOGRAM	POS	POSITIVE RESULT	TSF	TONS PER SQUARE FOOT
MS	MODERATE SHEEN	PP	POCKET PENETROMETER	UV	ULTRAVIOLET LIGHT TEST

GRAIN SIZE DEFINITIONS			MINOR FRACTIONS IN FINE GRAINED SOIL		GROUNDWATER SEEPAGE	
SAND	FINE	No. 200 to No. 40	No Mention (CLAY, SILT)	< 15 percent	Slow	< 1 gpm
	MEDIUM	No. 40 to No. 10	With Sand, With Gravel	15 to 30 percent	Moderate	1-3 gpm
	COARSE	No. 10 to No. 4	Sandy, Gravelly	30 to 49 percent	Rapid	> 3 gpm
GRAVEL	FINE	No. 4 to 3/4-inch	FIELD MOISTURE OBSERVATION		CAVING	
	COARSE	3/4- to 3-inch	Dry	Absence of moisture, dusty, dry to touch	Minor	
COBBLE		3-inches to 12-inches	Moist	Damp but no visible water.	Moderate	
BOULDER		> 12-inches	Wet	Saturated, below groundwater	Severe	

	2019	KEY TO BORING AND TEST PIT LOGS	
2839 SE Milwaukie Avenue Portland, OR 97202	Drawn By: GCN	SYMBOLS AND ABBREVIATIONS	2/5

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

	2019	KEY TO BORING AND TEST PIT LOGS	
2839 SE Milwaukie Avenue Portland, OR 97202	Drawn By: GCN	SOIL CLASSIFICATION	3/5

ROCK CLASSIFICATION GUIDELINES

HARDNESS		DESCRIPTION
Very soft	(RH-0)	For plastic material only
Soft	(RH-1)	Carved or gouged with a knife
Moderate	(RH-2)	Scratched with a knife
Hard	(RH-3)	Difficult to scratch with a knife
Very hard	(RH-4)	Rock scratches metal; rock cannot be scratched with a knife

STRENGTH	DESCRIPTION
Plastic	Easily deformable with finger pressure
Friable	Crumbles by rubbing with fingers
Weak	Crumbles only under light hammer blows
Moderately Strong	Few heavy hammer blows before breaking
Strong	Withstands few heavy hammer blows and yields large fragments
Very Strong	Withstands many heavy hammer blows, yields dust and small fragments

WEATHERING	DESCRIPTION
Severe	Rock decomposed; thorough discoloration; all fractures extensively coated with clay, oxides, or carbonates.
Moderate	Intense localized discoloration of rock; fracture surfaces coated with weathering minerals.
Little	Slight and intermittent discoloration of rock; few stains on fracture surfaces.
Fresh	Rock unaffected by weathering

FRACTURING	FRACTURE SPACING
Crushed	Less than 5/8 inch to contains clay
Highly Fractured	5/8 inch to 2 inches
Closely Fractured	2 inches to 6 inches
Moderately fractured	6 inches to 1 foot
Little Fractured	1 foot to 4 feet
Massive	Greater than 4 feet

JOINT SPACING	DESCRIPTION
Papery	Less than 1/8 inch
Shaley or Platey	1/8 inch to 5/8 inch
Very Close	5/8 inch to 3 inches
Close	3 inches to 2 feet
Blocky	2 to 4 feet
Massive	Greater than 4 feet

	2019	KEY TO BORING AND TEST PIT LOGS
2839 SE Milwaukie Avenue Portland, OR 97202	Drawn By: GCN	ROCK CLASSIFICATION

GLOSSARY

Alluvial – Made up of or found in the materials that are left by the water of rivers, streams, floods, etc.

Bearing pressure – The total stress transferred from the structure to the foundation, then to the soil below the foundation.

Bulk density (Soil density) – The total mass of water and soil particles contained in a unit volume of soil: lb/ft³.

Coefficient of active earth pressure – The ratio of the minimum horizontal effective stress of a soil to the vertical effective stress at a single point in a soil mass retained by a retaining wall as the wall moves away from the soil.

Cohesive soil – Clay type soil with angles of internal friction close to zero. Cohesion is the force that holds together molecules or like-particles within a substance.

Colluvium – A loose accumulation of soil and rock fragments deposited through the action of gravity, such as erosion and soil creep.

Differential settlement – The vertical displacement due to settlement of one point in a foundation with respect to another point of the foundation.

Engineered fill – Soil used as fill, such as retaining wall backfill, foundation support, dams, slopes, etc., that are to be placed in accordance with engineered specifications. These specifications may delineate soil grain-size, plasticity, moisture, compaction, angularity, and many other index properties depending on the application.

Excess pore pressure – That increment of pore water pressures greater than hydro-static values, produced by consolidation stresses in compressible materials or by shear strain; excess pore pressure is dissipated during consolidation.

Factor of safety – The ratio of a limiting value of a quantity to the design value of that quantity.

Fines – Material by weight passing the U.S. Standard No. 200 Sieve by washed analysis.

Fluvial – Produced by the action of rivers or streams.

Homogenous soil – A mass of soil where the soil is of one characteristic having the same engineering and index properties.

In situ – Undisturbed, existing field conditions.

Lacustrine – Of a lake, e.g., the depositional environment of a lake.

Liquefaction – The sudden, large decrease of shear strength of cohesionless soil caused by collapse of the soil structure, produced by small shear strains associated with sudden but temporary increase of pore water pressure. Usually a problem in submerged, poorly graded sands within the upper 50 feet of subgrade in earthquake-prone environments.

Maximum dry density – A soil property obtained in the laboratory from a Proctor test. Density of soil at 100% compaction.

Overbank deposit – Sediment that has been deposited on the floodplain of a river or stream by flood waters that have broken through or overtopped the banks.

Permeability – A measure of continuous voids in a soil. The property which allows the flow of water through a soil. See also coefficient of permeability.

Porosity (Pore space) – The ratio of the volume of voids to the total volume: unitless or expressed as a percentage.

Residual soil – Soil that has been formed in place by rock decay.

Shear strength – The maximum shear stress which a soil can sustain under a given set of conditions. For clay, shear strength = cohesion. For sand, shear strength = the product of effective stress and the tangent of the angle of internal friction.

Surcharge – An additional force applied at the exposed upper surface of a restrained soil.

Tuff – An igneous rock (from molten material) that forms from the debris ejected by an explosive volcanic eruption.

Unit weight – The ratio of the total weight of soil to the total volume of a unit of soil: lb/ft³.

	2019	KEY TO BORING AND TEST PIT LOGS	
2839 SE Milwaukie Avenue Portland, OR 97202	Drawn By: GCN	GLOSSARY	5/5

STRATADESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-01

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	45.45
Drilling Co.:	Bill Hughes	Northing:	-123.96
Method of drilling:	Test Pit	Ground Elevation:	310.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
						310.00		
0.00–4.00					SM		6" root zone Brown, Silty Sand (SM), 20% fines, 80% sand, Moist	
4.00–8.00					SP		Light brown, poorly graded SAND (SP), 20% fines, 80% sand, Moist Transfers to Dune Sand at 6 ft, 5% fines, 95% sand 100% sand at 5 ft Caving at 7 ft	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00

Key:

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423   STRATA-DESIGN.COM

Test Pit: TP-02

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	328.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 4.00					SP-SM	328.00	6" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
4.00 – 8.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00

Key:

STRATADESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-03

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	378.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00–5.00					SP-SM	378.00	6" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
5.00–6.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00

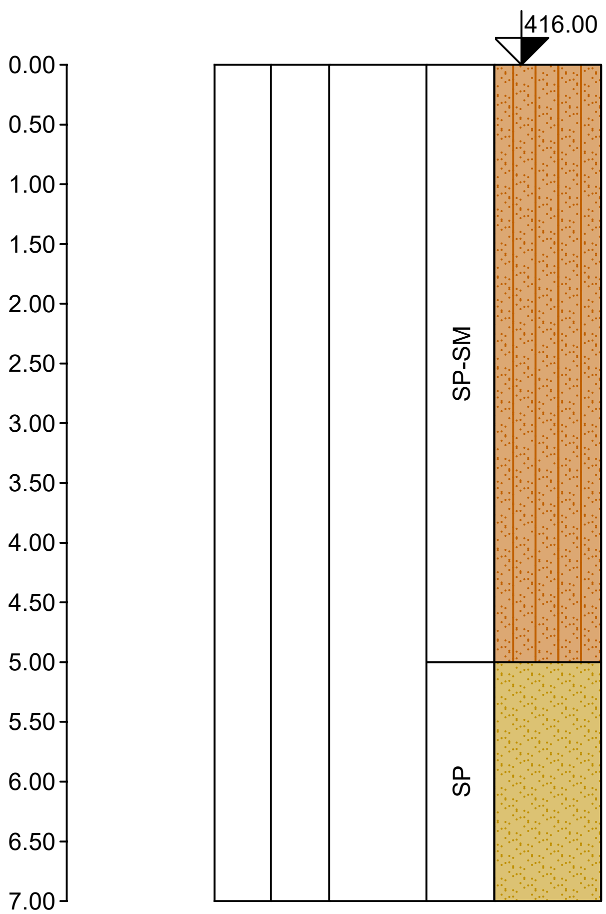
Key:

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-04

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Tes Pit	Ground Elevation:	416.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 5.00					SP-SM		6" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
5.00 – 7.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	



Key:

STRATADESIGN

Test Pit: TP-05

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	443.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 5.00					SP-SM	443.00	12" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
5.00 – 10.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.00

Key:

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-06

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	443.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00–6.50					SP-SM	443.00	12" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
6.50–7.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00

Key:

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-07

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	402.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 4.50					SP-SM		6" root zone Brownish red, Poorly graded SAND with SILT (SP-SM), 10% fines, 90% sand, Moist, cemented	
4.50 – 5.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Ground surface elevation: 402.00

Depth scale [ft]: 0.00, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.25, 3.50, 3.75, 4.00, 4.25, 4.50, 4.75, 5.00

Key:

Test Pit: TP-08

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	376.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 4.00					SP	376.00	6" root zone Brown, Poorly graded SAND (SP), 5% fines, 95% sand, Moist, cemented	
4.00 – 7.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00

Key:

STRATA DESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-09

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test Pit	Ground Elevation:	351.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 5.00					SP-SM	351.00	Brownish red, Poorly graded SAND with SILT (SP-SM), 5% fines, 95% sand, Moist, cemented	
5.00 – 7.00					SP		Light brown, poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00

Key:

STRATADESIGN
2117 NE Oregon Street, Suite 502 • Portland, OR 97232
503 • 819 • 4423 STRATA-DESIGN.COM

Test Pit: TP-10

Project:	Avalon Heights Residential Subdivision	Date start:	3/17/2021
Project ID:	21-0375	Date end:	3/17/2021
Location:	41901 Old Highway 30		
Client	Bill Hughes	Easting:	
Drilling Co.:	Bill Hughes	Northing:	
Method of drilling:	Test PIt	Ground Elevation:	349.00
Logged by:	CVF Checked by: RG	Altitude system:	user
Notes:		Scale:	one page

Depth [ft]	Samples and GWT	Recovery [%]	RQD [%]	Number of Blows[][BL/12 in]	USCS Classification	Graphical log	Layers description	Environmental Data - Vapor
0.00 – 6.00					SP	349.00	6" root zone Brown, Poorly graded DUNE SAND (SP), 100% sand, Moist	

Depth scale: 0.00, 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00

Key:

DEPTH (ft bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	BLOW COUNT DCP/4-INCHES	MOISTURE CONTENT (%)	GROUNDWATER	FIELD TESTING	TESTING AND LABORATORY DATA
0			Loose, light brown, poorly graded SAND; moist. (DUNE SAND) (6-inch thick heavily rooted zone at the ground surface)						
5				1	2-2-3				
10				2	2-3-2				
15				3	2-3-4				
20									
25		SP	Becomes dense at 25 feet.	4	9-21-28				
30			Becomes medium dense at 30 feet.	5	4-8-7				
35									
40				6	6-10-11				
45									
50				7	6-9-12				
55			End at 51-1/2 feet in medium dense sand. Caving between 17 and 20 feet. No groundwater encountered during site exploration. Boring backfilled with bentonite.						
60									

BORING METHOD: SS	ELEVATION REFERENCE:	START CARD/TAG ID:
BOREHOLE DIAMETER: 3"	GROUND SURFACE ELEVATION:	
DRILL RIG: Big Beaver	CASING ELEVATION:	
CONTRACTOR: Dan Fischer Excavating	LOCATION: See Figure 2	
LOGGED BY: Cory Van Fosson	DRILLING DATES:	

Avalon Heights

21-0375

2117 NE Oregon Street, Ste. 502
Portland OR 97232
Tel 503-819-4423
STRATA-DESIGN.COM

STRATA DESIGN

LOG OF BORING

B-1

DEPTH (ft bgs)	GRAPHIC LOG	USCS SYMBOL	SOIL DESCRIPTION	SAMPLE	BLOW COUNT DCP/4-INCHES	MOISTURE CONTENT (%)	GROUNDWATER	FIELD TESTING	TESTING AND LABORATORY DATA
0		SP	Loose, light brown, poorly graded, fine SAND; moist. (DUNE SAND) (6-inch thick heavily rooted zone at the ground surface)						
5				1	2-2-4				
10				2	3-3-4				
15			Becomes loose to medium dense at 15 feet.	3	3-5-5				
20			Becomes loose at 20 feet.	4	3-3-5				
25									
30			Becomes medium dense at 30 feet.	5	3-6-7				
35									
40				6	7-10-13				
45									
50				7	5-8-9				
55			End at 51-1/2 feet in medium dense sand. No caving and no groundwater observed during site exploration. Borehole backfilled with bentonite.						
60									

BORING METHOD: SS

BOREHOLE DIAMETER: 3"

DRILL RIG: Big Beaver

CONTRACTOR: Dan Fischer Excavating

LOGGED BY: Cory Van Fosson

ELEVATION REFERENCE:

GROUND SURFACE ELEVATION:

CASING ELEVATION:

LOCATION: See Figure 2

DRILLING DATES:

START CARD/TAG ID:

Avalon Heights

21-0375

2117 NE Oregon Street, Ste. 502
Portland OR 97232
Tel 503-819-4423
STRATA-DESIGN.COM

STRATA DESIGN

LOG OF BORING

B-2

PRELIMINARY STORMWATER REPORT

Second Avalon Heights Subdivision
Located in SE ¼ of SE ¼ of Sec 30 T1S R10W W.M.
Tax Lot 200
Tillamook County, OR

October 11, 2021
FDG# E20-036

Prepared By:

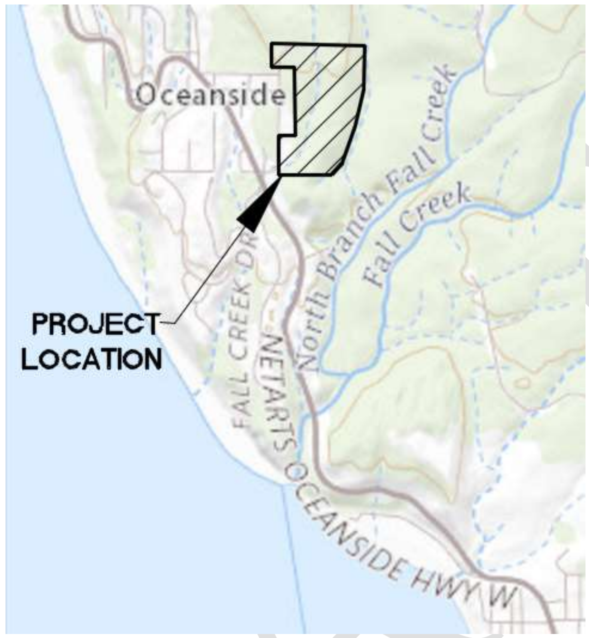
FIRWOOD DESIGN GROUP
Reliable Engineering Solutions

359 E. Historic Columbia River Highway
Troutdale, OR 97060
503.668.3737- fax 503.668.3788

TABLE OF CONTENTS

I. PROJECT DESCRIPTION & OBJECTIVE

The proposed project is a single-family residential subdivision encompassing approximately 21 acres of unincorporated Tillamook County near Oceanside. The project location is shown on the map below.



Currently, much of the project site drains to a large existing on-site depression or basin located at the south west corner of the site where runoff infiltrates into native soils. Post-development, the subdivision will partially drain to and be infiltrated in the same location. Some of the existing depression basin will be filled to enlarge the buildable area on Lots 1, 2 and 4, but most of it will be retained with slight grading to service as an infiltration pond for the subdivision. Two separate upstream infiltration facilities (both deep drywell systems) will retain and infiltrate some of the subdivision's post-development stormwater runoff to minimize the required size of the pond.

The objective of this preliminary stormwater report is to demonstrate feasibility of the conceptual stormwater management plan for the land use phase of this project. Final detailed design and plans will be provided for construction permitting.

II. SITE DATA

Site Rainfall Data

Rainfall data for the site was obtained from the NOAA Atlas 2 Precipitation Frequency Estimate tool: NOAA Atlas 2 Precipitation Frequency Estimates (weather.gov)

Precipitation Frequency Data Output

NOAA Atlas 2

Oregon 45.45°N 123.95°W
Site-specific Estimates

Map	Precipitation (inches)	Precipitation Intensity (in/hr)
2-year 6-hour	1.51	0.25
2-year 24-hour	3.05	0.13
100-year 6-hour	3.00	0.50
100-year 24-hour	6.50	0.27

Go to PFDS
Go to NA2

Hydrometeorological Design Studies Center - NOAA/National Weather Service
1325 East-West Highway - Silver Spring, MD 20910 - (301) 713-1669
Mon Jan 11 17:23:53 2021

Additionally, using available NOAA isopluvial maps, it was determined that the 50-year, 24-hour storm for the project site is 6.0 inches. This 50-year storm, the 1.5 inch 2-year storm and the 6.5-inch 100-year 24-hour design storm will be used for this project.

Site Soils

Soil data for the site was obtained from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey. The soil resource report is included in the appendix for reference. The site, especially areas tributary to the infiltration area, consists primarily of Netarts fine sandy loam, a Type A hydrologic group soil with a Ksat (capacity of most limiting layer to transmit water) of 1.98 to 5.95 inches per hour.

Environmental Management Systems Inc (EMS) performed an infiltration test in the approximate location of the proposed infiltration pond. The report is included in the appendix for reference. Two falling-head infiltration tests were performed; the second infiltration test result (19.5 inches per hour) was slightly lower than the first test and is therefore used for design. A safety factor of two is applied, so the design infiltration rate used is 9.75 inches per hour. The infiltration testing was performed 30” below ground surface.

III. RUNOFF, CONVEYANCE, AND INFILTRATION

Runoff

A basin map and HydroCAD model were developed for concept-level hydrological and infiltration calculations; both are included in the appendix for reference. As part of developing the basin map, assumptions were made for impervious surfaces at full build-out; lots are assumed to average approximately 4,000 square feet of impervious per lot, which equates to a 50'x50' house and a 75'x20' driveway. Roadway impervious areas were calculated from the concept design drawings.

The HydroCAD model uses the Santa Barbara Urban Hydrograph (SBUH) with a Type 1A rainfall distribution methodology. The time of concentration for basins 1A and 2 were calculated using the basin map and the HydroCAD time of concentration calculation tool for the most hydraulically distant point of the drainage basin. Basin 1B and 1C have a time of concentration path that only follows steep (>10%) roadside conveyance ditch lines so the time of concentration for these basins was assumed at the minimum of 5 minutes.

The Curve Numbers (CN) used in hydrological calculations are:
Impervious (pavement, gravel, driveways, and houses): 98
On-site pervious (lawns, roadside ditches, stormwater easement, Type A soil): 49
Off-site pervious (woods): 36

All sub-basins of the subdivision will be managed via on-site infiltration facilities. Basin 1A will discharge into a series of three connected 30' deep dry wells in the right of way along Grand Avenue. Basin 1B will discharge into a series of two connected 30' deep dry wells. Basins 1C and 2 will discharge directly into the infiltration pond. Overflow from the dry well systems will be conveyed into the infiltration pond.

Calculated peak runoff inflow and outflow (overflow rates) for the 50-year water quantity design storm and 100-year check storm for Basins 1A and 1B.

Basin 1A (Drywell A) In	Basin 1A (Drywell A) Out	Basin 1B (Drywell B) In	Basin 1B (Drywell B) Out
3.00 cfs	1.57 cfs	1.84 cfs	1.09 cfs

Basin 1A (Drywell A) In	Basin 1A (Drywell A) Out	Basin 1B (Drywell B) In	Basin 1B (Drywell B) Out
3.26 cfs	1.68 cfs	2.08 cfs	1.33 cfs

Calculated peak runoff rates for the 50-year water quantity design storm and 100-year check storm entering the infiltration pond. Basins 1A & 1B are combined as they share an overflow point to the pond, however, the sum of their peak flows does not equal their peak flow into the pond as each drywell system experiences peak outflows at different times.

Basin 1A & B	Basin 1C	Basin 2	Total
2.52 cfs	1.49 cfs	2.66 cfs	6.67 cfs

Basin 1A & 1B	Basin 1C	Basin 2	Total
3.01 cfs	1.73 cfs	2.97 cfs	7.71 cfs

The infiltration pond is designed to retain and infiltrate the 100-year check storm, with a minimum of 6” freeboard to the embankment emergency overflow route.

Conveyance

The capacity of roadside ditches and culverts was calculated with Manning’s Equation using HydraFlow Express, an extension for AutoCAD Civil3D. Manning’s coefficients used are from the ODOT Hydraulics Manual, Chapter 8, Appendix A – Hydraulic Roughness (Manning’s n) Values of Conduits and Channels. The HydraFlow calculations and an excerpt of the ODOT tables are included in the appendix of this report.

Maximum capacity of stormwater conveyance facilities:
Roadside ditch with 0” freeboard at 1.00% slope: 13.79 cfs
18” smooth plastic at 1.00% slope: 13.35 cfs
12” smooth plastic at 1.00% slope: 4.53 cfs
12” smooth plastic at 2.00% slope: 6.40 cfs

As the minimum proposed road grade is 1%, roadside ditch and pipe capacity at 1% slope was checked against the peak runoff flow rates from the 100-year design storm for Basin 1. As shown, all roadside ditches and 18” smooth plastic storm lines have sufficient capacity to convey peak flow rates. At 1% minimum grade, 12” smooth plastic storm lines do not have sufficient capacity to convey the peak flow rate; the minimum slope required for capacity was calculated to be 2.00%. As most of the proposed roadway grade is steeper than this minimum, most individual lot driveway culverts can be 12” diameter. On any driveway approaches where conveyance capacity cannot be met with 12” diameter culverts, an 18” culvert may be installed. Therefore, the concept design of roadside ditches and culverts is feasible.

Water Quality

Water quality standards will be met via pre-treatment sedimentation manholes installed upstream of the infiltration pond and dry well systems. Water quality treatment of some areas may be met via vegetated conveyance swales that will serve as biofiltration strips, but this will be addressed in the final design in more detail.

Infiltration

Currently, much of the project property drains to an existing on-site low point. After development, most of the project property and some off-site areas will drain to this low point. As proposed development will create a significant amount of impervious surface, it was decided to implement upstream infiltration facilities as discussed above, to avoid enlarging the existing gully. These facilities are a drywell system of three 30’ deep dry wells for Basin 1A and two dry wells for Basin 1B. As discussed in Section II of the report, the design infiltration rate for all infiltration facilities is 9.75 inches per hour.

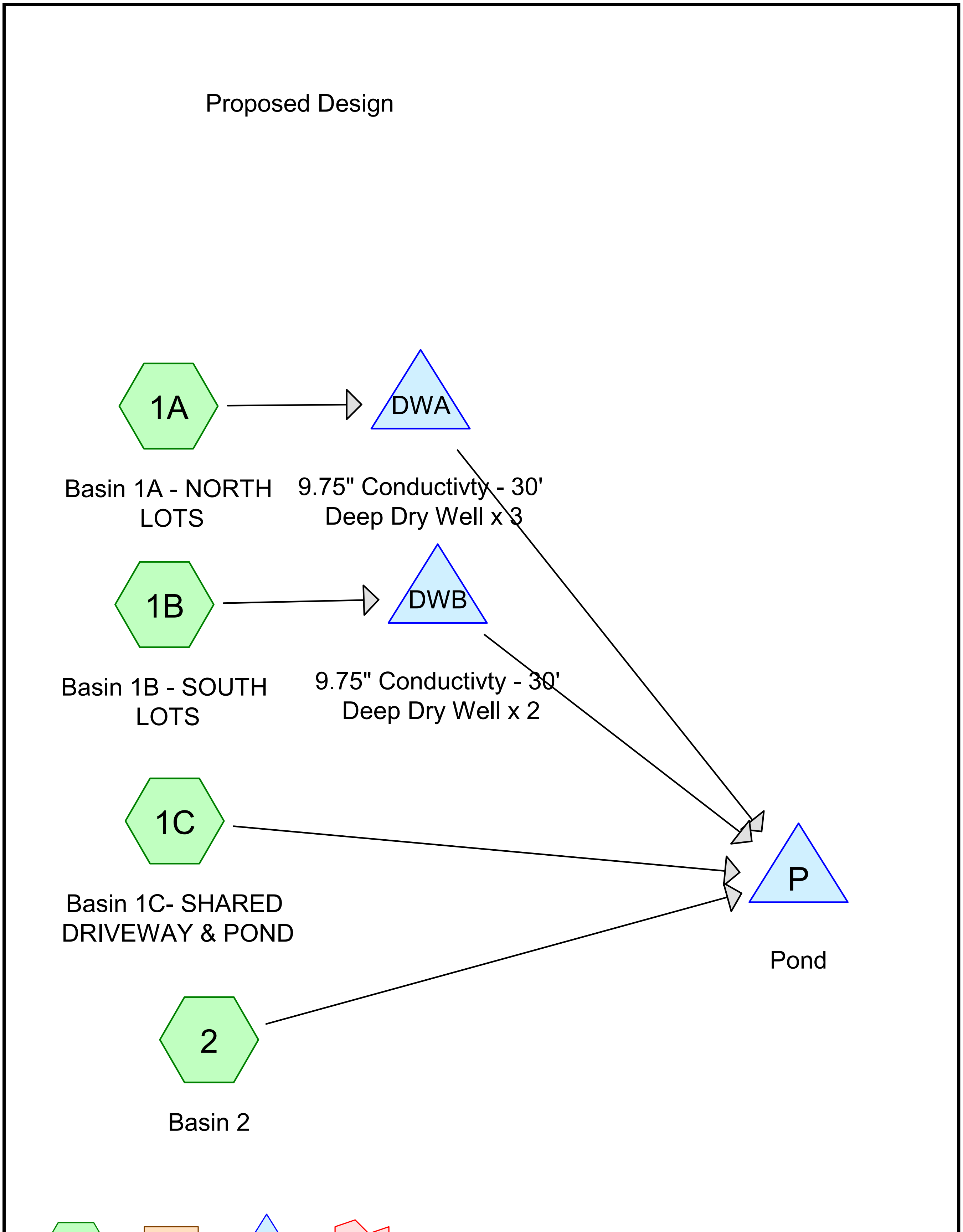
The pond is situated at the bottom of a large hill; its geometry is designed to roughly fit the existing hill topography with the southern end being filled in to create shallower 4:1 interior slopes for the pond and to create more buildable area on Lot 1. The concept basin was sized using stage storage with HydroCAD and AutoCAD Civil3D modeling. Tributary runoff hydrograph, basin stage storage volume, and exfiltration from the basin was calculated/modeled using HydroCAD. Refer to the concept infiltration pond plan for additional information on the configuration of the pond and maintenance access road.

Additional considerations to be addressed further with final design:

- Lots adjacent to the infiltration pond should have a building finish floor elevation above the infiltration pond overflow elevation, which is the low point in the saddle with an elevation of 297.9 (see sheets 12 and 13 of plan set). The current grading plan demonstrates that this is feasible.
- Basin side-slopes, especially portions located along the existing hill, may need stabilization measures such as riprap, erosion control blankets, or vegetation.
- Erosion protection and sediment/trash capture to protect the pond from erosion and excessive sedimentation, such as a forebay, flow dispersion features, riprap protection, or other design measures, may be required.
- Infiltration of stormwater in the roadside ditches is not analyzed separately in the preliminary design for two reasons. First, infiltration of rainfall in the ditches is generally accounted for by including the ditches in the Curve Number calculations as pervious area. Second, significant lengths of the roadside ditches will be piped at full build-out by driveway culverts, reducing the length of ditch where any additional infiltration may occur. Final design of roadside ditch may include rock check dams or other facilities to reduce flow velocities and increase hydraulic residence time and therefore increased infiltration in roadside ditches.

APPENDIX A

Calculations



Routing Diagram for E20-036 Avalon Prelim HydroCAD 4
Prepared by Firwood Design Group, Printed 10/11/2021
HydroCAD® 10.10-3b s/n M12773 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Yr	Type IA 24-hr		Default	24.00	1	3.05	2
2	10-YR	Type IA 24-hr		Default	24.00	1	4.10	2
3	50-YR	Type IA 24-hr		Default	24.00	1	6.00	2
4	100-Yr	Type IA 24-hr		Default	24.00	1	6.50	2

Summary for Subcatchment 1A: Basin 1A - NORTH LOTS

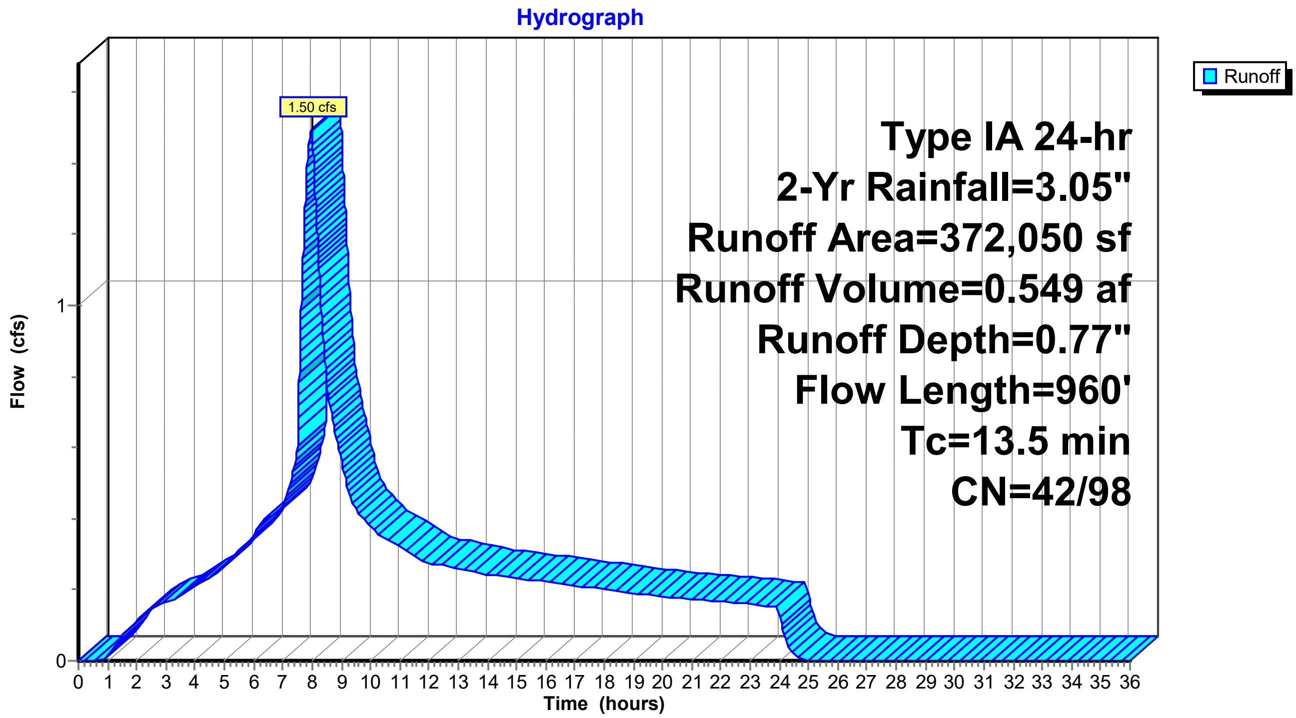
Runoff = 1.50 cfs @ 8.00 hrs, Volume= 0.549 af, Depth= 0.77"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Yr Rainfall=3.05"

	Area (sf)	CN	Description
*	29,260	98	Roads
*	72,000	98	On-Site Houses & Driveways (18)
	114,790	49	50-75% Grass cover, Fair, HSG A
	156,000	36	Woods, Fair, HSG A
	372,050	57	Weighted Average
	270,790	42	72.78% Pervious Area
	101,260	98	27.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	110	0.3500	0.24		**Sheet Flow, Sheet - Offsite Woods** Woods: Light underbrush n= 0.400 P2= 3.05"
3.8	300	0.0700	1.32		**Shallow Concentrated Flow, Offsite Woods** Woodland Kv= 5.0 fps
2.1	550	0.0720	4.43	35.46	**Channel Flow, Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
13.5	960	Total			

Subcatchment 1A: Basin 1A - NORTH LOTS



Summary for Subcatchment 1B: Basin 1B - SOUTH LOTS

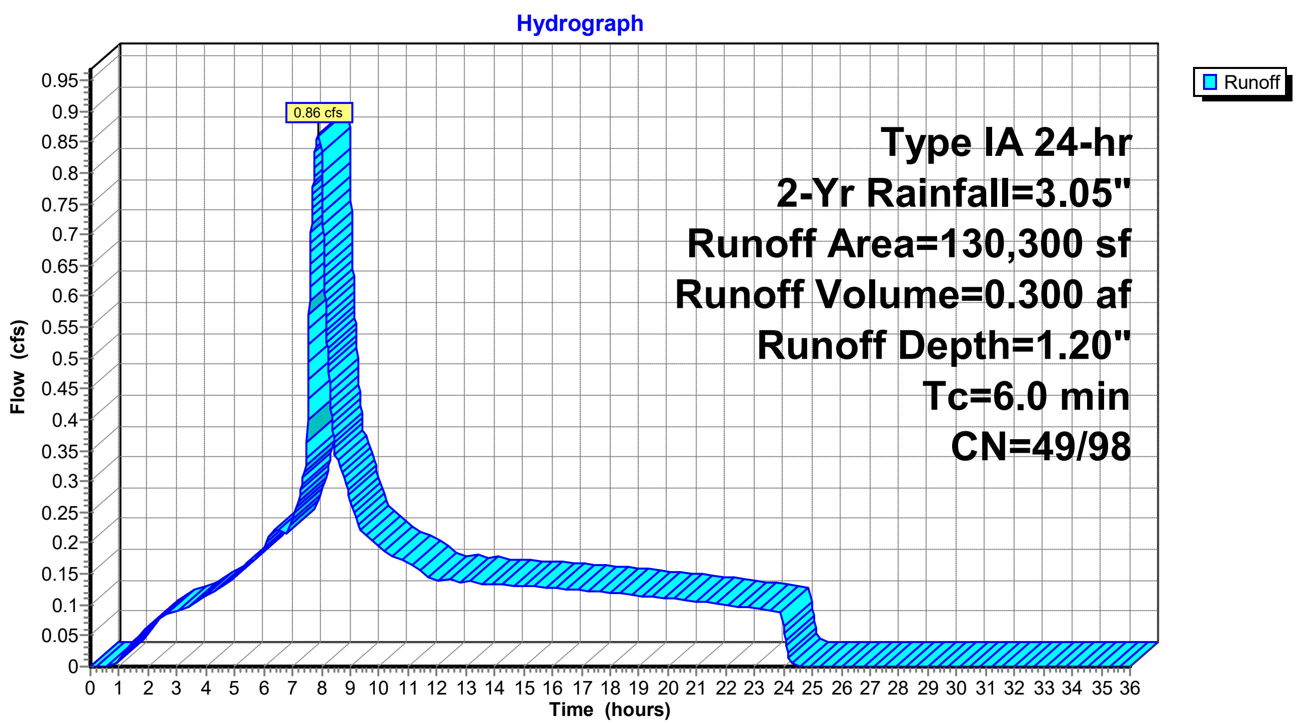
Runoff = 0.86 cfs @ 7.90 hrs, Volume= 0.300 af, Depth= 1.20"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Yr Rainfall=3.05"

	Area (sf)	CN	Description
*	13,420	98	Roads
*	40,000	98	On-Site Houses & Driveways (10)
*	76,880	49	Pervious - 50-75% Grass Cover, HSG A
	130,300	69	Weighted Average
	76,880	49	59.00% Pervious Area
	53,420	98	41.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1B: Basin 1B - SOUTH LOTS



Summary for Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND

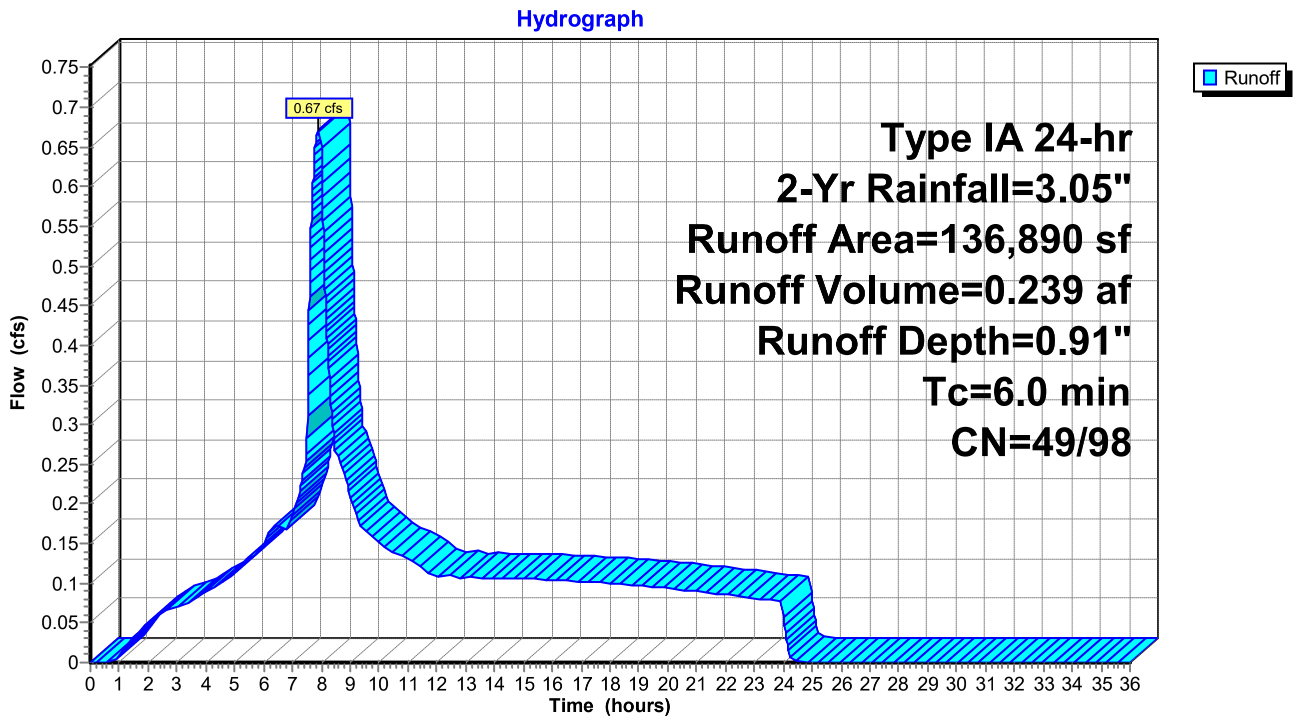
Runoff = 0.67 cfs @ 7.90 hrs, Volume= 0.239 af, Depth= 0.91"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Yr Rainfall=3.05"

	Area (sf)	CN	Description
*	17,610	98	Roads
*	24,000	98	On-Site Houses & Driveways (6)
*	95,280	49	Pervious - 50-75% Grass Cover, HSG A
	136,890	64	Weighted Average
	95,280	49	69.60% Pervious Area
	41,610	98	30.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND



Summary for Subcatchment 2: Basin 2

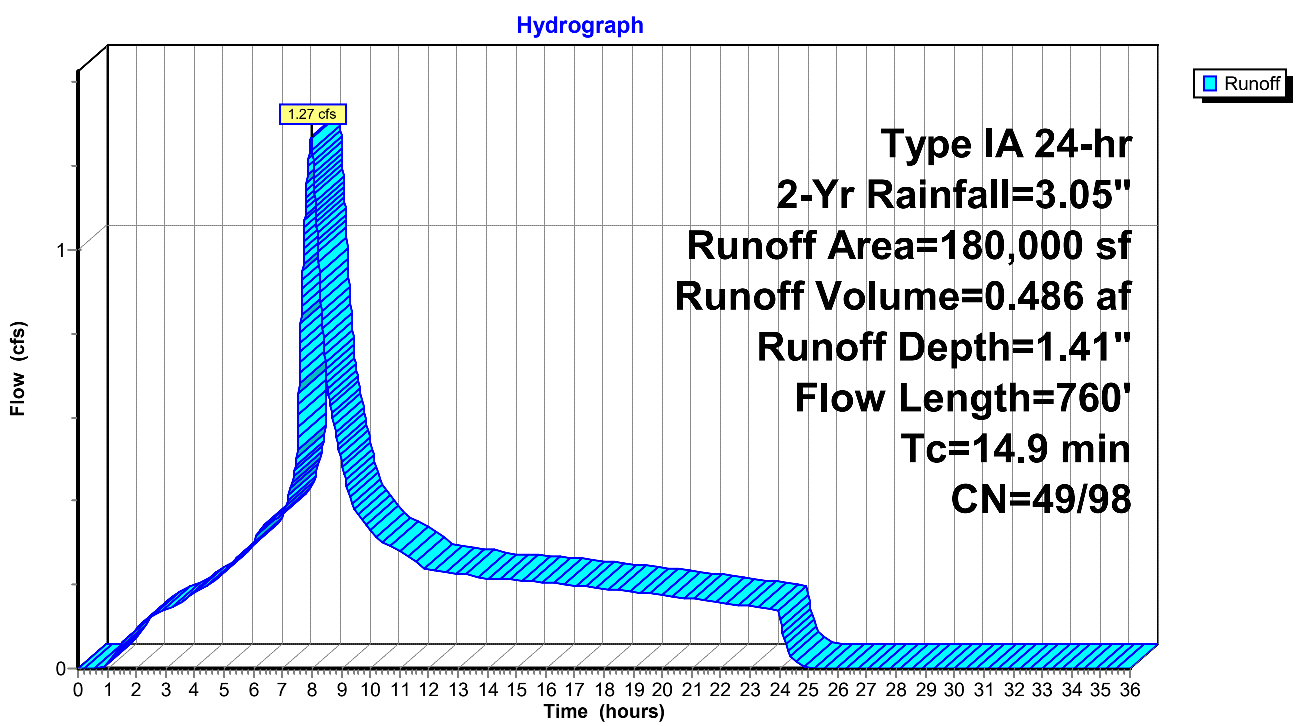
Runoff = 1.27 cfs @ 8.00 hrs, Volume= 0.486 af, Depth= 1.41"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 2-Yr Rainfall=3.05"

	Area (sf)	CN	Description
*	15,500	98	On-Site Roads
*	44,000	98	On-Site Houses & Driveways (11)
*	20,000	98	Off-Site Houses & Driveways
*	92,500	49	Pervious - 50-75% Grass cover, Fair, HSG A
*	8,000	98	Off-Site - Future Highland Road
	180,000	73	Weighted Average
	92,500	49	51.39% Pervious Area
	87,500	98	48.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.3	280	0.2000	0.35		**Sheet Flow, Sheet - Lot Yards** Grass: Dense n= 0.240 P2= 3.05"
1.6	480	0.0900	4.96	39.65	**Channel Flow, Future Road Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
14.9	760	Total			

Subcatchment 2: Basin 2



Summary for Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3

Inflow Area =	8.541 ac,	27.22% Impervious,	Inflow Depth = 0.77"	for 2-Yr event	
Inflow =	1.50 cfs @	8.00 hrs,	Volume=	0.549 af	
Outflow =	1.17 cfs @	8.19 hrs,	Volume=	0.549 af,	Atten= 22%, Lag= 11.8 min
Discarded =	1.17 cfs @	8.19 hrs,	Volume=	0.549 af	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 362.30' @ 8.19 hrs Surf.Area= 115 sf Storage= 1,534 cf

Plug-Flow detention time= 17.8 min calculated for 0.549 af (100% of inflow)
Center-of-Mass det. time= 17.8 min (696.7 - 678.9)

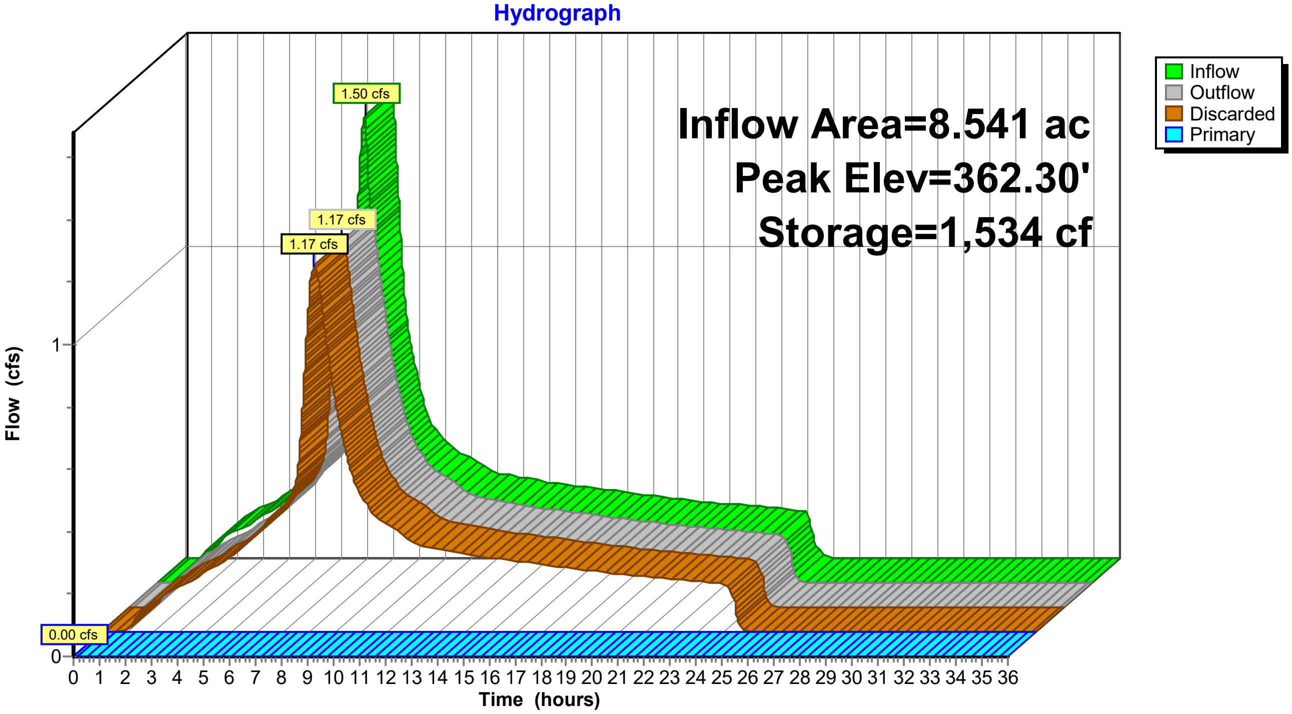
Volume	Invert	Avail.Storage	Storage Description
#1	340.00'	933 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 3 3,464 cf Overall - 1,131 cf Embedded = 2,333 cf x 40.0% Voids
#2	340.00'	1,131 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 3 Inside #1
		2,064 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	340.00'	**9.750 in/hr Exfiltration X 3.00 over Wetted area** Conductivity to Groundwater Elevation = 220.00'
#2	Primary	369.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=1.17 cfs @ 8.19 hrs HW=362.30' (Free Discharge)
↑—**1=Exfiltration** (Controls 1.17 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=340.00' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3



Summary for Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2

Inflow Area =	2.991 ac, 41.00% Impervious, Inflow Depth = 1.20" for 2-Yr event			
Inflow =	0.86 cfs @	7.90 hrs, Volume=	0.300 af	
Outflow =	0.61 cfs @	8.13 hrs, Volume=	0.300 af,	Atten= 29%, Lag= 13.8 min
Discarded =	0.61 cfs @	8.13 hrs, Volume=	0.300 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 314.52' @ 8.13 hrs Surf.Area= 77 sf Storage= 1,124 cf

Plug-Flow detention time= 27.6 min calculated for 0.300 af (100% of inflow)
Center-of-Mass det. time= 27.5 min (715.5 - 687.9)

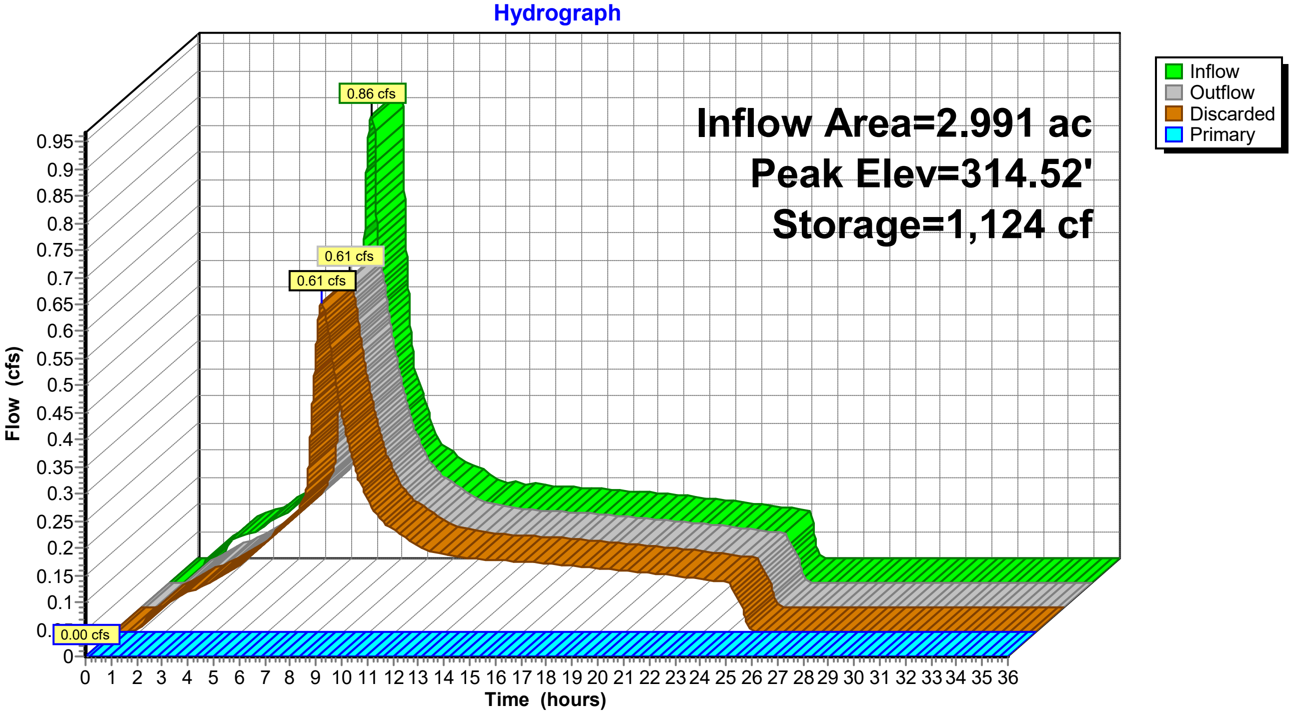
Volume	Invert	Avail.Storage	Storage Description
#1	290.00'	622 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 2 2,309 cf Overall - 754 cf Embedded = 1,555 cf x 40.0% Voids
#2	290.00'	754 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 2 Inside #1
		1,376 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	290.00'	**9.750 in/hr Exfiltration X 2.00 over Wetted area** Conductivity to Groundwater Elevation = 220.00'
#2	Primary	319.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.61 cfs @ 8.13 hrs HW=314.51' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.61 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=290.00' (Free Discharge)
↑—**2=Orifice/Grate** (Controls 0.00 cfs)

Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2



Summary for Pond P: Pond

Inflow Area = 18.807 ac, 34.64% Impervious, Inflow Depth = 0.46" for 2-Yr event
Inflow = 1.93 cfs @ 7.98 hrs, Volume= 0.726 af
Outflow = 0.78 cfs @ 8.84 hrs, Volume= 0.726 af, Atten= 59%, Lag= 51.5 min
Discarded = 0.78 cfs @ 8.84 hrs, Volume= 0.726 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 293.87' @ 8.84 hrs Surf.Area= 3,448 sf Storage= 4,308 cf

Plug-Flow detention time= 40.2 min calculated for 0.725 af (100% of inflow)
Center-of-Mass det. time= 40.2 min (734.3 - 694.1)

Volume	Invert	Avail.Storage	Storage Description
#1	292.00'	30,785 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

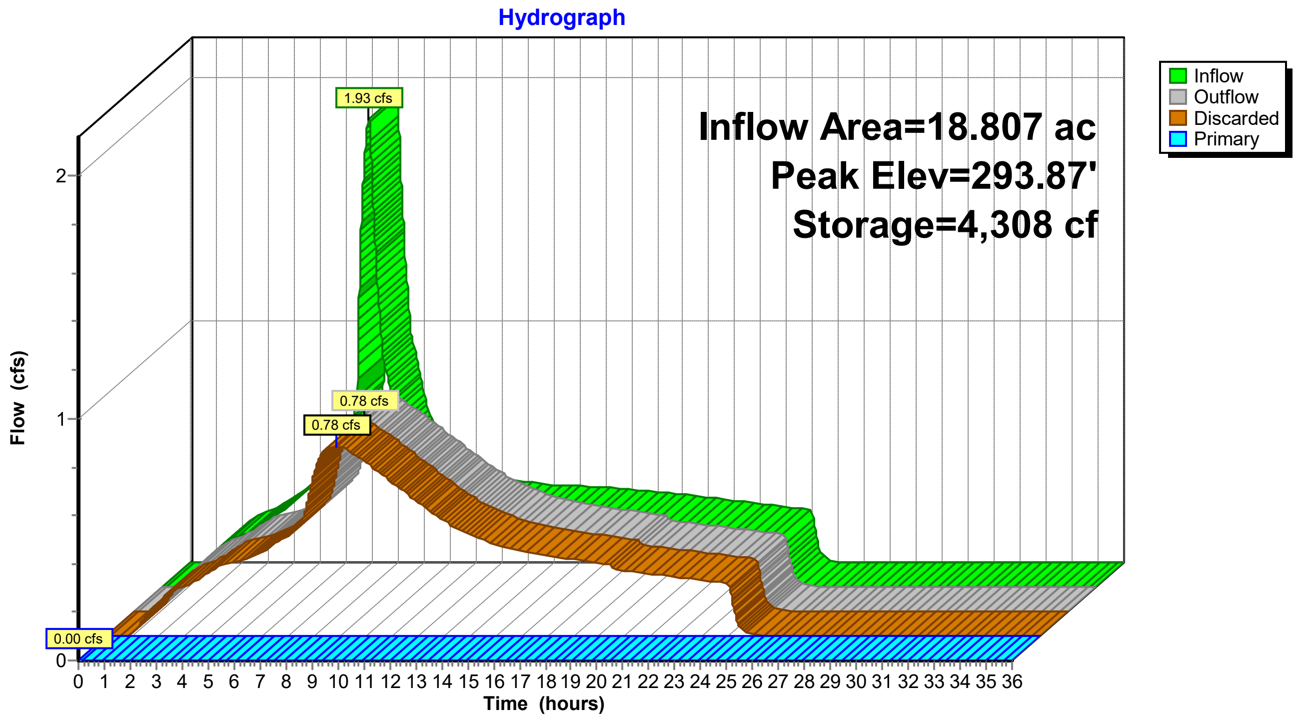
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
292.00	1,257	0	0	1,257
293.00	2,366	1,783	1,783	2,376
294.00	3,621	2,971	4,754	3,646
295.00	4,947	4,267	9,021	4,992
296.00	6,356	5,637	14,657	6,426
297.00	8,046	7,184	21,842	8,142
298.00	9,871	8,943	30,785	9,998

Device	Routing	Invert	Outlet Devices
#1	Discarded	292.00'	**9.750 in/hr Exfiltration over Wetted area**
#2	Primary	297.50'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=0.78 cfs @ 8.84 hrs HW=293.87' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.78 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=292.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P: Pond


Hydrograph
1.93 cfs
0.78 cfs
0.78 cfs
0.00 cfs
Inflow Area=18.807 ac
Peak Elev=293.87'
Storage=4,308 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
0
1
2
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

Summary for Subcatchment 1A: Basin 1A - NORTH LOTS

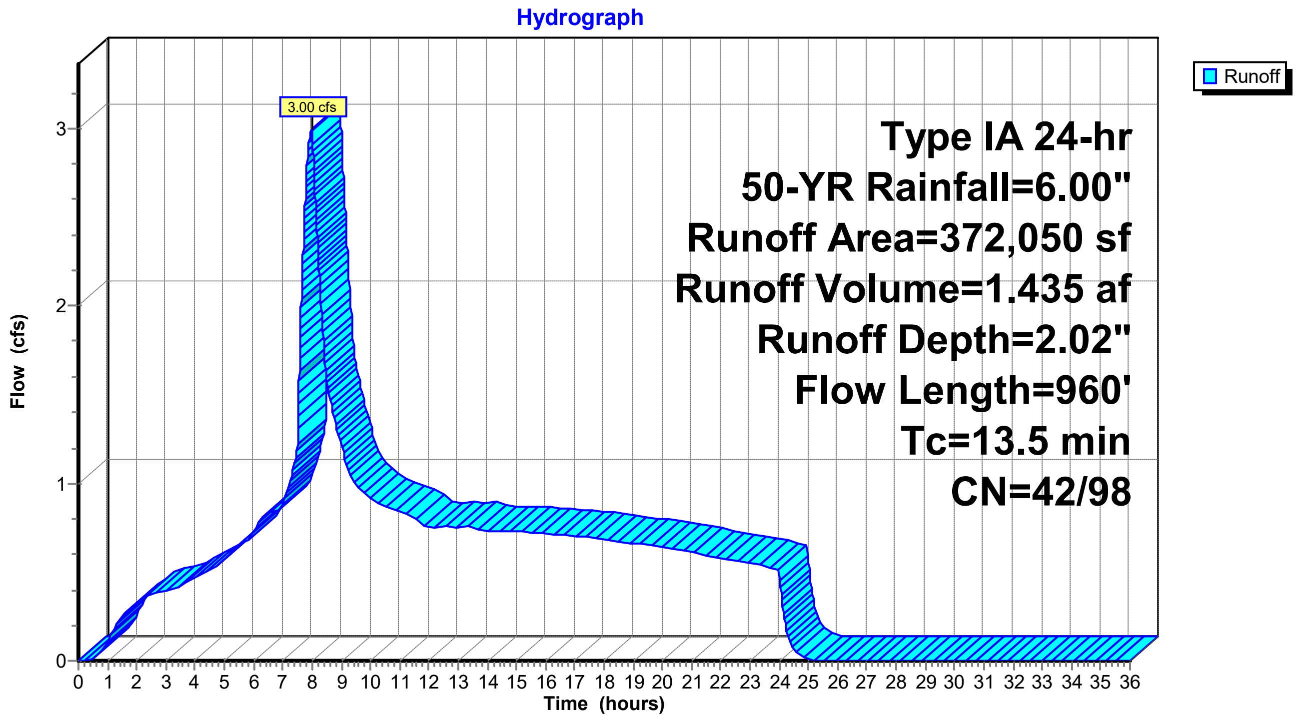
Runoff = 3.00 cfs @ 8.00 hrs, Volume= 1.435 af, Depth= 2.02"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 50-YR Rainfall=6.00"

	Area (sf)	CN	Description
*	29,260	98	Roads
*	72,000	98	On-Site Houses & Driveways (18)
	114,790	49	50-75% Grass cover, Fair, HSG A
	156,000	36	Woods, Fair, HSG A
	372,050	57	Weighted Average
	270,790	42	72.78% Pervious Area
	101,260	98	27.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	110	0.3500	0.24		**Sheet Flow, Sheet - Offsite Woods** Woods: Light underbrush n= 0.400 P2= 3.05"
3.8	300	0.0700	1.32		**Shallow Concentrated Flow, Offsite Woods** Woodland Kv= 5.0 fps
2.1	550	0.0720	4.43	35.46	**Channel Flow, Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
13.5	960	Total			

Subcatchment 1A: Basin 1A - NORTH LOTS



Summary for Subcatchment 1B: Basin 1B - SOUTH LOTS

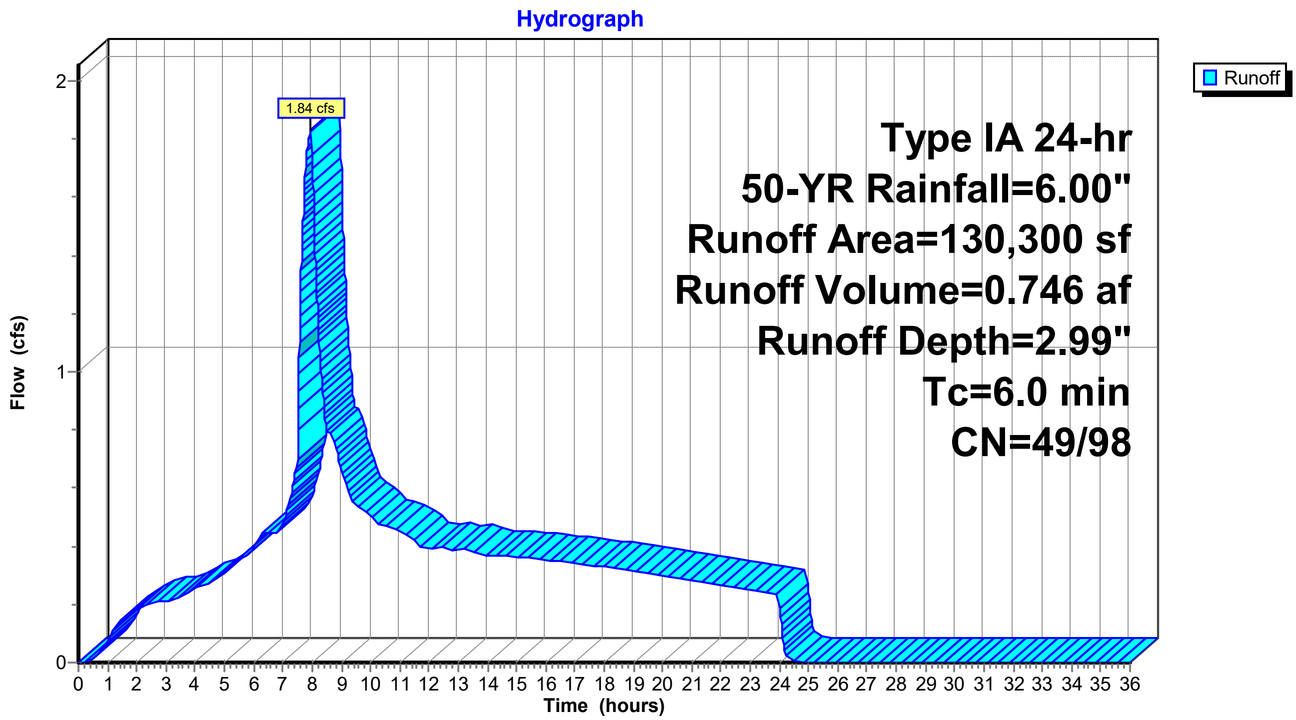
Runoff = 1.84 cfs @ 7.95 hrs, Volume= 0.746 af, Depth= 2.99"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 50-YR Rainfall=6.00"

	Area (sf)	CN	Description
*	13,420	98	Roads
*	40,000	98	On-Site Houses & Driveways (10)
*	76,880	49	Pervious - 50-75% Grass Cover, HSG A
	130,300	69	Weighted Average
	76,880	49	59.00% Pervious Area
	53,420	98	41.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1B: Basin 1B - SOUTH LOTS



Summary for Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND

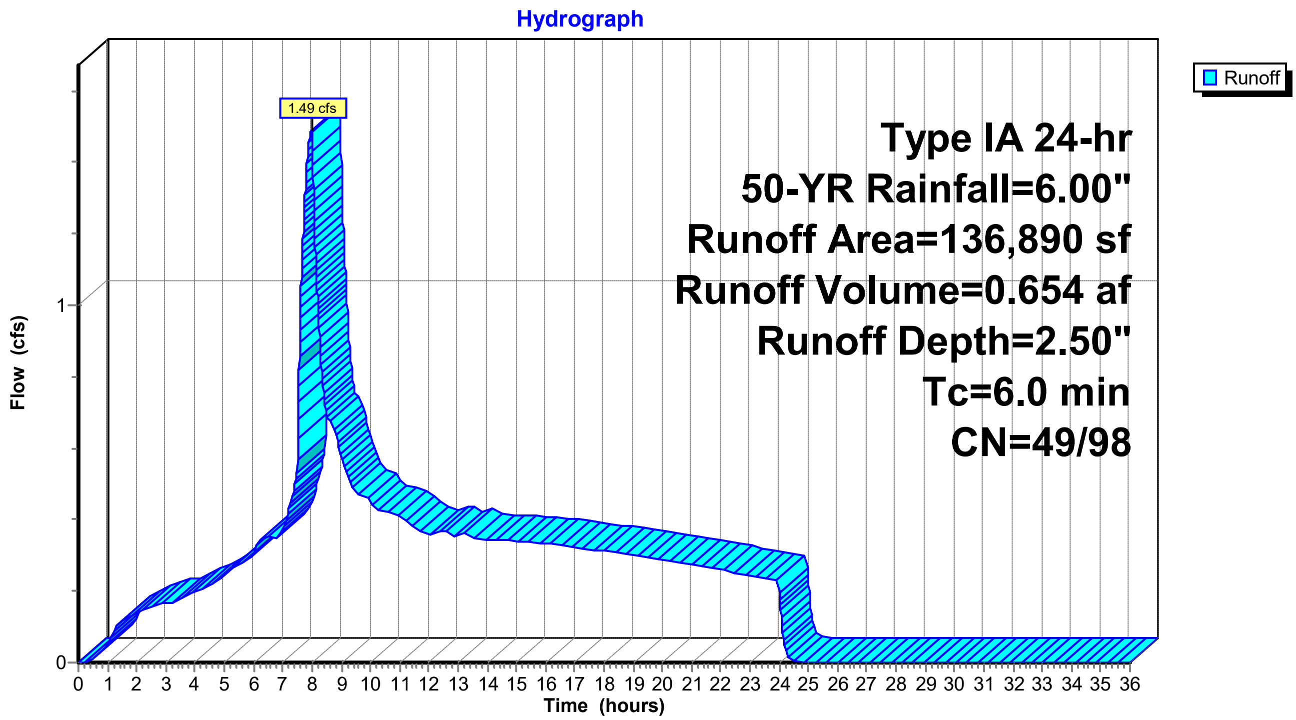
Runoff = 1.49 cfs @ 7.98 hrs, Volume= 0.654 af, Depth= 2.50"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 50-YR Rainfall=6.00"

	Area (sf)	CN	Description
*	17,610	98	Roads
*	24,000	98	On-Site Houses & Driveways (6)
*	95,280	49	Pervious - 50-75% Grass Cover, HSG A
	136,890	64	Weighted Average
	95,280	49	69.60% Pervious Area
	41,610	98	30.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND



Summary for Subcatchment 2: Basin 2

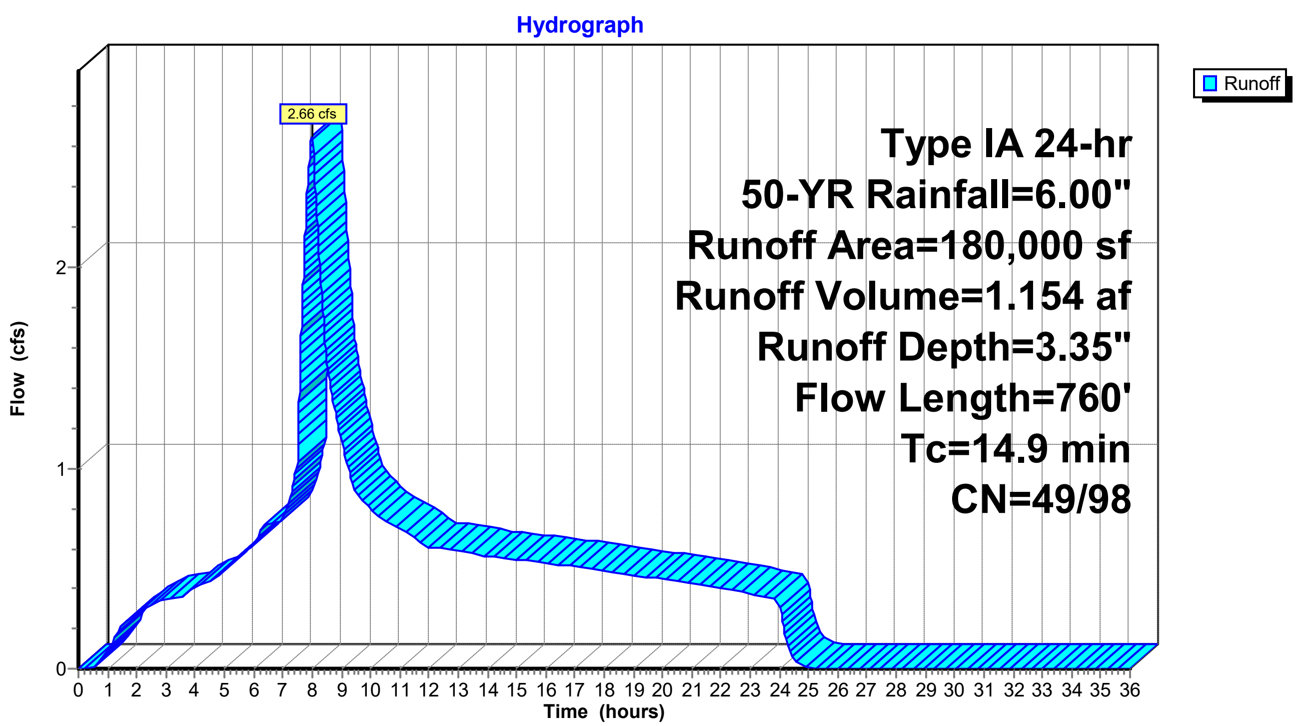
Runoff = 2.66 cfs @ 8.00 hrs, Volume= 1.154 af, Depth= 3.35"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 50-YR Rainfall=6.00"

	Area (sf)	CN	Description
*	15,500	98	On-Site Roads
*	44,000	98	On-Site Houses & Driveways (11)
*	20,000	98	Off-Site Houses & Driveways
*	92,500	49	Pervious - 50-75% Grass cover, Fair, HSG A
*	8,000	98	Off-Site - Future Highland Road
	180,000	73	Weighted Average
	92,500	49	51.39% Pervious Area
	87,500	98	48.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.3	280	0.2000	0.35		**Sheet Flow, Sheet - Lot Yards** Grass: Dense n= 0.240 P2= 3.05"
1.6	480	0.0900	4.96	39.65	**Channel Flow, Future Road Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
14.9	760	Total			

Subcatchment 2: Basin 2



Summary for Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3

Inflow Area = 8.541 ac, 27.22% Impervious, Inflow Depth = 2.02" for 50-YR event
Inflow = 3.00 cfs @ 8.00 hrs, Volume= 1.435 af
Outflow = 3.00 cfs @ 8.00 hrs, Volume= 1.435 af, Atten= 0%, Lag= 0.1 min
Discarded = 1.57 cfs @ 8.00 hrs, Volume= 1.382 af
Primary = 1.43 cfs @ 8.00 hrs, Volume= 0.053 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 369.63' @ 8.00 hrs Surf.Area= 115 sf Storage= 2,039 cf

Plug-Flow detention time= 20.4 min calculated for 1.434 af (100% of inflow)
Center-of-Mass det. time= 20.4 min (760.9 - 740.5)

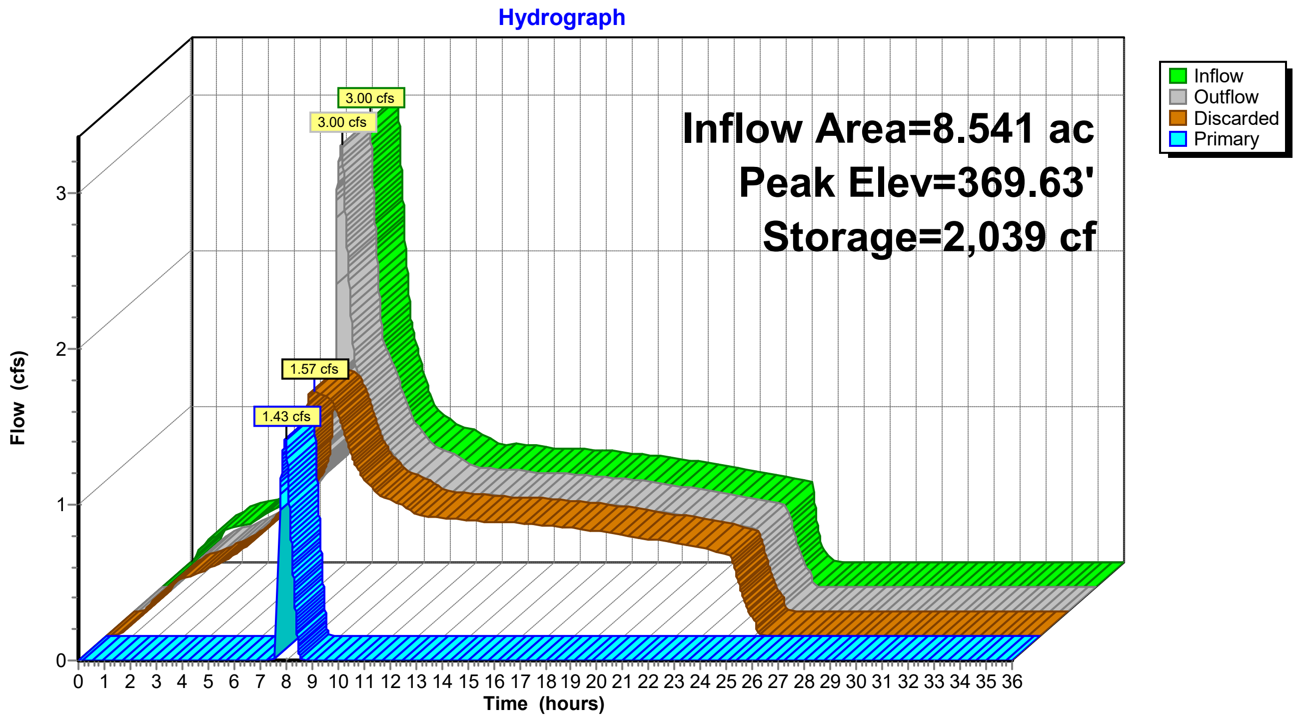
Volume	Invert	Avail.Storage	Storage Description
#1	340.00'	933 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 3 3,464 cf Overall - 1,131 cf Embedded = 2,333 cf x 40.0% Voids
#2	340.00'	1,131 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 3 Inside #1
		2,064 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	340.00'	**9.750 in/hr Exfiltration X 3.00 over Wetted area** Conductivity to Groundwater Elevation = 220.00'
#2	Primary	369.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=1.57 cfs @ 8.00 hrs HW=369.63' (Free Discharge)
└─**1=Exfiltration** (Controls 1.57 cfs)

Primary OutFlow Max=1.41 cfs @ 8.00 hrs HW=369.63' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.41 cfs @ 2.70 fps)

Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3



Summary for Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2

Inflow Area =	2.991 ac, 41.00% Impervious, Inflow Depth = 2.99" for 50-YR event			
Inflow =	1.84 cfs @	7.95 hrs, Volume=	0.746 af	
Outflow =	1.84 cfs @	7.96 hrs, Volume=	0.746 af,	Atten= 0%, Lag= 0.2 min
Discarded =	0.74 cfs @	7.96 hrs, Volume=	0.701 af	
Primary =	1.09 cfs @	7.96 hrs, Volume=	0.045 af	

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 319.53' @ 7.96 hrs Surf.Area= 77 sf Storage= 1,355 cf

Plug-Flow detention time= 28.7 min calculated for 0.746 af (100% of inflow)
Center-of-Mass det. time= 28.7 min (742.4 - 713.7)

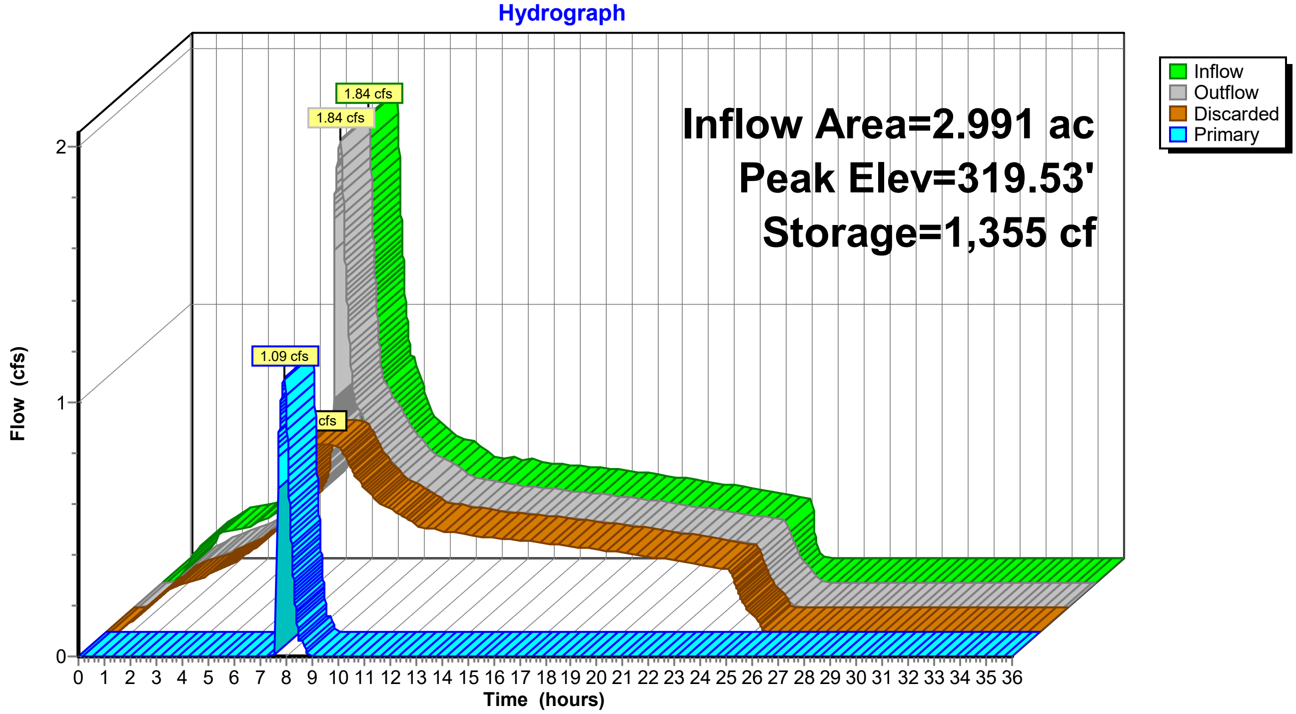
Volume	Invert	Avail.Storage	Storage Description
#1	290.00'	622 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 2 2,309 cf Overall - 754 cf Embedded = 1,555 cf x 40.0% Voids
#2	290.00'	754 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 2 Inside #1
		1,376 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	290.00'	**9.750 in/hr Exfiltration X 2.00 over Wetted area** Conductivity to Groundwater Elevation = 220.00'
#2	Primary	319.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.74 cfs @ 7.96 hrs HW=319.53' (Free Discharge)
└─**1=Exfiltration** (Controls 0.74 cfs)

Primary OutFlow Max=1.06 cfs @ 7.96 hrs HW=319.53' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.06 cfs @ 2.48 fps)

Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2



Summary for Pond P: Pond

Inflow Area = 18.807 ac, 34.64% Impervious, Inflow Depth = 1.22" for 50-YR event
Inflow = 6.67 cfs @ 8.00 hrs, Volume= 1.906 af
Outflow = 1.57 cfs @ 9.16 hrs, Volume= 1.906 af, Atten= 76%, Lag= 69.8 min
Discarded = 1.57 cfs @ 9.16 hrs, Volume= 1.906 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 296.33' @ 9.16 hrs Surf.Area= 6,898 sf Storage= 16,868 cf

Plug-Flow detention time= 123.9 min calculated for 1.905 af (100% of inflow)
Center-of-Mass det. time= 123.9 min (831.6 - 707.6)

Volume	Invert	Avail.Storage	Storage Description
#1	292.00'	30,785 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

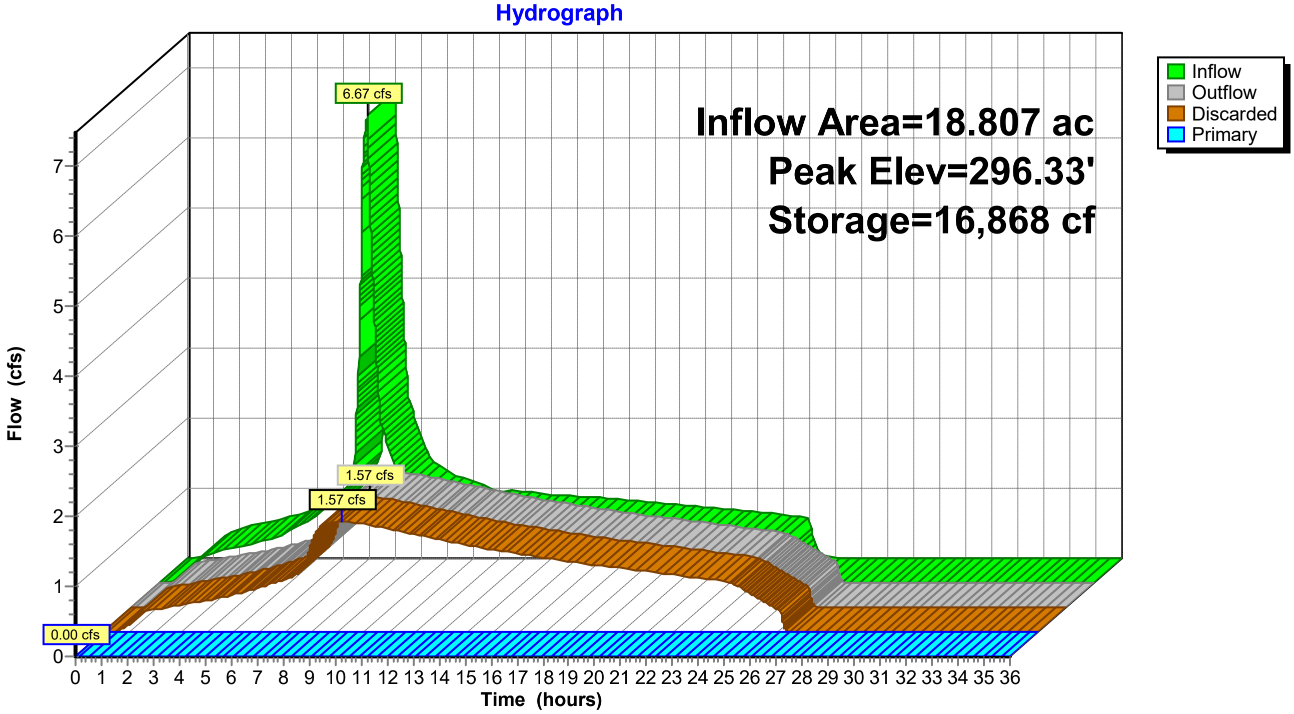
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
292.00	1,257	0	0	1,257
293.00	2,366	1,783	1,783	2,376
294.00	3,621	2,971	4,754	3,646
295.00	4,947	4,267	9,021	4,992
296.00	6,356	5,637	14,657	6,426
297.00	8,046	7,184	21,842	8,142
298.00	9,871	8,943	30,785	9,998

Device	Routing	Invert	Outlet Devices
#1	Discarded	292.00'	**9.750 in/hr Exfiltration over Wetted area**
#2	Primary	297.50'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=1.57 cfs @ 9.16 hrs HW=296.33' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.57 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=292.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P: Pond


Hydrograph
6.67 cfs
1.57 cfs
1.57 cfs
0.00 cfs
Inflow Area=18.807 ac
Peak Elev=296.33'
Storage=16,868 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

Summary for Subcatchment 1A: Basin 1A - NORTH LOTS

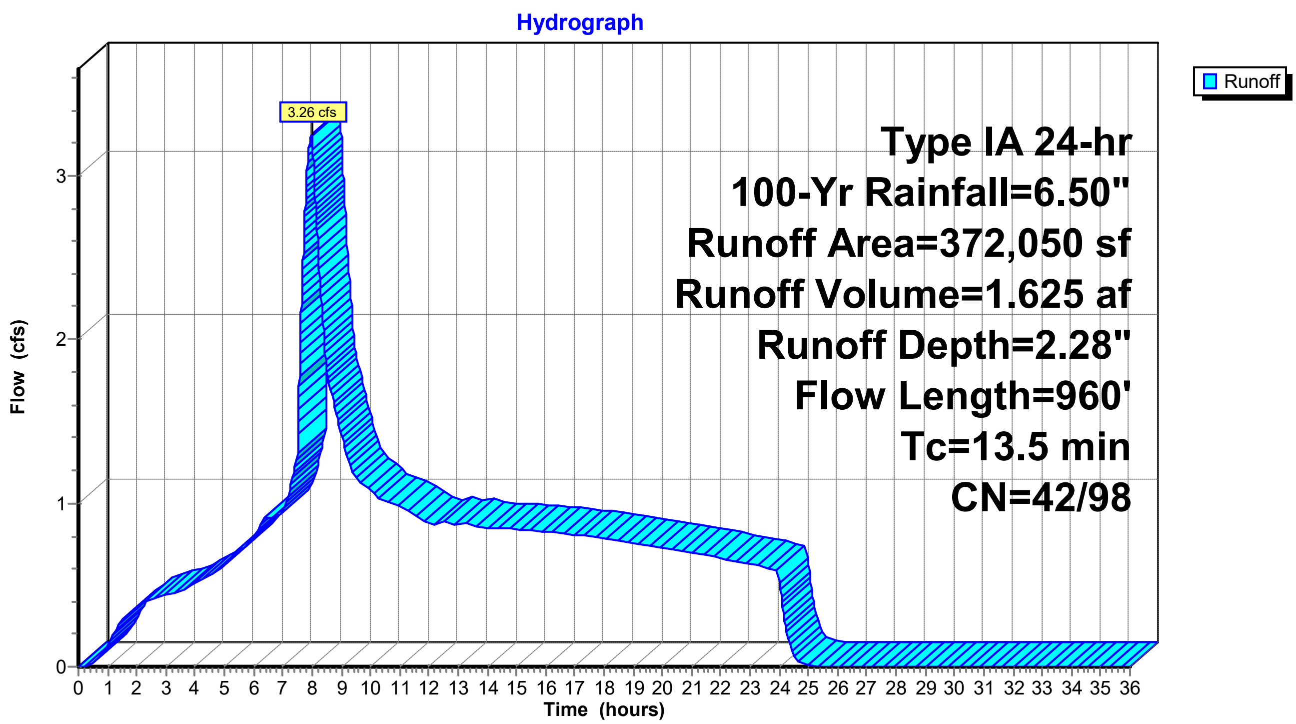
Runoff = 3.26 cfs @ 8.00 hrs, Volume= 1.625 af, Depth= 2.28"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-Yr Rainfall=6.50"

	Area (sf)	CN	Description
*	29,260	98	Roads
*	72,000	98	On-Site Houses & Driveways (18)
	114,790	49	50-75% Grass cover, Fair, HSG A
	156,000	36	Woods, Fair, HSG A
	372,050	57	Weighted Average
	270,790	42	72.78% Pervious Area
	101,260	98	27.22% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	110	0.3500	0.24		**Sheet Flow, Sheet - Offsite Woods** Woods: Light underbrush n= 0.400 P2= 3.05"
3.8	300	0.0700	1.32		**Shallow Concentrated Flow, Offsite Woods** Woodland Kv= 5.0 fps
2.1	550	0.0720	4.43	35.46	**Channel Flow, Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
13.5	960	Total			

Subcatchment 1A: Basin 1A - NORTH LOTS



Summary for Subcatchment 1B: Basin 1B - SOUTH LOTS

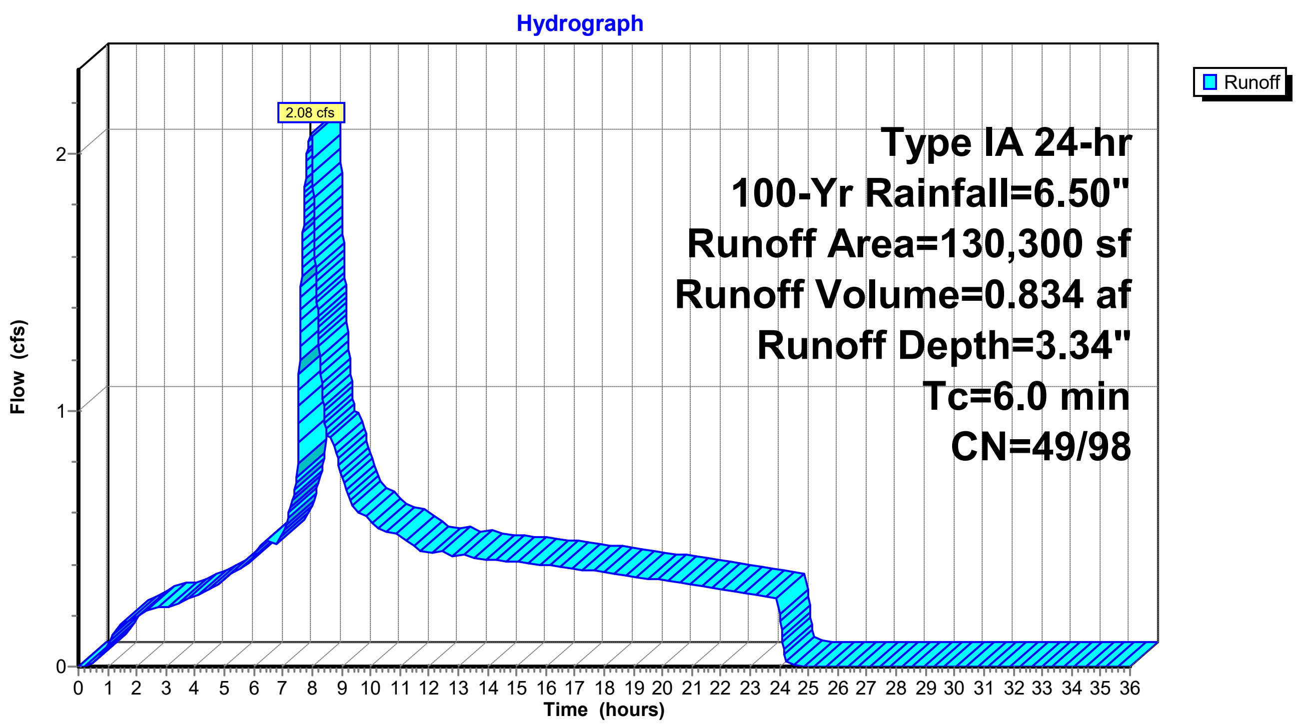
Runoff = 2.08 cfs @ 7.96 hrs, Volume= 0.834 af, Depth= 3.34"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-Yr Rainfall=6.50"

	Area (sf)	CN	Description
*	13,420	98	Roads
*	40,000	98	On-Site Houses & Driveways (10)
*	76,880	49	Pervious - 50-75% Grass Cover, HSG A
	130,300	69	Weighted Average
	76,880	49	59.00% Pervious Area
	53,420	98	41.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1B: Basin 1B - SOUTH LOTS



Summary for Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND

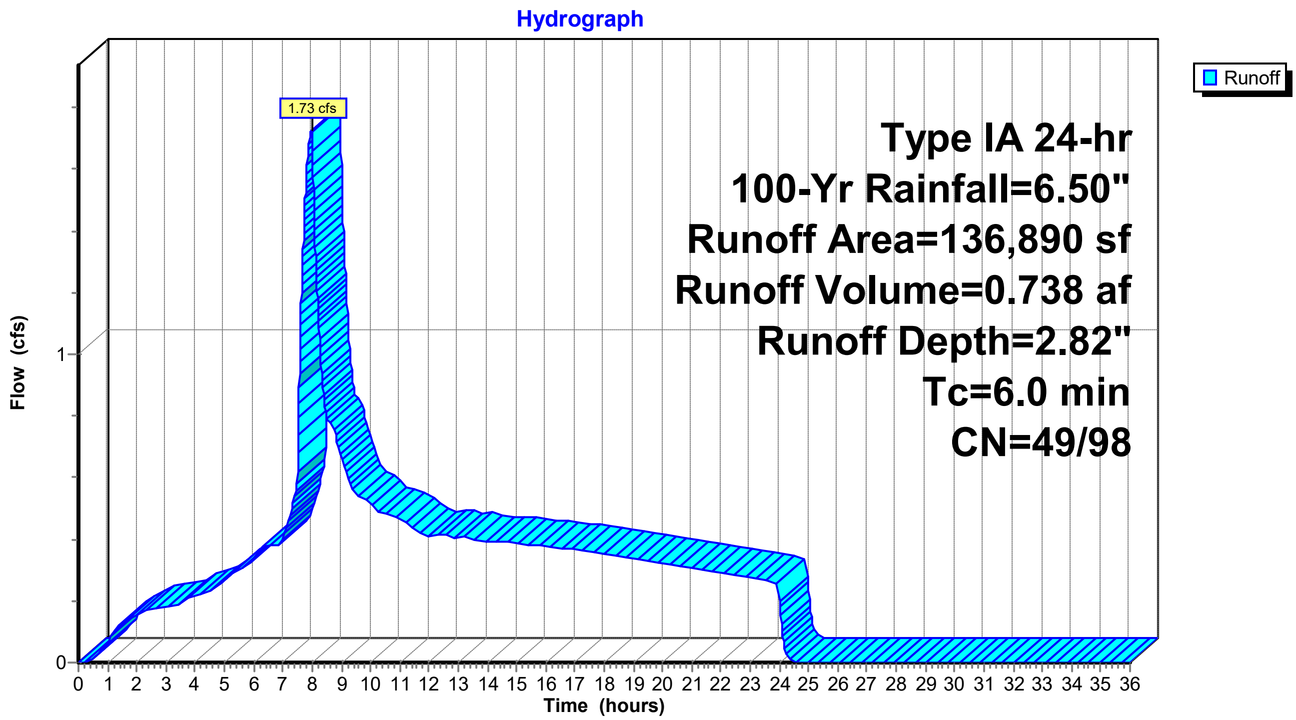
Runoff = 1.73 cfs @ 7.98 hrs, Volume= 0.738 af, Depth= 2.82"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-Yr Rainfall=6.50"

	Area (sf)	CN	Description
*	17,610	98	Roads
*	24,000	98	On-Site Houses & Driveways (6)
*	95,280	49	Pervious - 50-75% Grass Cover, HSG A
	136,890	64	Weighted Average
	95,280	49	69.60% Pervious Area
	41,610	98	30.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, Minimum**
5.0	0	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1C: Basin 1C- SHARED DRIVEWAY & POND



Summary for Subcatchment 2: Basin 2

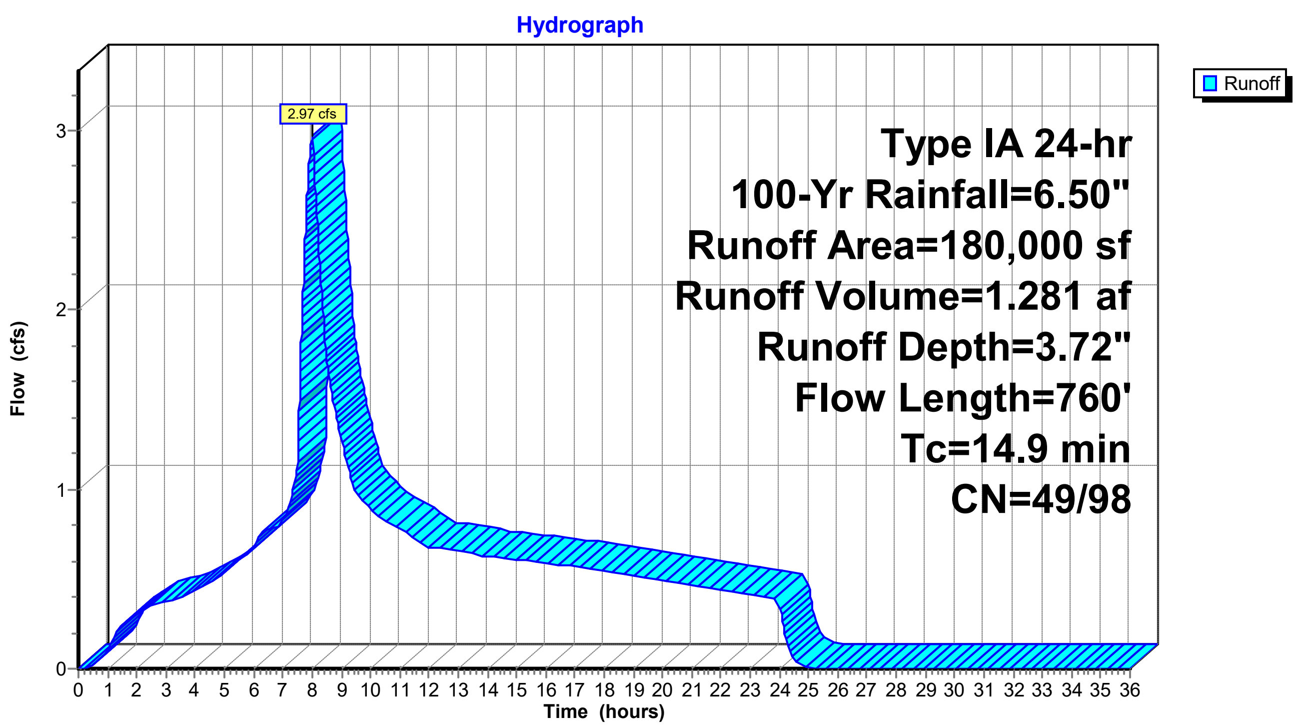
Runoff = 2.97 cfs @ 8.00 hrs, Volume= 1.281 af, Depth= 3.72"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-Yr Rainfall=6.50"

	Area (sf)	CN	Description
*	15,500	98	On-Site Roads
*	44,000	98	On-Site Houses & Driveways (11)
*	20,000	98	Off-Site Houses & Driveways
*	92,500	49	Pervious - 50-75% Grass cover, Fair, HSG A
*	8,000	98	Off-Site - Future Highland Road
	180,000	73	Weighted Average
	92,500	49	51.39% Pervious Area
	87,500	98	48.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.3	280	0.2000	0.35		**Sheet Flow, Sheet - Lot Yards** Grass: Dense n= 0.240 P2= 3.05"
1.6	480	0.0900	4.96	39.65	**Channel Flow, Future Road Ditch** Area= 8.0 sf Perim= 26.0' r= 0.31' n= 0.041 Riprap, 2-inch
14.9	760	Total			

Subcatchment 2: Basin 2



Summary for Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3

Inflow Area = 8.541 ac, 27.22% Impervious, Inflow Depth = 2.28" for 100-Yr event
Inflow = 3.26 cfs @ 8.00 hrs, Volume= 1.625 af
Outflow = 3.26 cfs @ 8.00 hrs, Volume= 1.625 af, Atten= 0%, Lag= 0.1 min
Discarded = 1.57 cfs @ 8.00 hrs, Volume= 1.551 af
Primary = 1.68 cfs @ 8.00 hrs, Volume= 0.074 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 369.70' @ 8.00 hrs Surf.Area= 115 sf Storage= 2,044 cf

Plug-Flow detention time= 20.4 min calculated for 1.625 af (100% of inflow)
Center-of-Mass det. time= 20.4 min (765.5 - 745.1)

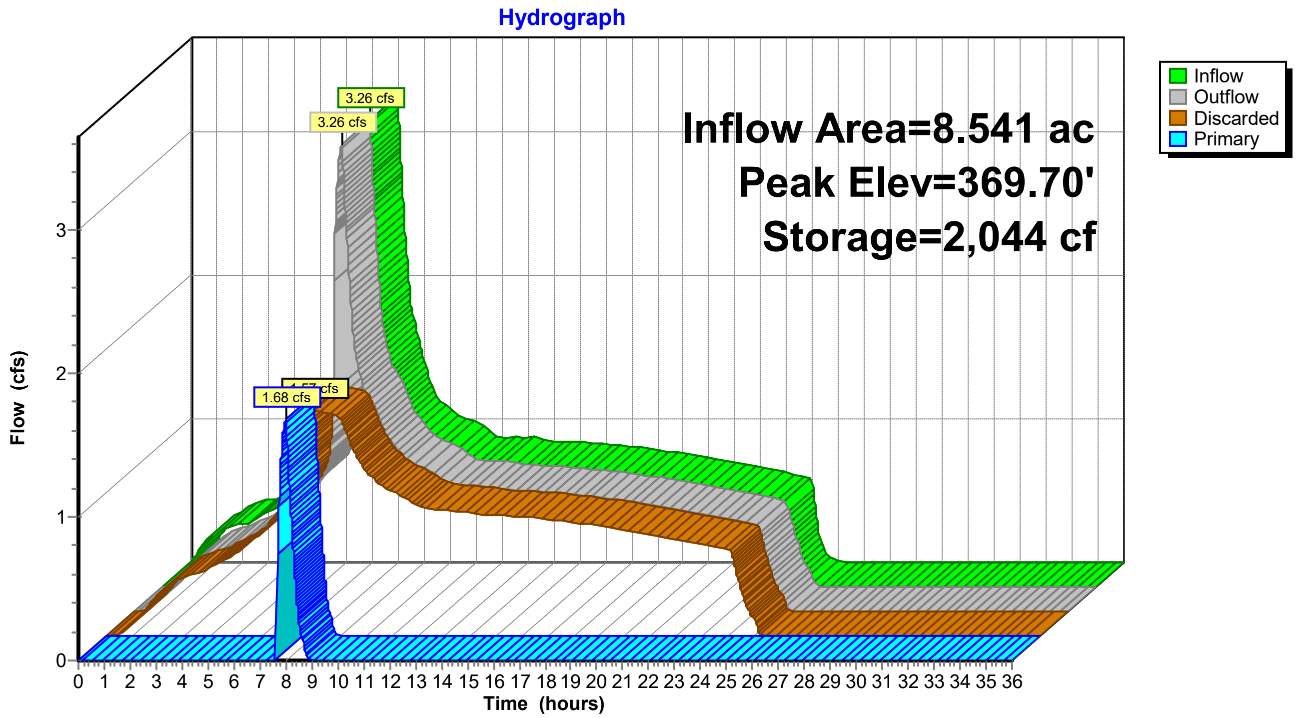
Volume	Invert	Avail.Storage	Storage Description
#1	340.00'	933 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 3 3,464 cf Overall - 1,131 cf Embedded = 2,333 cf x 40.0% Voids
#2	340.00'	1,131 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 3 Inside #1
		2,064 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	340.00'	**9.750 in/hr Exfiltration X 3.00 over Wetted area** Conductivity to Groundwater Elevation = 220.00'
#2	Primary	369.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=1.57 cfs @ 8.00 hrs HW=369.70' (Free Discharge)
└─**1=Exfiltration** (Controls 1.57 cfs)

Primary OutFlow Max=1.68 cfs @ 8.00 hrs HW=369.70' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.68 cfs @ 2.85 fps)

Pond DWA: 9.75" Conductivty - 30' Deep Dry Well x 3



Summary for Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2

Inflow Area = 2.991 ac, 41.00% Impervious, Inflow Depth = 3.34" for 100-Yr event
Inflow = 2.08 cfs @ 7.96 hrs, Volume= 0.834 af
Outflow = 2.08 cfs @ 7.96 hrs, Volume= 0.834 af, Atten= 0%, Lag= 0.2 min
Discarded = 0.75 cfs @ 7.96 hrs, Volume= 0.770 af
Primary = 1.33 cfs @ 7.96 hrs, Volume= 0.064 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 319.60' @ 7.96 hrs Surf.Area= 77 sf Storage= 1,358 cf

Plug-Flow detention time= 28.3 min calculated for 0.834 af (100% of inflow)
Center-of-Mass det. time= 28.3 min (743.3 - 715.0)

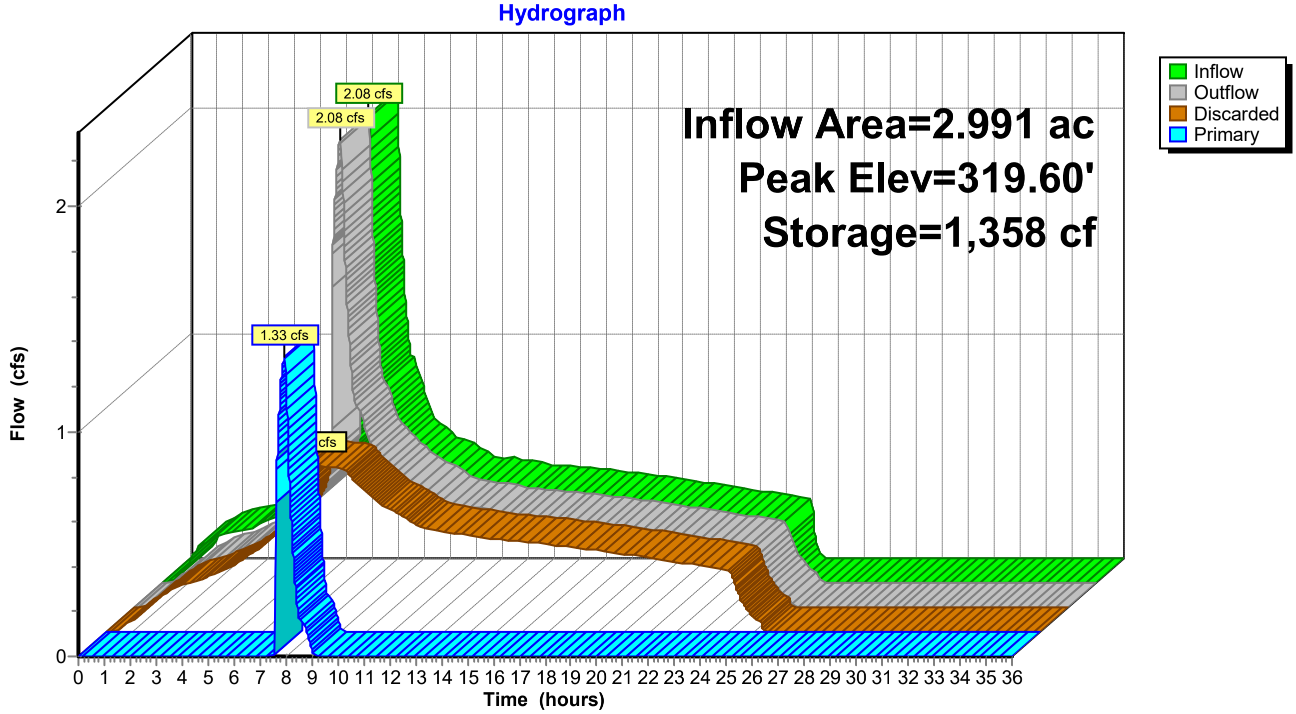
Volume	Invert	Avail.Storage	Storage Description
#1	290.00'	622 cf	**7.00'D x 30.00'H Vertical Cone/Cylinder** x 2
			2,309 cf Overall - 754 cf Embedded = 1,555 cf x 40.0% Voids
#2	290.00'	754 cf	**4.00'D x 30.00'H Vertical Cone/Cylinder** x 2 Inside #1
		1,376 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Discarded	290.00'	**9.750 in/hr Exfiltration X 2.00 over Wetted area**
			Conductivity to Groundwater Elevation = 220.00'
#2	Primary	319.00'	**12.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.75 cfs @ 7.96 hrs HW=319.60' (Free Discharge)
└─**1=Exfiltration** (Controls 0.75 cfs)

Primary OutFlow Max=1.31 cfs @ 7.96 hrs HW=319.60' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.31 cfs @ 2.64 fps)

Pond DWB: 9.75" Conductivty - 30' Deep Dry Well x 2



Summary for Pond P: Pond

Inflow Area = 18.807 ac, 34.64% Impervious, Inflow Depth = 1.38" for 100-Yr event
Inflow = 7.71 cfs @ 8.00 hrs, Volume= 2.157 af
Outflow = 1.77 cfs @ 9.17 hrs, Volume= 2.157 af, Atten= 77%, Lag= 70.5 min
Discarded = 1.77 cfs @ 9.17 hrs, Volume= 2.157 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 296.82' @ 9.17 hrs Surf.Area= 7,735 sf Storage= 20,459 cf

Plug-Flow detention time= 137.6 min calculated for 2.157 af (100% of inflow)
Center-of-Mass det. time= 137.6 min (843.5 - 705.9)

Volume	Invert	Avail.Storage	Storage Description
#1	292.00'	30,785 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

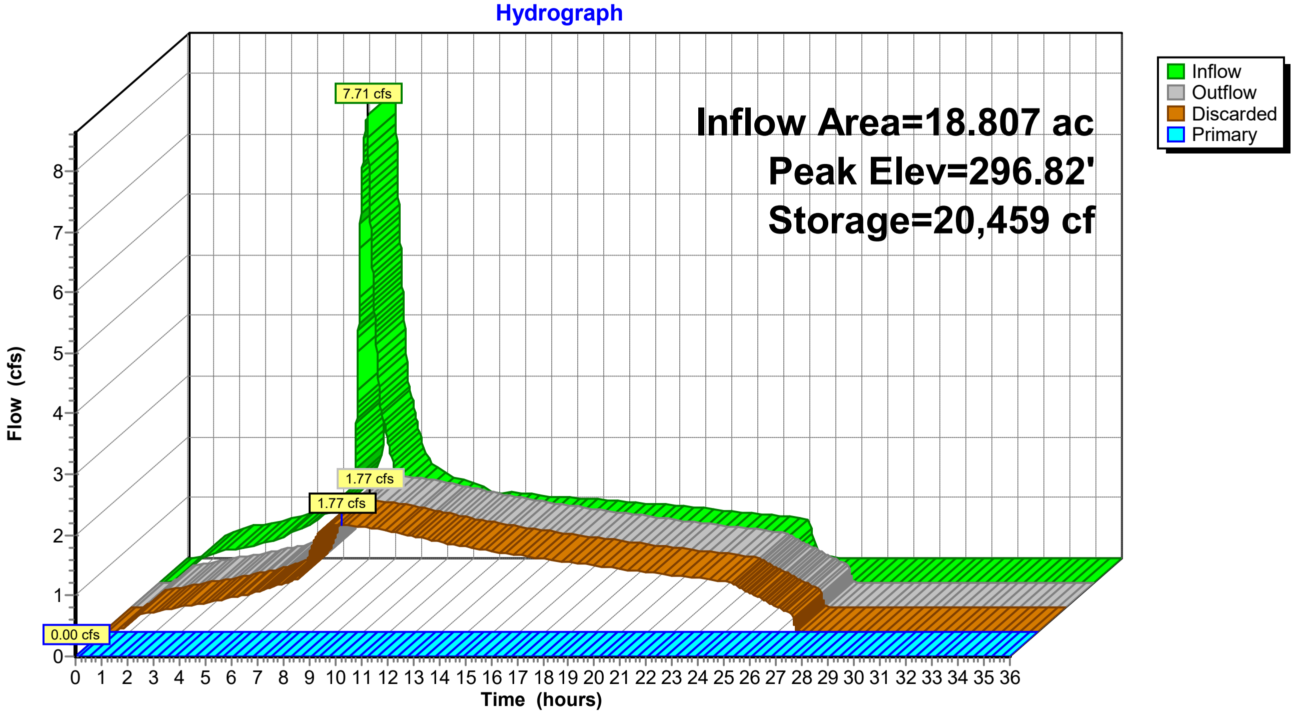
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
292.00	1,257	0	0	1,257
293.00	2,366	1,783	1,783	2,376
294.00	3,621	2,971	4,754	3,646
295.00	4,947	4,267	9,021	4,992
296.00	6,356	5,637	14,657	6,426
297.00	8,046	7,184	21,842	8,142
298.00	9,871	8,943	30,785	9,998

Device	Routing	Invert	Outlet Devices
#1	Discarded	292.00'	**9.750 in/hr Exfiltration over Wetted area**
#2	Primary	297.50'	**25.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Discarded OutFlow Max=1.77 cfs @ 9.17 hrs HW=296.82' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.77 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=292.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

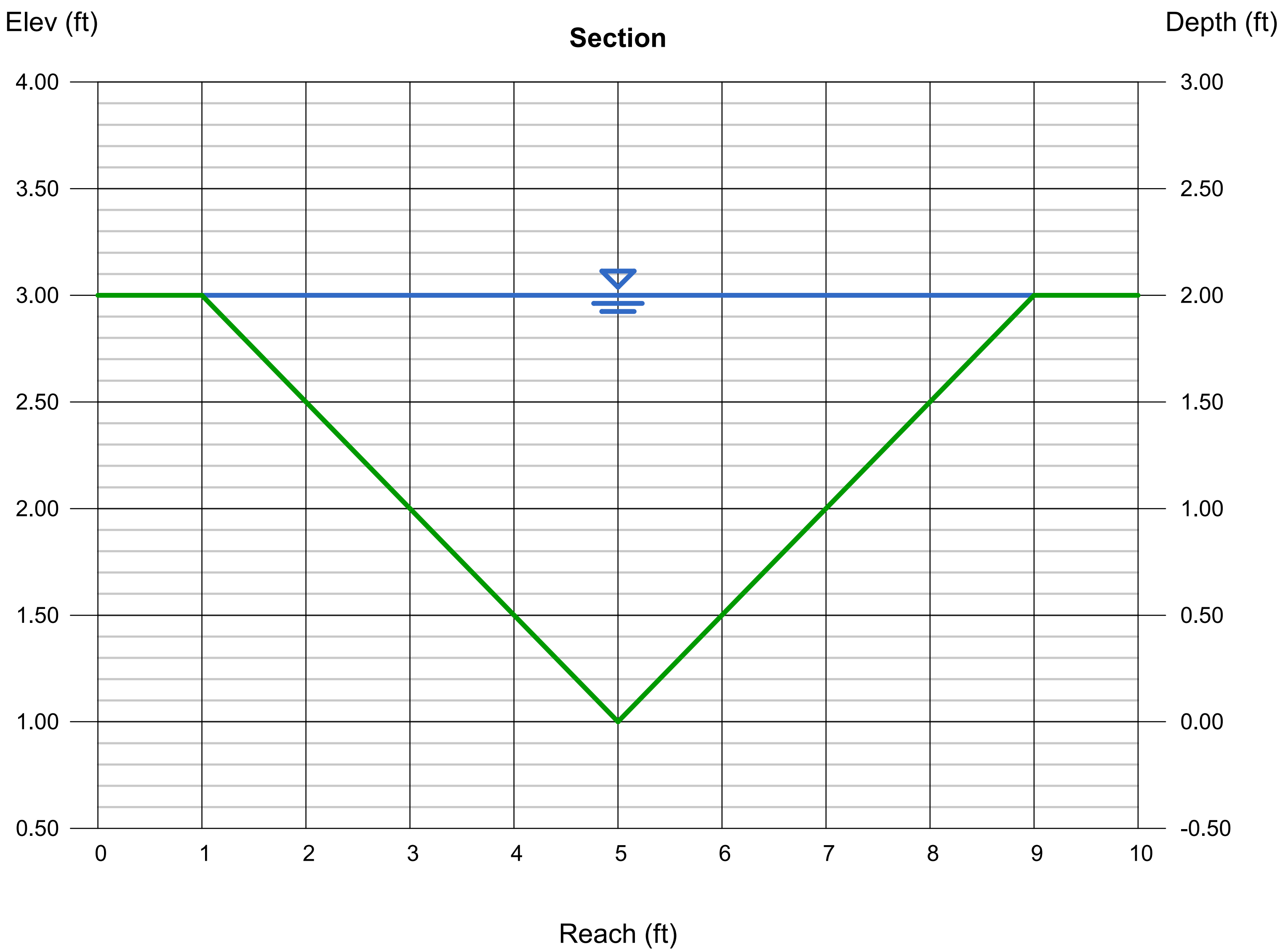
Pond P: Pond


Hydrograph
7.71 cfs
1.77 cfs
1.77 cfs
0.00 cfs
Inflow Area=18.807 ac
Peak Elev=296.82'
Storage=20,459 cf
Inflow
Outflow
Discarded
Primary
Flow (cfs)
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

Channel Report

Max Capacity - Ditch at 1.00%

Triangular		**Highlighted**	
Side Slopes (z:1)	= 2.00, 2.00	Depth (ft)	= 2.00
Total Depth (ft)	= 2.00	Q (cfs)	= 13.79
		Area (sqft)	= 8.00
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 1.72
Slope (%)	= 1.00	Wetted Perim (ft)	= 8.94
N-Value	= 0.080	Crit Depth, Yc (ft)	= 1.25
		Top Width (ft)	= 8.00
Calculations		EGL (ft)	= 2.05
Compute by:	Known Depth		
Known Depth (ft)	= 2.00		



Depth	Q	Area	Veloc	Wp
(ft)	(cfs)	(sqft)	(ft/s)	(ft)
0.10	0.005	0.020	0.23	0.45
0.20	0.030	0.080	0.37	0.89
0.30	0.088	0.180	0.49	1.34
0.40	0.189	0.320	0.59	1.79
0.50	0.342	0.500	0.68	2.24
0.60	0.556	0.720	0.77	2.68
0.70	0.839	0.980	0.86	3.13
0.80	1.198	1.280	0.94	3.58
0.90	1.640	1.620	1.01	4.02
1.00	2.172	2.000	1.09	4.47
1.10	2.801	2.420	1.16	4.92
1.20	3.532	2.880	1.23	5.37
1.30	4.373	3.380	1.29	5.81
1.40	5.328	3.920	1.36	6.26
1.50	6.405	4.500	1.42	6.71
1.60	7.607	5.120	1.49	7.16
1.70	8.943	5.780	1.55	7.60
1.80	10.42	6.480	1.61	8.05
1.90	12.03	7.220	1.67	8.50
2.00	13.79	8.000	1.72	8.94

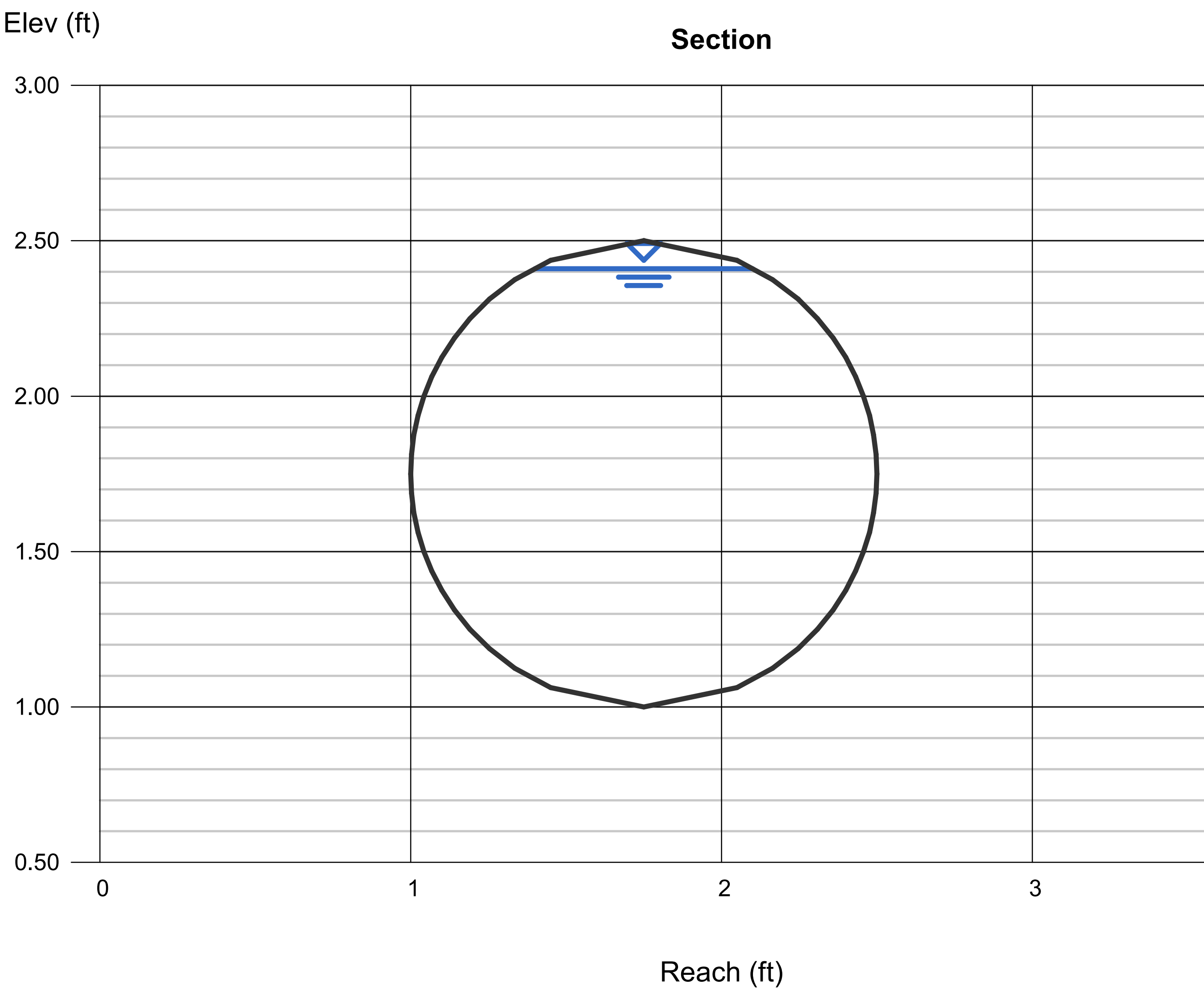
Yc	TopWidth	Energy
(ft)	(ft)	(ft)
0.06	0.40	0.10
0.11	0.80	0.20
0.17	1.20	0.30
0.23	1.60	0.41
0.29	2.00	0.51
0.35	2.40	0.61
0.41	2.80	0.71
0.47	3.20	0.81
0.53	3.60	0.92
0.60	4.00	1.02
0.66	4.40	1.12
0.73	4.80	1.22
0.79	5.20	1.33
0.85	5.60	1.43
0.92	6.00	1.53
0.98	6.40	1.63
1.05	6.80	1.74
1.12	7.20	1.84
1.18	7.60	1.94
1.25	8.00	2.05

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Jan 11 2021

Max Capacity - 18in at 1.00%

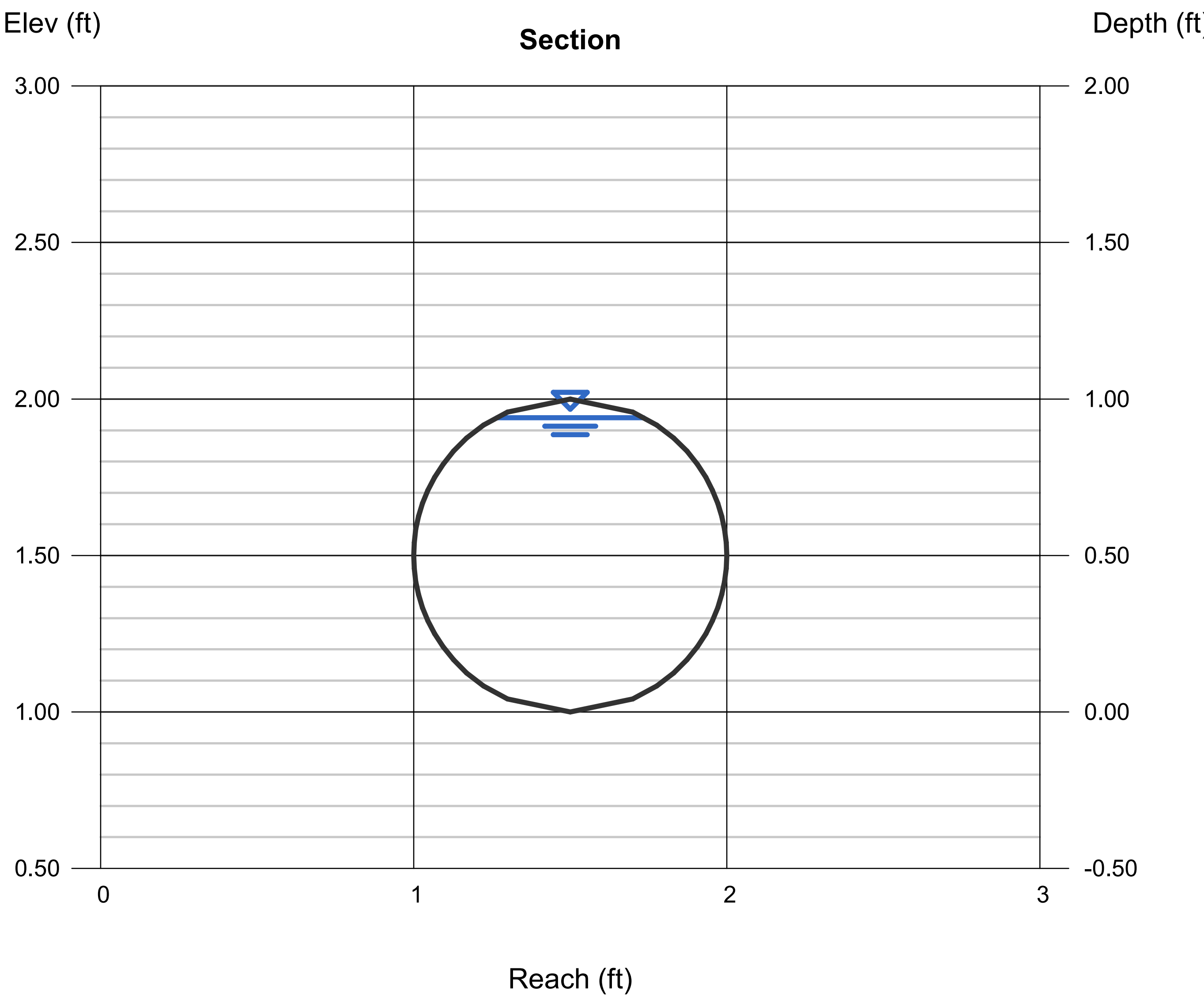
Circular		**Highlighted**	
Diameter (ft)	= 1.50	Depth (ft)	= 1.41
		Q (cfs)	= 13.35
		Area (sqft)	= 1.72
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 7.74
Slope (%)	= 1.00	Wetted Perim (ft)	= 3.98
N-Value	= 0.011	Crit Depth, Yc (ft)	= 1.37
		Top Width (ft)	= 0.71
Calculations		EGL (ft)	= 2.34
Compute by:	Known Depth		
Known Depth (ft)	= 1.41		



Channel Report

Max Capacity - 12in at 1.00%

Circular		**Highlighted**	
Diameter (ft)	= 1.00	Depth (ft)	= 0.94
		Q (cfs)	= 4.527
		Area (sqft)	= 0.77
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 5.91
Slope (%)	= 1.00	Wetted Perim (ft)	= 2.65
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.89
		Top Width (ft)	= 0.47
Calculations		EGL (ft)	= 1.48
Compute by:	Known Depth		
Known Depth (ft)	= 0.94		

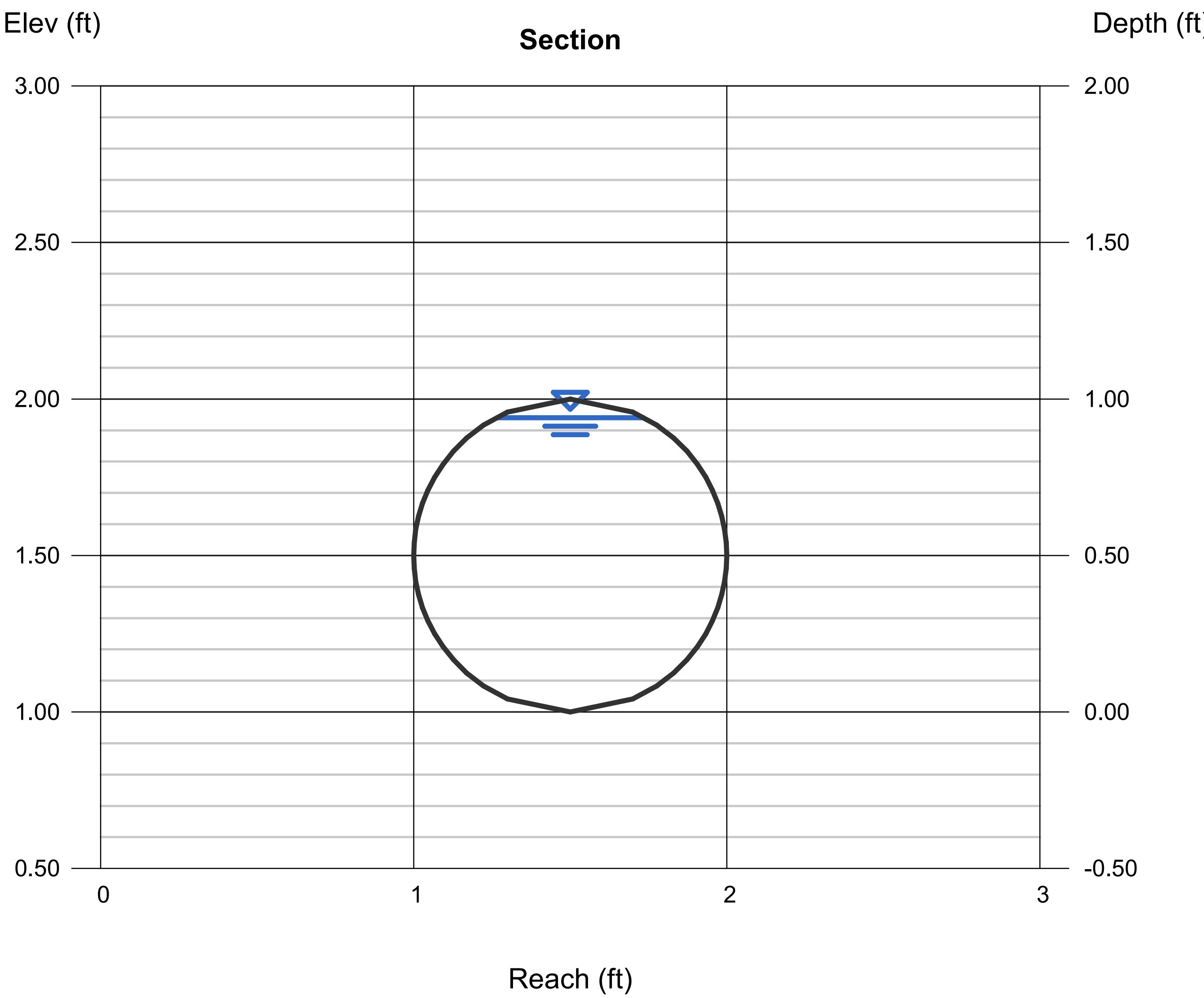


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Mar 31 2021

Max Capacity - 12in at 2.00%

Circular		**Highlighted**	
Diameter (ft)	= 1.00	Depth (ft)	= 0.94
		Q (cfs)	= 6.402
		Area (sqft)	= 0.77
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 8.35
Slope (%)	= 2.00	Wetted Perim (ft)	= 2.65
N-Value	= 0.011	Crit Depth, Yc (ft)	= 0.97
		Top Width (ft)	= 0.47
Calculations		EGL (ft)	= 2.02
Compute by:	Known Depth		
Known Depth (ft)	= 0.94		



APPENDIX B

Referenced Data

United States Department of Agriculture

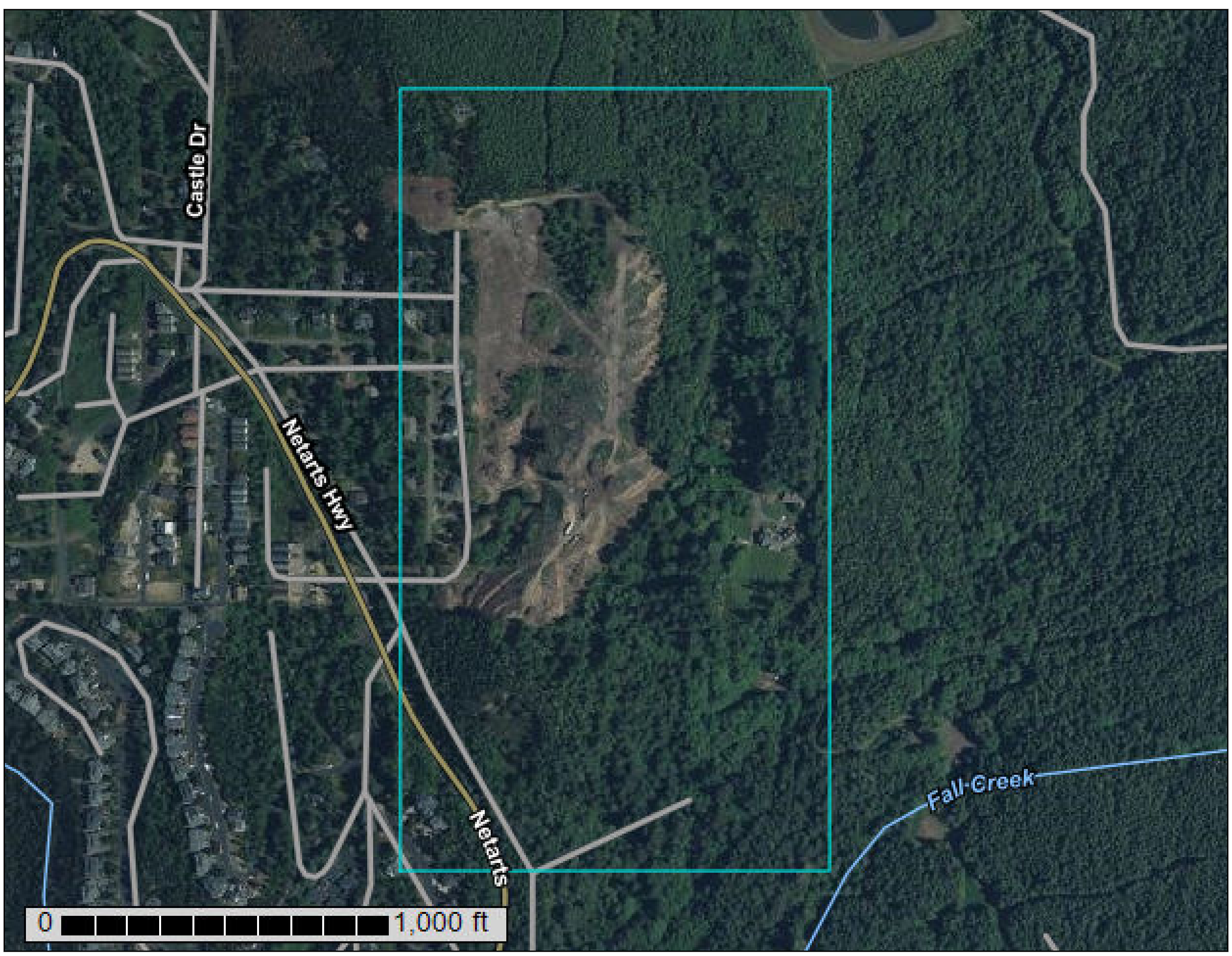
NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

Tillamook County, Oregon



November 25, 2020

Preface

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

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

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

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

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

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

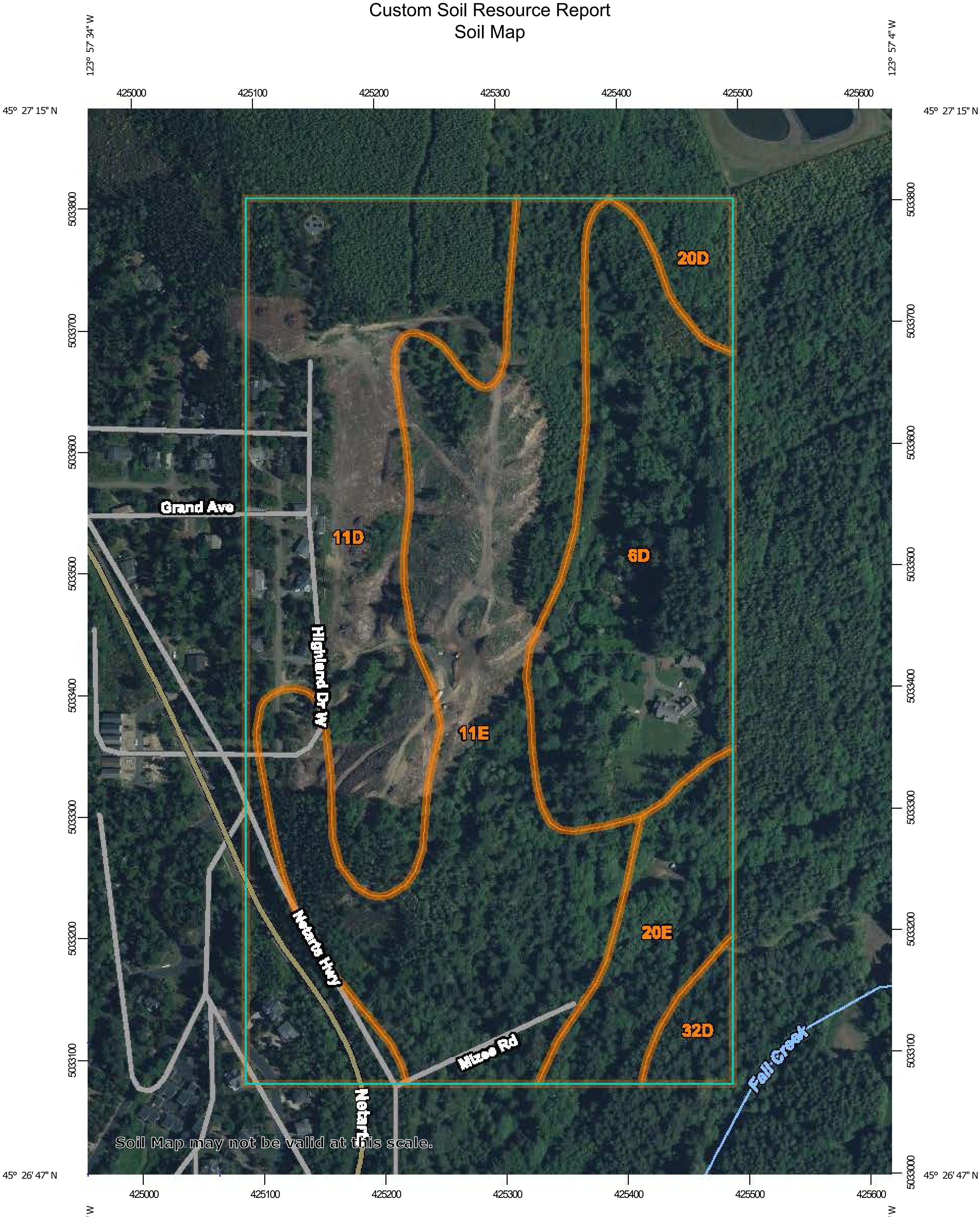
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Soil Map

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

Soil Map



Map Scale: 1:4,260 if printed on A portrait (8.5" x 11") sheet.

N

0 50 100 200 300 Meters

0 200 400 800 1200 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

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

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

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

Soil Survey Area: Tillamook County, Oregon
Survey Area Data: Version 12, Jun 11, 2020

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

Date(s) aerial images were photographed: May 28, 2020—Jun 22, 2020

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6D	Horseprairie-Ferrelo complex, 3 to 20 percent slopes	15.3	21.0%
11D	Netarts fine sandy loam, 5 to 30 percent slopes	23.5	32.4%
11E	Netarts fine sandy loam, 30 to 60 percent slopes	25.5	35.2%
20D	Klootchie-Necanicum complex, 5 to 30 percent slopes	1.8	2.4%
20E	Klootchie-Necanicum complex, 30 to 60 percent slopes	5.1	7.0%
32D	Munsoncreek-Flowerpot complex, 5 to 30 percent slopes	1.4	1.9%
Totals for Area of Interest		**72.5**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Tillamook County, Oregon

6D—Horseprairie-Ferrelo complex, 3 to 20 percent slopes

Map Unit Setting

National map unit symbol: 280k
Elevation: 100 to 300 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Horseprairie and similar soils: 65 percent
Ferrelo and similar soils: 25 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Horseprairie

Setting

Landform: Marine terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian and/or marine deposits

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 11 inches: medial loam
Bw1 - 11 to 28 inches: loam
Bw2 - 28 to 45 inches: loam
2C - 45 to 62 inches: loamy sand

Properties and qualities

Slope: 3 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 10.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Forage suitability group: Well Drained <15% Slopes (G004AY014OR)
Other vegetative classification: Well Drained <15% Slopes (G004AY014OR), Sitka spruce/oxalis, swordfern-moist (902)
Hydric soil rating: No

Description of Ferrelo

Setting

Landform: Marine terraces
Landform position (three-dimensional): Riser
Down-slope shape: Convex
Across-slope shape: Linear, convex
Parent material: Eolian and/or marine deposits

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 19 inches: loam
Bw - 19 to 37 inches: loam
2C1 - 37 to 55 inches: loamy fine sand
2C2 - 55 to 89 inches: fine sand

Properties and qualities

Slope: 3 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Forage suitability group: Well Drained <15% Slopes (G004AY014OR)
Other vegetative classification: Well Drained <15% Slopes (G004AY014OR), Sitka spruce/oxalis, swordfern-moist (902)
Hydric soil rating: No

Minor Components

Depoe

Percent of map unit: 5 percent
Landform: Depressions on marine terraces
Hydric soil rating: Yes

11D—Netarts fine sandy loam, 5 to 30 percent slopes

Map Unit Setting

National map unit symbol: 27w3
Elevation: 20 to 300 feet
Mean annual precipitation: 80 to 100 inches

Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 180 to 300 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Netarts and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Netarts

Setting

Landform: Dunes on marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 5 inches: fine sandy loam
E - 5 to 9 inches: loamy fine sand
ABs - 9 to 15 inches: loamy fine sand
Bs1 - 15 to 19 inches: fine sand
Bs2 - 19 to 37 inches: fine sand
BCs - 37 to 54 inches: fine sand
C - 54 to 67 inches: fine sand

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Other vegetative classification: Sitka spruce/salal-mesic (901)
Hydric soil rating: No

11E—Netarts fine sandy loam, 30 to 60 percent slopes

Map Unit Setting

National map unit symbol: 280q
Elevation: 20 to 300 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 49 to 52 degrees F

Frost-free period: 180 to 300 days
Farmland classification: Not prime farmland

Map Unit Composition

Netarts and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Netarts

Setting

Landform: Dunes on marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Eolian sands

Typical profile

Oi - 0 to 2 inches: slightly decomposed plant material
A - 2 to 5 inches: fine sandy loam
E - 5 to 9 inches: loamy fine sand
ABs - 9 to 15 inches: loamy fine sand
Bs1 - 15 to 19 inches: fine sand
Bs2 - 19 to 37 inches: fine sand
BCs - 37 to 54 inches: fine sand
C - 54 to 67 inches: fine sand

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Other vegetative classification: Sitka spruce/salal-mesic (901)
Hydric soil rating: No

20D—Klootchie-Necanicum complex, 5 to 30 percent slopes

Map Unit Setting

National map unit symbol: 27xq
Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Farmland classification: Not prime farmland

Map Unit Composition

Klootchie and similar soils: 60 percent
Necanicum and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Mountaintop, mountainbase
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Colluvium and residuum derived from igneous rock and tuff

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A1 - 1 to 9 inches: medial silt loam
A2 - 9 to 19 inches: medial silt loam
Bw1 - 19 to 44 inches: medial silty clay loam
Bw2 - 44 to 68 inches: medial silty clay loam

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: Sitka spruce/salmonberry-wet (903)
Hydric soil rating: No

Description of Necanicum

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Mountaintop, mountainbase
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous rock and tuff

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A1 - 1 to 10 inches: very gravelly medial loam
A2 - 10 to 18 inches: very gravelly medial loam
Bw1 - 18 to 27 inches: very gravelly medial loam

Bw2 - 27 to 49 inches: extremely cobbly medial loam
Bw3 - 49 to 71 inches: extremely cobbly medial loam

Properties and qualities
Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.8 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: Sitka spruce/salmonberry-wet (903)
Hydric soil rating: No

20E—Klootchie-Necanicum complex, 30 to 60 percent slopes

Map Unit Setting
National map unit symbol: 27x3
Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition
Klootchie and similar soils: 55 percent
Necanicum and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Klootchie

Setting
Landform: Mountain slopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Center third of mountainflank, lower third of mountainflank
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Colluvium and residuum derived from igneous rock and tuff

Typical profile
Oi - 0 to 1 inches: slightly decomposed plant material
A1 - 1 to 9 inches: medial silt loam
A2 - 9 to 19 inches: medial silt loam

Bw1 - 19 to 44 inches: medial silty clay loam
Bw2 - 44 to 68 inches: medial silty clay loam

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: Sitka spruce/oxalis, swordfern-moist (902)
Hydric soil rating: No

Description of Necanicum

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Upper third of mountainflank, lower third of mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous rock and tuff

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A1 - 1 to 10 inches: very gravelly medial loam
A2 - 10 to 18 inches: very gravelly medial loam
Bw1 - 18 to 27 inches: very gravelly medial loam
Bw2 - 27 to 49 inches: extremely cobbly medial loam
Bw3 - 49 to 71 inches: extremely cobbly medial loam

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Other vegetative classification: Sitka spruce/oxalis, swordfern-moist (902)
Hydric soil rating: No

32D—Munsoncreek-Flowerpot complex, 5 to 30 percent slopes

Map Unit Setting

National map unit symbol: 27zw
Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Munsoncreek and similar soils: 65 percent
Flowerpot and similar soils: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Munsoncreek

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Mountainbase, mountaintop, base slope, interfluve
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Colluvium and residuum derived from sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 10 inches: medial silt loam
AB - 10 to 18 inches: silty clay loam
Bw1 - 18 to 28 inches: silty clay loam
Bw2 - 28 to 41 inches: silty clay loam
Bw3 - 41 to 58 inches: extremely paragravelly silty clay loam
Cr - 58 to 68 inches: weathered bedrock

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 11.4 inches)

Interpretive groups

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

Other vegetative classification: Sitka spruce/salmonberry-wet (903)
Hydric soil rating: No

Description of Flowerpot

Setting

Landform: Hillslopes, mountain slopes
Landform position (two-dimensional): Toeslope, summit
Landform position (three-dimensional): Mountainbase, mountaintop, interfluve, base slope
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Colluvium and residuum derived from sedimentary rock

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A1 - 1 to 8 inches: medial silty clay loam
A2 - 8 to 14 inches: silty clay loam
AB - 14 to 22 inches: silty clay loam
Bw - 22 to 30 inches: silty clay loam
Bg - 30 to 52 inches: silty clay loam
BC - 52 to 60 inches: silty clay loam

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.57 in/hr)
Depth to water table: About 14 to 22 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 13.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C/D
Other vegetative classification: Sitka spruce/salmonberry-wet (903)
Hydric soil rating: No

APPENDIX A - HYDRAULIC ROUGHNESS (MANNING'S n) VALUES OF CONDUITS AND CHANNELS

This appendix lists Manning's roughness (n) values for various conduits and channels, as follows:

Sources: • Chow, Ven Te, "Open-Channel Hydraulics," 1959

• FHWA, "Design of Urban Highway Drainage, The State of the Art," 1979

• FHWA, "Hydraulic Design Series No. 3, Design Charts for Open-Channel Flow," 1961

• FHWA, "Hydraulic Engineering Circular No. 15, Design of Roadside Channels with Flexible Linings," 1988

• FHWA, "Hydraulic Engineering Circular No. 22, Urban Drainage Design Manual," 1996

• ODOT, "Memo to Designers, Helical Corrugated Pipe," 1992

TABLE 1: CONDUITS

Conduit	HYDRAULIC ROUGHNESS (MANNING'S n) VALUES		
	Minimum	**Normal**	**Maximum**
A. Concrete or asbestos-cement pipe	0.011	0.013	0.015
B. Metal pipe or pipe-arch with annular corrugations			
1. 2-2/3-inch x ½-inch corrugations			
a. Plain or fully coated	.....	0.024	.....
b. Paved invert (range represents 25 and 50 percent of circumference paved, with larger n value representing 25 percent paved)			
1. Full flow depth	0.018	.....	0.021
2. Flow 80 percent of depth	0.016	.....	0.021
3. Flow 60 percent of depth	0.013	.....	0.019
2. 3-inch x 1-inch corrugations	.....	0.027	.....
3. 6-inch x 2-inch corrugations	.....	0.032	.....
C. Smooth walled helical spiral rib pipe	0.012	.....	0.013
D. Corrugated metal subdrain	0.017	0.019	0.021
E. Plastic pipe USE n=0.011 FOR NEW CULVERTS			
1. Smooth	$\boxed{0.011}$	.....	0.015
2. Corrugated	.....	0.024	.....
F. Metal pipe or pipe arch with helically wound corrugations			
1. Smaller pipes			
12 inch	.....	0.013	.....
15 inch	.....	0.014	.....
18 *inch*	.....	0.015	.....

TABLE 5: EXCAVATED ARTIFICIAL CHANNELS

Channel	HYDRAULIC ROUGHNESS (MANNING'S n) VALUES		
	Minimum	Normal	Maximum
A. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
B. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
C. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
D. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
E. Channels not maintained, weeds and brush uncut	ROADSIDE DITCH – ASSUME n=0.080		
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080

EMS
ENVIRONMENTAL
MANAGEMENT
SYSTEMS, INC.

OR: 503-353-9691
OREGON COAST: 503-322-2700
FAX: 503-353-9695
WA: 360-735-1109
www.envmgtsys.com
4080 SE International Way
Suite B112
Milwaukie, OR 97222

February 12th, 2021
Report # 21-0008

Bill Hughes
Avalon Heights LLC
41901 Old Highway 30
Astoria, OR 97103

REGARDING: Stormwater Infiltration Test, Avalon Heights, Netarts-Oceanside, Oregon
T: 1S, R: 10W, SW ¼ SE ¼ Section 30, TL 200

Dear Mr. Hughes,

As requested, Environmental Management Systems Inc. (EMS) has performed the following services and provides this report for your use.

PROJECT DESCRIPTION:
The purpose of this report is to document the results of soil infiltration testing and to determine the potential for onsite stormwater disposal. The subject property is a 21.20-acre lot located near Oceanside, Oregon. A 56-lot subdivision is planned for the property and must be developed in accordance with Tillamook County Development Standards. On February 5th, 2020, EMS conducted a soil infiltration test in the proposed stormwater infiltration area near the south end of the property. This report describes existing site conditions, methods used, and results.

SUMMARY:
Onsite stormwater infiltration appears feasible. The average infiltration rate was 21.45 inches per house. No cementation or restrictive layers were observed in the test pit which was dug to a depth of 30". The stormwater infiltration facility should be engineered in manner that prevents erosion and does not cause instability of the steep slopes on the site.

LIMITATIONS:
Findings and recommendations in this report are based infiltration testing performed in one location. Conditions encountered during the test are believed to be representative of the site conditions, however subsurface conditions may vary across the site. If there

are changes to the plan that involve infiltrating stormwater elsewhere onsite, additional testing may be required.

SITE CONDITIONS:

Existing Uses for the Property

The site is currently undeveloped but was logged within the last couple of years.

Topography

The site is an irregularly shaped lot that sits on top of a large hill (stable dune) at elevations ranging between 300 and 430 feet above sea level. The terrain is rolling hills with an overall southward facing slope. Slopes are variable across the site with the majority western part of the site being less than 20%. A broad gulley-like depression runs through the center of the property from north to south that serves as a seasonal drainageway or infiltration swale (see photos 1 and 2, below). The southern end of this gulley is topographically the lowest area on the site and is proposed to be used for infiltrating stormwater runoff for the subdivision.

Photo 1 The gulley-like drainageway, facing north.

Photo 2 The drainageway, facing south. The infiltration test hole is shown in the lower center of frame.

Site Stability

The site is mapped as a moderate to high landslide hazard area by Oregon Department of Geology and Mineral Industries (DOGAMI)[1]. According to DOGAMI Statewide Landslide Information Layer for Oregon (SLIDO)[2] there is a large area of landslide topography near the east property line that extends to the east. No instability or landslide activity was observed during the site visit. See Geological Hazard Report prepared by EMS on April 12th, 2018 for more details.

Vegetation

Most of the site has been logged, but previously the vegetation on site consisted of a mix of conifers including Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), and western hemlock (*Tsuga heterophylla*). The drainage swale is still

---

[1] Oregon Department of Geology and Mineral Industries. Oregon HazVu: Statewide Geohazards Viewer. https://gis.dogami.oregon.gov/maps/hazvu/

[2] Oregon Department of Geology and Mineral Industries. Statewide Landslide Information Database for Oregon (SLIDO). http://gis.dogami.oregon.gov/slido/

vegetated predominantly with red alder (*Alnus* rubra), sword fern (*Polystichum munitum*), salal (*Gaultheria shallon*), and huckleberry (*Vaccinium spp.*).

Soils

Soils on site are mapped as 11D and 11E – Netarts fine sandy loam (5-30 percent slopes and 30-60 percent slopes respectively) by the Natural Resource Conservation Service (NRCS)[3]. The typical setting for this soil type is dunes on marine terraces with a parent material of eolin sands. This unit is described as well drained with the depth to restrictive feature being more than 80 inches. According to NRCS, the typical soil profile is as follows:

0 to 2 inches: slightly decomposed plant material
2 to 5 inches: fine sandy loam
5 to 15 inches: loamy fine sand
15 to 67 inches: fine sand

For the soil infiltration test, one 24" by 36" test pit was dug to a depth of 30" and the soil profile was evaluated prior to conducted the test. One inch of slightly decomposed plant material was observed at the soil surface. 1 inch to 30 inches from the soil surface is somewhat silty fine sand. No cementation or restrictive layers were observed. Medium roots were common and extended to the bottom of the pit.

Wetlands / Surface Water

No surface water was observed during the site assessment. No wetlands are mapped on the site by the National Wetland Inventory (US Fish & Wildlife). There is no local wetland inventory available for the Oceanside-Netarts area. Obligate wetland vegetation was not observed in the stormwater infiltration area.

METHODS:

One 24" by 36" test pit was dug to a depth of 30" near the bottom of the proposed infiltration facility. Water for the infiltration test was provided by Netarts-Oceanside Fire district. Precipitation data was obtained from a nearby weather station (TILLAMOOK 6.9 SSE, OR). The month of January had received 19.02 inches of precipitation which is approximately 140% of normal[1] for that month. The vicinity had received approximately 3.5 inches of rain over the 4 days prior to the test. Therefore, the pit was not presoaked.

An open-pit falling-head test was conducted twice. The falling head test was prepared by filling the pit to a known depth (15" from the bottom) and measuring the time it took to recede to the bottom of the pit using a stopwatch. Between tests #1 and #2, the constant head flow rate was measured using a 5-gallon bucket and stopwatch and determined to be 5.43 gallons per minute.

---

[3] Natural Resource Conservation Service. Web Soil Survey. https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

RESULTS:
Results of the infiltration tests are shown in Table 1, below. The average infiltration rate is 21.45 inches per hour.

Table 1. Infiltration Test Results

Test	Measured Infiltration Rate	Inches per Hour
#1	15" / 39 minutes	23.4
#2	15" / 46.3 minutes	19.5

CONCLUSION:
Infiltration in the area of the drainage swale is fairly rapid, therefore onsite infiltration of stormwater for the proposed subdivision appears feasible. The stormwater facility will need to be sized appropriately to manage stormwater for all new impervious surfaces created by the project and will need to be constructed in a manner that will not cause erosion and instability at the bottom of the slope.

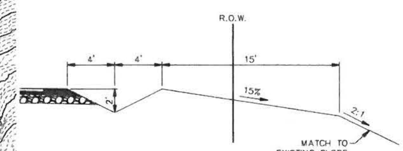
DISCLOSURE: The information and statements in this report are true and accurate to the best of our knowledge. Neither Environmental Management Systems, Inc., nor the undersigned have any economic interests in the project.

Thank you for your business, and we look forward to assisting you to achieve your development objectives. If you have any questions, please contact me at 503-353-9691.

Sincerely,

Emma Eichhorn, REHS
Environmental Health Specialist
ENVIRONMENTAL MANAGEMENT SYSTEMS, Inc.

Enclosed:
Site plan



LOTS 10 & 29-37
SCALE: N.T.S.

NOTES

1. PER TILLAMOOK COUNTY, THE PROJECT IS WITHIN AN AREA OF GEOLOGIC HAZARD. A GEOLOGIC HAZARD REPORT IS REQUIRED.
2. REFER TO THE GEOLOGIC HAZARD REPORT INCLUDED WITH THE LAND USE SUBMITTAL DOCUMENTS:
"GEOHAZARD REPORT, PROPOSED AVALON HEIGHTS SUBDIVISION, OCEANSIDE, TILLAMOOK COUNTY, OREGON, T:1S, R:10W, SEC:30, TL:200. PREPARED BY ENVIRONMENTAL MANAGEMENT SYSTEMS, INC DATED APRIL 12, 2018.

0 60 120
SCALE IN FEET

DATE	NO.	REVISION

DRAWN: BD	DESIGNED: BD	CHECKED: EH
SCALE: AS SHOWN	DATE: JAN 12, 2021	
PROJECT NO. E20-036		

FDG
Firwood Design Group, LLC
SURVEYING ✦ ENGINEERING ✦ PLANNING
359 E. HISTORIC COLUMBIA RIVER HWY
TROUTDALE, OREGON 97060
BUS (503) 668-3737 ✦ FAX (503) 668-3788

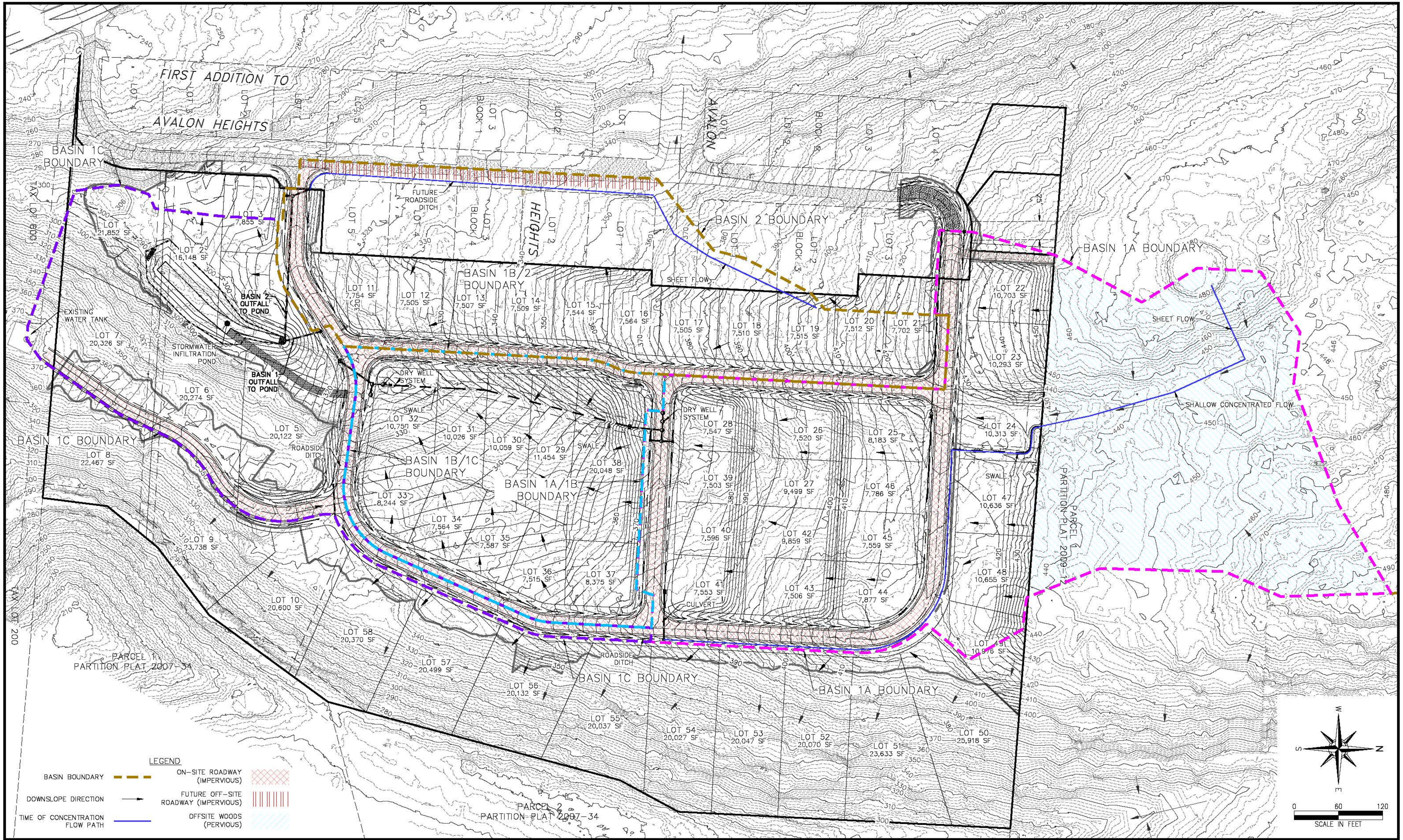
AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

OVERALL CONCEPT GRADING PLAN
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

5/12

APPENDIX C

Basin Map



10/11/21	1	REVISED LAND USE SUBMITTAL
DATE:	NO.	REVISION

DRAWN: BD DESIGNED: BD CHECKED: EH
SCALE: AS SHOWN DATE: MAR 31, 2021
PROJECT NO. E20-036

FDG Firwood Design Group, LLC
SURVEYING + ENGINEERING + PLANNING
359 E. HISTORIC COLUMBIA RIVER HWY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 + FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

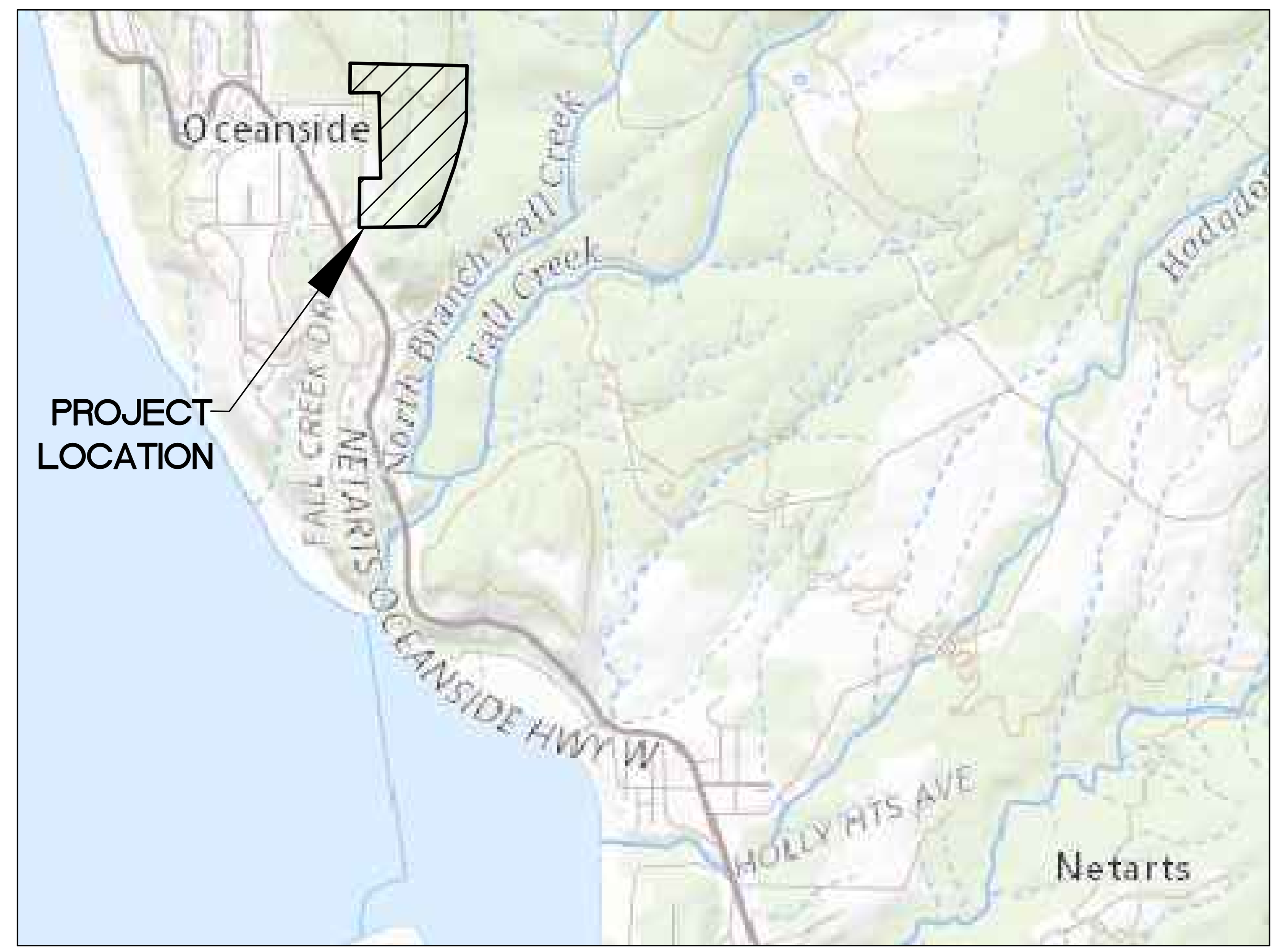
CONCEPT STORMWATER BASIN MAP
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

1 / 1

SECOND ADDITION TO AVALON HEIGHTS SUBDIVISION

LAND USE PLANS

TAXMAP: 01S10W30DC TAXLOT: 200
LOCATED IN SE 1/4 OF SEC 30 T1S R10W W.M.
TILLAMOOK COUNTY, OREGON



VICINITY MAP
NTS

SHEET INDEX:

OWNER:

BILL HUGHES
AVALON HEIGHTS LLC
41901 OLD HIGHWAY 30
ASTORIA, OR 97103
503–741–6706

ENGINEER:

ERIK HOOVESTOL, PE
FIRWOOD DESIGN GROUP LLC
359 E. HISTORIC COLUMBIA RIVER DRIVE
TROUTDALE, OREGON 97060
(503) 668–3737

SURVEYOR:

JACK WHITE, PLS
S&F LAND SERVICES
1725 N ROOSEVELT DRIVE, SUITE B
SEASIDE, OR 97138
503–738–3425

VERTICAL DATUM: NAVD 88
COORDINATE SYSTEM: OREGON COAST ZONE

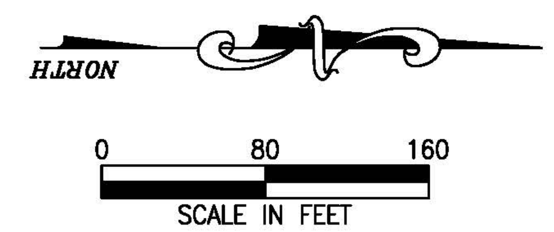
DATE:	NO.	REVISION
10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

DRAWN: BD	DESIGNED: BD	CHECKED: EH
SCALE: AS SHOWN	DATE: MAR 22, 2021	
PROJECT NO. E20–036		

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

COVER SHEET
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS



LEGEND

SANITARY MANHOLE	SANITARY SEWER LINE
CLEANOUT	WATERLINE
FIRE HYDRANT	UNDERGROUND COMMUNICATION
WATER VALVE	UNDERGROUND ELECTRICAL
WATER METER	CHAINLINK FENCE
COMMUNICATION RISER/BOX	EDGE OF ASPHALT
ELECTRICAL RISER	EDGE OF GRAVEL
UTILITY POLE	TOP/TOE SLOPE
SIGN	STRIPE
GRAVEL SURFACE	MAJOR CONTOUR
SURVEY CONTROL POINT	MINOR CONTOUR
FOUND MONUMENT	

MANHOLE INVERTS

10138 SSMH
RIM 312.10'
IE IN N. =302.20'
IE OUT W. =300.80'

10192 SSMH
RIM 337.37'
IE IN E. =329.37'
IE IN W. =329.37'
IE OUT S. =329.57'

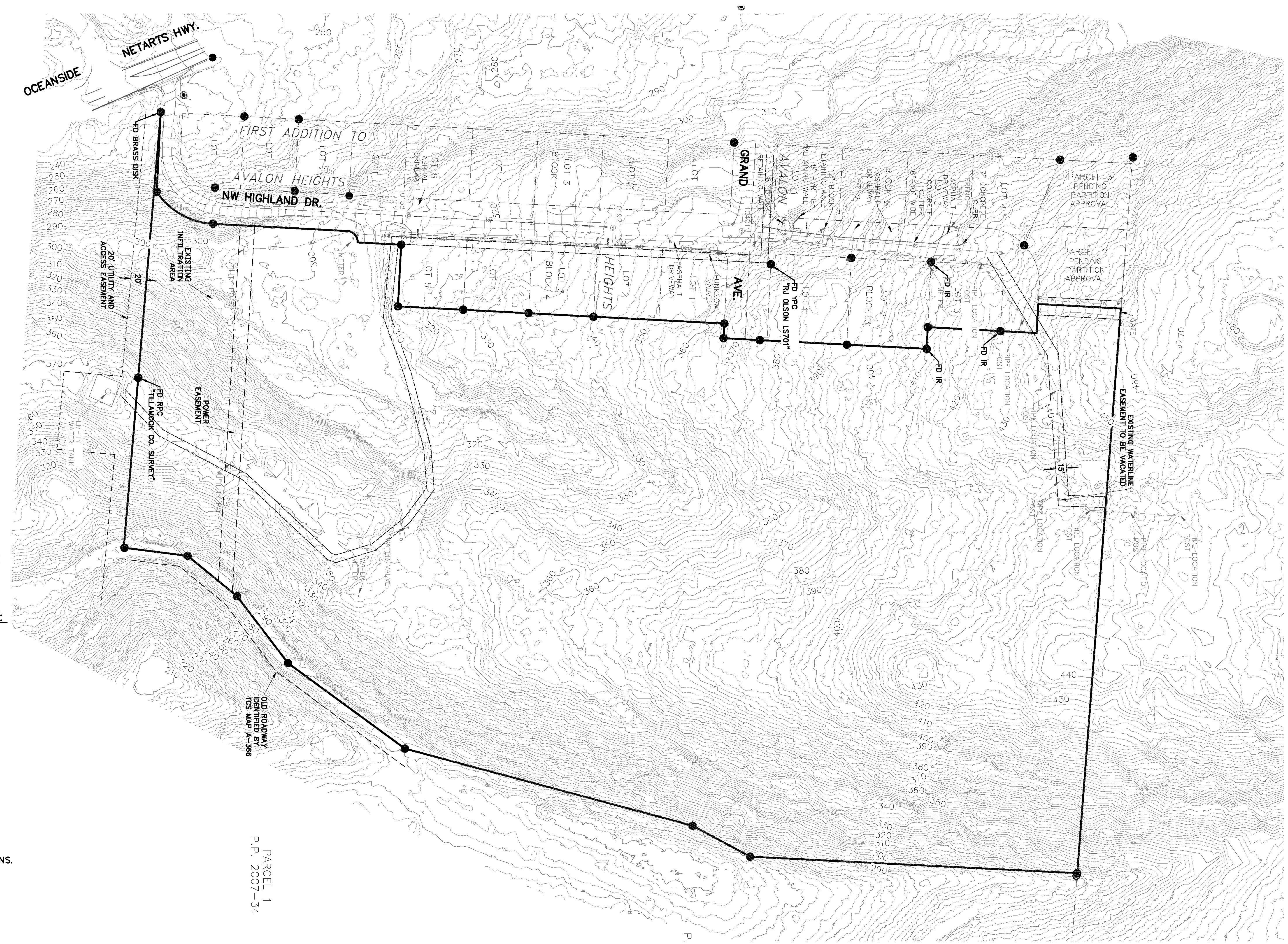
10401 SSMH
RIM 347.51'
IE IN SW. =340.11'
IE IN N. =340.16'
IE OUT W. =339.96'

TOPOGRAPHIC SURVEY:

FIRWOOD DESIGN GROUP LLC
359 E. HISTORIC COLUMBIA RIVER DRIVE
TROUTDALE, OREGON 97060
(503) 668-3737

BOUNDARY & PRELIMINARY PLAT:

JACK WHITE, PLS
S&F LAND SERVICES
1725 N ROOSEVELT DRIVE, SUITE B
SEASIDE, OR 97138
503-738-3425



NOTES:

1. UNDERGROUND UTILITY LOCATES WITHIN THE PUBLIC RIGHT-OF-WAYS WERE REQUESTED THROUGH THE ONE-CALL UTILITY NOTIFICATION CENTER.
2. THE UNDERGROUND UTILITIES SHOWN HAVE BEEN LOCATED FROM FIELD SURVEY INFORMATION AND EXISTING DRAWINGS. FIRWOOD MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. FIRWOOD DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED. HOWEVER UTILITIES ARE LOCATED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE.
3. THIS DRAWING IS NOT A RECORD OF SURVEY AND IS ONLY FOR DESIGN SHOWING EXISTING CONDITIONS.

DATUM:

VERTICAL DATUM: NAVD88 (OPUS SOLUTION, GEOID18B)

HORIZONTAL DATUM: STATE PLANE, OR-N

FDG FIELD WORK PERFORMED ON: NOVEMBER 9, 2020

LIDAR OBTAINED FROM NOAA DATASET 2009 OREGON DOGAMI, NAVD88 VERTICAL DATUM
LIDAR DATA UTILIZED OUTSIDE OF SURVEYED IMPROVEMENTS

BENCHMARK (PER S&F LAND SERVICES):

SOUTH-EAST PROPERTY CORNER
TOP OF YELLOW PLASTIC CAP
ELEVATION = 285.91' NAVD88

DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

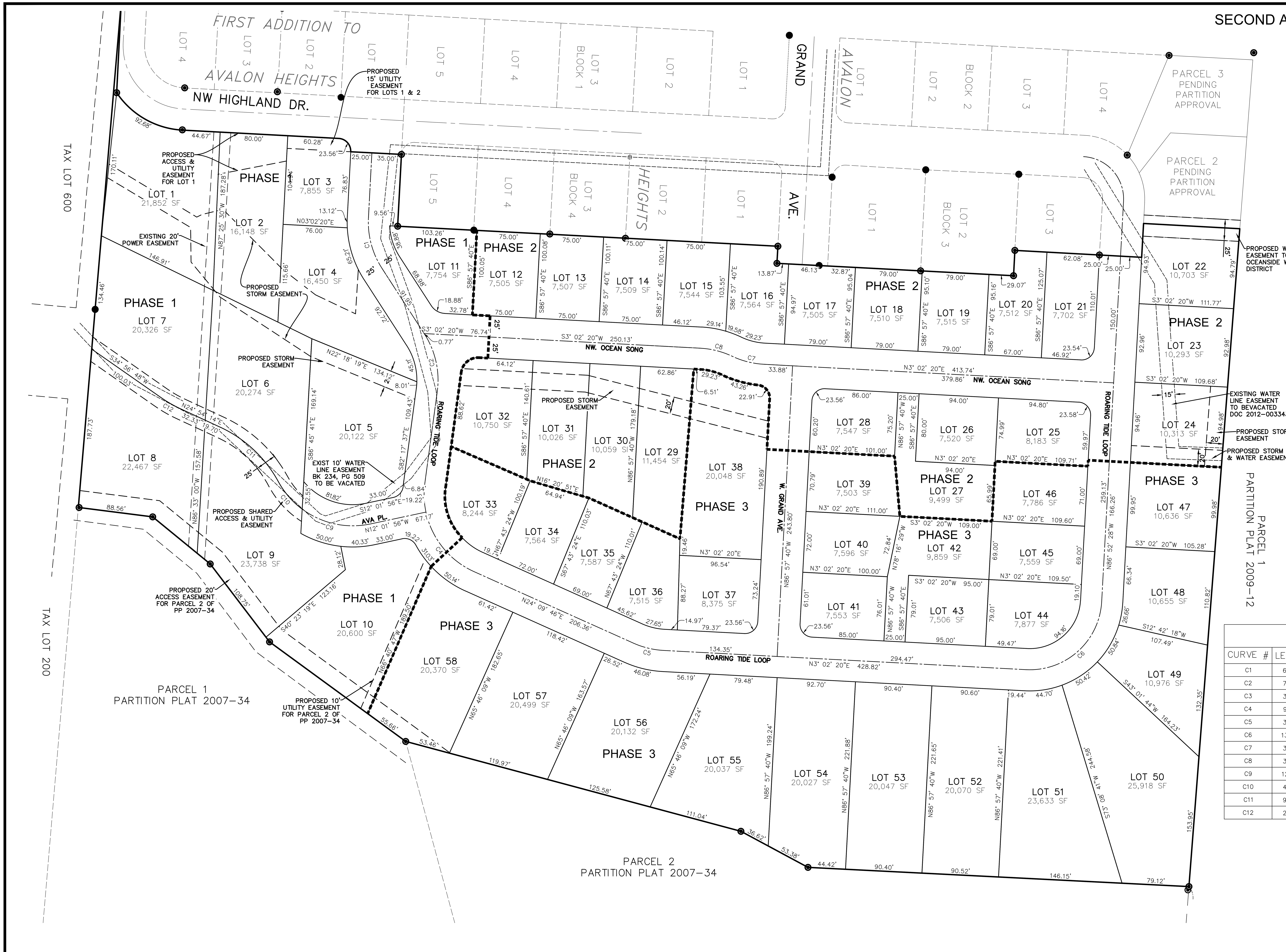
DRAWN: BD	DESIGNED: BD	CHECKED: EH
SCALE: AS SHOWN	DATE: MAR 22, 2021	
PROJECT NO. E20-036		

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

EXISTING CONDITIONS
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

2 / 14



SECOND ADDITION TO AVALON HEIGHTS SUBDIVISION

LOCATED IN SE 1/4 OF SE 1/4 OF SEC 30 T1S
R10W WILLAMETTE MERIDIAN
UNINCORPORATED TILLAMOOK COUNTY

OWNER:

BILL HUGHES
AVALON HEIGHTS LLC
41901 OLD HIGHWAY 30
ASTORIA, OR 97103
503-741-6706

SURVEYOR:

JACK WHITE, PLS
S&F LAND SERVICES
1725 N ROOSEVELT DRIVE, SUITE B
SEASIDE, OR 97138
503-738-3425

ENGINEER:

ERIK HOOVESTOL, PE
FIRWOOD DESIGN GROUP LLC
359 E. HISTORIC COLUMBIA RIVER DRIVE
TROUTDALE, OREGON 97060
(503) 668-3737

NOTES

1. PROJECT ZONING: RESIDENTIAL OCEANSIDE (ROS) (TCLUO 3.310)
   GEOLOGIC HAZARD AREA (TCLUO 4.070)
2. TCLUO 3.310(4) STANDARDS
   (A) MINIMUM LOT SIZE: 7,500 SQ FT WHERE SLOPE AVERAGES LESS THAN 19 PERCENT, 10,000 SQ FT WHERE SLOPE AVERAGES FROM 19 TO 29 PERCENT, 20,000 SQ FT WHERE SLOPE AVERAGES GREATER THAN 29 PERCENT. SEE SHEET 5 FOR ADDITIONAL INFORMATION ON LOT SLOPE.
   (B) MINIMUM LOT WIDTH: 60 FT
   (C) MINIMUM LOT DEPTH: 75 FT
   (D) MINIMUM FRONT YARD SETBACK: 20 FT
   (E) MINIMUM SIDE YARD SETBACK: 5 FT
   ON SIDE STREET OF A CORNER LOT: 15 FT
   (F) MINIMUM REAR YARD SETBACK: 20 FT
   ON A CORNER LOT: 5 FT
3. SEE SHEET 6 FOR SETBACKS AND CONCEPT BUILDING FOOTPRINTS.

Curve Table

CURVE #	LENGTH	RADIUS	DELTA	LENGTH	CHORD BEARING	CHORD LENGTH
C1	62.66'	100.00'	35° 54' 09"	62.66'	S75° 04' 20"W	61.64'
C2	70.83'	100.00'	40° 35' 08"	70.83'	N77° 24' 49"E	69.36'
C3	34.45'	100.00'	19° 44' 19"	34.45'	N87° 50' 13"E	34.28'
C4	93.91'	100.00'	53° 48' 18"	93.91'	N51° 03' 55"E	90.49'
C5	36.87'	100.00'	21° 07' 25"	36.87'	N13° 36' 03"E	36.66'
C6	133.39'	85.00'	89° 54' 48"	133.39'	S41° 55' 04"E	120.12'
C7	38.98'	100.00'	22° 19' 54"	38.98'	S14° 12' 17"W	38.73'
C8	38.98'	100.00'	22° 19' 54"	38.98'	S14° 12' 17"W	38.73'
C9	128.21'	100.00'	73° 27' 40"	128.21'	S24° 41' 54"W	119.61'
C10	43.25'	100.00'	24° 46' 57"	43.25'	N49° 02' 15"E	42.92'
C11	95.62'	150.00'	36° 31' 30"	95.62'	N43° 09' 59"E	94.01'
C12	26.29'	150.00'	10° 02' 34"	26.29'	N29° 55' 31"E	26.26'

0 60 120
SCALE IN FEET

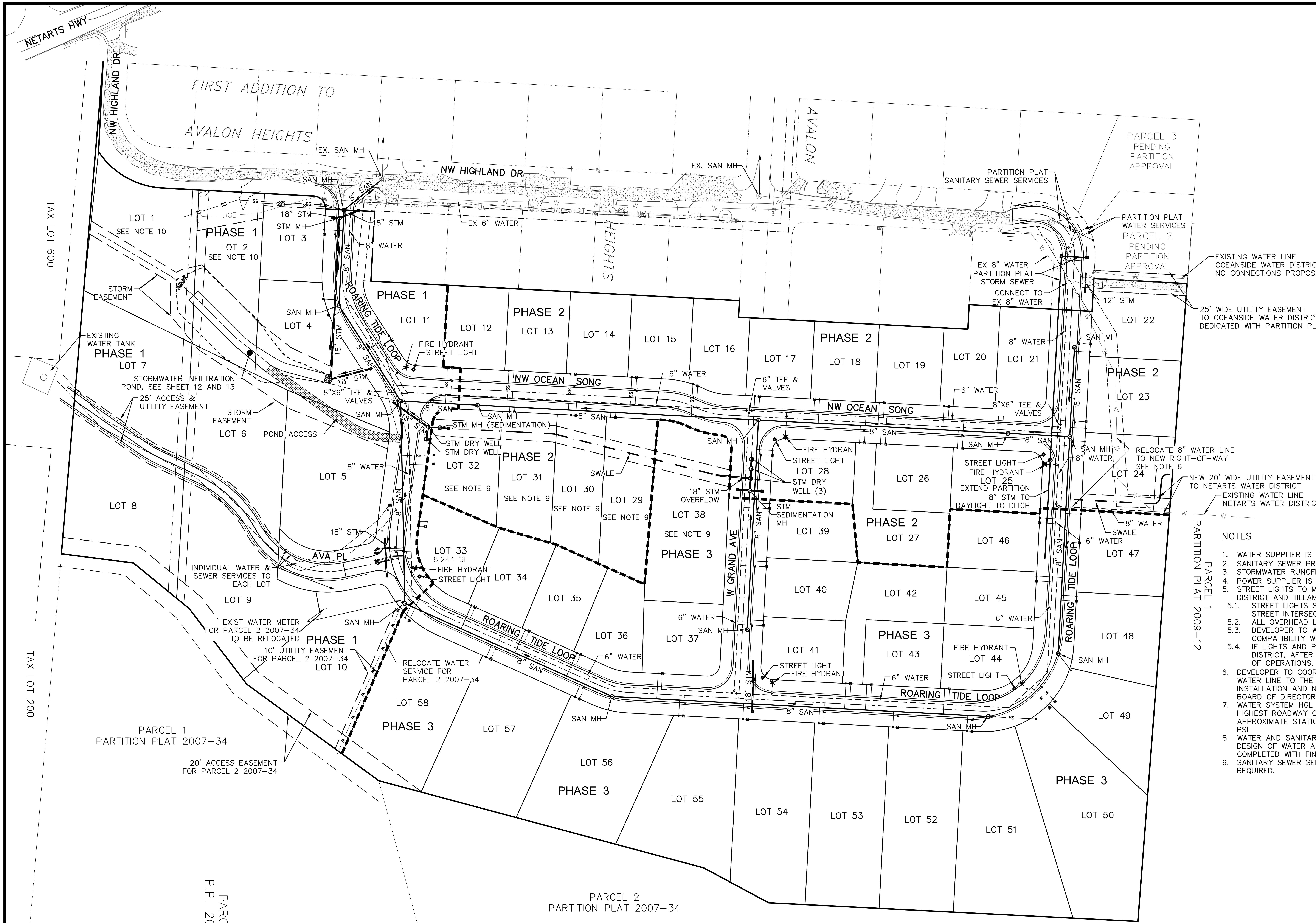
DATE:	NO.	REVISION
10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

PRELIMINARY PLAT
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS



NOTES

1. WATER SUPPLIER IS NETARTS WATER DISTRICT (NWD).
2. SANITARY SEWER PROVIDER IS NETARTS OCEANSIDE SANITARY DISTRICT (NOSD).
3. STORMWATER RUNOFF WILL BE INFILTRATED IN THE AREA SHOWN.
4. POWER SUPPLIER IS TILLAMOOK PUBLIC UTILITY DISTRICT (TPUD).
5. STREET LIGHTS TO MEET NETARTS-OCEANSIDE RURAL FIRE PROTECTION DISTRICT AND TILLAMOOK PUBLIC UTILITY DISTRICT REQUIREMENTS.
   - 5.1. STREET LIGHTS SHALL BE LOCATED TO ILLUMINATE FIRE HYDRANTS AND STREET INTERSECTIONS.
   - 5.2. ALL OVERHEAD LIGHTS MUST BE FULLY SHIELDED LUMINARY FIXTURES.
   - 5.3. DEVELOPER TO WORK WITH TILLAMOOK PUBLIC UTILITY DISTRICT FOR COMPATIBILITY WITH THEIR GUIDELINES.
   - 5.4. IF LIGHTS AND POLES ARE INSTALLED PER TILLAMOOK PUBLIC UTILITY DISTRICT, AFTER INSTALLATION THE FIRE DISTRICT WILL ASSUME THE COST OF OPERATIONS.
6. DEVELOPER TO COORDINATE RELOCATION OF NETARTS WATER DISTRICT (NWD) WATER LINE TO THE NEW ROADWAY RIGHT-OF-WAY. DEVELOPER WILL DO THE INSTALLATION AND NWD WILL FURNISH THE PIPE PER APRIL 22, 2019 NWD BOARD OF DIRECTORS MEETING MINUTES.
7. WATER SYSTEM HGL PER NWD: 525 FT
   HIGHEST ROADWAY CENTERLINE ELEVATION NEAR LOTS 22 & 23: ±430 FT
   APPROXIMATE STATIC WATER PRESSURE AT LOTS 22 & 23: 95 FT HEAD = ±41 PSI
8. WATER AND SANITARY SEWER LOCATIONS SHOWN ARE APPROXIMATE. DETAILED DESIGN OF WATER AND SANITARY SEWER, INCLUDING SERVICES, WILL BE COMPLETED WITH FINAL CONSTRUCTION PERMIT PLANS.
9. SANITARY SEWER SERVICE TO SOME LOTS MAY INCLUDE GRINDER PUMPS, AS REQUIRED.

W S N E

0 60 120
SCALE IN FEET

10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21
DATE:	NO.	REVISION

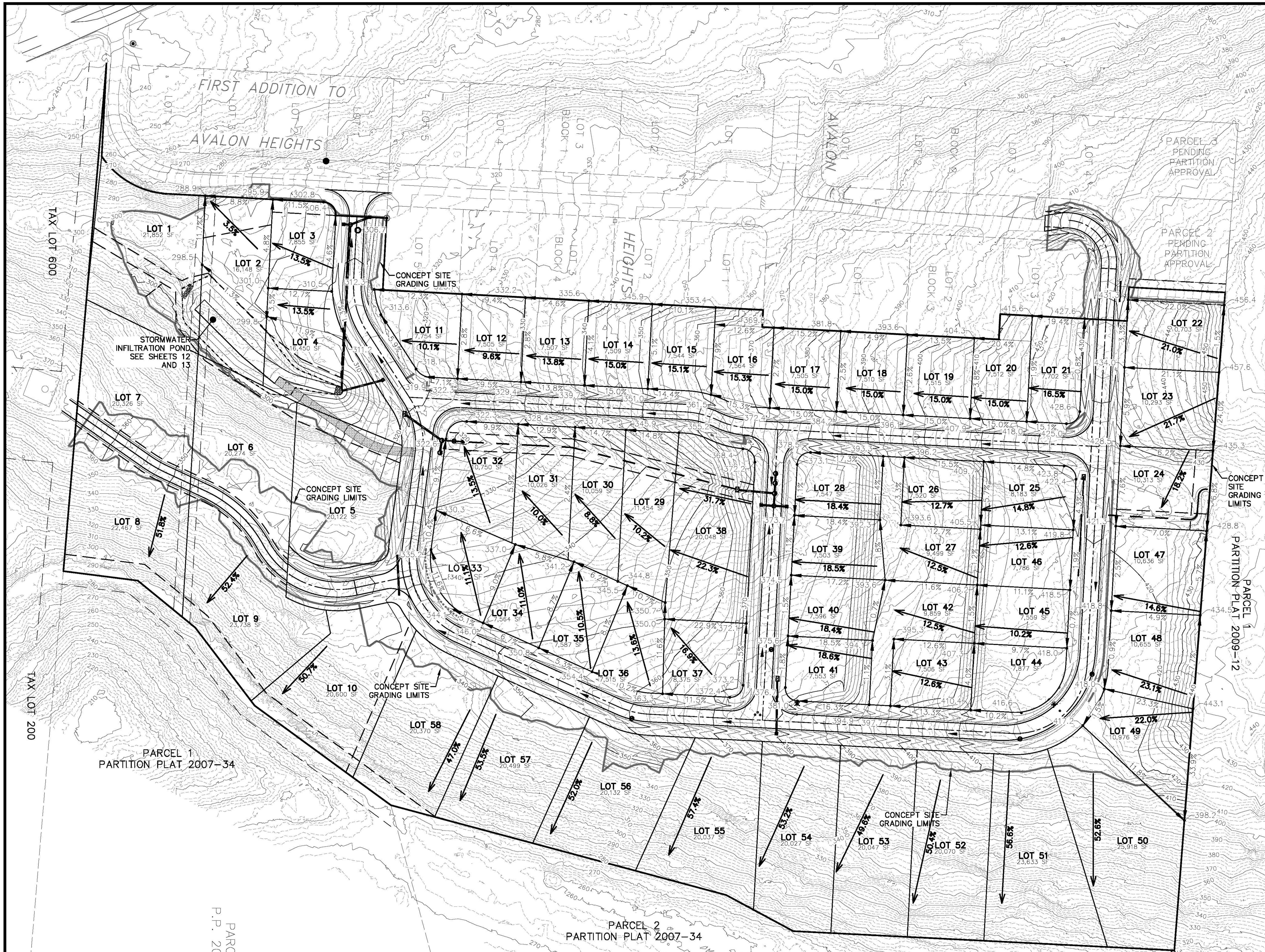
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

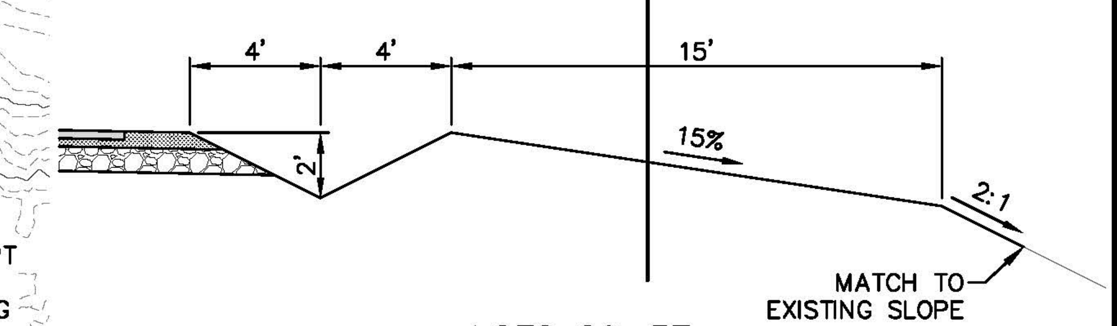
OVERALL CONCEPT UTILITY PLAN
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

4 / 14



SLOPE LABEL LEGEND

X.X%	REPRESENTATIVE LOT SLOPE
X.X%	LOT LINE SLOPE



LOTS 29-37

SCALE: N.T.S.

TCLUO 3.310 MINIMUM LOT SIZE

WHERE SLOPE AVERAGES LESS THAN 19%: 7,500 SF
WHERE SLOPE AVERAGES FROM 19% TO 29%: 10,000 SF
WHERE SLOPE AVERAGES GREATER THAN 29%: 20,000 SF

DETAILED LOT SLOPE DATA NOT PROVIDED ON THIS PLAN FOR LOTS OVER 20,000 SF

NOTES

1. PER TILLAMOOK COUNTY, THE PROJECT IS WITHIN AN AREA OF GEOLOGIC HAZARD. A GEOLOGIC HAZARD REPORT IS REQUIRED.
2. REFER TO THE GEOLOGIC HAZARD REPORT INCLUDED WITH THE LAND USE SUBMITTAL DOCUMENTS: GEOHAZARD REPORT, PROPOSED AVALON HEIGHTS SUBDIVISION, OCEANSIDE, TILLAMOOK COUNTY, OREGON, T:1S, R:10W, SEC:30, TL:200. PREPARED BY ENVIRONMENTAL MANAGEMENT SYSTEMS, INC DATED APRIL 12, 2018 WHICH IS SUPERCEDED BY THE GEOTECHNICAL ENGINEERING REPORT DATED OCTOBER 2021 BY STRATA DESIGN.

W N E S

0 60 120

SCALE IN FEET

DATE:	NO.	REVISION
10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

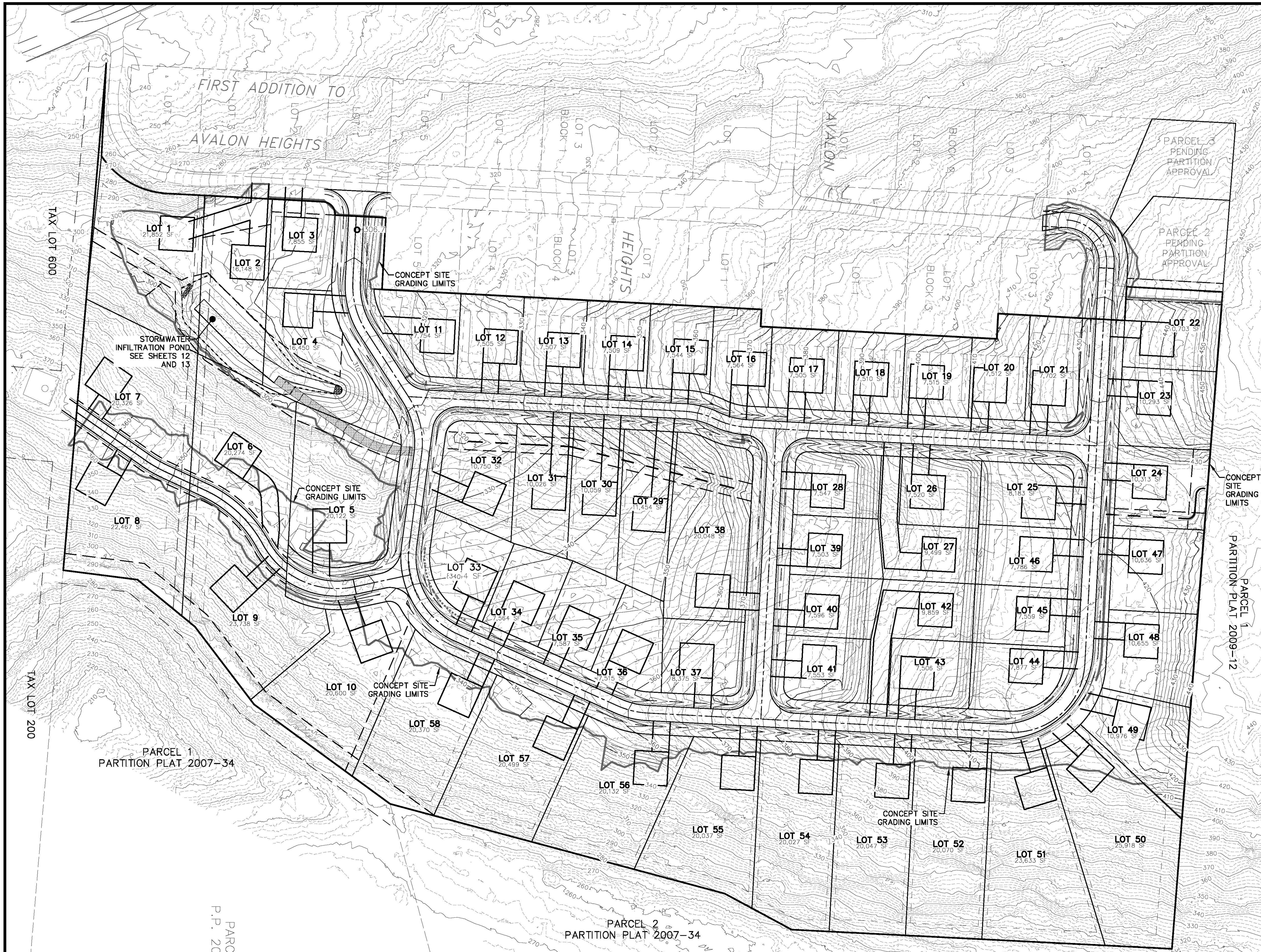
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

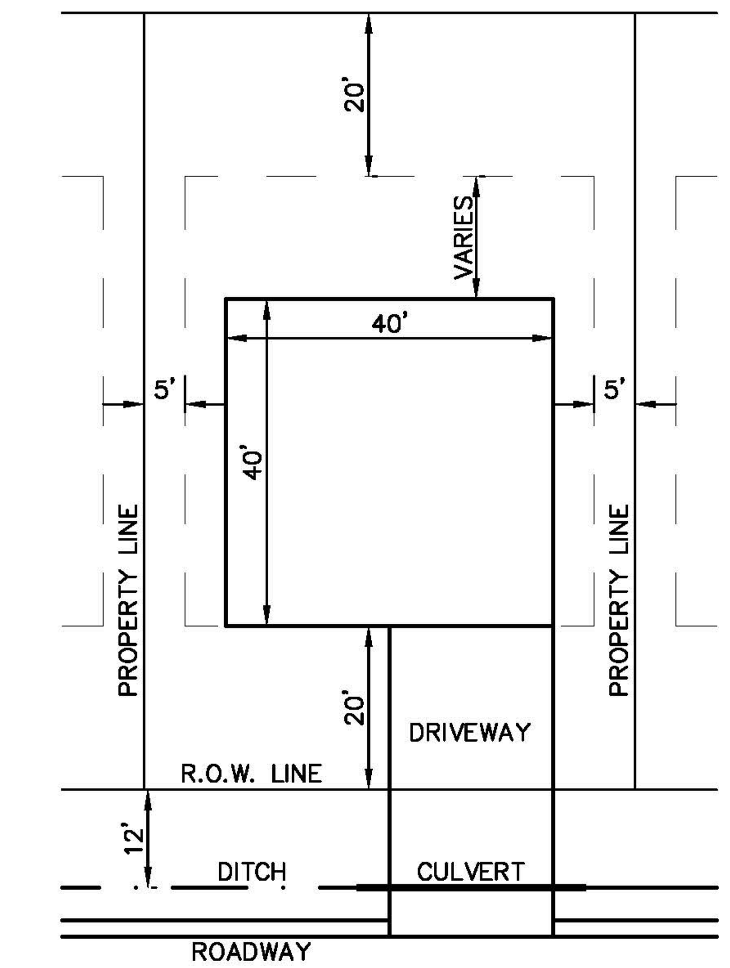
FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

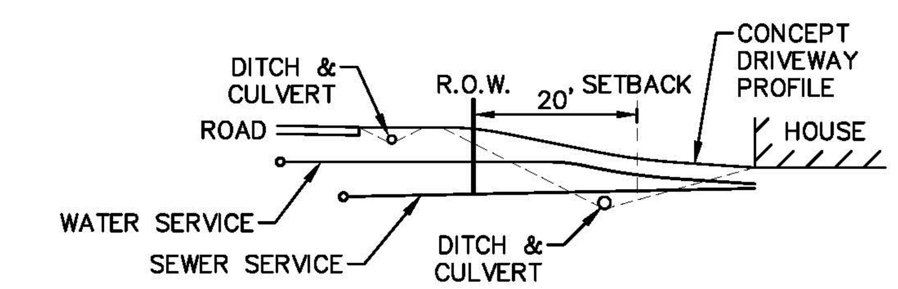
CONCEPT GRADING & LOT SLOPE ANALYSIS
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

5 / 14





CONCEPT BUILDING FOOTPRINT & SETBACKS
SCALE: N.T.S.



LOTS 29–31 SCHEMATIC
SCALE: N.T.S.

NOTES

1. PER TILLAMOOK COUNTY, THE PROJECT IS WITHIN AN AREA OF GEOLOGIC HAZARD. A GEOLOGIC HAZARD REPORT IS REQUIRED.
2. REFER TO THE GEOLOGIC HAZARD REPORT INCLUDED WITH THE LAND USE SUBMITTAL DOCUMENTS: GEOHAZARD REPORT, PROPOSED AVALON HEIGHTS SUBDIVISION, OCEANSIDE, TILLAMOOK COUNTY, OREGON, T:1S, R:10W, SEC:30, TL:200. PREPARED BY ENVIRONMENTAL MANAGEMENT SYSTEMS, INC DATED APRIL 12, 2018 WHICH IS SUPERCEDED BY THE GEOTECHNICAL ENGINEERING REPORT DATED OCTOBER 2021 BY STRATA DESIGN.

0 60 120
SCALE IN FEET

DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

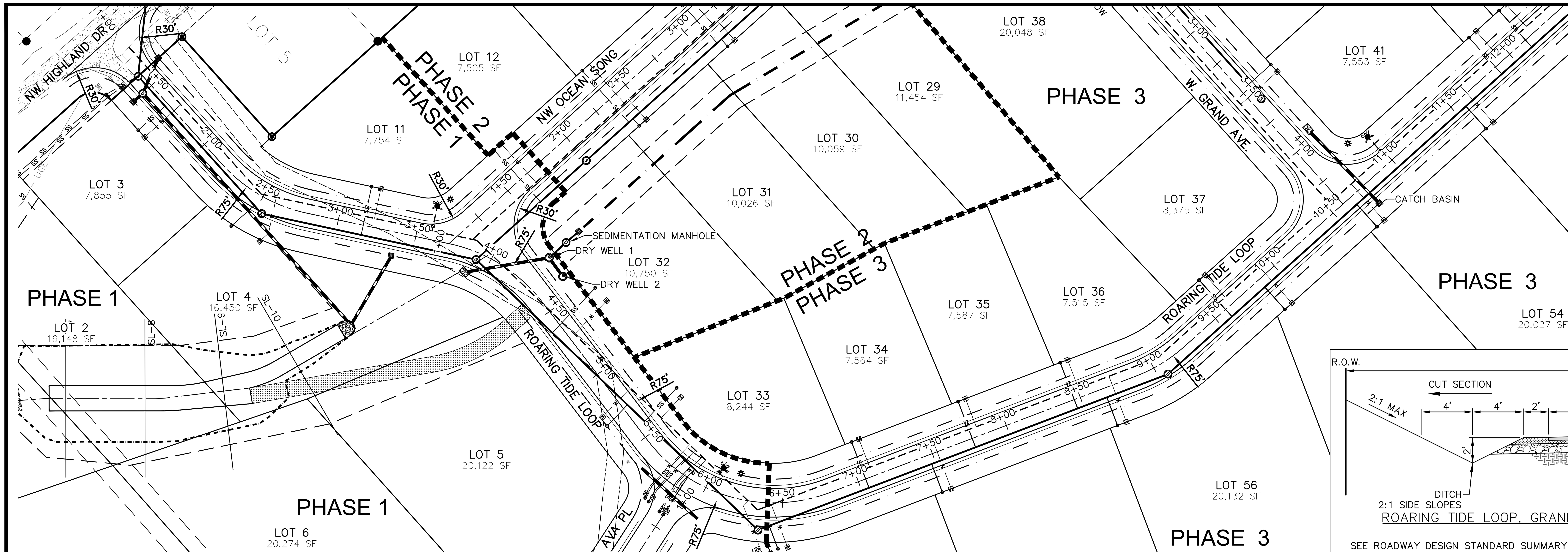
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

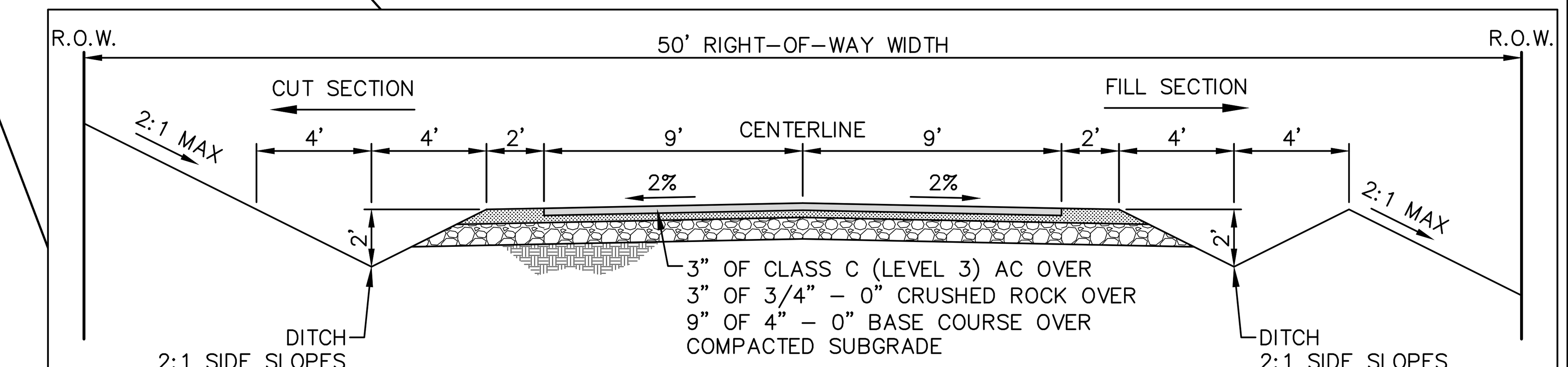
FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

CONCEPT LOCATION OF LOT DEVELOPMENT
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

6
14

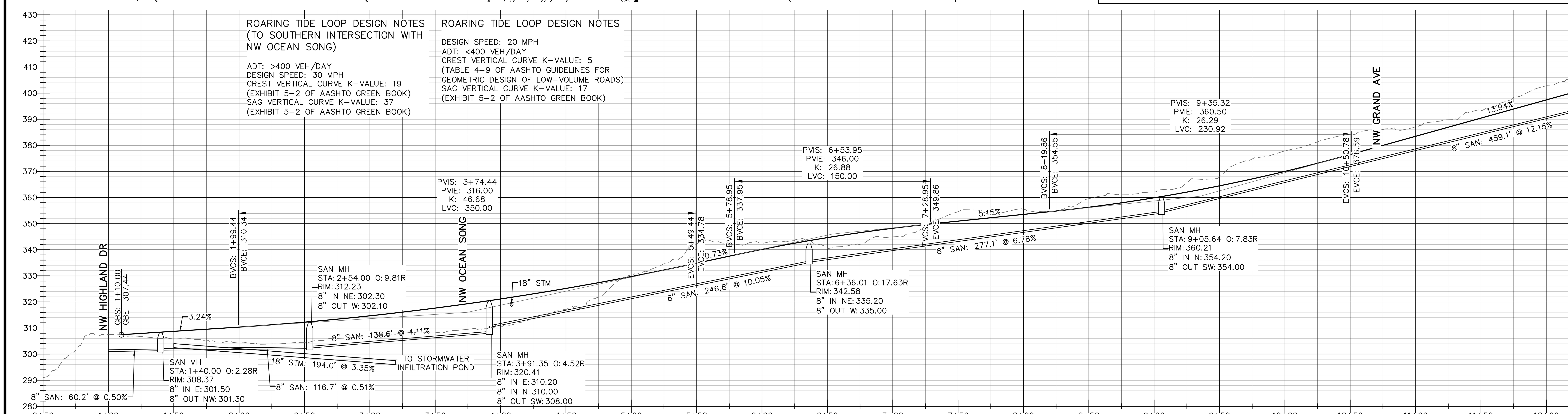


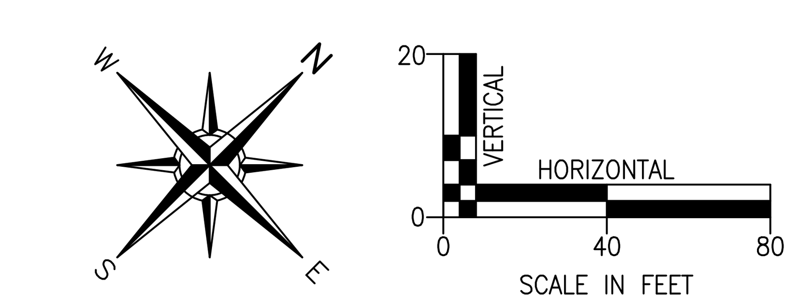


ROARING TIDE LOOP, GRAND AVE, NW OCEAN SONG, & AVA PL TYPICAL SECTION

SCALE: N.T.S.

SEE ROADWAY DESIGN STANDARD SUMMARY FOR INFO ON DESIGN SPEED AND WIDTHS FOR ROADS IN MOUNTAINOUS TERRAIN.





DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

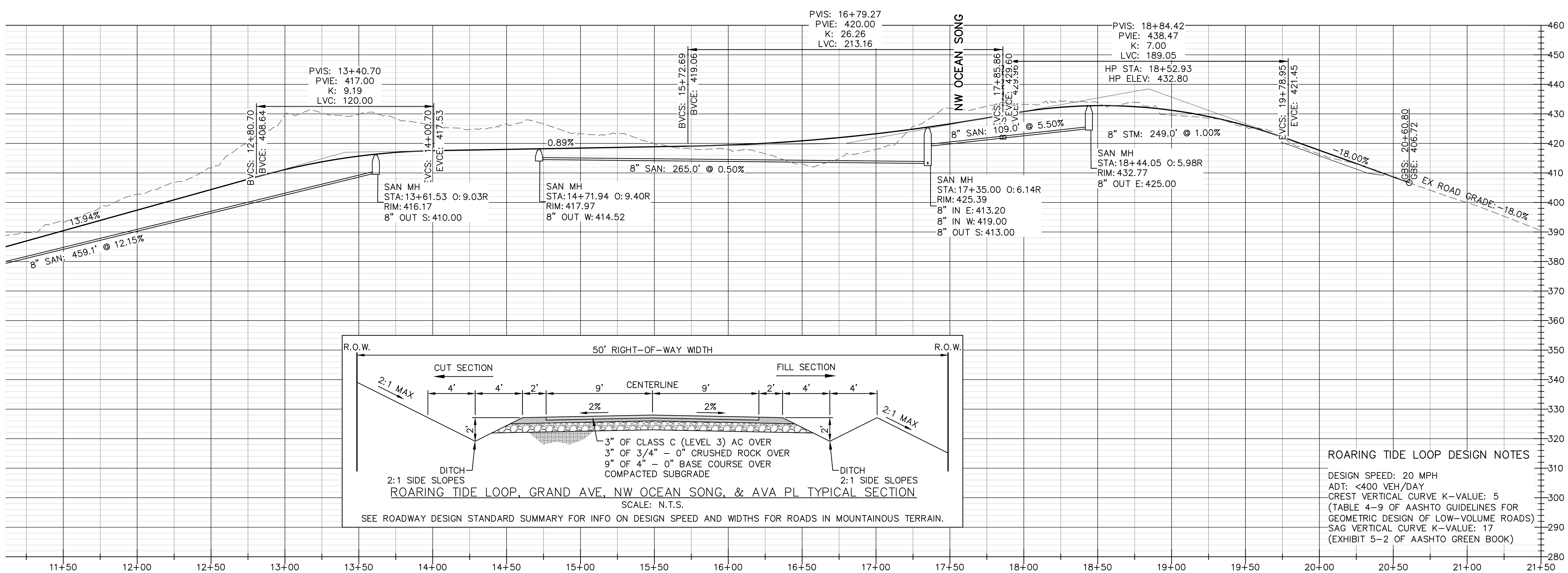
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

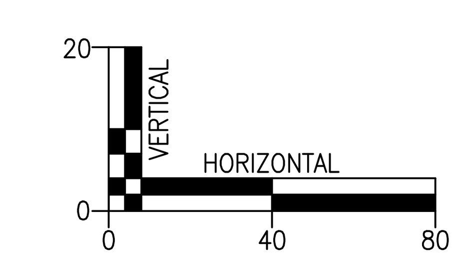
ROARING TIDE LOOP CONCEPT PROFILE
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

7 / 14



ROARING TIDE LOOP DESIGN NOTES

DESIGN SPEED: 20 MPH
ADT: <400 VEH/DAY
CREST VERTICAL CURVE K-VALUE: 5
(TABLE 4-9 OF AASHTO GUIDELINES FOR GEOMETRIC DESIGN OF LOW-VOLUME ROADS)
SAG VERTICAL CURVE K-VALUE: 17
(EXHIBIT 5-2 OF AASHTO GREEN BOOK)



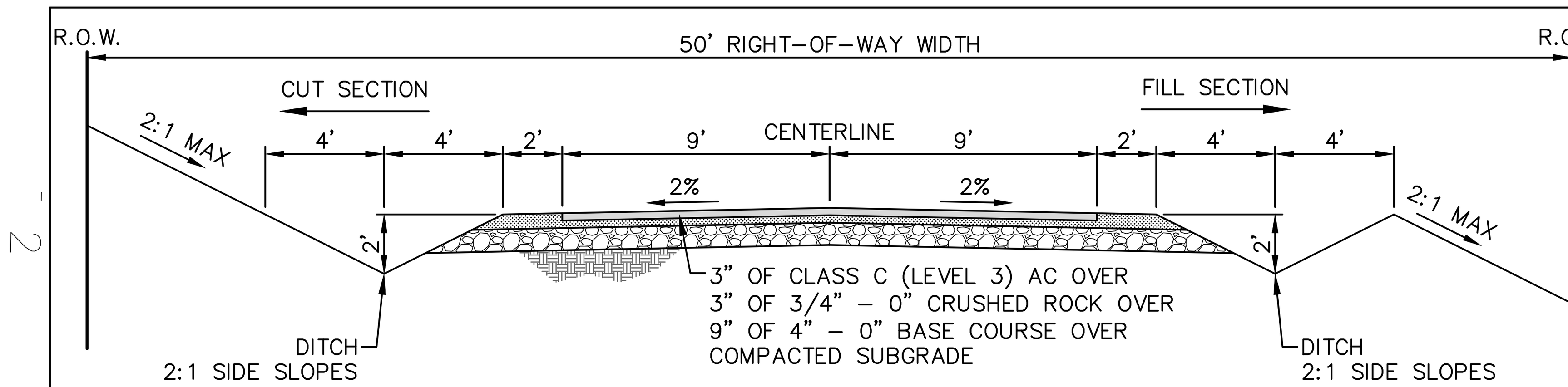
DATE	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

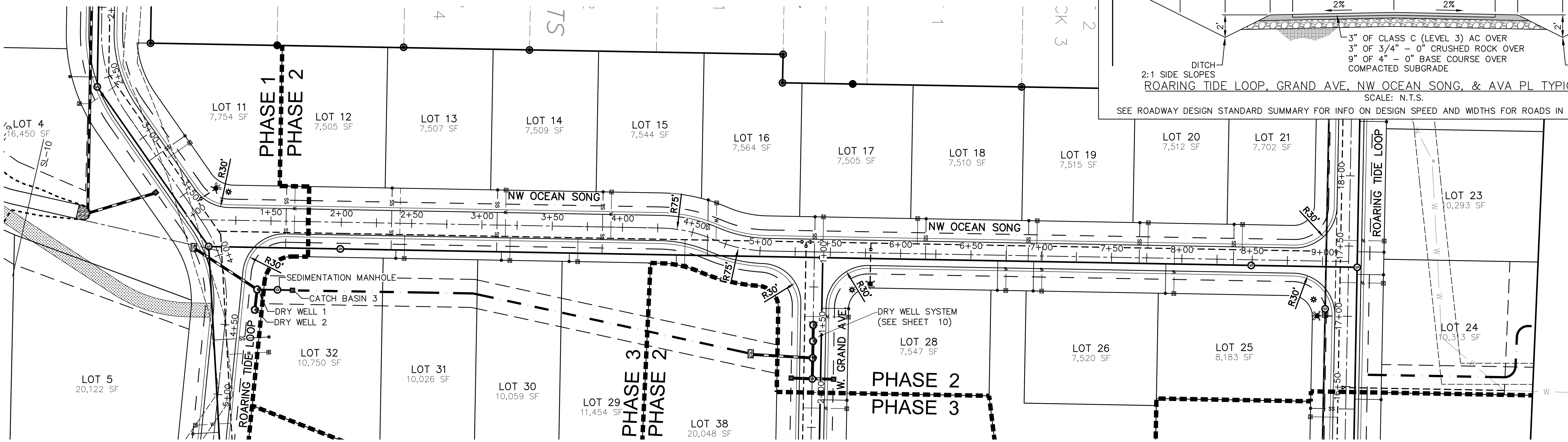
ROARING TIDE LOOP CONCEPT PROFILE
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

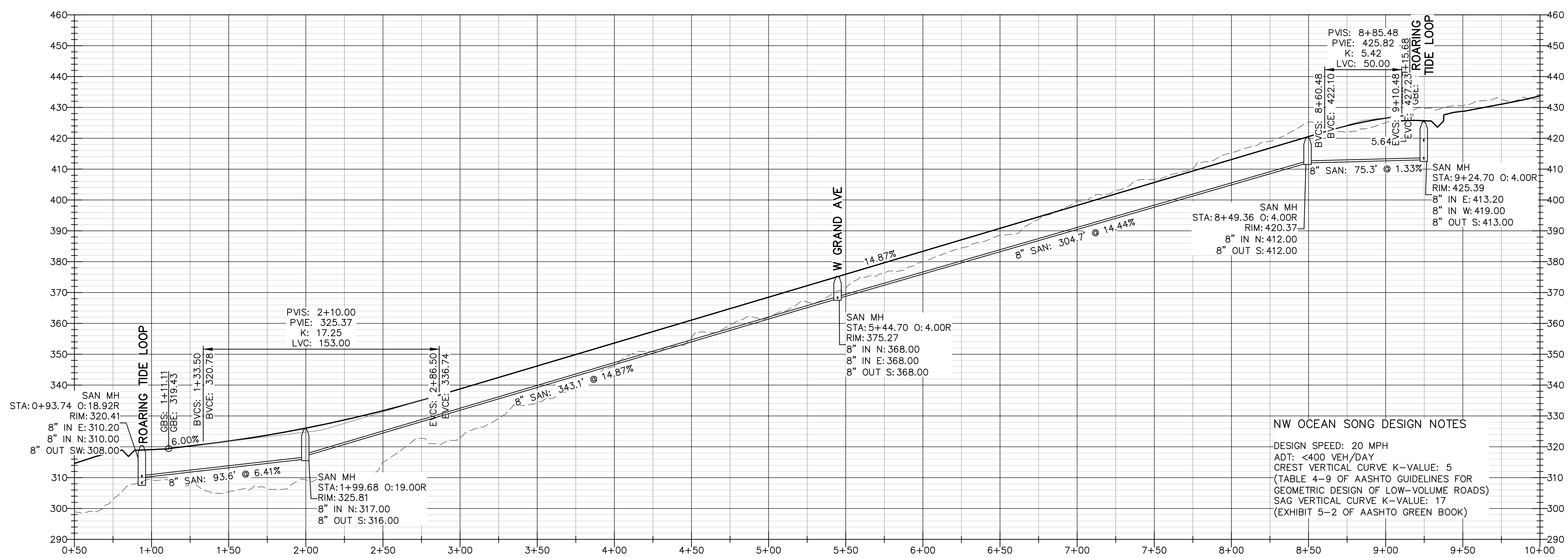


ROARING TIDE LOOP, GRAND AVE, NW OCEAN SONG, & AVA PL TYPICAL SECTION

SCALE: N.T.S.

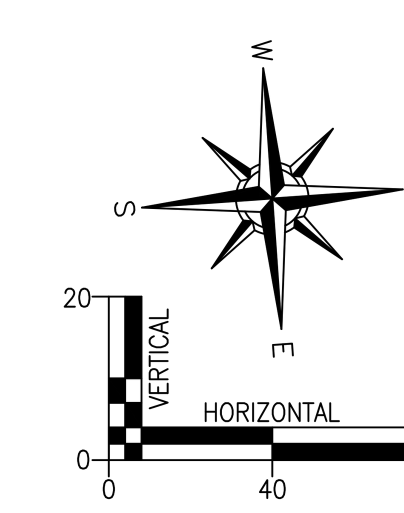
SEE ROADWAY DESIGN STANDARD SUMMARY FOR INFO ON DESIGN SPEED AND WIDTHS FOR ROADS IN MOUNTAINOUS TERRAIN.





NW OCEAN SONG DESIGN NOTES

DESIGN SPEED: 20 MPH
ADT: <400 VEH/DAY
CREST VERTICAL CURVE K-VALUE: 5
(TABLE 4-9 OF AASHTO GUIDELINES FOR GEOMETRIC DESIGN OF LOW-VOLUME ROADS)
SAG VERTICAL CURVE K-VALUE: 17
(EXHIBIT 5-2 OF AASHTO GREEN BOOK)



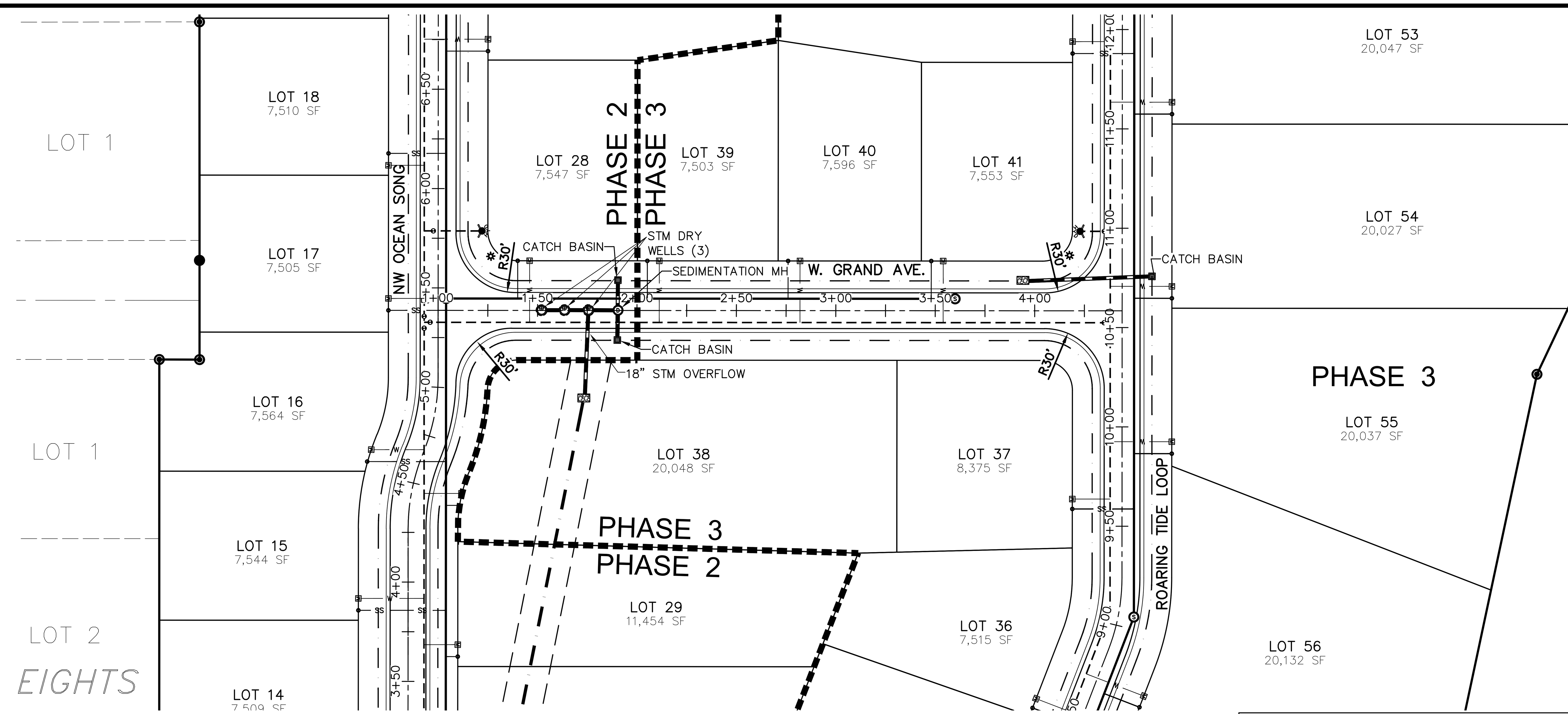
DATE:	NO.	REVISION
10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

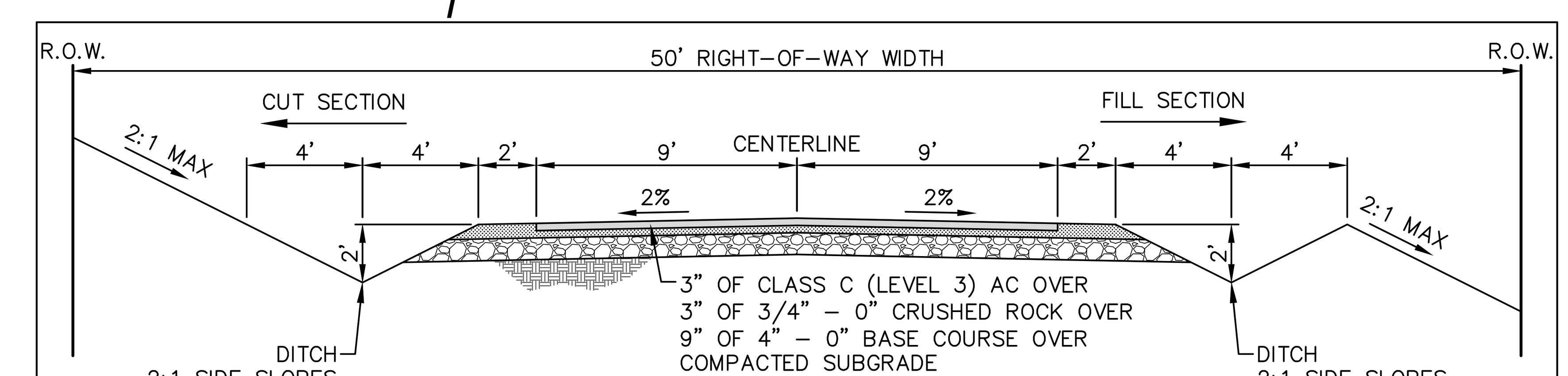
DRAWN: BD	DESIGNED: BD	CHECKED: EH
SCALE: AS SHOWN	DATE: MAR 22, 2021	
PROJECT NO. E20-036		

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

NW OCEAN SONG CONCEPT PROFILE
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS





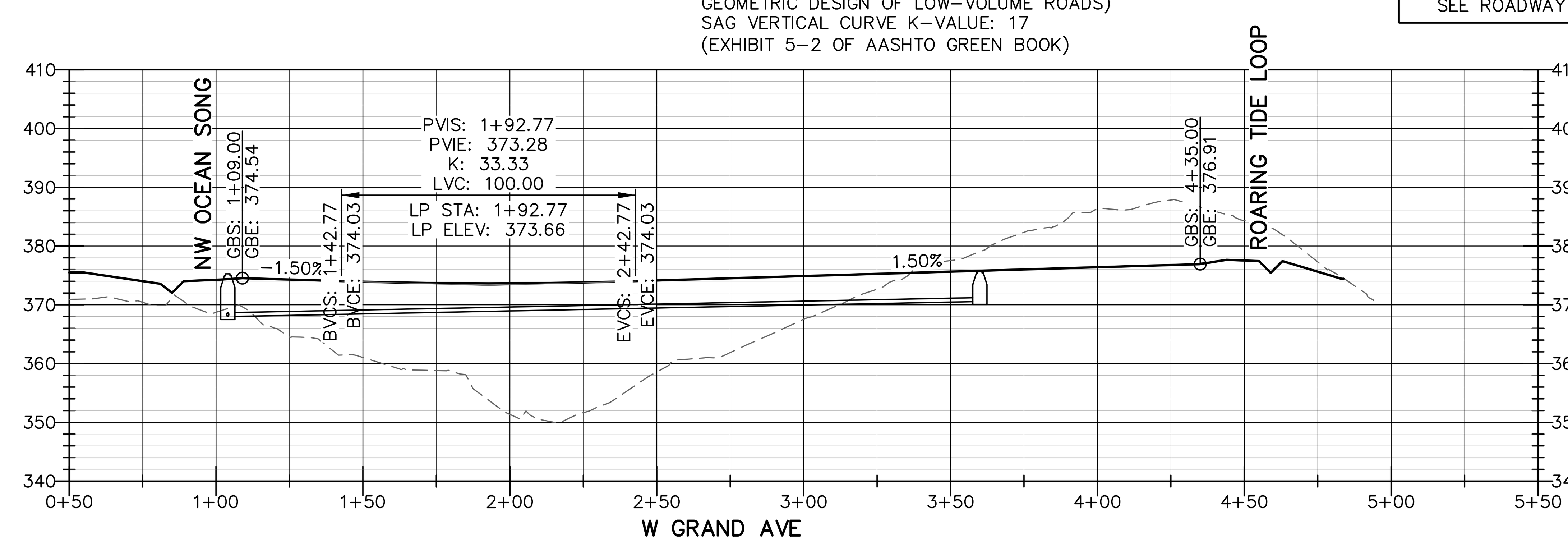
ROARING TIDE LOOP, GRAND AVE, NW OCEAN SONG, & AVA PL TYPICAL SECTION

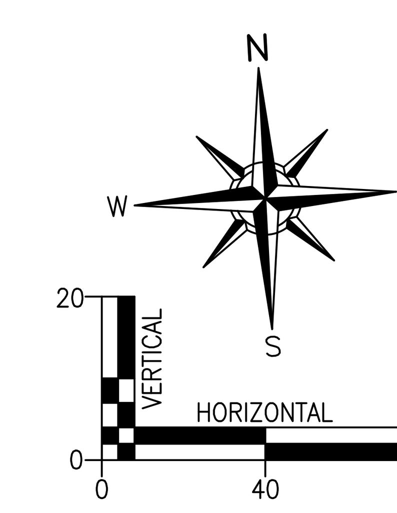
SCALE: N.T.S.

SEE ROADWAY DESIGN STANDARD SUMMARY FOR INFO ON DESIGN SPEED AND WIDTHS FOR ROADS IN MOUNTAINOUS TERRAIN.

W GRAND AVE DESIGN NOTES

DESIGN SPEED: 20 MPH
ADT: <400 VEH/DAY
CREST VERTICAL CURVE K-VALUE: 5
(TABLE 4-9 OF AASHTO GUIDELINES FOR GEOMETRIC DESIGN OF LOW-VOLUME ROADS)
SAG VERTICAL CURVE K-VALUE: 17
(EXHIBIT 5-2 OF AASHTO GREEN BOOK)





DATE:	NO.	REVISION
10/11/2	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

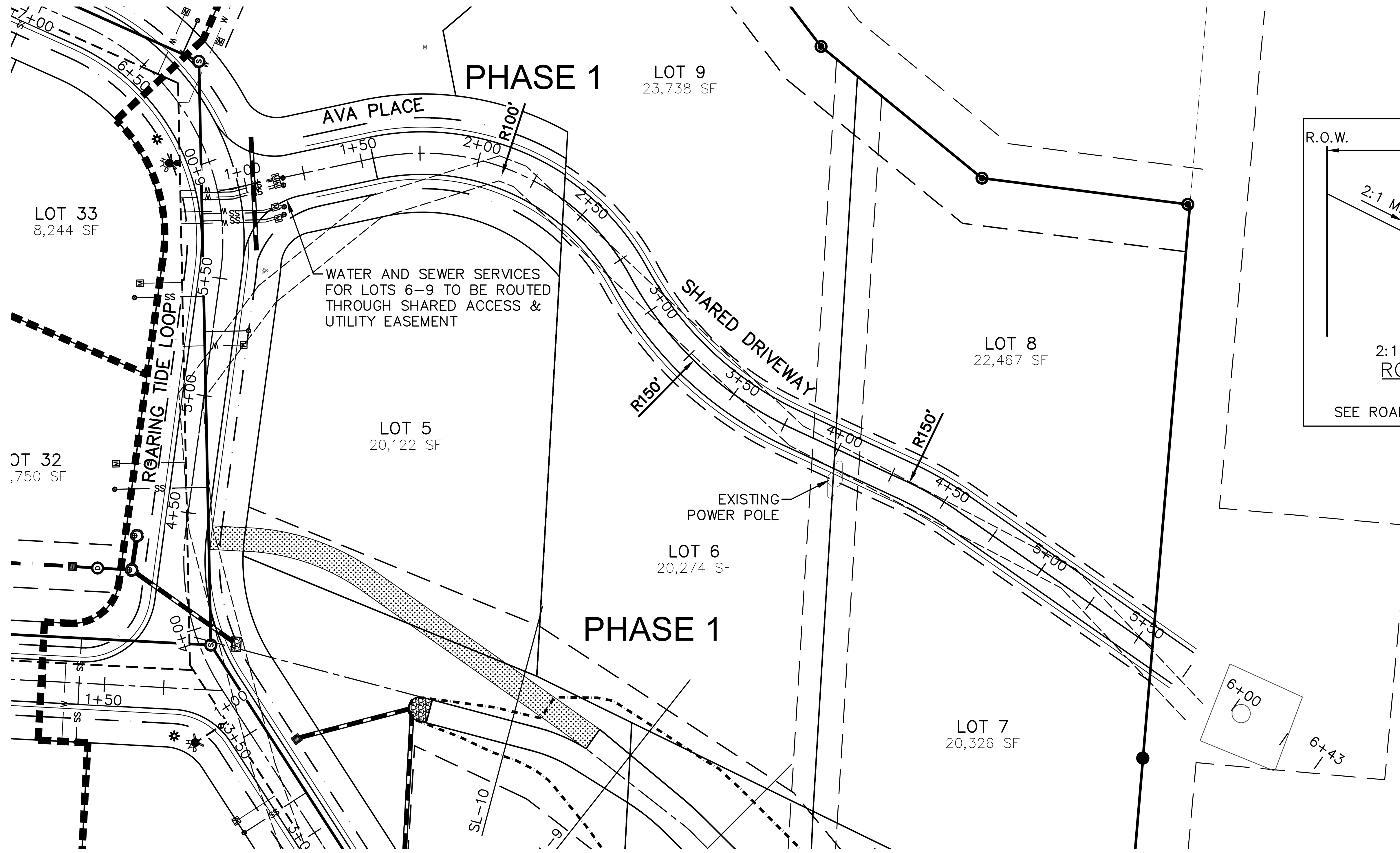
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

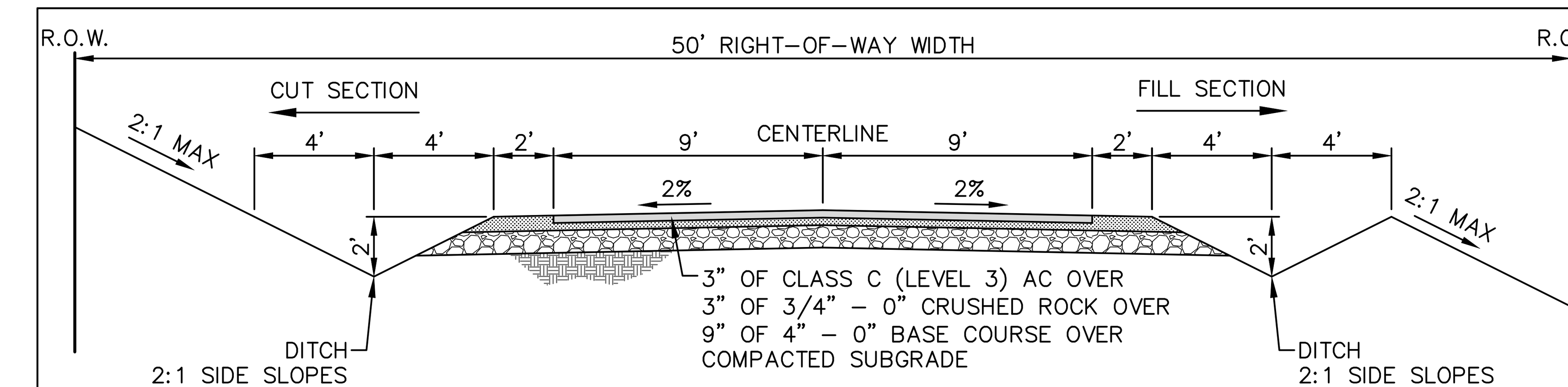
FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

W GRAND AVE CONCEPT PROFILE
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

10 / 14

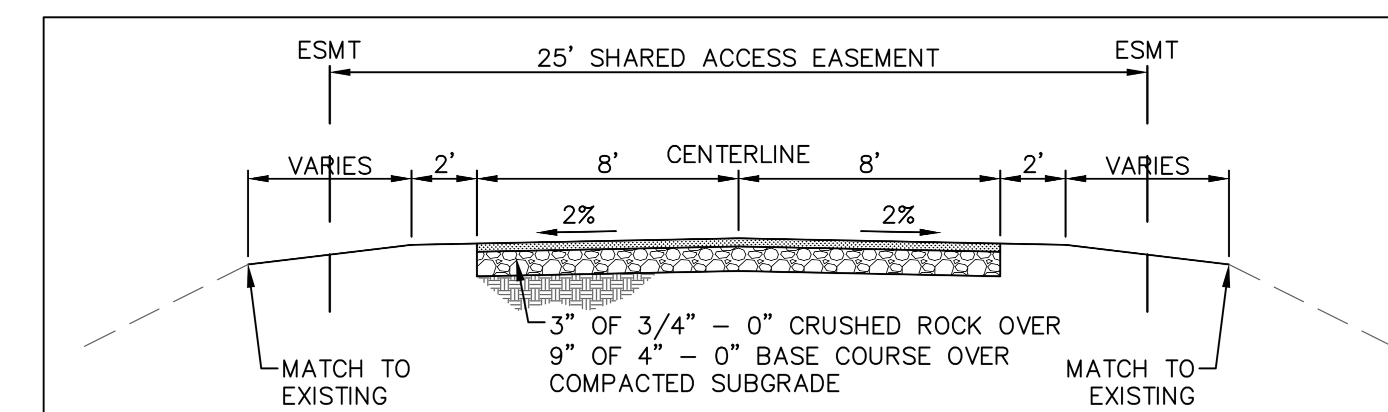




ROARING TIDE LOOP, GRAND AVE, NW OCEAN SONG, & AVA PL TYPICAL SECTION

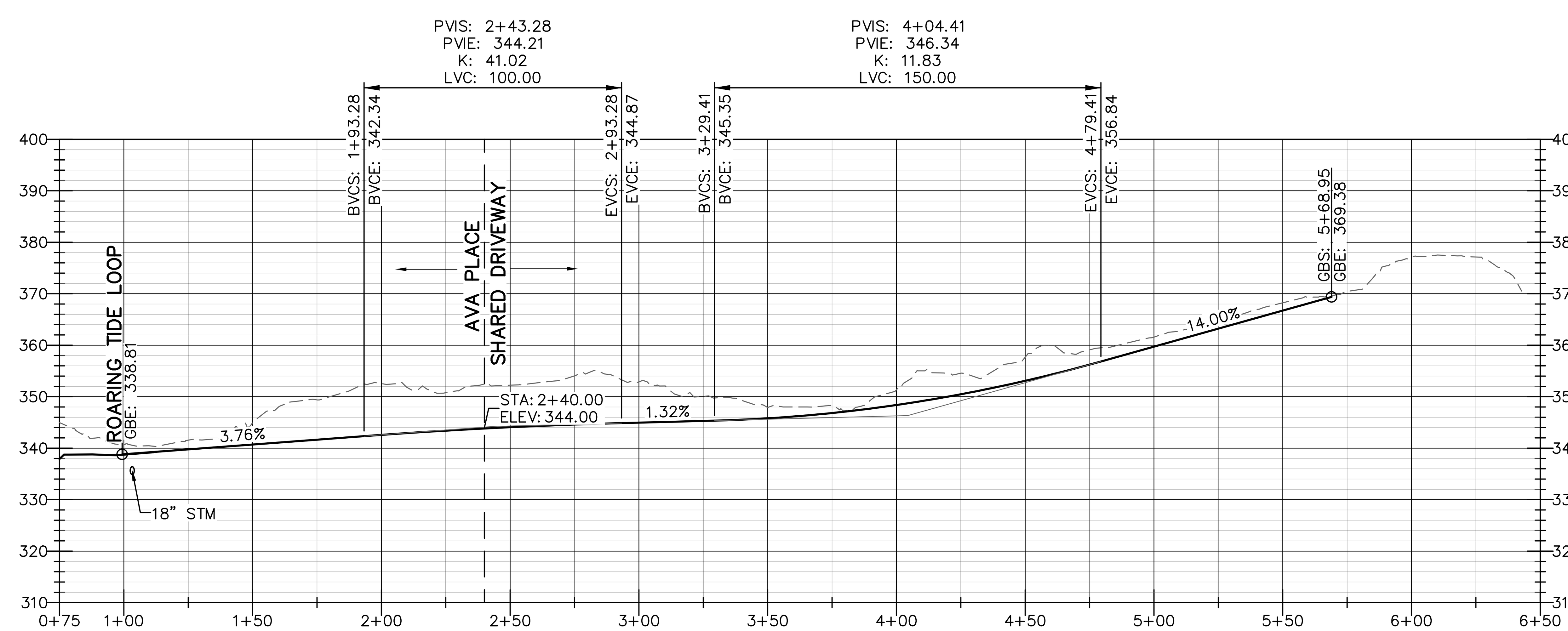
SCALE: N.T.S.

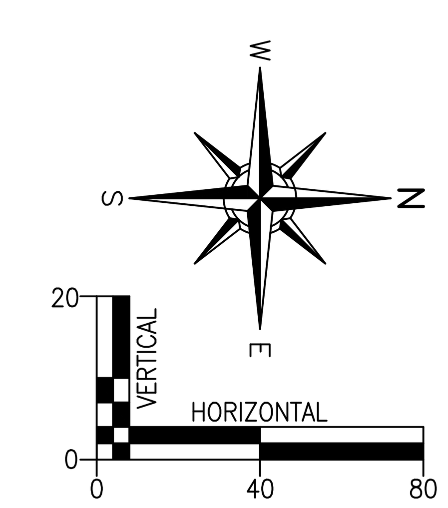
SEE ROADWAY DESIGN STANDARD SUMMARY FOR INFO ON DESIGN SPEED AND WIDTHS FOR ROADS IN MOUNTAINOUS TERRAIN.



PRIVATE SHARED DRIVEWAY TYPICAL SECTION

SCALE: N.T.S.





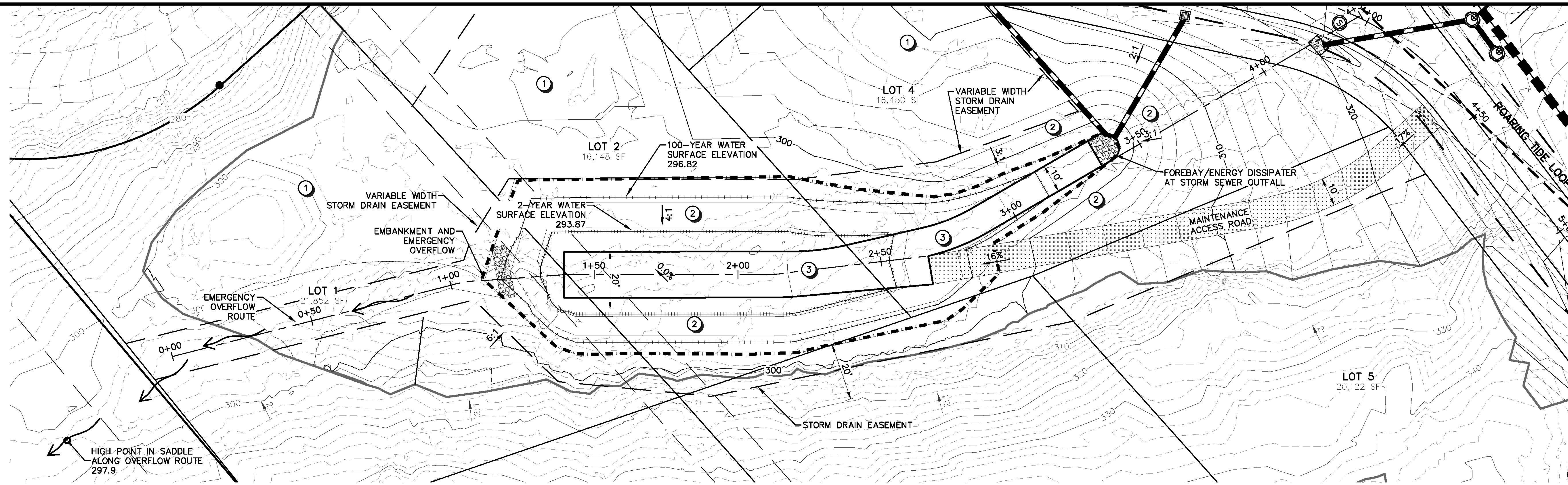
10/11/2	3	REVISED LAND USE SUBMITTAL	DRAWN: BD	DESIGNED: BD	CHECKED: EH	
10/1/21	2	10/1/21	SCALE: AS SHOWN	DATE: MAR 22, 2021		
6/18/21	1	6/18/21	PROJECT NO. E20-036			
DATE:	NO.	REVISION				

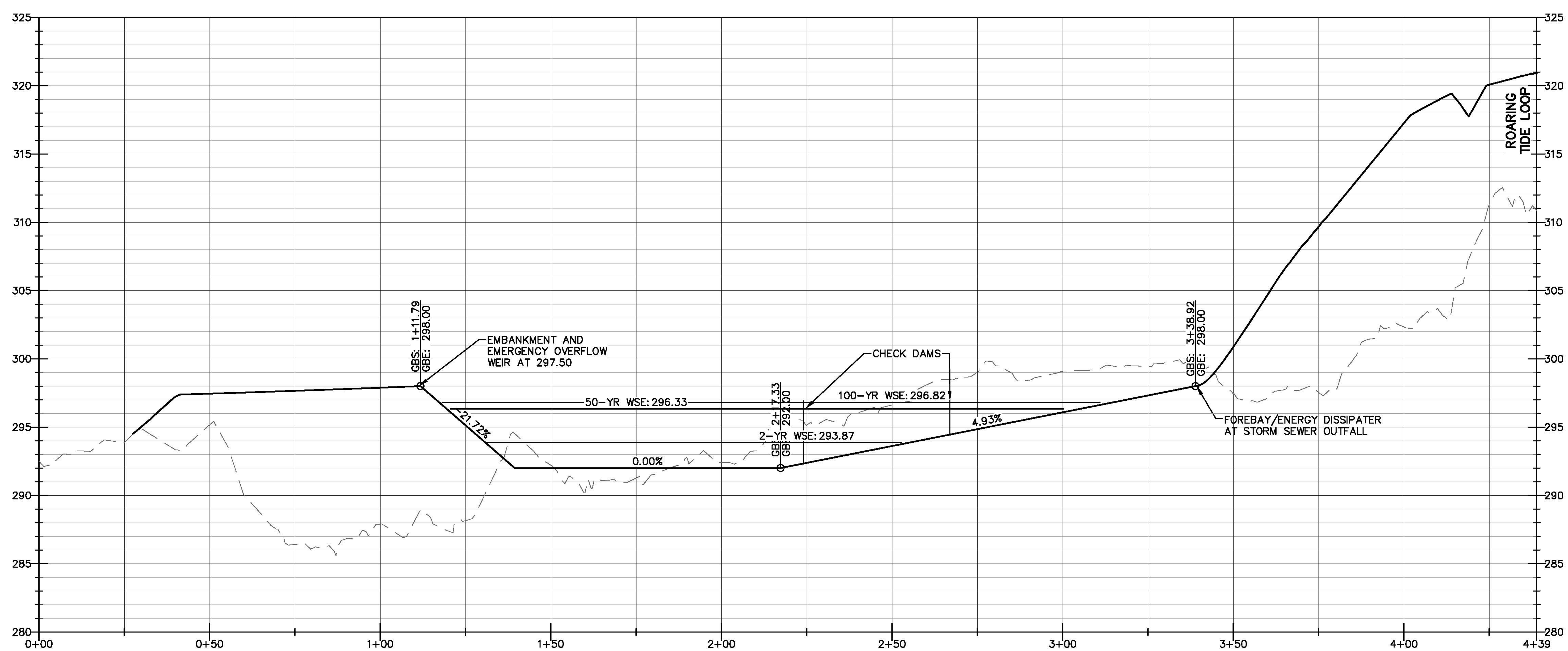
FIRWOOD DESIGN GROUP

359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

SHARED DRIVEWAY CONCEPT PROFILE
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS





NOTES:

1. HOMES BUILT NEXT TO POND SHALL HAVE A FINISHED FLOOR ELEVATION ABOVE 297.9
2. PROVIDE EROSION CONTROL MEASURES TO POND SLOPES INCLUDING EROSION CONTROL BLANKETS AND VEGETATION
3. FLOW DISPERSION CHECK DAM ALONG POND FLOW PATH

SCALE IN FEET (VERTICAL 0–5; HORIZONTAL 0, 20, 40)

DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

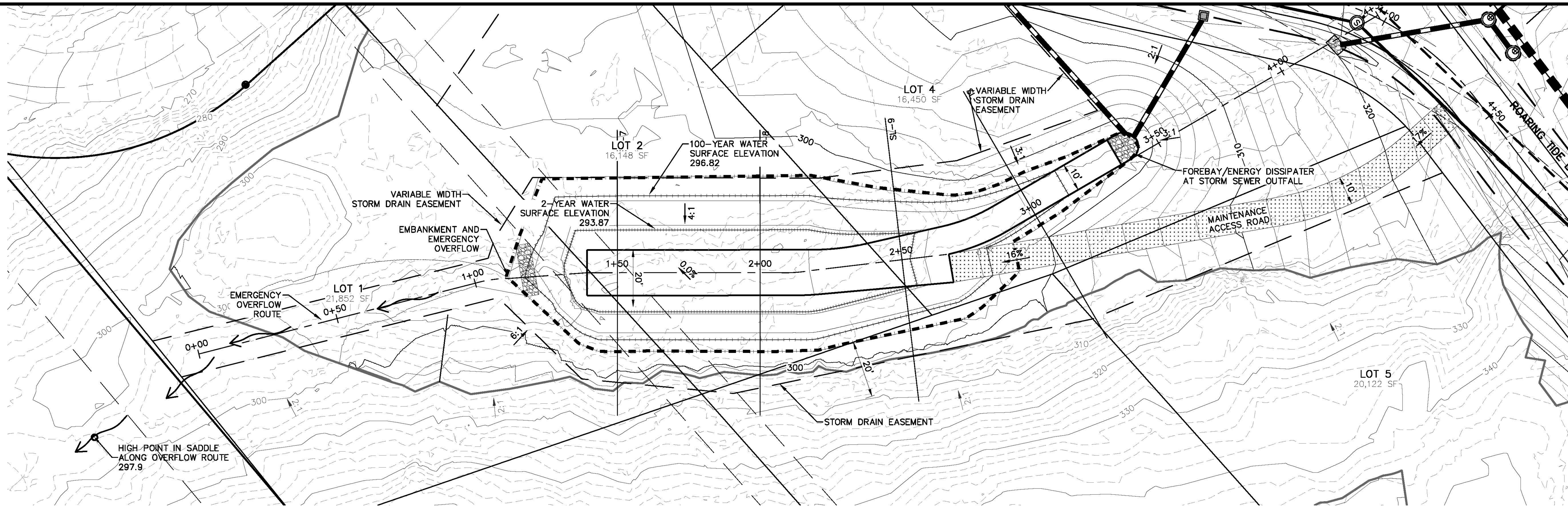
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

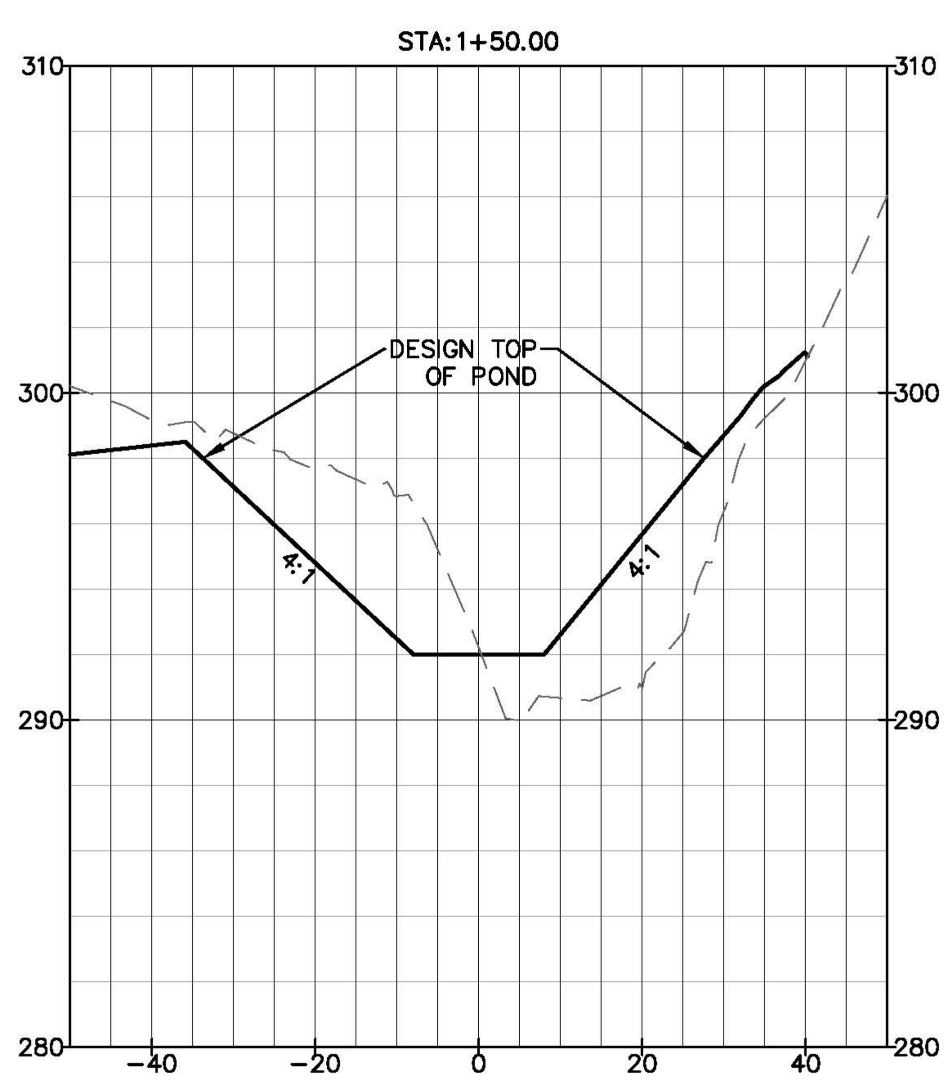
FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

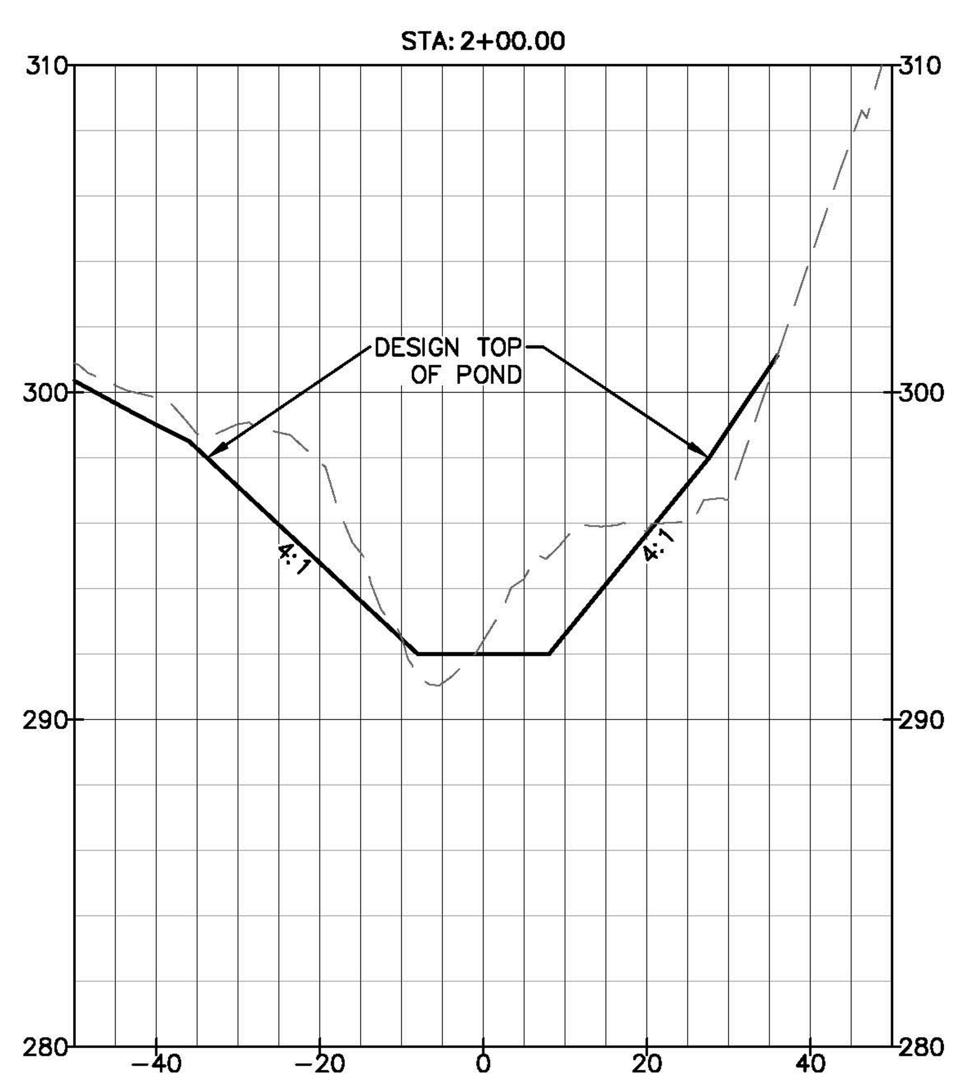
AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

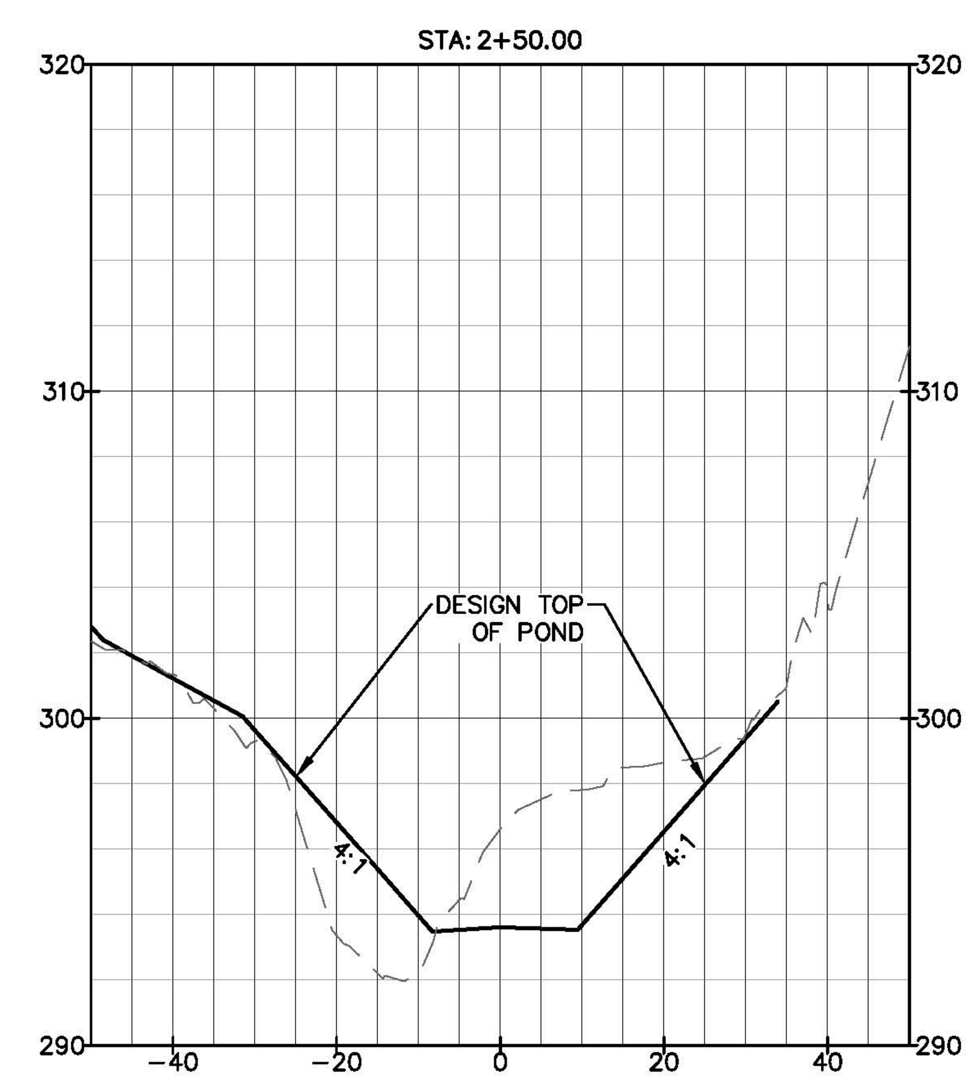
CONCEPT INFILTRATION POND PLAN
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

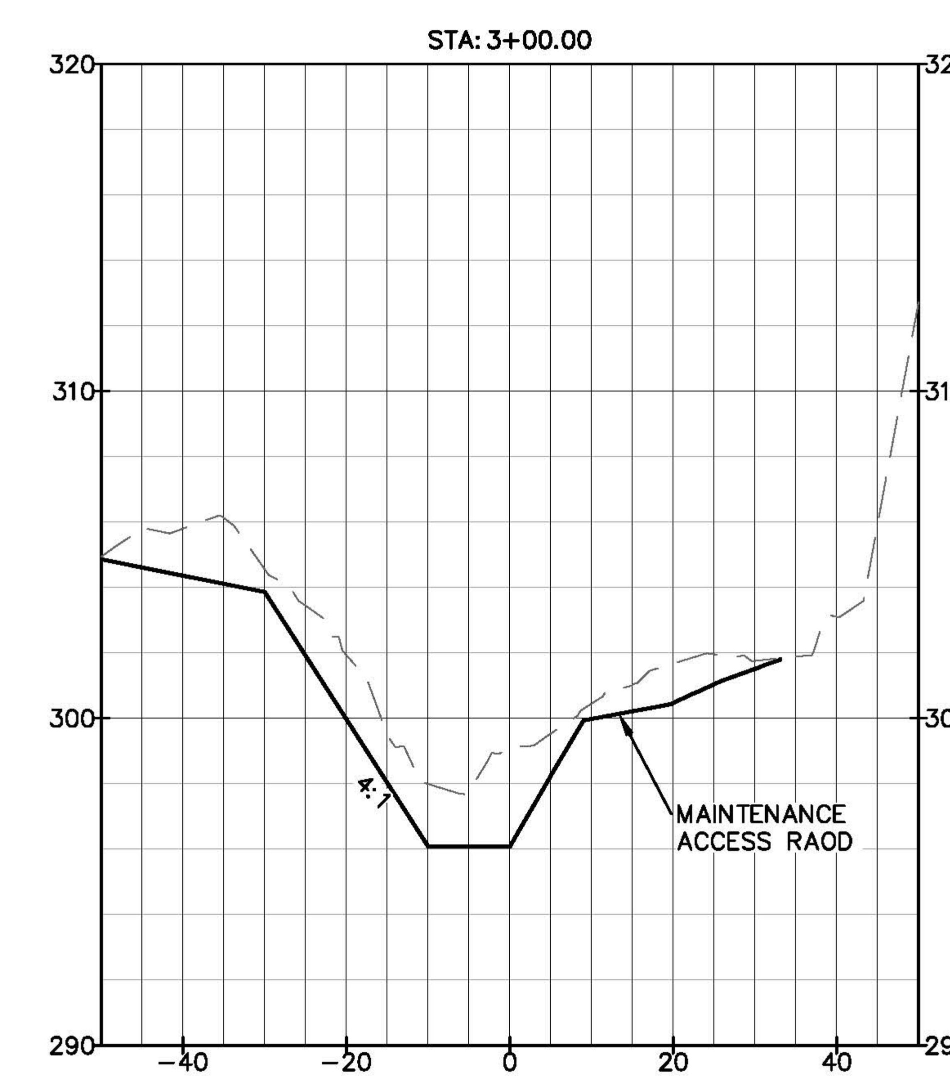
12 / 14

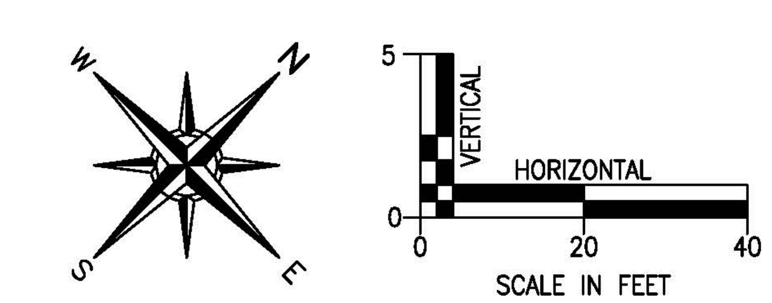












DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

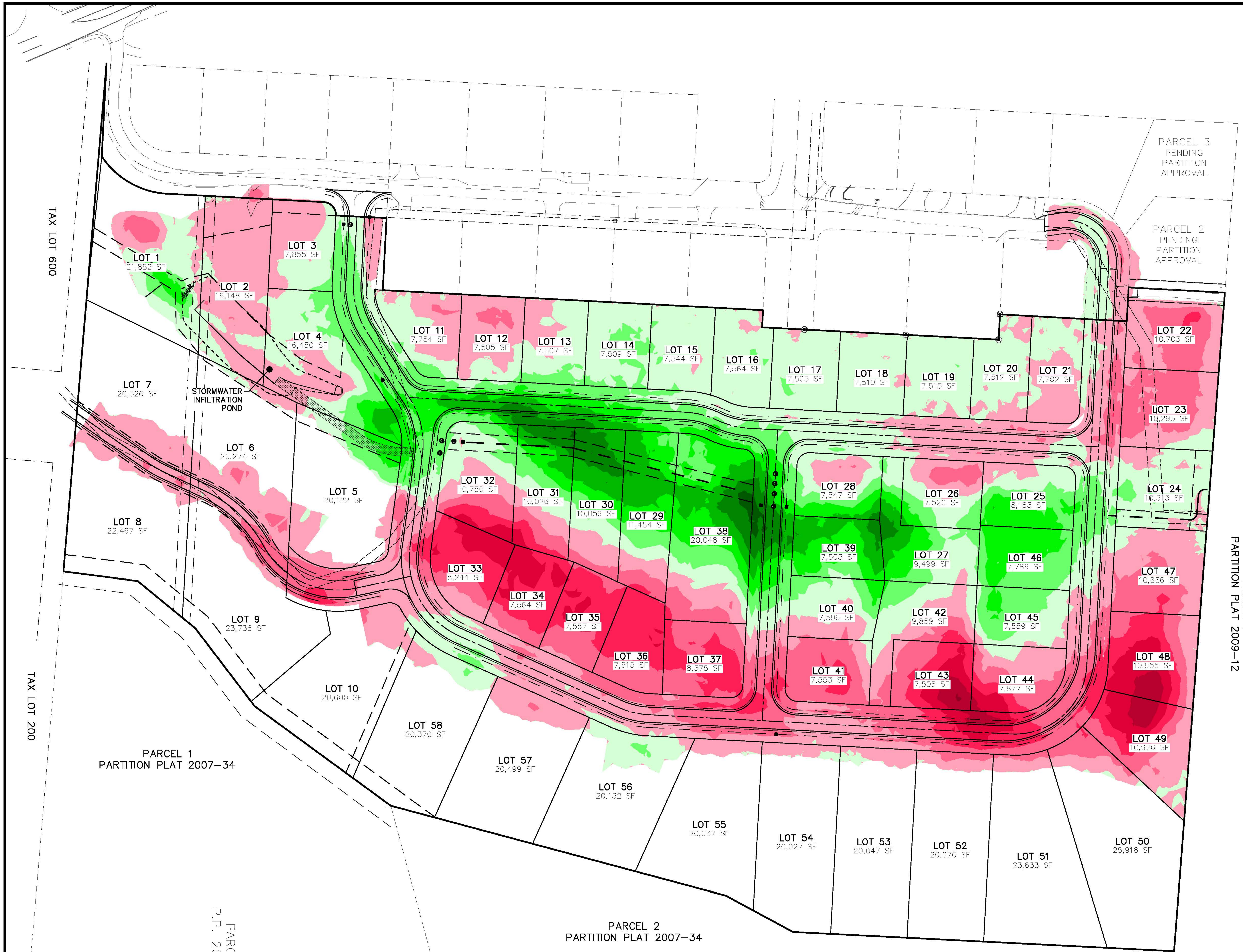
DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP

359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

CONCEPT INFILTRATION POND SECTIONS
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS



CUT-FILL			
#	MIN RANGE	MAX RANGE	COLOR
1	-30	-25	
2	-25	-20	
3	-20	-15	
4	-15	-10	
5	-10	-5	
6	-5	0	
7	0	5	
8	5	10	
9	10	15	
10	15	20	
11	20	25	
12	25	30	

CUT
FILL

NOTES

1. PRELIMINARY ESTIMATED EARTHWORK:
   CUT: 67,500 CY
   FILL: 68,000 CY
   PRELIMINARY ESTIMATE IS EXISTING GRADE TO FINISH GRADE IN THE LIMITS OF GRADING SHOWN. TOPSOIL STRIPPING, IMPORTED ROAD/UTILITY TRENCH MATERIAL, ETC IS NOT ACCOUNTED FOR. FINAL DESIGN GRADING VOLUMES WILL LIKELY DIFFER SIGNIFICANTLY. IT IS EXPECTED THAT GRADING WILL BALANCE ON-SITE.
3. EXISTING TOPOGRAPHY IS FROM 2009 USACE LIDAR DATA. ACTUAL CONDITIONS (AND THEREFORE CUT AND FILL VOLUMES) MAY VARY.

W
S
N
E

0 60 120
SCALE IN FEET

DATE:	NO.	REVISION
10/11/21	3	REVISED LAND USE SUBMITTAL
10/1/21	2	10/1/21
6/18/21	1	6/18/21

DRAWN: BD | DESIGNED: BD | CHECKED: EH
SCALE: AS SHOWN | DATE: MAR 22, 2021
PROJECT NO. E20-036

FIRWOOD DESIGN GROUP
359 EAST HISTORIC COLUMBIA RIVER HIGHWAY
TROUTDALE, OREGON 97060
BUS: (503) 668-3737 ✦ FAX: (503) 668-3788

AVALON HEIGHTS LLC - BILL HUGHES
41901 OLD HIGHWAY 30
ASTORIA, OREGON 97103

CUT-FILL MAP
SECOND AVALON HEIGHTS SUBDIVISION
LAND USE PLANS

Melissa Jenck

From: eh@firwooddesign.com
Sent: Thursday, October 14, 2021 12:27 PM
To: Melissa Jenck
Cc: Chris Laity; Skip Urling; Bill Hughes; 'Ty K. Wyman'
Subject: EXTERNAL: Avalon Heights Traffic Impact Addendum
Attachments: Addendum Memo - Second Avalon Heights 2.0 FINAL.pdf

Melissa,
Please find attached the revised Transportation Impact Study Addendum #1 for the Second Avalon Heights Subdivision that addresses questions raised at the last Commissioners hearing. Please enter this into the record and feel free to contact us if you have any questions or concerns.

Erik Hoovestol, P.E.

FIRWOOD DESIGN GROUP

359 E. Historic Columbia River Highway
Troutdale, OR 97060

P:503-668-3737
C:503-706-6557

lancaster mobley

321 SW 4th Ave., Suite 400
Portland, OR 97204
503.248.0313
lancastermobley.com

REGISTERED PROFESSIONAL ENGINEER
59946PE
Melissa A. Webb
OREGON
JULY 12, 2005
MELISSA A. WEBB
EXPIRATION DATE: 6/30/2022

Memorandum

To: Bill Hughes

From: Melissa Webb, PE
Daniel Stumpf, PE

Date: October 14, 2021

Subject: Second Avalon Heights Subdivision
Transportation Impact Study Addendum #1

Executive Summary

1. Traffic volumes traveling along OR-131 to and from Cape Meares Loop were captured in the 2006 counts and accounted for in the traffic study.
2. With site trips being split between Grand Avenue and Highland Drive W, all study intersections are currently operating acceptably per ODOT standards and are projected to continue operating acceptably through the 2023 buildout year of the site. No operational mitigation is necessary or recommended at these intersections.
3. Trip generation for a recreational home will generally be less than that of a typical single-family dwelling during a typical weekday. On a typical Friday, the trip generation for a recreational home is only slightly higher than that of a typical single-family dwelling. Even if all 60 units were rented as vacation homes, the number of trips generated during the Friday evening peak hour would be very similar to the number of trips generated for 60 single-family dwelling units for the same peak hour.
4. There is no guarantee that recreational homes will be occupied daily year-round like a single-family dwelling would be. Recreational homes are also less likely to generate vehicle trips during the morning and evening peak hours, as these hours are typically impacted and capture commuter traffic associated with residents going to and from work locations as well as traffic associated with schools, the latter of which will likely not be in session during the peak summer months of vacation rentals.
5. No significant trends or crash patterns were identified at the intersection of OR-131 at Grand Avenue that are indicative of safety concerns. No safety mitigation is recommended per the crash data analysis.
6. Adequate sight distance is available along OR-131 at Grand Avenue to ensure safe operation for northbound and southbound approaching vehicles at the intersection.
7. Due to insufficient traffic volumes, preliminary traffic signal warrants are not projected to be met at the unsignalized intersection of OR-131 at Grand Avenue under any of the analysis scenarios. In addition, left-turn lane warrants are not projected to be met at the study intersection under any of the analysis scenarios.

Introduction

This memorandum is written in response to comments received by the Tillamook County Board of Commissioners regarding the *Second Avalon Heights Subdivision Transportation Impact Study*, dated April 1st, 2021, and serves as an addendum to the original report.

County Commissioners have requested additional information in four main areas, each of which are addressed in detail in this addendum:

1. Address additional traffic along OR-131 in the project vicinity due to the reopening of Cape Meares Loop.
2. Assume that site trips to/from the project site are split between Grand Avenue and Highland Drive W rather than all site trips using Highland Drive W, as assumed in the transportation impact study (TIS).
3. Address vacation rentals and their traffic characteristics.
4. Discussion of geometry and safety at the intersection of OR-131 at Grand Avenue.

Cape Meares Loop Traffic Volumes

Cape Meares Loop has been closed between mileposts 1 and 2.5 due to landslide activity since January 2013. During the Planning Commission hearing, there were concerns that when this road reopens there will be an increase in traffic along OR-131 near the project vicinity and that this increase in volume should be included in the traffic study.

Due to the ongoing COVID-19 viral pandemic, as of mid-March 2020, traffic volumes have been depressed relative to normal conditions. Under these conditions, traditional traffic count data collection methods are not recommended. Based on guidance and input from Oregon Department of Transportation (ODOT) and Tillamook County staff, historical traffic count data collected in July 2006 was used. Because Cape Meares Loop was open during this time, traffic using OR-131 to access Cape Meares Loop would have been captured in the 2006 counts and accounted for in the traffic study.

It is important to note that the intersection counts from 2006 were adjusted and *increased* to bring the volumes to 2021 conditions while reflecting the 30th highest hour traffic volumes. ODOT staff provided guidance on this adjustment, and a linear growth rate of one percent per year was applied to all through movement volumes along OR-131 over a 15-year period to determine year 2021 existing volumes. For all other turning movements, a linear growth rate of one-half percent per year was applied to the 2006 traffic volumes over a 15-year period to determine year 2021 existing volumes.

New traffic counts were collected at the study intersection of OR-131 at Highland Drive W on Tuesday, June 9, 2020. These counts were adjusted to bring the counts to year 2021 existing conditions, and both a COVID-19 adjustment factor and a seasonal adjustment factor were applied. The final traffic volumes from the 2006 and the 2020 counts were compared, and the 2006 counts produced the highest turn movement volumes. Therefore, the data from the 2006 counts was used for the traffic study in order to show a "worst-case" analysis scenario at the study intersection. These 2006 counts would have included traffic using OR-131 to access Cape Meares Loop, as the roadway was open during this time.

Traffic Volumes – Grand Avenue

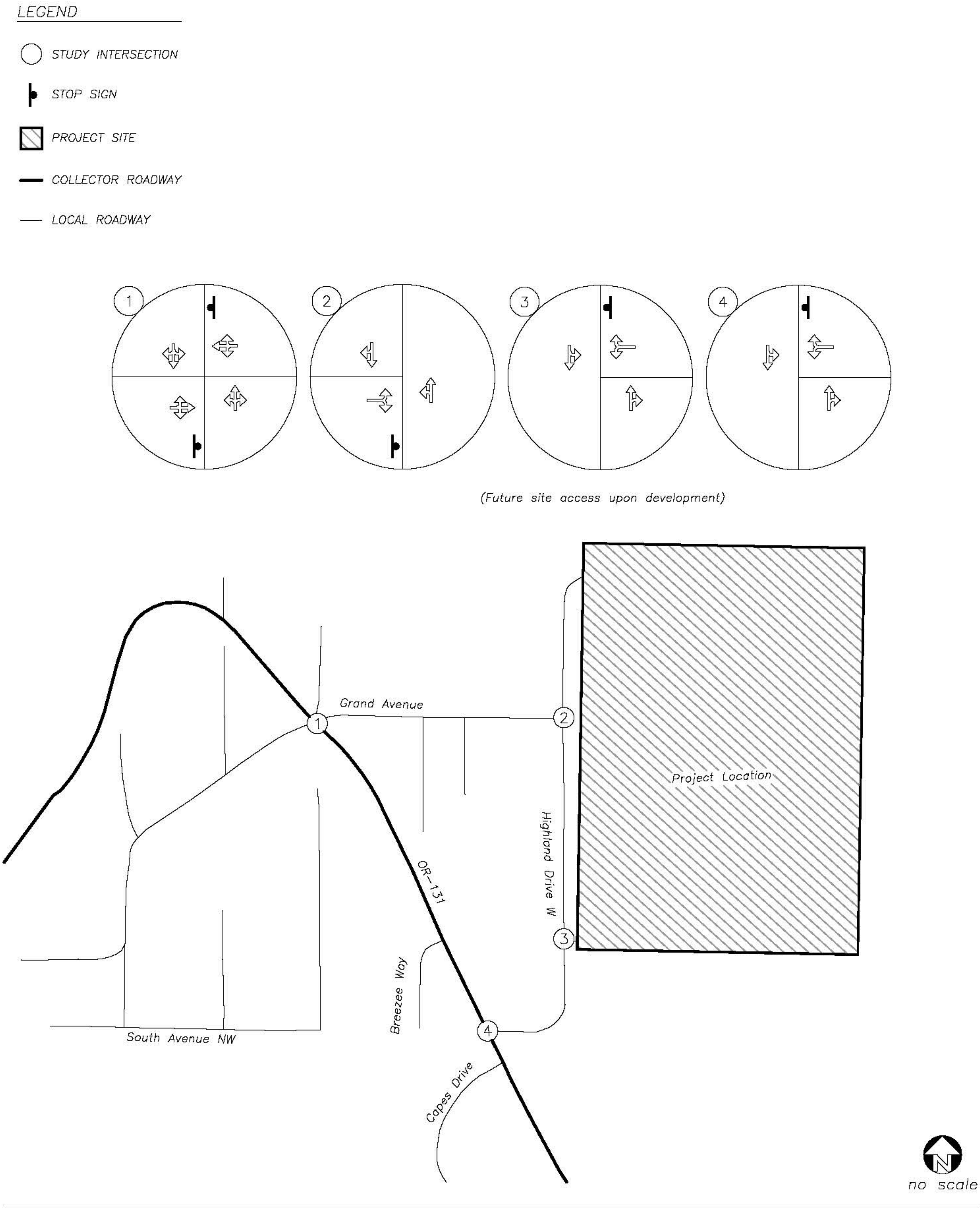
County/ODOT staff initially only requested analysis of the OR-131/Highland Drive W intersection. The traffic study assumes that all traffic generated by the proposed development uses this intersection as a "worst case" scenario and shows that even if all vehicles use Highland Dr W to access the project site, the intersection will still operate within acceptable standards, and no turn lanes or traffic signals will be needed. County Commissioners have requested an update to the TIS to assume traffic traveling to and from the proposed development is split between Grand Avenue and Highland Drive W, and to include an operational analysis at the intersection of OR-131 at Grand Avenue. In addition, left-turn lane warrants and signal warrants will be examined for this intersection.

Grand Avenue is an unpaved, local road through a residential area with a statutory speed of 25 mph. There are no sidewalks, curbs, or designated bicycle lanes along either side of the roadway. On-street parking is permitted where available. As part of the proposed development, the roadway will be improved, including regrading.

The intersection of OR-131 at Grand Avenue is a four-legged intersection that is stop-controlled for the eastbound and westbound approaches. All approaches each have one shared lane for all turning movements.

The intersection of Grand Avenue at Highland Drive W is a three-legged intersection that is stop-controlled for the eastbound approach. All approaches each have one shared lane for all turning movements.

An updated vicinity map is provided in Figure 1.



lancaster mobley

VICINITY MAP

Figure 1

Second Avalon Heights Subdivision

9/21/2021

Trip Assignment and Distribution

While the site trip generation of the proposed development will remain the same as reported in the TIS, the distribution of site trips will be adjusted slightly to account for two site accesses instead of one. Vehicles have the option of traveling along either Grand Avenue or Highland Drive W to access the project site.

Based on the location of lots in the proposed development, it was assumed that 13 of the lots would use Grand Avenue for access to and from the north on OR-131. The rest of the lots would use Highland Drive W to travel to and from the north on OR-131. It was also assumed that all lots would use Highland Drive W to travel to and from the south on OR-131.

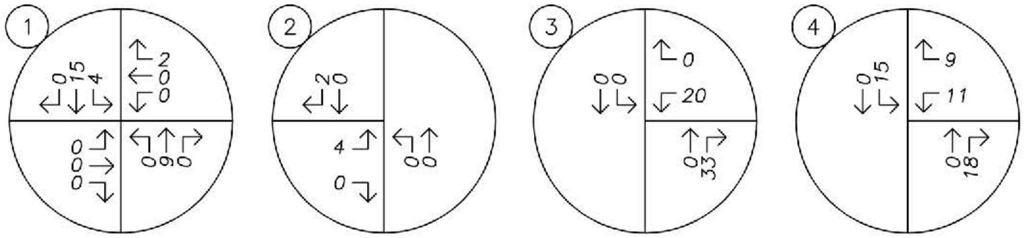
The directional distribution of turning movements at Grand Avenue to and from OR-131 was adjusted based on County staff input. The project site is located between the cities of Oceanside and Netarts. Both cities offer dining, shopping, and recreational opportunities, all of which would appeal to both vacationers as well as residents. Because Oceanside is slightly closer to the project site than Netarts is, the following directional distribution was assumed: approximately 60 percent of site trips will travel to/from the north along OR-131, and approximately 40 percent of site trips will travel to/from the south along OR-131. This is a slight change from the original trip distribution percentages of 50 percent of site trips traveling to/from the north and 50 percent of site trips traveling to/from the south along OR-131.

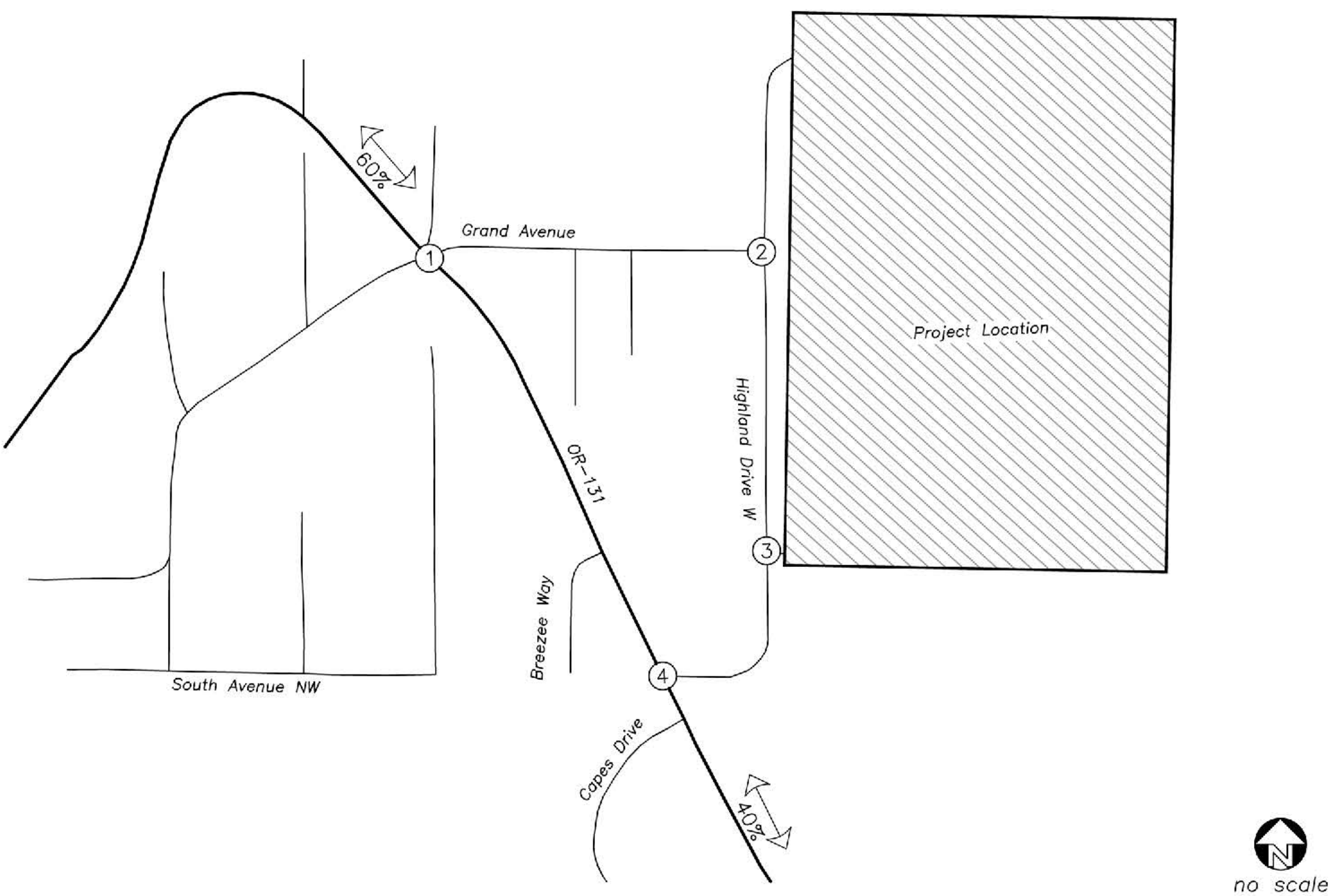
The updated trip distribution and assignment for the net site trips generated during the evening peak hour are shown in Figure 2.

LEGEND

XX% PERCENT OF PROJECT TRIPS

NET TRIP GENERATION			
	IN	OUT	TOTAL
PM	37	22	59





SITE TRIP DISTRIBUTION & ASSIGNMENT
Proposed Development Plan - Net Site Trips
PM Peak Hour

Figure 2
Second Avalon Heights Subdivision
9/21/2021

lancaster mobley

Existing Conditions

Based on guidance from County staff, assumptions of existing vehicular traffic along Grand Avenue were determined based on the number of residential units that are estimated to be using Grand Avenue for access onto OR-131.

Grand Avenue west of the highway provides the only access onto OR-131 for approximately 60 residences, while residences along and near Grand Avenue east of the highway can use both Grand Avenue and Highland Drive W as access roadways. The Tillamook County Public Works department estimates that there are currently 14 residences that are using Grand Avenue for access to and from OR-131.

Data for land use code 210, *Single-Family Detached Housing*, was used to estimate the existing vehicular traffic along Grand Avenue based on the number of dwelling units. The evening peak hour generally occurs between 3:00/4:00 PM and 6:00 PM on a typical weekday (Tuesday through Thursday) and is considered the peak of afternoon traffic along adjacent roadways. This timeframe is intended to capture traffic conditions when roadways are typically congested on an average weekday and is generally associated with commuter travel between employment and residential locations. Table 1 shows the estimated existing vehicular traffic along Grand Avenue.

Table 1: Existing Vehicular Traffic Along Grand Avenue

Land Use	ITE Code	Size	Evening Peak Hour			Weekday
			In	Out	Total	Total
Single-Family Detached Housing	210	60 units	39	23	62	650
Single-Family Detached Housing	210	14 units	9	6	15	170

The existing evening peak hour traffic volumes at the study intersections are shown in Figure 3.

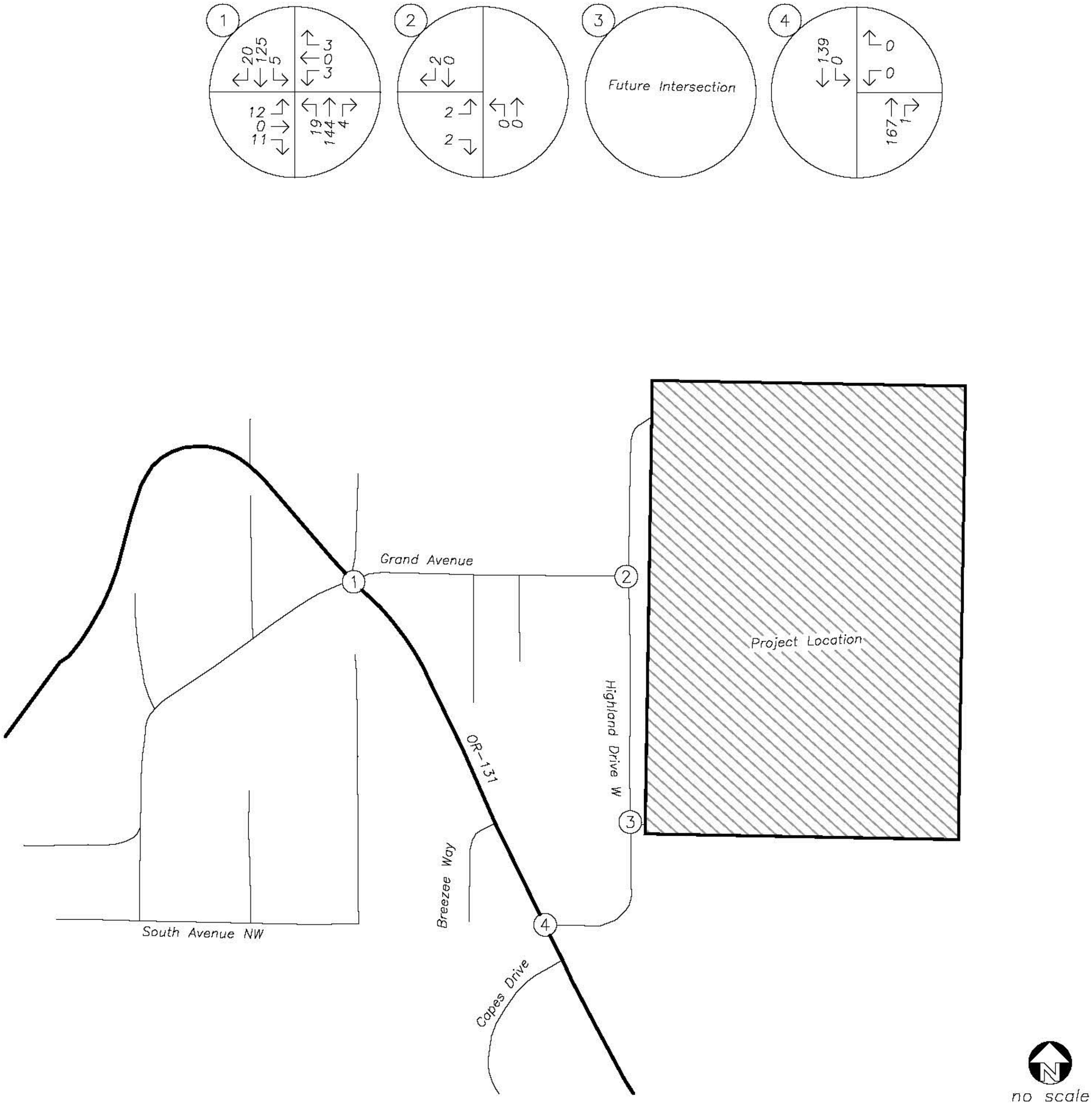
Background Conditions

Growth rates consistent with the methodology shown in the original TIS were applied to the existing 2006 traffic volumes in order to calculate year 2023 background volumes. Figure 4 shows the projected year 2023 background traffic volumes at the study intersections during the evening peak hour.

Buildout Conditions

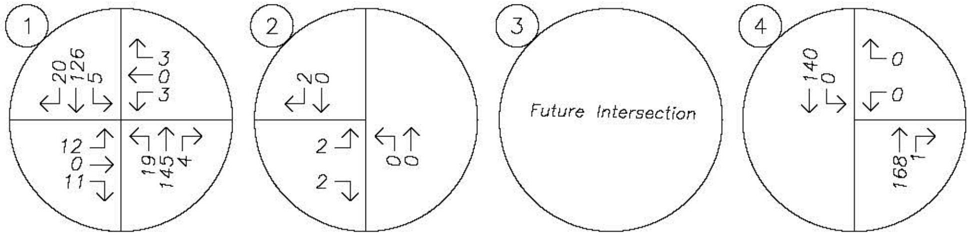
Peak hour trips calculated to be generated by the proposed development, as described within the *Trip Assignment and Distribution* section of this memorandum, were added to the projected year 2023 background traffic volumes to obtain the expected year 2023 site buildout volumes. 2023 is the expected full buildout year of the site.

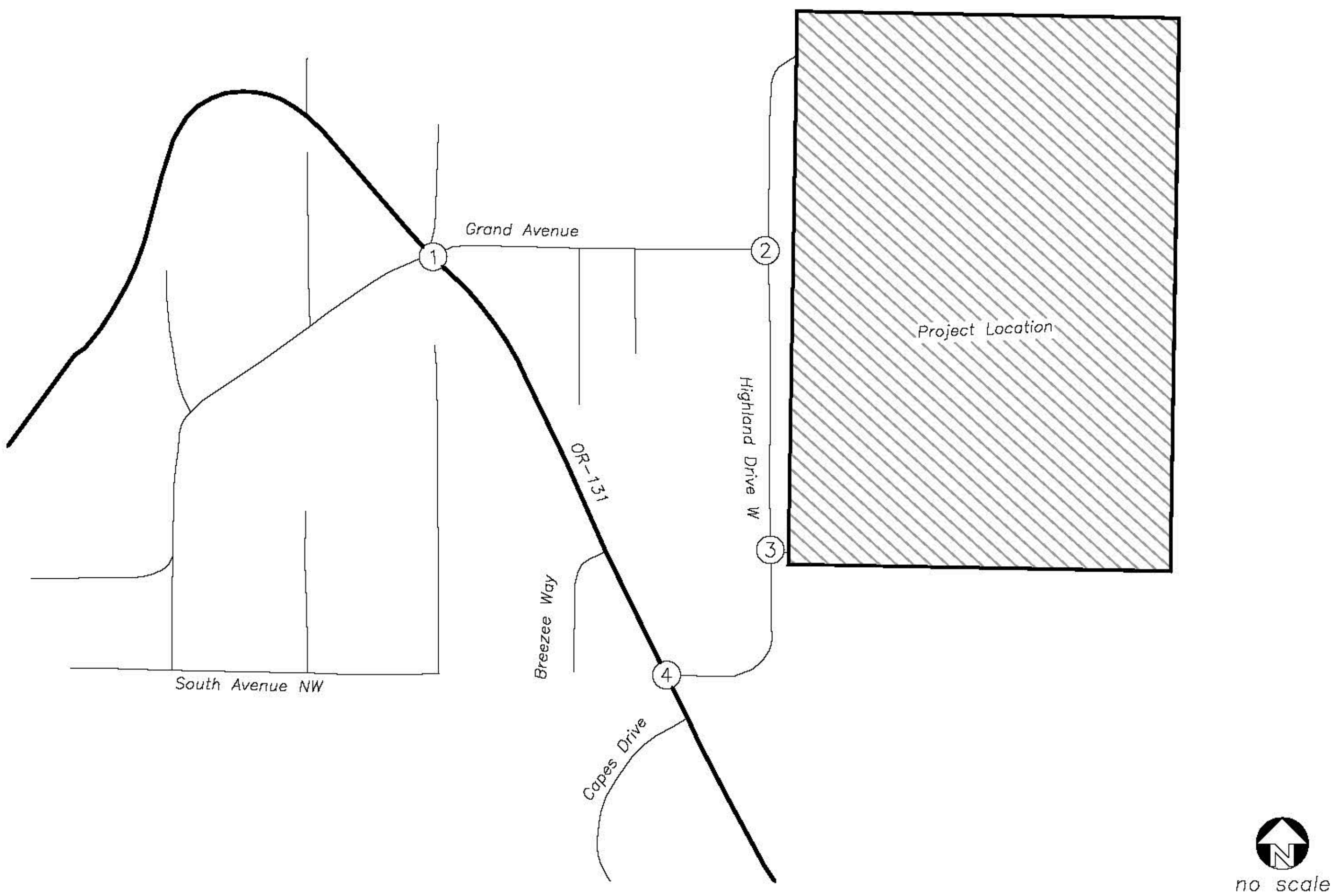
Figure 5 shows year 2023 buildout traffic volumes at the study intersections during the evening peak hour.



TRAFFIC VOLUMES
Year 2021 Existing Adjusted Conditions
PM Peak Hour

Figure 3
Second Avalon Heights Subdivision
9/21/2021

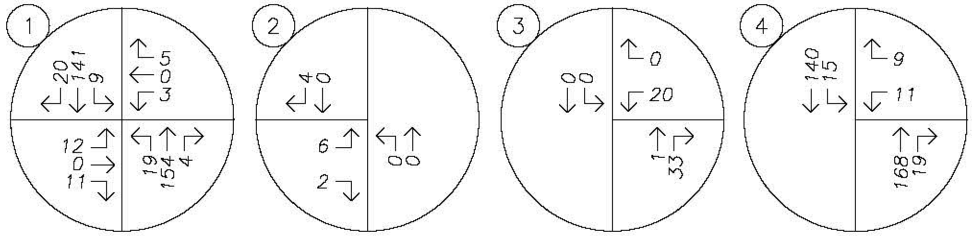


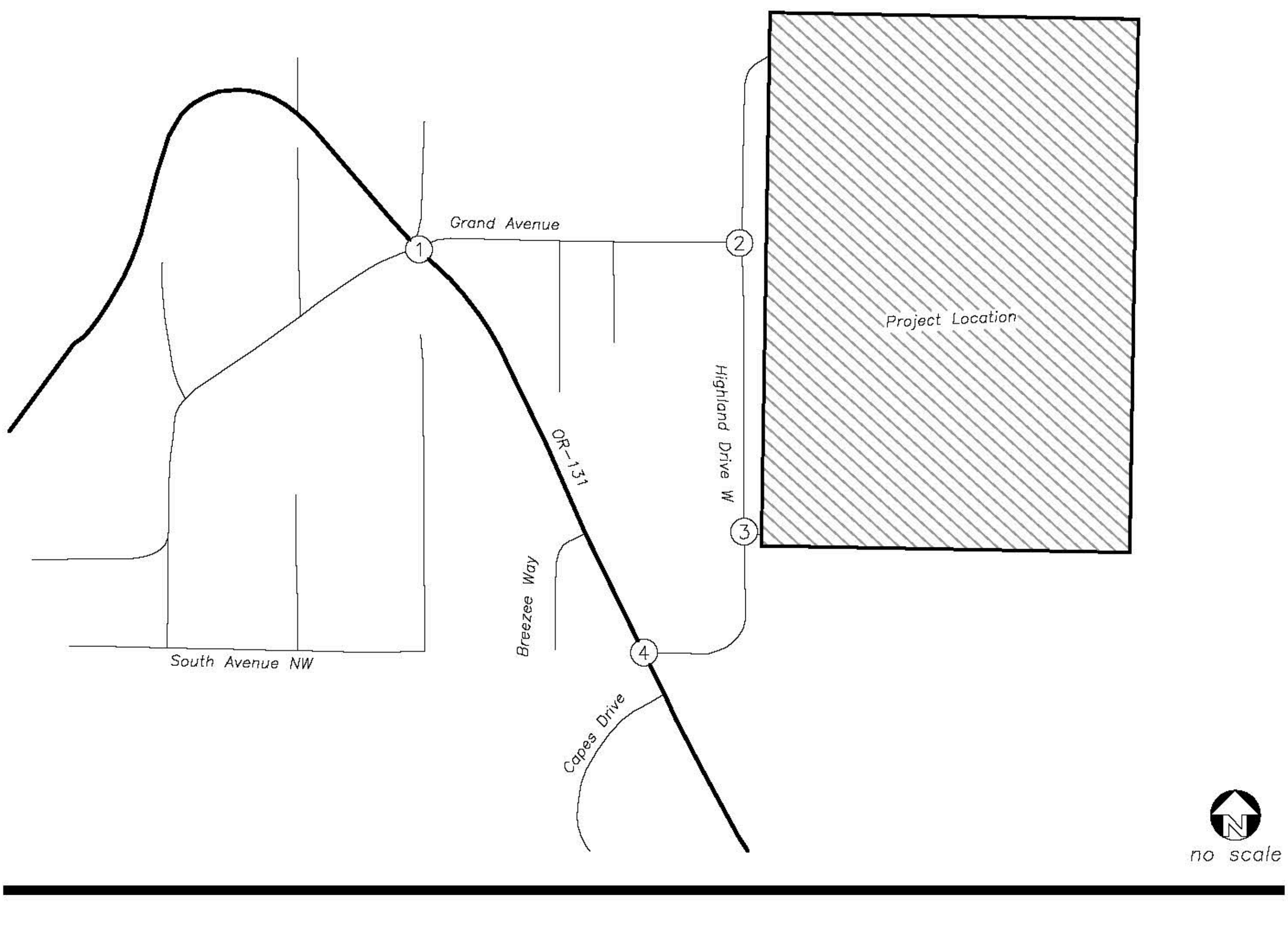


lancaster mobley

TRAFFIC VOLUMES
Year 2023 Background Conditions
PM Peak Hour

Figure 4
Second Avalon Heights Subdivision
9/21/2021





TRAFFIC VOLUMES
Year 2023 Buildout Conditions
PM Peak Hour

Figure 5
Second Avalon Heights Subdivision
9/21/2021

Vacation Rental Characteristics

At the Planning Commission hearing, concerns were raised that vacation rentals would generate more traffic coming and going through the neighborhood vs. typical single-family dwelling traffic patterns.

To estimate the number of trips that will be generated by the proposed development, trip equations from the *Trip Generation Manual*[1] are referenced. Data for land-use code 210, *Single-Family Detached Housing*, was used to estimate the proposed development's trip generation based on the number of dwelling units.

The *Trip Generation Manual* also contains data for land-use code 260, *Recreational Homes*. This land-use describes a recreational home as "*located within a resort that contains local services and complete recreational facilities. These dwellings are often second homes used by the owner periodically or rented on a seasonal basis*." While the description is not an exact match to the proposed Second Avalon Heights subdivision (i.e. the homes are not located within a resort), the land-use is a reasonable representation considering the city of Oceanside could be considered a vacation location, and the city offers local services and a variety of recreational facilities and activities.

Trip generation data from the evening peak hour of adjacent street traffic was used from both land uses (Single-Family Detached Housing and Recreational Housing) to determine traffic impacts in the surrounding area. The evening peak hour is typically considered the highest volume hour between 3:00/4:00 PM and 6:00 PM of the afternoon of an average weekday. Tillamook County staff have reported that the nearby city of Pacific City has a PM peak hour from 3:45 PM to 4:45 PM. Pacific City is similar in ownership and type of community to Oceanside.

Table 2 shows a trip generation comparison between 60 units of single-family detached housing and 60 units of recreational housing.

Table 2: Trip Generation Comparison

Land Use	ITE Code	Size	Evening Peak Hour			Weekday
			In	Out	Total	Total
Single-Family Detached Housing	210	60 units	39	23	62	650
Recreational Housing (Weekday)	260	60 units	7	10	17	208
Recreational Housing (Friday)	260	60 units	40	27	67	-

Table Notes: Trip rates were used for Recreational Housing data, as trip equations were not available

The table shows that trip generation for a recreational home will generally be less than that of a typical single-family dwelling during a typical weekday. On a typical Friday, the trip generation for a recreational home is only slightly higher than that of a typical single-family dwelling. Even if all 60 units were rented as vacation homes, the number of trips generated during the evening peak hour on a Friday would be very similar to the number of trips generated during the Friday evening peak hour for 60 single-family dwelling units.

There is no guarantee that recreational homes will be occupied daily year-round like a single-family dwelling would be (one rental company specializing in Oregon Coast vacation rentals estimates that the average home

[1] Institute of Transportation Engineers, *Trip Generation Manual*, 10th Edition, 2017.

rents about 140 calendar nights per year[2]). Recreational homes located near the Oregon Coast typically will see higher occupancy in the summer months, with less occupancy during the fall, winter, and spring. Recreational homes are also less likely to generate vehicle trips during the morning and evening peak hours, as these hours are typically impacted and capture commuter traffic associated with residents going to and from work locations as well as traffic associated with schools, the latter of which will likely not be in session during the peak summer months of vacation rentals.

According to the *2018 Oceanside Community Plan*, approximately 10% of residential lots were licensed as vacation rental units in 2018 (1,057 residential lots and 104 licensed vacation rental units)[3]. The most recent data obtained from Tillamook County staff shows a total of 115 active short-term rental licenses in Oceanside, slightly higher than the number reported in 2018.

OR-131 at Grand Avenue Intersection

County Commissioners have requested an update to the TIS to include an operational analysis at the intersection of OR-131 at Grand Avenue. In addition, crash history, sight distance, left-turn lane warrants and signal warrants will be examined for the intersection.

OR-131 at Grand Avenue is a four-legged intersection that is stop-controlled for the eastbound and westbound legs. All approaches each have one shared lane for all turning movements. There are no striped bicycle lanes along any of the roadways, and crosswalks are unmarked across all four intersection legs. There is a private driveway located north of the intersection on the eastern side of OR-131.

Capacity Analysis

The study intersection of OR-131 at Grand Avenue is under the jurisdiction of ODOT. The applicable minimum operation standard for this facility is established under the *Oregon Highway Plan* and is based on the v/c ratio of the intersection. According to the *Oregon Highway Plan*, OR-131 is a district route located outside any urban growth boundaries and within an unincorporated community and has a maximum allowable v/c ratio of 0.80. The above-mentioned intersection along OR-131 was analyzed according to this standard.

Mainline v/c ratios along OR-131 were reviewed according to the guidance listed in ODOT's *Analysis Procedures Manual, Version 2* (APM). It should be noted that there is a limitation of the *Highway Capacity Manual, 6th Edition*, unsignalized intersection methodology for shared left turn approaches within the Synchro analysis software: major street left turns are always treated as exclusive turn lanes regardless of how they are coded. As a result, the v/c ratio value is reported only for the left turn movement and does not include the through movement. Using methodology in Chapter 12 of the APM (Example 12-3), a shared through-left v/c ratio was calculated for the intersections of OR-131 at Grand Avenue and OR-131 at Highland Drive W. The highest calculated v/c ratio was reported.

The LOS, delay, and v/c results of the capacity analysis are shown in Table 3 for the evening peak period. Detailed calculations as well as tables showing the relationship between delay and LOS are included as an attachment to this report.

[2] https://www.oregonbeachvacations.com/owner-faqs#41

[3] Oceanside Neighborhood Association, *Oceanside Community Plan*, 2018. Table 1, page 34

Table 3: Capacity Analysis Summary

	Evening Peak Hour		
	LOS	Delay (s)	v / c
1. OR-131 at Grand Avenue			
2021 Existing Conditions	B	11	0.14 (NBLT)
2023 Background Conditions	B	11	0.14 (NBLT)
2023 Buildout Conditions	B	11	0.14 (NBLT)
2. Grand Avenue at Highland Drive W			
2021 Existing Conditions	A	8	0.00 (EBL)
2023 Background Conditions	A	8	0.00 (EBL)
2023 Buildout Conditions	A	9	0.01 (EBL)
3. Highland Drive W at Roaring Tide Loop (site access)			
2021 Existing Conditions	-	-	-
2023 Background Conditions	-	-	-
2023 Buildout Conditions	A	9	0.02 (WBL)
4. OR-131 at Highland Drive W			
2021 Existing Conditions	B	10	0.11 (SBLT)
2023 Background Conditions	B	10	0.11 (SBLT)
2023 Buildout Conditions	B	11	0.13 (SBLT)

LOS, Delay, v/c: For two-way stop, these values are taken from the movement with the worst (highest) delay value. ***BOLDED*** *results indicate operation above acceptable jurisdictional standards*

All study intersections are currently operating acceptably per ODOT standards and are projected to continue operating acceptably through the 2023 buildout year, regardless of the potential increase in site trip generation upon development of the site. No operational mitigation is necessary or recommended at these intersections.

Crash History

Using data obtained from the ODOT Crash Data System, a review of approximately five years of the most recent available crash history (January 2015 through December 2019) was performed at the intersection. The crash data was evaluated based on the number of crashes, the type of collisions, and the severity of the collisions. Crash severity is based on injuries sustained by people involved in the crash, and includes five categories:

- *PDO* – Property Damage Only;
- *Injury C* – Possible Injury;
- *Injury B* – Suspected Minor Injury;
- *Injury A* – Suspected Serious Injury; and
- *Fatality*

The intersection of OR-131 at Grand Avenue had one reported crash during the analysis period. The crash was a turning movement collision and occurred when the driver of an eastbound vehicle making a left-turn failed to yield right-of-way to a northbound vehicle. There were no reported injuries and the crash was classified as *Property Damage Only*. Detailed ODOT crash reports are attached to this memorandum.

Crash rates provide the ability to compare safety risks at different intersections by accounting for both the number of crashes that have occurred during the study period and the number of vehicles that typically travel through the intersection. Crash rates were calculated using the evening peak hour traffic volumes shown in Figure 3. Crash rates in excess of 1.00 crashes per million entering vehicles (CMEV) may be indicative of design deficiencies and therefore require a need for further investigation and possible mitigation. Based on the number of crashes and the number of vehicles along the roadway, a crash rate of 0.16 CMEV was calculated. ODOT's 90th percentile crash rate for three-legged minor stop-controlled intersections in a rural area is 0.475 CMEV[4].

Based on a review of the available crash data and crash rates, patterns are consistent with the geometry and traffic control provided at the study intersections. No significant trends or crash patterns were identified at any of the study intersections that are indicative of safety concerns. Accordingly, no safety mitigation is recommended per the crash data analysis.

Sight Distance

Sight distances along OR-131 at the intersection with Grand Avenue were measured and evaluated in accordance with standards established in in *A Policy on Geometric Design of Highways and Streets*[5] published by the American Association of State Highway and Transportation Officials (AASHTO).

Intersection sight distance is an operational measure intended to provide sufficient line of sight along the major-street so that a driver can enter the roadway without impeding the flow of through traffic. For intersection sight distance, the driver's eye is assumed to be 14.5 feet from the near edge of the nearest travel lane of the intersecting street and at a height of 3.5 feet above the minor-street approach pavement. The vehicle driver's eye-height along the major-street approach is assumed to be 3.5 feet above the cross-street pavement.

Based on a posted speed of 35 mph along OR-131, the minimum recommended intersection sight distance is 390 feet. Sight distance to the north was measured to exceed 390 feet, while sight distance to the south was impeded due to placement of residential mailboxes along OR-131 at the intersection. However, drivers will likely inch forward past the mailboxes to have a clear view of the roadway. Once drivers are able to look past the mailboxes, the sight distance to the south was measured to exceed 390 feet.

There is a private driveway on the east side of OR-131 located approximately 45 feet north of the intersection of OR-131 at Grand Avenue. The proposed project will not add any vehicle trips to this private driveway, nor will the project create any sight distance-related obstructions at the driveway. Vehicles stopped at Grand Avenue can clearly see vehicles at the private driveway entrance, and the driveway volumes are likely very low, whereby the potential for additional crashes specifically related to the private driveway will not significantly increase.

Based on the detailed sight distance analysis, adequate sight distances are available along OR-131 at the Grand Avenue intersection to ensure safe operation for northbound and southbound approaching vehicles.

---

[4] Oregon Department of Transportation, *Analysis Procedures Manual Version 2*, 2019, Exhibit 4.1, page 4.3.

[5] American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets*, 6th Edition, 2011.

Left-Turn Lane Warrants

Left-turn lane warrants were examined using methodologies provided in ODOT's *Analysis Procedures Manual* (APM). Left-turn lane warrants were evaluated based on the number of advancing and opposing vehicles, number of turning vehicles, travel speed, and the number of through lanes.

Due to insufficient traffic volumes, left-turn lanes are not projected to be met at the intersection of OR-131 at Grand Avenue under any of the analysis scenarios.

Preliminary Traffic Signal Warrants

Preliminary traffic signal warrants were examined for the unsignalized intersection of OR-131 at Grand Avenue to determine whether the installation of a new traffic signal will be warranted at the intersection upon completion of the proposed development.

Due to insufficient traffic volumes, traffic signal warrants are not projected to me bet at the intersection of OR-131 at Grand Avenue under any of the analysis scenarios.

Conclusions

Key findings of this study include:

- Traffic volumes traveling along OR-131 to and from Cape Meares Loop were captured in the 2006 counts and accounted for in the traffic study.
- With site trips being split between Grand Avenue and Highland Drive W, all study intersections are currently operating acceptably per ODOT standards and are projected to continue operating acceptably through the 2023 buildout year, regardless of the potential increase in site trip generation upon development of the site. No operational mitigation is necessary or recommended at these intersections.
- Trip generation for a recreational home will generally be less than that of a typical single-family dwelling during a typical weekday. On a typical Friday, the trip generation for a recreational home is only slightly higher than that of a typical single-family dwelling. Even if all 60 units were rented as vacation homes, the number of trips generated during the Friday evening peak hour would be very similar to the number of trips generated during the Friday evening peak hour for 60 single-family dwelling units.
- There is no guarantee that recreational homes will be occupied daily year-round like a single-family dwelling would be. Recreational homes are also less likely to generate vehicle trips during the morning and evening peak hours, as these hours are typically impacted and capture commuter traffic associated with residents going to and from work locations as well as traffic associated with schools, the latter of which will likely not be in session during the peak summer months of vacation rentals.
- Based on the most recent five years of crash data, no significant trends or crash patterns were identified at the intersection of OR-131 at Grand Avenue that are indicative of safety concerns. Accordingly, no safety mitigation is recommended per the crash data analysis.
- Adequate sight distance is available along OR-131 at Grand Avenue to ensure safe operation for northbound and southbound approaching vehicles at the intersection.

- Due to insufficient traffic volumes, preliminary traffic signal warrants are not projected to be met at the unsignalized intersection of OR-131 at Grand Avenue under any of the analysis scenarios. In addition, left-turn lane warrants are not projected to be met at the study intersection under any of the analysis scenarios.

If you have any questions regarding this memorandum, please don't hesitate to contact us.

TRIP GENERATION CALCULATIONS
(Estimated Along Grand Avenue)

Land Use: Single-Family Detached Housing
Land Use Code: 210
Setting/Location General Urban/Suburban
Variable: Dwelling Units
Variable Value: 60

AM PEAK HOUR

Trip Equation: T = 0.71(X) +4.80

	Enter	Exit	Total
Directional Distribution	25%	75%	
Trip Ends	12	35	47

PM PEAK HOUR

Trip Equation: Ln(T)=0.96Ln(X)+0.20

	Enter	Exit	Total
Directional Distribution	63%	37%	
Trip Ends	39	23	62

WEEKDAY

Trip Equation: Ln(T)=0.92Ln(X)+2.71

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	325	325	650

SATURDAY

Trip Equation: Ln(T)=0.94Ln(X)+2.56

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	304	304	608

Source: Trip Generation Manual, Tenth Edition

TRIP GENERATION CALCULATIONS

(Estimated Along Grand Avenue)

Land Use: Single-Family Detached Housing
Land Use Code: 210
Setting/Location General Urban/Suburban
Variable: Dwelling Units
Variable Value: 14

AM PEAK HOUR

Trip Equation: T = 0.71(X) +4.80

	Enter	Exit	Total
Directional Distribution	25%	75%	
Trip Ends	4	11	15

PM PEAK HOUR

Trip Equation: Ln(T)=0.96Ln(X)+0.20

	Enter	Exit	Total
Directional Distribution	63%	37%	
Trip Ends	9	6	15

WEEKDAY

Trip Equation: Ln(T)=0.92Ln(X)+2.71

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	85	85	170

SATURDAY

Trip Equation: Ln(T)=0.94Ln(X)+2.56

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	77	77	154

Source: Trip Generation Manual, Tenth Edition

TRIP GENERATION CALCULATIONS

Land Use: Recreational Homes
Land Use Code: 260
Setting/Location Rural
Variable: Dwelling Units
Variable Value: 60

AM PEAK HOUR (Weekday)

Trip Rate: 0.22

	Enter	Exit	Total
Directional Distribution	67%	33%	
Trip Ends	9	4	13

PM PEAK HOUR (Weekday)

Trip Rate: 0.28

	Enter	Exit	Total
Directional Distribution	41%	59%	
Trip Ends	7	10	17

PM PEAK HOUR (Friday)

Trip Rate: 1.11

	Enter	Exit	Total
Directional Distribution	59%	41%	
Trip Ends	40	27	67

WEEKDAY

Trip Rate: 3.47

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	104	104	208

SATURDAY

Trip Rate: 2.99

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	90	90	180

SUNDAY

Trip Rate: 2.82

	Enter	Exit	Total
Directional Distribution	43%	57%	
Trip Ends	73	97	170

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	0	11	3	0	3	19	144	4	5	125	20
Future Vol, veh/h	12	0	11	3	0	3	19	144	4	5	125	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	16	0	15	4	0	4	26	195	5	7	169	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	449	449	183	454	460	198	196	0	0	200	0	0
Stage 1	197	197	-	250	250	-	-	-	-	-	-	-
Stage 2	252	252	-	204	210	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	524	508	865	520	501	848	1389	-	-	1384	-	-
Stage 1	809	742	-	759	704	-	-	-	-	-	-	-
Stage 2	757	702	-	803	732	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	511	494	865	501	487	848	1389	-	-	1384	-	-
Mov Cap-2 Maneuver	511	494	-	501	487	-	-	-	-	-	-	-
Stage 1	792	738	-	743	689	-	-	-	-	-	-	-
Stage 2	738	687	-	784	728	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11	10.8	0.9	0.3
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1389	-	-	635	630	1384	-	-
HCM Lane V/C Ratio	0.018	-	-	0.049	0.013	0.005	-	-
HCM Control Delay (s)	7.6	0	-	11	10.8	7.6	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.2	0	0	-	-

Intersection	
Int Delay, s/veh	4.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	2	2	1	1	1	2
Future Vol, veh/h	2	2	1	1	1	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	2	1	1	1	2

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	5	2	3	0	-	0
Stage 1	2	-	-	-	-	-
Stage 2	3	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	1017	1082	1619	-	-	-
Stage 1	1021	-	-	-	-	-
Stage 2	1020	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	1016	1082	1619	-	-	-
Mov Cap-2 Maneuver	1016	-	-	-	-	-
Stage 1	1020	-	-	-	-	-
Stage 2	1020	-	-	-	-	-

Approach	EB		NB		SB	
HCM Control Delay, s	8.4		3.6		0	
HCM LOS	A					

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1619	-	1048	-	-
HCM Lane V/C Ratio	0.001	-	0.004	-	-
HCM Control Delay (s)	7.2	0	8.4	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection						
Int Delay, s/veh	0.1					

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	1	1	167	1	1	139
Future Vol, veh/h	1	1	167	1	1	139
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	1	1	226	1	1	188

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	417	227	0	0	227	0
Stage 1	227	-	-	-	-	-
Stage 2	190	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	596	817	-	-	1353	-
Stage 1	815	-	-	-	-	-
Stage 2	847	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	595	817	-	-	1353	-
Mov Cap-2 Maneuver	595	-	-	-	-	-
Stage 1	815	-	-	-	-	-
Stage 2	846	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.2	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	689	1353	-
HCM Lane V/C Ratio	-	-	0.004	0.001	-
HCM Control Delay (s)	-	-	10.2	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	0	11	3	0	3	19	145	4	5	126	20
Future Vol, veh/h	12	0	11	3	0	3	19	145	4	5	126	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	16	0	15	4	0	4	26	196	5	7	170	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	451	451	184	456	462	199	197	0	0	201	0	0
Stage 1	198	198	-	251	251	-	-	-	-	-	-	-
Stage 2	253	253	-	205	211	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	522	507	864	518	500	847	1388	-	-	1383	-	-
Stage 1	808	741	-	758	703	-	-	-	-	-	-	-
Stage 2	756	701	-	802	731	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	509	493	864	499	487	847	1388	-	-	1383	-	-
Mov Cap-2 Maneuver	509	493	-	499	487	-	-	-	-	-	-	-
Stage 1	791	737	-	742	688	-	-	-	-	-	-	-
Stage 2	737	686	-	783	727	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11	10.8	0.9	0.3
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1388	-	-	633	628	1383	-	-
HCM Lane V/C Ratio	0.018	-	-	0.049	0.013	0.005	-	-
HCM Control Delay (s)	7.6	0	-	11	10.8	7.6	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.2	0	0	-	-

Intersection	
Int Delay, s/veh	4.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	2	2	1	1	1	2
Future Vol, veh/h	2	2	1	1	1	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	2	2	1	1	1	2

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	5	2	3	0	-	0
Stage 1	2	-	-	-	-	-
Stage 2	3	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	1017	1082	1619	-	-	-
Stage 1	1021	-	-	-	-	-
Stage 2	1020	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	1016	1082	1619	-	-	-
Mov Cap-2 Maneuver	1016	-	-	-	-	-
Stage 1	1020	-	-	-	-	-
Stage 2	1020	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.4	3.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1619	-	1048	-	-
HCM Lane V/C Ratio	0.001	-	0.004	-	-
HCM Control Delay (s)	7.2	0	8.4	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Int Delay, s/veh	0.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	1	1	168	1	1	140
Future Vol, veh/h	1	1	168	1	1	140
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	1	1	227	1	1	189

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	419	228	0	0	228	0
Stage 1	228	-	-	-	-	-
Stage 2	191	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	595	816	-	-	1352	-
Stage 1	815	-	-	-	-	-
Stage 2	846	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	594	816	-	-	1352	-
Mov Cap-2 Maneuver	594	-	-	-	-	-
Stage 1	815	-	-	-	-	-
Stage 2	845	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.3	0	0.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	688	1352	-
HCM Lane V/C Ratio	-	-	0.004	0.001	-
HCM Control Delay (s)	-	-	10.3	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	12	0	11	3	0	5	19	154	4	9	141	20
Future Vol, veh/h	12	0	11	3	0	5	19	154	4	9	141	20
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	74	74	74	74	74	74	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0	0	0	0	0	0	0
Mvmt Flow	16	0	15	4	0	7	26	208	5	12	191	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	495	494	205	499	505	211	218	0	0	213	0	0
Stage 1	229	229	-	263	263	-	-	-	-	-	-	-
Stage 2	266	265	-	236	242	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	488	479	841	485	473	834	1364	-	-	1369	-	-
Stage 1	778	718	-	747	694	-	-	-	-	-	-	-
Stage 2	744	693	-	772	709	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	472	464	841	465	458	834	1364	-	-	1369	-	-
Mov Cap-2 Maneuver	472	464	-	465	458	-	-	-	-	-	-	-
Stage 1	761	711	-	731	679	-	-	-	-	-	-	-
Stage 2	722	678	-	751	702	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11.4	10.7	0.8	0.4
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1364	-	-	597	643	1369	-	-
HCM Lane V/C Ratio	0.019	-	-	0.052	0.017	0.009	-	-
HCM Control Delay (s)	7.7	0	-	11.4	10.7	7.7	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.2	0.1	0	-	-

Intersection	
Int Delay, s/veh	5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	6	2	1	1	1	4
Future Vol, veh/h	6	2	1	1	1	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	7	2	1	1	1	4

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	6	3	5	0	-	0
Stage 1	3	-	-	-	-	-
Stage 2	3	-	-	-	-	-
Critical Hdwy	6.42	6.22	4.12	-	-	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	2.218	-	-	-
Pot Cap-1 Maneuver	1015	1081	1616	-	-	-
Stage 1	1020	-	-	-	-	-
Stage 2	1020	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	1014	1081	1616	-	-	-
Mov Cap-2 Maneuver	1014	-	-	-	-	-
Stage 1	1019	-	-	-	-	-
Stage 2	1020	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.5	3.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1616	-	1030	-	-
HCM Lane V/C Ratio	0.001	-	0.008	-	-
HCM Control Delay (s)	7.2	0	8.5	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Int Delay, s/veh	3.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	20	1	1	33	1	1
Future Vol, veh/h	20	1	1	33	1	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	22	1	1	36	1	1

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	22	19	0	0	37	0
Stage 1	19	-	-	-	-	-
Stage 2	3	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	995	1059	-	-	1574	-
Stage 1	1004	-	-	-	-	-
Stage 2	1020	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	994	1059	-	-	1574	-
Mov Cap-2 Maneuver	994	-	-	-	-	-
Stage 1	1004	-	-	-	-	-
Stage 2	1019	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	8.7	0	3.6
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	997	1574	-
HCM Lane V/C Ratio	-	-	0.023	0.001	-
HCM Control Delay (s)	-	-	8.7	7.3	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0.1	0	-

Intersection	
Int Delay, s/veh	0.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	11	9	168	19	15	140
Future Vol, veh/h	11	9	168	19	15	140
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	74	74	74	74	74	74
Heavy Vehicles, %	0	0	0	0	0	0
Mvmt Flow	15	12	227	26	20	189

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	469	240	0	0	253	0
Stage 1	240	-	-	-	-	-
Stage 2	229	-	-	-	-	-
Critical Hdwy	6.4	6.2	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	556	804	-	-	1324	-
Stage 1	805	-	-	-	-	-
Stage 2	814	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	547	804	-	-	1324	-
Mov Cap-2 Maneuver	547	-	-	-	-	-
Stage 1	805	-	-	-	-	-
Stage 2	800	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.9	0	0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	639	1324	-
HCM Lane V/C Ratio	-	-	0.042	0.015	-
HCM Control Delay (s)	-	-	10.9	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.1	0	-

CONTINUOUS SYSTEM CRASH LISTING

131: NETARTS **Highway 131 ALL ROAD TYPES, MP 0.98 to 1.0 01/01/2015 to 12/31/2019, Both Add and Non-Add mileage**

1 - 1 of 1 Crash records shown.

SER# INVEST RD DPT UNLOC?	S D M P R J S W E A U I C O E L G N H R D C S V L K	DATE DAY TIME LAT	COUNTY CITY URBAN AREA LONG	RD# FC COMPNT MLG TYP MILEPNT	CONN# FIRST STREET SECOND STREET LRS	RD CHAR DIRECT LOCTN	INT-TYPE (MEDIAN) LEGS (#LANES)	INT-REL TRAF- CONTL	OFFRD RNDBT DRVWY	WTHR SURF LIGHT	CRASH COLL SVRTY	V#	SPCL USE TRLR QTY OWNER TYPE	MOVE FROM TO	P#	PRTC TYPE	INJ SVRTY	A G E	S E X	LICNS RES	PED LOC	ERROR	ACT	EVENT	CAUSE
00028	N N N N	01/26/2015	TILLAMOOK	1 07		INTER	5-LEG	N	N	CLR	ANGL-OTH	01	NONE 0	TURN-L											02
NONE		MO		MN 0		CN		STOP SIGN	N	DRY	TURN		PRVTE	W -N									015		00
N		11A		0.99		04	0		N	DAY	PDO		PSNGR CAR		01	DRVR	NONE	70	M	OR-Y		028	000		02
N		45 27 5.78	-123 57 36.44		013100100S00															OR<25					
												02	NONE 0	STRGHT											
													PRVTE	S -N									000		00
													PSNGR CAR		01	DRVR	NONE	00	M	OTH-Y		000	000		00
																				UNK					

Oregon
Kate Brown, Governor

Department of Transportation
Region 2 Tech Center
455 Airport Road SE, Building A
Salem, Oregon 97301-5397
Telephone (503) 986-2990
Fax (503) 986-2839

DATE: October 13, 2021

TO: Karen Strauss, PE
Development Review Coordinator

Arielle F

FROM: Arielle Ferber, PE
Traffic Analysis Engineer

SUBJECT: Second Avalon Heights Subdivision (Tillamook County, OR) – Outright Use TIS Addendum Review Comments

---

ODOT Region 2 Traffic has completed our review of the submitted traffic impact study addendum (dated September 22, 2021) to address traffic impacts due to development northeast of the Netarts Highway No. 131 (OR 131) at Highland Drive intersection in Tillamook County, with respect to consistency and compliance with ODOT's Analysis Procedures Manual, Version 2 (APM). The APM was most recently updated in October 2020. The current version is published online at: http://www.oregon.gov/ODOT/TD/TP/Pages/APM.aspx. As a result, we submit the following comments for the County's consideration:

Analysis items to note:

1. Mainline v/c ratios should be reviewed for in addition to minor street v/c ratios. It should be noted that there is a limitation within Synchro of the HCM unsignalized intersection methodology for shared left-turn approaches on the mainline whereby left-turns are always treated as exclusive turn lanes regardless of how they are coded. Mainline v/c ratios on shared lane approaches should include traffic volumes from all movements. See Section 12 of the APM (Example 12-3) for further guidance. This will affect the operations results but not the conclusions of the study as none of the mainline operations are close to exceeding their respective mobility targets.

Proposed mitigation comments:

2. ODOT maintains jurisdiction of the Netarts Highway No. 131 (OR 131) and ODOT approval shall be required for all proposed mitigation measures to this facility.
3. No mitigation measures have been proposed. This conclusion appears reasonable for this proposed development.

Thank you for the opportunity to review this traffic impact study addendum. As the analysis software files were not provided, Region 2 Traffic has only reviewed the submitted memo.

<u>This traffic impact study addendum has been, for the most part, prepared in accordance with ODOT analysis procedures and methodologies. No further analysis work should be required.</u>

If there are any questions regarding these comments, please contact me at (503) 986-2857 or Arielle.Ferber@ODOT.state.or.us