WILSONVILLE
OREGON

June 21, 2023

Dan Grimberg
West Hills Land Development
3330 NW Yeon St.
Suite 100
Portland, OR 97210

Re: Case File AR23-0007

Dear Mr. Grimberg,

Enclosed you will find the Administrative Review and Decision on your request for the Tentative Plat Revision, Administrative Relief, and Type B Tree Removal. Enclosed is a sign-off sheet accepting Conditions of Approval for you to sign and return. Please call us if you have any questions.

Sincerely,

Mandi Simmons
Administrative Assistant

cc James Cramer, Otak Inc. james.cramer@otak.com

June 21, 2023

Notice of Administrative Decision

Project Name: Twelve Lot Tentative Plat Revision, Administrative Relief and Tree Removal at the Frog Pond Overlook Subdivision.

Case File No.: AR23-0007 Class II Administrative Review, ARC223-0003 Tentative Plat Revision, ARC223-0007 Administrative Relief, TREE23-0009 Type B Tree Removal

Owner/Applicant: West Hills Development (Contact: Dan Grimberg)

Applicant's Representative: Otak, Inc. (Contact: James Cramer)

Location: 7135 SW Frog Pond Lane. The property is specifically known as TLID 00700, Section 12D, Township 3 South, Range 1 West, Willamette Meridian, Clackamas County, Oregon.

Request: Tentative Plat Partition Revisions for the previously approved Frog Pond Overlook Subdivision, Administrative Relief for setbacks of lots 7 and 12 and Type B Tree Removal for two trees impacted by construction.

On June 21, 2023 an administrative decision was rendered, granting approval with conditions on the above-referenced applications:

The written decision is on file in the planning division. A copy of the applications, all documents and evidence submitted by or on behalf of the applicant and applicable criteria are available for inspection at no cost and will be provided at $.25 per page at the Wilsonville Planning Division, 29799 SW Town Center Loop E., Wilsonville OR, 97070.

Section 4.232(.05) of the Wilsonville Code and ORS 197.375 provides that this decision may be appealed by the applicant or any person or organization who files comments within the time period established under ORS 197.365.

Note: Any appeal must be filed with the City Recorder. The notice of appeal shall be in writing and indicate the specific qualifying basis for the appeal per ORS 197.375(1)(c). Should you require further information, please contact Georgia McAlister, Associate Planner, with the City Planning Division at 503-682-4960.

For more information, contact the Wilsonville Planning Division at 503-682-4960

Planning Division Staff Report
Administrative Decision

Twelve Lot Tentative Plat Revision, Administrative Relief and Tree Removal at the Frog Pond Overlook Subdivision

Date of Report/Decision:	June 21, 2023
Application No.:	AR23-0007 Class II Administrative Review, ARC223-0003 Tentative Plat Revision, ARC223-0007 Administrative Relief, TREE23-0009 Type B Tree Removal
Request Summary:	The City of Wilsonville's Planning Director, pursuant to Sections 4.030, 4.035, and 4.210 of the Wilsonville Code, is approving a Tentative Partition Plat to create two parcels.
Location:	7135 SW Frog Pond Lane. The property is specifically known as TLID 00700, Section 12D, Township 3 South, Range 1 West, Willamette Meridian, Clackamas County, Oregon.
Owner:	West Hills Development (Contact: Dan Grimberg)
Applicant:	Otak, Inc. (Contact: James Cramer)
Comprehensive Plan Map Designation:	Residential Neighborhood
Zone Map Classification:	Residential Neighborhood (RN)
Staff Reviewers:	Georgia McAlister, Associate Planner Amy Pepper, PE, Development Engineering Manager
Action Taken:	**Approval with conditions of** the requested tentative partition plat. The conditions can be found beginning on page 17 of this report.

Applicable Review Criteria:

Development Code:	
Section 4.008	Application Procedures-In General
Section 4.009	Who May Initiate Application
Section 4.010	How to Apply
Section 4.011	How Applications are Processed
Section 4.014	Burden of Proof
Section 4.030	Jurisdiction and Powers of the Planning Director and Community Development Director
Section 4.030 (.01)D.	Administrative Relief by Planning Director
Subsection 4.035 (.04)	Site Development Permit Application
Subsection 4.035 (.05)	Complete Submittal Requirement
Section 4.110	Zones
Section 4.118	Standards Applying to Planned Development Zones
Section 4.127	Residential Neighborhood Zone
Section 4.140	Planned Development Regulations
Section 4.196	Variances
Sections 4.200 through 4.290	Land Divisions
Sections 4.600(.50)-4.610(.30) and 4.620	Tree Preservation and Protection

Vicinity Map:

Background / Summary:

The proposed tentative plat partition is a revision of the original Frog Pond Overlook subdivision plat approved as a part of application DB22-0002. The revision includes minor adjustments to all previously approved lots. The adjustment will allow for a more ideal lot configuration at the time of development. In addition to the minor adjustments to the lots sizes the applicant is requesting Administrative Relief for the setbacks for lots 7 and 12 and the removal of two trees for construction. The Administrative Relief is the minimum adjustment necessary to accommodate the adjacent Boeckman Creek trail and SROZ while keeping the lots from having an irregular shape. 107 trees were approved for removal as a part of the original application for the Frog Pond Overlook Subdivision (DB22-0002) due to construction impacts. Upon further review it is clear that an additional two trees, one ponderosas pine and one Douglas fir tree, will be impacted by construction and therefore will need to be removed.

Exhibit List:

The following exhibits are hereby entered into the public record as confirmation of consideration of the application as submitted. The exhibit list includes exhibits for Planning Case File AR20-0007.

Planning Staff Materials

A1. Staff Report and Findings (this document)

Materials from Applicant

B1. Signed Application Form

B2. Property Report
Land Use Narrative
Proposed Preliminary Plat
Storm Memo

Procedural Statements and Background Information:

1. The statutory 120-day time limit applies to this application. The application was received on April 3, 2023. On May 3, 2023 the application was deemed complete. The City must render a final decision for the request, including any appeals, by August 31, 2023.

2. Surrounding land uses are as follows:

Compass Direction	Zone:	Existing Use:
North:	Clackamas County – RRFF5	Rural Residential

East:	Clackamas County – RRFF5	Rural Residential
South:	Clackamas County – RRFF5	Rural Residential
West:	Clackamas County – RRFF5	Rural Residential

3. Prior relevant land use actions include:

DB22-0002, Frog Pond Overlook 12-Lot Subdivision

4. The applicant has complied with Sections 4.008 through 4.035 and 4.210 pertaining to review procedures and submittal requirements.

5. Public notice has been provided giving invitation to interested parties to submit information within ten (10) days of the date of the Notice of Administrative Action, relevant to the standards pertinent to the proposal and soliciting reason why the application should or should not be approved, or proposing conditions which they believe are necessary for approval to City standards. Property owners within 250 feet of the project boundary have received notice and Staff has not received objections, either in writing or orally, against the proposed modifications. In addition to those receiving the Notice of Administrative Action of this application, this notice of decision will be sent to the Development Review Board.

Findings:

NOTE: Pursuant to Section 4.014 the burden of proving that the necessary findings of fact can be made for approval of any land use or development application rests with the applicant in the case.

As described in the Findings below, the request meets the applicable criteria or will by Conditions of Approval.

General Information

Application Procedures-In General
Section 4.008

1. The application is being processed in accordance with the applicable general procedures of this Section.

Initiating Application
Section 4.009

2. The application has been submitted on behalf of the property owners West Hills Land Development by representative Dan Grimberg. The application form is signed by Dan Grimberg.

Pre-Application Conference
Subsection 4.010 (.02)

3. Planning Division held a pre-application conference on September 16, 2021 (PA21-0021) in accordance with this subsection for the most recent land use approvals. City staff determined an additional pre-application conference was not required for the proposed revised tentative plat, administrative relief and Type B tree removal application. A separate meeting was held on February 27, 2023, prior to submitting the application.

Lien Payment before Approval
Subsection 4.011 (.02) B.6

4. No applicable liens exist for the subject property. The application can thus move forward.

General Submission Requirements
Subsection 4.035 (.04) A.

5. The applicant has provided all of the applicable general submission requirements contained in this subsection.

Zoning-Generally
Section 4.110

6. This proposed development is in conformity with the applicable zoning district and general development regulations listed in Sections 4.154 through 4.199 have been applied in accordance with this Section.

Request A: AR20-0019 Tentative Partition Plat

Land Division Authorization

Plat Review Authority
Subsection 4.202 (.01) through (.03)

A1. The tentative partition plat is being reviewed by the Planning Director according to this subsection. The final plat will be reviewed by the Planning Division under the authority of the Planning Director to ensure compliance with the tentative partition plat.

Legally Lot Requirement
Subsection 4.202 (.04) A.

A2. It is understood that no parcels will be sold or transferred until the final plat has been approved by the Planning Director and recorded.

Undersized Lots Prohibited
Subsection 4.202 (.04) B.

A3. No parcels will be divided into a size smaller than allowed by the Residential Neighborhood (RN) Zone designation R-10 large lot sub-district 8 . The minimum lot size in the RN zone R-10 large lot sub-district is 8,000 square feet. The resulting twelve parcels range between 8,060 and 9,145 square feet.

Plat Application Procedure

Pre-Application Conference
Subsection 4.210 (.01)

A4. Planning Division held a pre-application conference on September 16, 2021 (PA21-0021) in accordance with this subsection for the most recent land use approvals. City staff determined an additional pre-application conference was not required for the proposed revised tentative plat, administrative relief and Type B tree removal application. A separate meeting was held on February 27, 2023, prior to submitting the application.

Tentative Plat Preparation
Subsection 4.210 (.01) A.

A5. The applicant's Exhibit B2 includes a preliminary partition plat prepared in accordance with this subsection.

Tentative Plat Submission
Subsection 4.210 (.01) B.

A6. The tentative partition plat has been submitted with the required information.

Phases to Be Shown
Subsection 4.210 (.01) D.

A7. No new construction or development for the subject property is proposed at this point. No phasing for development or improvements to the subject property has been submitted.

Remainder Tracts
Subsection 4.210 (.01) E.

A8. All affected property has been incorporated into the tentative partition plat.

Street Requirements for Land Divisions

Adjoining Streets Relationship
Subsection 4.236 (.02)

A9. The proposed plat enables the extension of streets consistent with the Frog Pond West Master Plan.

General Land Division Requirements- Easements

Utility Line Easements
Subsection 4.237 (.02) A.

A10. As will be further verified during the Public Works Permit review and Final Plat review, public utilities will be placed within public rights-of-way or within public utility easements (PUE) adjacent to the public streets. Stormwater facility easements are proposed where these facilities are located on private property and are intended to be shared between more than one lot. Franchise utility providers will install their lines within public utility easements established on the plat. A condition of approval will ensure the water line easement is shown on the recorded partition

Water Course
Subsection 4.237 (.02) B.

A11. The applicant proposes a dedicated tract for the drainage way and associated riparian area of the Boeckman Creek SROZ.

General Land Division Requirements- Lot Size and Shape

Lot Size and Shape Appropriate
Subsection 4.237 (.05)

A12. The size, width, shape, and orientation of lots comply with the identified sub-districts in the Frog Pond West Master Plan. See Finding A18.

Lot Size and Shape Meet Zoning Requirements
Subsection 4.237 (.05)

A13. The proposed parcels meet the requirements of the Residential Neighborhood (RN) Zone designation R-10 large lot sub-district 8 . The minimum lot size in the RN zone R-10 large lot sub-district is 8,000 square feet. The resulting twelve parcels range between 8,060 and 9,145 square feet. See Finding A18. The proposed lot shapes are consistent with other lots within the surrounding area.

On-Site Sewage Disposal
Subsection 4.237 (.05) A.

A14. The property will be served by public sewer; therefore an on-site sewage disposal permit is not required from the City.

Lot Size and Width for Planned Developments
Subsection 4.237 (.05) C.

A15. The proposed partition has twelve (12) residential lots ranging in size from 8,060 square feet to 9,145 square feet. The minimum lot size in the RN zone R-10 large lot sub-district is 8,000 square feet. The minimum lot width at the building line in is 40 feet. The minimum lot depth is 60 feet. All lots meet these standards.

General Land Division Requirements- Access

Minimum Street Frontage
Subsection 4.237 (.06)

A16. The full width of the front lot line of each lot fronts a public street. Each lot meets or exceeds the minimum lot width at the front lot line

Standards Applying to the Residential Neighborhood Zone

Minimum and Maximum Residential Lots
Subsection 4.127 (.06)

A17. The proposed number of residential lots, preservation of open space, and general block and street layout are generally consistent with the Frog Pond West Master Plan. Specifically in regards to residential lot count, the proposed Stage 1 area includes a portion of large lot Sub-district 8. The following table summarizes how the proposed residential lots in each Sub-district are consistent with the Master Plan recommendations. The applicant proposes 12 lots in Sub-district 8, which is one (1) lot greater than the maximum proportional density calculation for the site

Subdistrict and Land Use Designation	Gross Site Area (ac)	Percent of Sub-district	Established lot range for Sub-district	Lot Range for Site	Proposed Lots	Total lots within Sub-district - Approved and Proposed
8 – R-10	3.96	20.7%	43-53	9-11	12	25 Approved 12 Proposed 37 Total

The proportional density allocation does not account for site-specific characteristics that influence the ability of a specific property to accommodate residential lots meeting minimum dimensional standards. The portion of the subject property within Sub-district 8

that is not dedicated as right-of-way (82.5%) is much greater than in other subareas. Minimal right-of-way dedication is required because the section of SW Frog Pond Lane adjacent to the site is a local street, which allows driveway access and the layout of Street A has been designed to accommodate the Boeckman Creek Trail on the western portion of the property resulting in the reduction of anticipated right-of-way dedication. As a result of the minimal right-of-way dedication it is possible to for the site to easily accommodate 12 lots, one (1) greater than the maximum density, while meeting minimum lot size standards. The configuration of lots as proposed will allow for buildout of the sub-district consistent with the Master Plan recommendations.

General Lot Development Standards
Subsection 4.127 (.08) Table 2.

A18. The applicant proposes lots reviewed for consistency with applicable development code standards and the Frog Pond West Master Plan. The proposed lots meet or exceed the standards of Table 2, or the applicant can meet or exceed the standards with final design, as follows:

Standard	R-10 Large Lot Sub-district 8		Compliance Notes
	Required	Proposed	
Min. Lot Size	8,000 sf	8,007-10,078 sf	Standard is met.
Min. Lot Depth	60 ft	71+ ft	Standard is met.
Min. Lot Width	40 ft	64+ ft	Standard is met.
Max. Lot Coverage	40%	40% max	Standard can be met.
Max. Bldg Height	35 ft	35 ft max	Standard can be met. Per applicant's materials, houses will be max 35 ft height.
Min. Front Setback	20 ft	20 ft min	Standard can be met for all lots aside from 7 and 12. See Request B.
Min. Rear Setback	20 ft	20 ft min	Standard can be met for all lots aside from 7 and 12. See Request B.
Min. Side Setback	5 feet (10 feet for corner lots)	5 ft min (10 ft min on corner lots)	Standard can be met for all lots aside from 7 and 12. See Request B.
Min. Garage Setback from Alley	18 ft	18 ft. min	Standard can be met.
Min. Garage Setback from Street	20 ft	20 ft min	Standard can be met for all lots aside from 7 and 12. See Request B.

General Land Division Requirements-Blocks

Blocks for Adequate Building Sites in Conformance with Zoning
Subsection 4.237 (.01)

A19. The proposed blocks substantially conform to Figure 18 of the Frog Pond West Master Plan. The proposed blocks allow for lots meeting the minimum size and other dimensional standards for the relevant sub-districts of the Frog Pond West Master Plan. See Finding D11 under Request D.

General Land Division Requirements-Easements

Utility Line Easements
Subsection 4.237 (.02) A.

A20. As will be further verified during the Public Works Permit review and Final Plat review, public utilities will be placed within public rights-of-way or within public utility easements (PUE) adjacent to the public streets. Stormwater facility easements are proposed where these facilities are located on private property and are intended to be shared between more than one lot. Franchise utility providers will install their lines within public utility easements established on the plat.

Water Courses
Subsection 4.237 (.02) B.

A21. The applicant proposes a dedicated tract for the drainage way and associated riparian area of the Boeckman Creek SROZ.

General Land Division Requirements-Pedestrian and Bicycle Pathways

Mid-block Pathways Requirement
Subsection 4.237 (.03)

A22. The blocks that will be created by the proposed subdivision are all less than 330 ft. in length, therefore, mid-block bicycle and pedestrian pathways are not required or proposed. See Finding D13.

General Land Division Requirements-Tree Planting

Tree Planting Plan Review and Street Tree Easements
Subsection 4.237 (.04)

A23. The City is reviewing the tree planting plan concurrently with the tentative plat, see Requests D and E.

General Land Division Requirements-Lot Size and Shape

Lot Size and Shape Appropriate
Subsection 4.237 (.05)

A24. The size, width, shape, and orientation of lots comply with the identified sub-districts in the Frog Pond West Master Plan. See Finding D8 in Request D.

General Land Division Requirements-Access

Minimum Street Frontage
Subsection 4.237 (.06)

A25. The full width of the front lot line of each lot fronts a public street. Each lot meets or exceeds the minimum lot width at the front lot line. See Finding D8 in Request D.

General Land Division Requirements-Other

Lot Side Lines
Subsection 4.237 (.08)

A26. Almost all side lot lines run at a 90-degree angle to the front line. Angles and curves of streets necessitate the exceptions, including Lot 8.

Land for Public Purposes
Subsection 4.237 (.12)

A27. The subject property contains SROZ land surrounding Boeckman Creek. The Frog Pond West Master Plan indicates that the Boeckman Creek Regional Trail shall be provided along the western and northern portion of the subject property along the SROZ. This land will become part of the parks and open space system to be dedicated to the City. A condition of approval ensures that prior to dedication of Tract A, the applicant/owner shall provide a Phase I Environmental Site Assessment, and if warranted, and Phase II Environmental Site Assessment, addressed to the City.

Corner Lots
Subsection 4.237 (.13)

A28. All corner lots have radii exceeding the 10-foot minimum.

Lots of Record

Defining Lots of Record
Section 4.250

A29. The existing parcel is a lot of record, and the resulting parcels will be of record.

Request B : ARC223-0007 Administrative Relief

Administrative Relief

Relief up to 20% of Quantifiable Provision
Subsection 4.030 (.01) D.

B1. The proposed relief is to allow a setback reduction for lots 7 and 12. The request is for a 2 foot reduction to the front setback reducing the front setback from 20 feet to 18 feet, a 4 foot reduction to the rear setback reducing the rear setback to 16 feet and a 1 foot reduction to the side setback reducing the side setback to 4 feet. The proposed reductions, which is equivalent to 20% or less of the required setbacks, are allowed reductions for the quantifiable provision of setback.

Variance Standards Applied for Administrative Relief
Subsection 4.135 (.01) D.

B2. As shown by Findings 3 through 8 below, the review applies the variance standards of 4.196.

Variance Standards

Difficultly Applies Regardless of Owner
Subsection 4.196 (.01) A.

B3. The requested relief would apply the same for any owner of the subject property.

Variance Not Result of Illegal Act
Subsection 4.196 (.01) B.

B4. The applicant has not done any illegal acts in relation to the request, in particular the applicant pursued City approval prior to any construction.

Unique Circumstances
Subsection 4.196 (.01) C.

B5. The difficulty to meet the setback standards of Section 4.127 arise due to the shape of Lots 7 and 12. The western portion of the overall site contains a SROZ which requires preservation measures. The project site is located within the Frog Pond West Subdistricts 8/R10 which is exempt from requiring open space; however, the 2006 Bicycle and Pedestrian Master Plan identifies the extension and development of the Boeckman Creek Trail, identified as a major regional trail. Additionally, the 2017 Frog Pond West Master Plan incorporates a Bicycle and Pedestrian Framework (Figure 17), a planned trail through the property, and sidewalks along the property's SW Frog Pond Lane frontage. Due to the presence of the SROZ, required preservation needs and the required extension of the Boeckman Creek Trail, the Frog Pond Overlook development proposed and was approved to include Tract A as a recreational area/open space.

The Frog Pond Overlook development incorporated the above referenced Tract A as well as the intended trail extension thus creating the irregular lot boundaries of Lots 7 and 12. The development approval included incorporating the SW Windflower Street right-of-way per the FPWMP that Lot 7 will take access from. This establishes the south property line of Lot 7 as the front property line which is 121.17 feet wide. Subsequently, the north property line is identified as the rear property line of Lot 7 which extends 123.57 feet between the side property lines. The side property lines (east and west) are perpendicular to the front (south) property line and range between 63.25 and 83.01 feet for an average lot depth of 73.13 feet. This results in the rear (north) property line that is not parallel to the front (south) property line thus creating an irregular shaped lot for future development. The required Boeckman Creek Trail extension eliminates the ability for Lot 7 to be extended north thus creating a deeper lot for future development is unattainable. When compared to neighboring properties within the same development, the depth of Lot 7 is approximately 24 percent shallower (73.13 / 96.24) than the next shallowest lot (Lot 3). The frontage of Lot 7 is also approximately 16 percent larger than the average width of the remaining 11 lots of the development (101.19 / 121.17). The irregular shape of Lot 7, results in a shallower depth and increased width, is unique and not typical within surrounding area resulting in undo difficulties when determining development potential of Lot 7.

Lot 12 is located within the southwest portion of the development adjacent to Tract A on the west, north and portions of it's east property lines. Due to the required Boeckman Creek Trail extension and topography within Tract A, the trail has been designed to curve northeast from the SW Frog Pond Lane right-of-way. The has resulted in Lot 12 having a curved west property line resulting in irregular lot widths. Specifically, Lot 12 has a frontage on SW Frog Pond Lane that extends a total of 60.44 feet, widens to approximately 70-feet-wide before tapering back to a rear (north) property line that is 31.12 feet wide. This results in a rear property line that is approximately 49 percent narrower than the front property line. The curved western property line results in an irregular property shape and varying lot widths that not typical within surrounding area resulting in undo difficulties when determining development potential of Lot 12.

Request Relates to Subject Property
Subsection 4.196 (.01) D.

B6. The request for a setback reduction is directly related to the subject property and not to other premises or personal conditions of the applicant.

Allowed Uses in Zone
Subsection 4.196 (.01) E.

B7. The proposed additional enabled by the requested administrative relief is the expansion of the allowed residential use on the property.

Minimum Necessary to Relieve Hardship
Subsection 4.196 (.01) F.

B8. Required SROZ protection and future trail accommodations result in the irregular shape of Lot 7. The average lot depth of Lot 7 is reduced by approximately 24 percent. The irregular shaped lot and reduced lot depth creates a shallow development area on the lot that is not consistent with the surrounding area. The west property line has been designed to be parallel with the required Boeckman Creek Trail extension. As such, Lot 12 has a frontage on SW Frog Pond Lane that extends a total of 60.44 feet, widens to approximately 70-feet-wide before tapering back to a rear (north) property line that is 31.12 feet wide. This results in a rear property line that is approximately 49 percent narrower than the front property line. The proposed administrative relief request to reduce the front, rear and side setbacks by 20 percent provides the opportunity for Lots 7 and 12 to accommodate future development that is in keeping with what is achievable on neighboring properties within the Frog Pond Overlook development. While the side and rear setback are the maximum reduction allowed it is the minimum to relieve the hardship.

Request C: TREE23-0009 Type B Tree Removal

Guidelines and Limitations on Tree Removal
Section 4.610.10

C1. The one (1) ponderosa tree and one (1) Douglas fir tree are proposed for removal in addition to the 107 trees approved for removal as a part of DB22-0002, as they are within in the grading area of the proposed subdivision.

Type A Tree Removal Criteria
Section 4.610.20 (.02)

C2. This request for removal is in addition to previously approved 107 trees, the current request does not meet the criteria to be reviewed as a Type A application. It is therefore being reviewed as a Type B application.

Submittal Requirements
Subsection 4.610.20 (.03) and Subsection 4.610.30 (.02)

C3. As indicated in the table below the applicant has either submitted the required documentation, has been granted a waiver under Subsection 4.610.30 (02) H. or supplying the information is a Condition of Approval.

Requirement	Submitted	Waiver Granted		Condition of Approval	Not Applicable	Additional findings/notes
		Info Already Available to City	Info Not Necessary for Review			
Statement why removal is necessary	☒	☐	☐	☐	☐	
Description of trees (common name, d.b.h.)	☒	☐	☐	☐	☐	
Name of person removing (if known)	☐	☐	☒	☐	☐	
Time of removal (if known)	☐	☐	☒	☐	☐	
Map showing location of tree(s)	☒	☐	☐	☐	☐	
Arborist's Report (health and condition, species, common name, d.b.h.)	☒	☐	☐	☐	☐	
Tree protection information	☐	☐	☐	☒	☐	
Replacement tree description (species, size, number, cost)	☒	☐	☐	☐	☐	
Copy of CC&R's	☐	☐	☒	☐	☐	

Additional findings:

Review Process for Type B Tree Permits
Subsection 4.610.30 (.03)

C4. This application has been reviewed according to the standards and processes referenced in this subsection.

Tree Relocation, Mitigation, or Replacement

Mitigation and Replacement Requirement Established
Subsection 4.620.00 (.01)

C5. The Applicant is proposing to remove the one (1) ponderosa and one (1) Douglas fir tree without replacement. A condition of approval will ensure the Applicant pays the fee amount equivalent to replanting a two trees into the City Tree Fund as mitigation.

Basis for Determining Replacement
Subsection 4.620.00 (.02)

C6. The Applicant is proposing not to replace the two trees proposed for removal due to lack of room for replacement on site. Thirty-Eight (38) trees will be planted during the construction of Frog Pond Overlook. There is not capacity for more trees on site. Therefore the Applicant will pay the fee amount equivalent to replanting the two (2) trees into the City Tree Fund as mitigation.

Replacement Tree Requirements-Comparable Characteristics
Subsection 4.620.00 (.03) A.

C7. The applicant is not proposing to replant the trees.

Replacement Tree Requirements-Tree Care and Guarantee
Subsections 4.620.00 (.03) B. and C.

C8. The applicant is not proposing to replace the trees.

Replacement Tree Requirements- Encouragement of Diversity of Species
Subsection 4.620.00 (.3) D.

C9. The applicant is not proposing to replant the trees.

Additional Requirements for Replacement Trees
Subsection 4.620.00 (.04)

C10. The applicant is not proposing to replace the trees.

Replacement Tree Location- Review Required
Subsection 4.620.00 (.05)

C11. The applicant is not proposing to replace the trees.

City Tree Fund
Subsection 4.620.00 (.06)

C12. The applicant will pay to the City Tree Fund the equivalent cost of planting one (1) ponderosa tree and one (1) Douglas fir tree as mitigation.

Exception for Tree Replacement

C13. The applicant is not requesting an exemption.

Action Taken and Conditions of Approval

THEREFORE, based on Staff analysis and Findings above, the Planning Director hereby **approves** the application as requested, subject to the following Conditions of Approval:

Planning Division Conditions:

PD 1.	The applicant/owner shall assure that the parcels not be sold or conveyed until such as time as the final plat is recorded with the county.
PD 2.	The applicant/owner shall submit an application for Final Plat review and approval on the Planning Division Site Development Application and Permit form. The Applicant/Owner shall also provide materials for review by the City's Planning Division in accordance with Section 4.220 of City's Development Code. The Final Plat shall be prepared in substantial accord with the Tentative Partition Plat as approved by this action and as amended by these conditions, except as may be subsequently altered by minor revisions approved by the Planning Director.
PD 3.	The applicant/owner shall illustrate existing and proposed easements on the Final Plat.
PD 4.	The applicant/owner shall pay the equivalent cost to replant to trees into the City Tree Fund.

The following Conditions of Approval are provided by the Engineering, Natural Resources, or Building Divisions of the City's Community Development Department or Tualatin Valley Fire and Rescue, all of which have authority over development approval. A number of these Conditions of Approval are not related to land use regulations under the authority of the Development Review Board or Planning Director. Only those Conditions of Approval related to criteria in Chapter 4 of Wilsonville Code and the Comprehensive Plan, including but not limited to those related to traffic level of service, site vision clearance, recording of plats, and concurrency, are subject to the Land Use review and appeal process defined in Wilsonville Code and Oregon Revised Statutes and Administrative Rules. Other Conditions of Approval are based on City Code chapters other than Chapter 4, state law, federal law, or other agency rules and regulations. Questions or requests about the applicability, appeal, exemption or non-compliance related to these other Conditions of Approval should be directed to the City Department, Division, or non-City agency with authority over the relevant portion of the development approval.

Engineering Division Conditions:

PF 1.	Prior to Issuance of Public Works Permit all necessary easements shall be recorded with the County for the temporary public water line to be located on Tax lot 800.

Case File #:AR23-0007

Approved:

Digitally signed by Daniel Pauly
Date: 2023.06.21 15:27:12 -07'00'

Daniel Pauly, Planning Manager for Date
Miranda Bateschell, Planning Director

Section 4.022(.01) of the Wilsonville Code provides that this decision may be appealed by the Applicant and party entitled to notice or adversely affected or aggrieved or called up for review by the Development Review Board. The notice of appeal shall indicate the nature of the action or interpretation that is being appealed or called up. The appeal shall regard a determination of the appropriateness of the action or interpretation of the Code requirements involved in the decision.

Note: The decision of the Planning Director may be appealed by an affected party or by three (3) Board members in accordance with Section 4.017 except that the review shall be of the record supplemented by oral commentary relevant to the record presented on behalf of the Applicant and the Planning Director. Any appeal must be filed with the City Recorder within fourteen (14) calendar days of the notice of the decision. The notice of appeal shall be in writing and indicate the specific issue(s) being appealed and the reason(s) therefore. Should you require further information, please contact Georgia McAlister, Associate Planner, with the City Planning Division at 503-682-4960. Last day to appeal: ***4:00 P.M. on July 5, 2023.***

For more information, contact the Wilsonville Planning Division at 503-682-4960.

Sign-off accepting Conditions of Approval

Case File # **AR23-0007**

Project Name: Frog Pond Overlook Tentative Plat Partition Revision, Administrative Relief and Type B Tree Removal

The Conditions of Approval have been received and accepted by:

Signature

Director of Land Development 7/12/23

Title Date

Signature

Title Date

This decision is not effective unless this form is signed and returned to the planning office as required by WC Section 4.140(.10)(A).

Adherence to Approved Plan and Modification Thereof: The Applicant shall agree in writing to be bound, for her/himself and her/his successors in interest, by the conditions prescribed for approval of a development.

Please sign and return to:

Shelley White
Planning Administrative Assistant
City of Wilsonville
29799 SW Town Center Loop E
Wilsonville OR 97070

Updated 1/11/2019 all previous version of this form are obsolete

WILSONVILLE OREGON

29799 SW Town Center Loop E, Wilsonville, OR 97070
Phone: 503.682.4960 Fax: 503.682.7025
Web: www.ci.wilsonville.or.us

Planning Division
Development Permit Application

Final action on development application or zone change is required within 120 days per ORS 227.175 or as otherwise required by state or federal law for specific application types.

A pre application conference may be required.

The City will not accept applications for wireless communication facilities or similar facilities without a completed copy of a Wireless Facility Review Worksheet.

The City will not schedule incomplete applications for public hearing or send administrative public notice until all of the required materials are submitted.

Applicant:
Name: Dan Grimberg
Company: West Hills Land Development
Mailing Address: 3330 NW Yeon St, Ste 100
City, State, Zip: Portland, OR 97210
Phone: 503.789.0358 Fax: _____
E-mail: dan@westhillsdevelopment.com

Authorized Representative:
Name: James Cramer
Company: Otak, Inc.
Mailing Address: 808 SW Third Ave, Ste 800
City, State, Zip: Portland, OR 97204
Phone: 971.230.5994 Fax: _____
E-mail: james.cramer@otak.com

Property Owner:
Name: Dan Grimberg
Company: West Hills Land Development
Mailing Address: 3330 NW Yeon St, Ste 200
City, State, Zip: Portland, OR 97210
Phone: 503.789.0358 Fax: _____
E-mail: dan@westhillsdevelopment.com

Property Owner's Signature:
Printed Name: Daniel E. Grimberg Date: 3/20/23
West Hills Land Development

Applicant's Signature: (if different from Property Owner)
Printed Name: Daniel E. Grimberg Date: 3/20/23
West Hills Land Development

Site Location and Description:
Project Address if Available: 7315 SW Frog Pong Ln. Suite/Unit _____
Project Location: _____
Tax Map #(s): 31W12D Tax Lot #(s): 700 County: ☐ Washington ■ Clackamas

Request:
A revision to the approved (SUBD22-0001) 12-lot residential subdivision (Frog Pond Overlook) and a Type B tree permit.

Project Type: Class I ☐ Class II ■ Class III ☐

■ Residential ☐ Commercial ☐ Industrial ☐ Other: _____

Application Type(s):

☐ Annexation	☐ Appeal	☐ Comp Plan Map Amend	☐ Parks Plan Review
☐ Final Plat	☐ Major Partition	☐ Minor Partition	☐ Request to Modify Conditions
☐ Plan Amendment	☐ Planned Development	■ Preliminary Plat	
☐ Request for Special Meeting	☐ Request for Time Extension	☐ Signs	☐ Site Design Review
☐ SROZ/SRIR Review	☐ Staff Interpretation	☐ Stage I Master Plan	☐ Stage II Final Plan
☐ Type C Tree Removal Plan	■ Tree Permit (B or C)	☐ Temporary Use	☐ Variance
☐ Villebois SAP	☐ Villebois PDP	☐ Villebois FDP	☐ Other (describe)
☐ Zone Map Amendment	☐ Waiver(s)	☐ Conditional Use	_____

Appendix A

Annexation Forms and
Legal Description

Exhibit B2

EXHIBIT A

LEGAL DESCRIPTION for ANNEXATION

January 28, 2022 (Otak #20015)

That property described in Statutory Warranty Deed to Daniel G. Ross and Debra L. Ross recorded March 2, 2012 as Document No. 2012-012440, Clackamas County Records together with the adjoining portion of S.W. Frog Pond Lane, (County Road No. 2362), in the northwest quarter of the southeast quarter of Section 12, Township 3 South, Range 1 West, Willamette Meridian, Clackamas County, Oregon, more particularly described as follows:

BEGINNING at a 3/4 inch iron pipe (as shown on Clackamas County Survey No. 7853) which bears North 01°40’13” East along the east line of the southeast quarter of said section a distance of 1748.96 feet, and North 88°35’30” West along the north right of way line of 33.00 foot wide S.W. Frog Pond Lane (County Road No. 2362) a distance of 1908.13 feet from the southeast corner of said section, said POINT OF BEGINNING being the southeast corner of said Ross property;

thence South 01°42’32” West a distance of 33.00 feet to the south right of way line of said S.W. Frog Pond Lane;

thence along said south right of way line, North 88°35’30” West a distance of 566.68 feet;

thence North 01°03’30” East a distance of 33.00 feet to the southwest corner of said Ross property;

thence along the most southerly east line of that property described in Statutory Warranty Deed to Derek Osterholme and Amber Osterholme recorded May 20, 2020 as Document No. 2020-036921, Clackamas County Records, continuing North 01°03’30” East a distance of 267.99 feet to a 5/8 inch iron rod with red plastic illegible cap (as shown on Clackamas County Survey No. 29676) found at the northwest corner of said Ross Property;

thence along the northerly line of said Ross property, North 82°39’16” East a distance of 577.29 feet to a 1 inch iron pipe (as shown on Clackamas County Survey No. 29676) found at the northeast corner of said Ross property, also being the most westerly northwest corner of that property described in Statutory Warranty Deed to Andy Finkbeiner and Tamara L. Pittman recorded May 30, 2001 as Document No. 2001-040160 Clackamas County Records;

thence along the west line of said Finkbeiner and Pittman property, South 01°42’32” West a distance of 355.85 feet to the POINT OF BEGINNING.

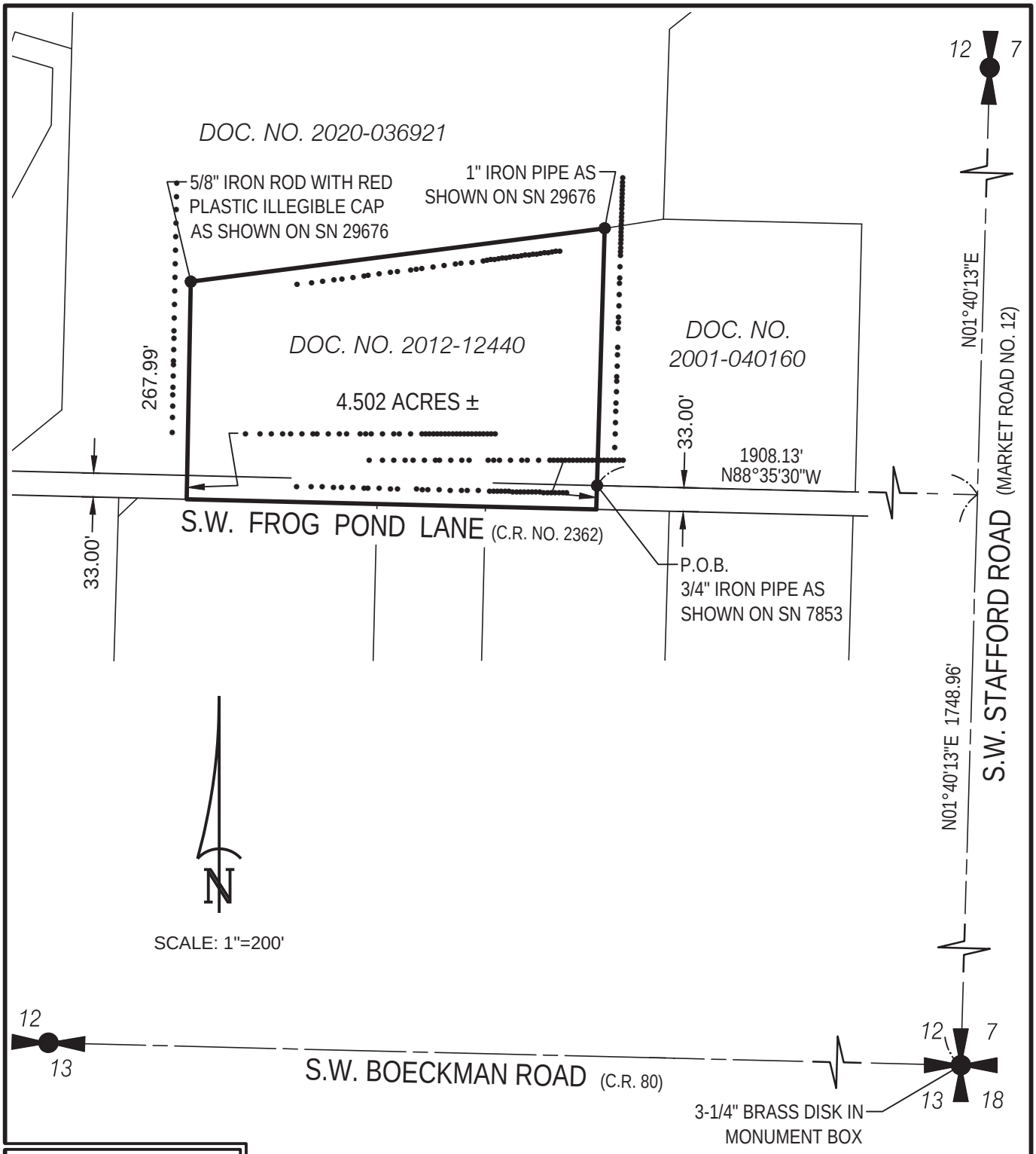
Contains 4.502 acres, more or less.

REGISTERED
PROFESSIONAL
LAND SURVEYOR

DIGITALLY SIGNED
2022.01.28 16:20:43-08'00'

OREGON
NOVEMBER 12, 2013
MICHAEL D. SPELTS
87475PLS

RENEWS: JUNE 30, 2022



Otak
808 SW 3rd Ave., Ste. 800
Portland, Oregon 97204
Phone: (503) 287-6825
www.otak.com
project: 20015

EXHIBIT B

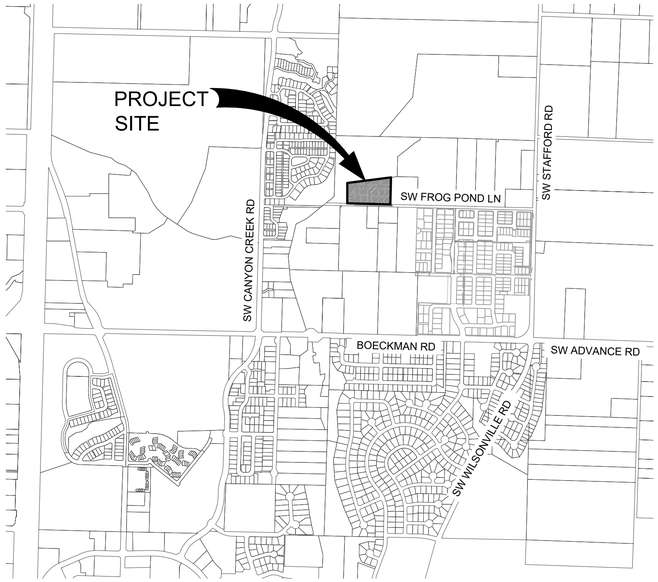
ANNEXATION OF THE ROSS PROPERTY & A PORTION OF S.W. FROG POND LANE

IN THE NW QUARTER OF THE SE QUARTER OF SECTION 12, TOWNSHIP 3 SOUTH, RANGE 1 WEST, WILLAMETTE MERIDIAN, CLACKAMAS COUNTY, OREGON

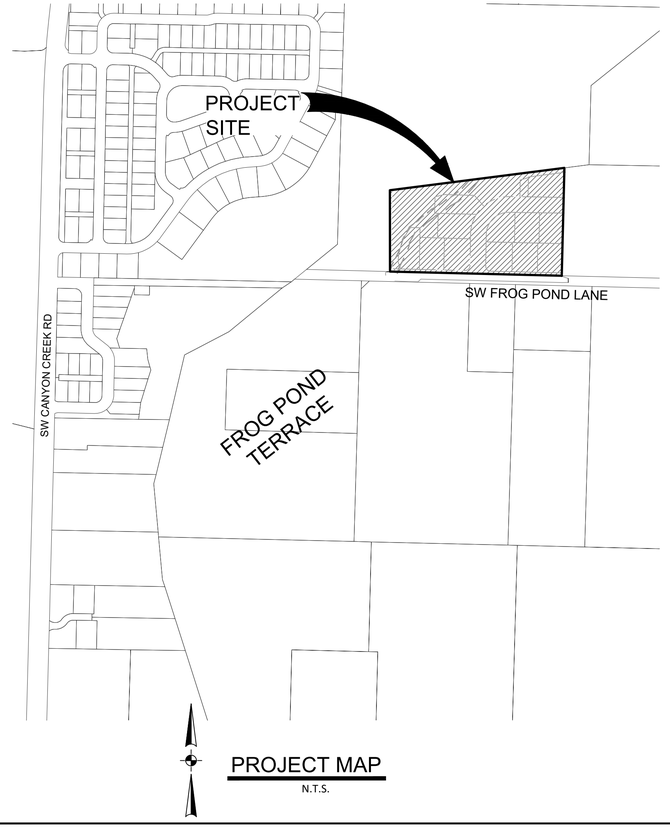
JANUARY 28, 2022

FROG POND OVERLOOK

REVISED TENTATIVE PLAT
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON



VICINITY MAP
N.T.S.



PROJECT MAP
N.T.S.

APPLICANT/ DEVELOPER

NAME:	WEST HILLS LAND DEVELOPMENT
CONTACT:	DAN GRIMBERG
ADDRESS:	3330 NW YEON AVENUE, SUITE 100
	PORTLAND, OR 97210
PHONE:	(503) 641-7342

PLANNER /CIVIL ENGINEER/ SURVEYOR/ LANDSCAPE ARCHITECT

NAME:	OTAK INCORPORATED
PLANNER:	JAMES CRAMER
ENGINEER:	KEITH BUISMAN, P.E.
SURVEYOR:	MICHAEL SPELTS, PLS
LANDSCAPE ARCHITECT:	GABRIEL KRUSE , PLS
ADDRESS:	808 SW THIRD AVENUE, SUITE 800
	PORTLAND, OR 97204
PHONE:	(503) 287-6825

GEOTECHNICAL ENGINEER

NAME:	HARDMAN GEOTECHNICAL SERVICES, INC.
CONTACT:	SCOTT HARDMAN, P.E.
ADDRESS:	10110 SW NIMBUS AVENUE, SUITE B-5
	PORTLAND, OR 97223
PHONE:	(503) 530-8076

ARBORIST

NAME:	PORTLAND TREE CONSULTING
CONTACT:	PETER TORRES
ADDRESS:	PO BOX 19042
	PORTLAND, OR 97280
PHONE:	(503) 421-3883

NATURAL RESOURCES CONSULTANT

NAME:	AKS ENGINEERING & FORESTRY, LLC
CONTACT:	STACEY REED, PWS
ADDRESS:	12965 SW HERMAN RD, SUITE 100
	TUALATIN, OR 97062
PHONE:	(503) 563-6151

BENCHMARK

ELEVATIONS ARE BASED ON GPS CONTROL POINT #6021 BEING A 3" DISK DOWN 0.57' IN A MONUMENT BOX IN PARKWAY AVENUE AT THE WEST 1/4 CORNER OF SECTION 13. PER DATA SHEET PROVIDED BY CITY THE NGVD 29 ELEVATION IS 192.260, WHICH EQUATES TO ELEVATION 195.711 WHEN CONVERTED TO THE PROJECT DATUM OF NAVD 88. UNITS IN INTERNATIONAL FEET.

COORDINATE SYSTEM IS A LOCAL DATUM PLAN BASED ON OREGON STATE PLANE, NORTH ZONE, NAD83 (2011) VALUES SCALED TO GROUND ABOUT COORDINATE 0,0 BY THE INVERSE OF A COMBINED SCALE FACTOR OF 0.999891042 (CALCULATED AT POINT #1.)

STREET LIGHTING

NAME:	KITTELSON & ASSOCIATES
CONTACT:	ANTHONY YI, P.E.
ADDRESS:	851 SW SIXTH AVE, SUITE 600
	PORTLAND, OR 97204
PHONE:	(503) 228-5230

GOVERNING JURISDICTION

LAND USE: CITY OF WILSONVILLE
SANITARY SEWER: CITY OF WILSONVILLE
STORM SEWER: CITY OF WILSONVILLE
WATER: CITY OF WILSONVILLE
GRADING: CITY OF WILSONVILLE
EROSION AND SEDIMENT CONTROL: CITY OF WILSONVILLE

FRANCHISE UTILITIES

PGE SUBDIVISION	
CONTACT:	PENKA TANTILOVA
PHONE:	(503) 431-1971
EMAIL:	penka.tantilova@pgn.com
PGE STREET LIGHTING	
CONTACT:	AMBER DRY
PHONE:	(503) 736-5627
EMAIL:	amber.dry@pgn.com
NW NATURAL	
CONTACT:	BRIAN KELLEY
PHONE:	(503) 220-2427
EMAIL:	brian.kelley@nwnatural.com
COMCAST	
CONTACT:	MIRCEA BURGHELEA
PHONE:	(503)798-5785
EMAIL:	mircea_burghelea@comcast.com
ZIPLY	
CONTACT:	LISA CLARK
PHONE:	(253) 904-5619
EMAIL:	lisa.clark@ziply.com

SITE INFORMATION

CLACKAMAS COUNTY
CITY OF WILSONVILLE, OREGON, 97070

TAXLOT	AREA (AC)
3S 1W 12D 700 (7315 SW FROG POND LANE)	4.07

CALL BEFORE YOU DIG
1-800-332-2344

ATTENTION EXCAVATORS: OREGON LAW REQUIRES COMPLIANCE WITH OAR 952-001-0010 THROUGH OAR 952-001-0090. THESE RULES MAY BE OBTAINED BY CALLING OREGON UTILITY NOTIFICATION CENTER (503) 232-1987. CONTRACTOR MUST NOTIFY THE CENTER AT LEAST TWO WORKING DAYS BEFORE, BUT NOT MORE THAN TEN DAYS BEFORE, COMMENCING EXCAVATION.

SHEET INDEX

Otak, Inc.
808 SW Third Avenue, Ste. 800
Portland, OR 97204
503. 287. 6825
www.otak.com

REGISTERED PROFESSIONAL ENGINEER
72,629
PRELIMINARY
OREGON
JUNE 11, 2008
KEITH BUISMAN
EXPIRES: 12/31/2023

STAMP

WEST HILLS LAND DEVELOPMENT
CONSULTANT

FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

COVER SHEET

TITLE

#	DATE	DESCRIPTION

REVISIONS

NAVD88
DATUM

OTAK CAD — KJB
DRAWN BY — CHECKED BY

LAND USE SUBMITTAL
STATUS

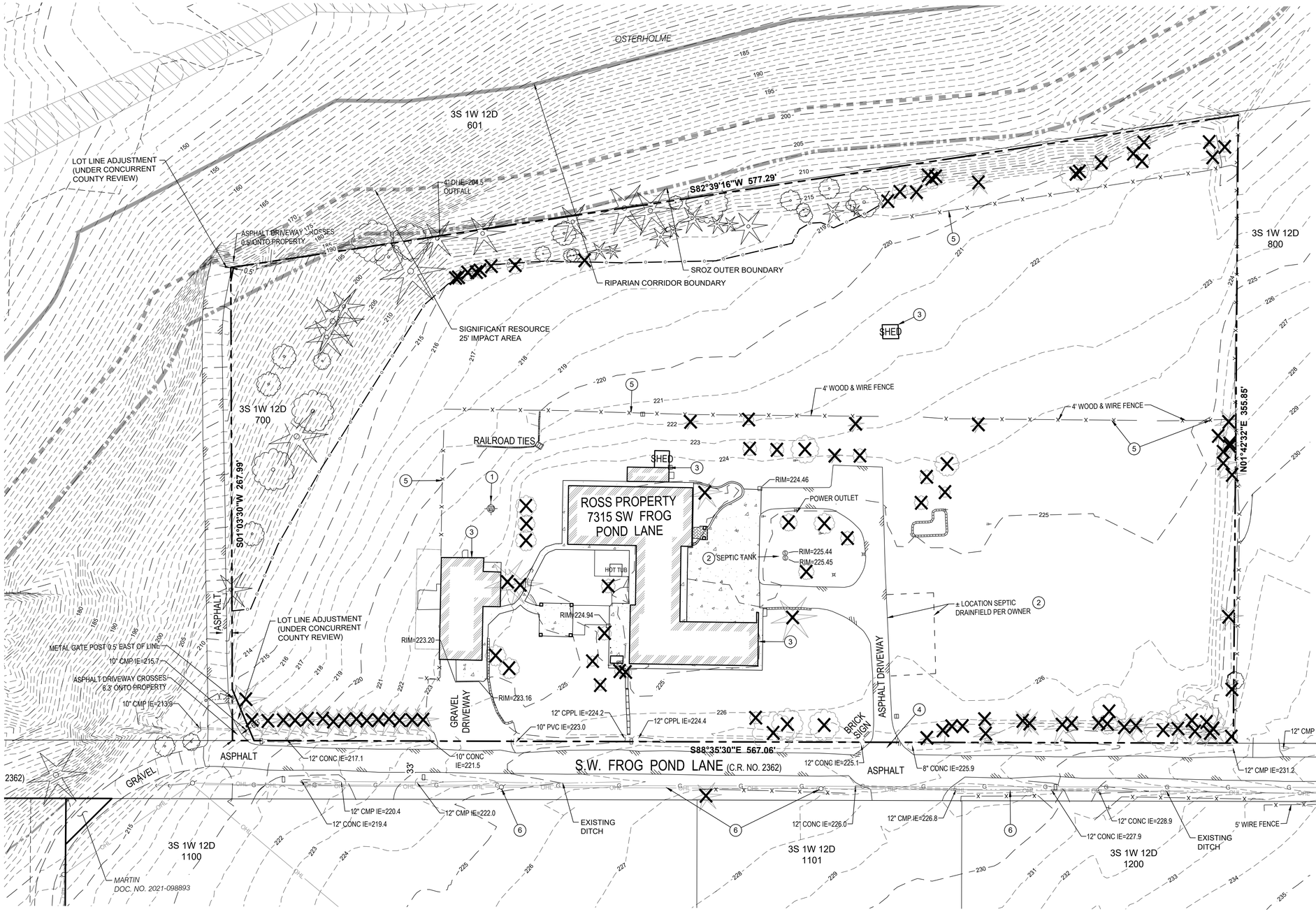
MARCH 15, 2023
DATE

21249
PROJECT NUMBER

C0.00

If this drawing is not 22" x 34", it has been reduced/enlarged. Scale accordingly.

Plotted: Apr 13, 2023 - 2:24pm Mike Havens I:\Projects\21249\04 CAD\ACAD\Dwg\Revised Tentative Plat\C21249C000.dwg Layout Name: C0.00



DEMOLITION NOTES:

1. DECOMMISSION EXISTING WELL. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO CONTACT THE CITY OF WILSONVILLE AND THE STATE OF OREGON WATER MASTER 503-681-7018 TO APPROVE REMOVAL OF ANY EXISTING WATER WELLS.
2. DECOMMISSION EXISTING SEPTIC TANK. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO CONTACT THE CITY OF WILSONVILLE AND THE STATE OF OREGON WATER MASTER 503-681-7018 TO APPROVE THE FILLING OF ANY SEPTIC TANKS.
3. DEMOLISH EXISTING BUILDING STRUCTURE. PRE-DEMOLITION PHOTOS OF ALL STRUCTURES MUST BE SUBMITTED WITH THE DEMOLITION PERMIT. A MINIMUM OF 6 PHOTOS FOR EACH STRUCTURE IS REQUIRED. SEE BUILDING DIVISION DEMOLITION POLICY BPP 123 FOR ADDITIONAL DEMOLITION PERMIT REQUIREMENTS.
4. REMOVE EXISTING STORM CULVERT.
5. REMOVE EXISTING FENCE.
6. PRESERVE AND PROTECT EXISTING OVERHEAD POLES AND LINES.

BENCHMARK

ELEVATIONS ARE BASED ON GPS CONTROL POINT #6021 BEING A 3" DISK DOWN 0.57' IN A MONUMENT BOX IN PARKWAY AVENUE AT THE WEST 1/4 CORNER OF SECTION 13. PER DATA SHEET PROVIDED BY CITY THE NGVD 29 ELEVATION IS 192.260, WHICH EQUATES TO ELEVATION 195.711 WHEN CONVERTED TO THE PROJECT DATUM OF NAVD 88. UNITS IN INTERNATIONAL FEET.

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EXISTING LEGEND

- PROPERTY LINE
- PROJECT LIMITS
- EXISTING 5' CONTOUR — 225
- EXISTING 5' CONTOUR — 221
- OVERHEAD LINE — OHL
- FENCE — X — X
- TREE PROTECTION FENCING
- CULVERT PIPE
- TREES
- TREES TO REMOVE

Otak

Otak, Inc.
808 SW Third Avenue, Ste. 800
Portland, OR 97204
503. 287. 6825
www.otak.com

REGISTERED PROFESSIONAL ENGINEER
72,629
PRELIMINARY
OREGON
JUNE 11, 2008
KEITH BUISMAN

EXPIRES: 12/31/2023

STAMP

WEST HILLS LAND DEVELOPMENT
CONSULTANT

FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

EXISTING CONDITIONS AND DEMO PLAN

TITLE

.	DATE	DESCRIPTION

REVISIONS

NAVD88
DATUM

OTAK CAD — KJB
DRAWN BY — CHECKED BY

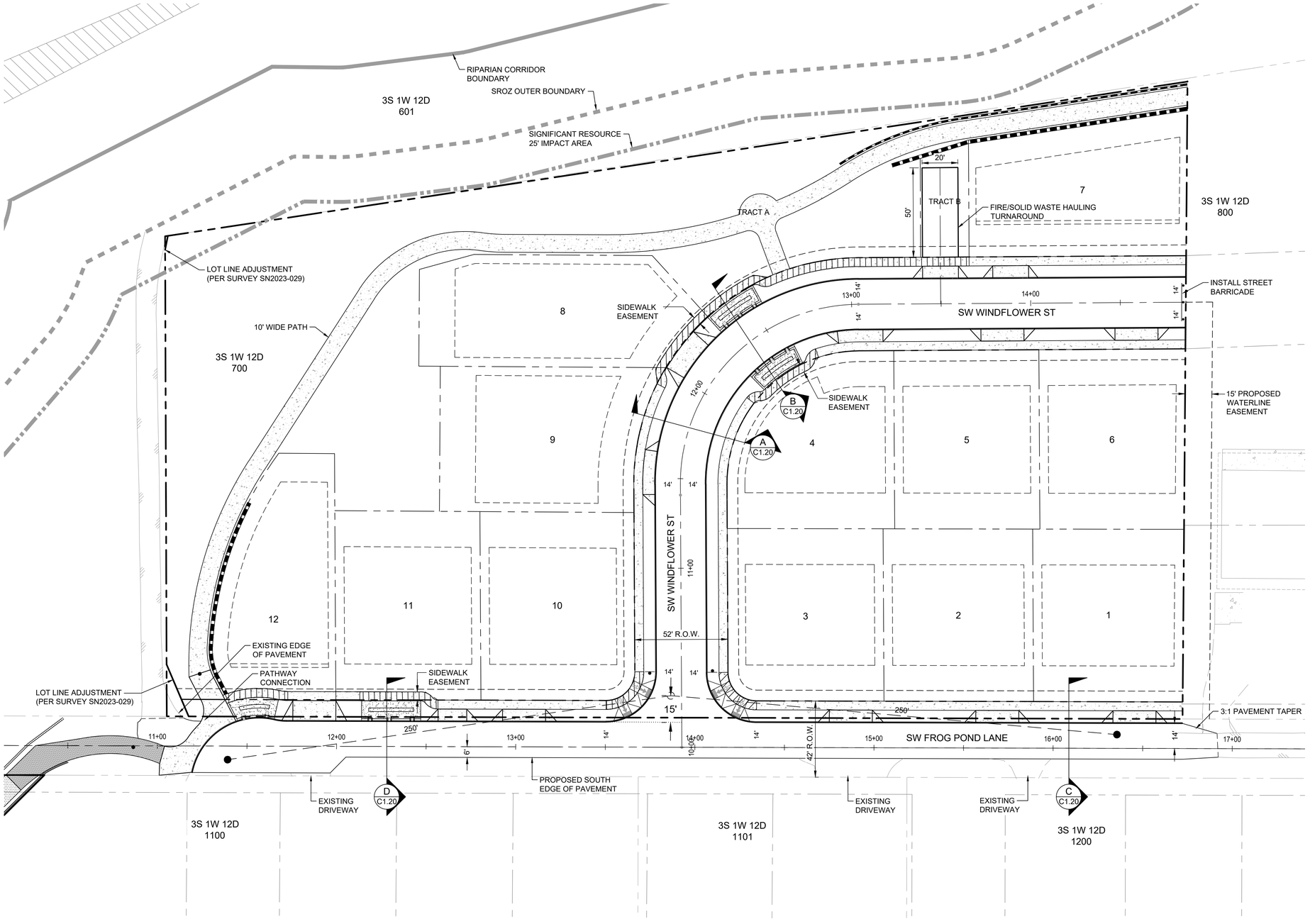
LAND USE SUBMITTAL
STATUS

MARCH 15, 2023
DATE

21249
PROJECT NUMBER

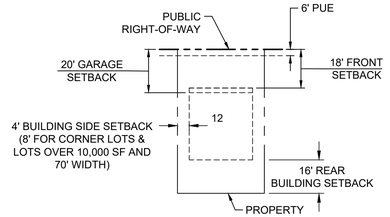
C1.00

Plotted: Apr 13, 2023 - 2:24pm Mike Haynes L:\Projects\21200\21249\04 CAD\ACAD\Dwg\Revised Tentative Plat\C21249C100.dwg Layout Name: C1.00

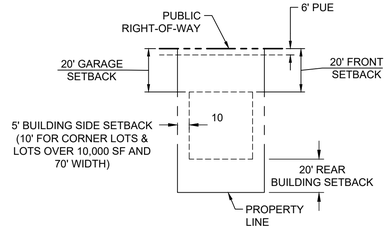


LEGEND

- PROPERTY LINE
- CENTER LINE
- LOT LINE
- LOT SETBACK
- LOT NUMBER / NAME — 16
- EASEMENT LINE
- STANDARD CURB
- SIDEWALK
- RETAINING WALL
- INTERSECTION SIGHT DISTANCE — [x'] x'=DESIGN SPEED(MPH)X10'/MPH
- TYPICAL STREET CROSS SECTION (SEE SHEET C1.20) — A C1.20
- PUBLIC RAIN GARDEN
- DRIVEWAY
- CURB RAMP



R10 FRONT LOADED SINGLE FAMILY BUILDING SETBACKS
NTS (LOTS 7 AND 12)



R10 FRONT LOADED SINGLE FAMILY BUILDING SETBACKS
NTS (LOTS 1-6 AND 8-11)

Development Summary	s.f.
Residential Lot Area	101,591
Open Space	44,694
Right of Way and Tract	30,947
Total Site Area	177,232
Minimum Lot Size	8,039
Average Lot Size	8,466

TRACT/ROW AREA	
TRACT	AREA
ROW	29,348 SF
TRACT A	44,694 SF
TRACT B	1,599 SF

LOT AREA	
LOT	AREA
1	8,080 SF
2	8,039 SF
3	8,315 SF
4	8,094 SF
5	8,088 SF
6	8,151 SF
7	9,019 SF
8	9,043 SF
9	9,145 SF
10	8,984 SF
11	8,539 SF
12	8,096 SF

0 30 60
SCALE IN FEET

Otak
Otak, Inc.
808 SW Third Avenue, Ste. 800
Portland, OR 97204
503. 287. 6825
www.otak.com

REGISTERED PROFESSIONAL ENGINEER 72,629 PRELIMINARY OREGON JUNE 11, 2008 KEITH BUISMAN
EXPIRES: 12/31/2023

STAMP

WEST HILLS LAND DEVELOPMENT
CONSULTANT

FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

SITE PLAN

TITLE

#	DATE	DESCRIPTION

REVISIONS

NAVD88
DATUM

OTAK CAD — DRAWN BY
KJB — CHECKED BY

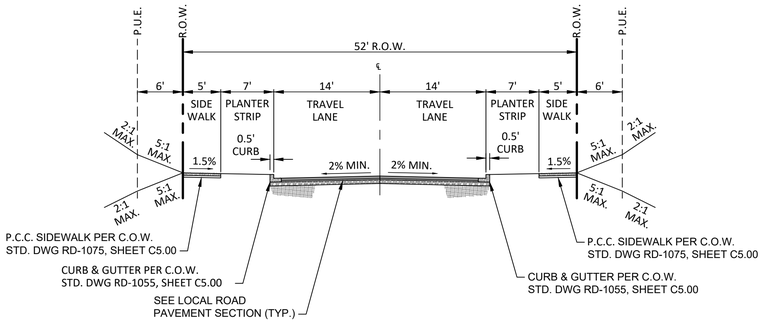
LAND USE SUBMITTAL
STATUS

MARCH 15, 2023
DATE

21249
PROJECT NUMBER

C1.10

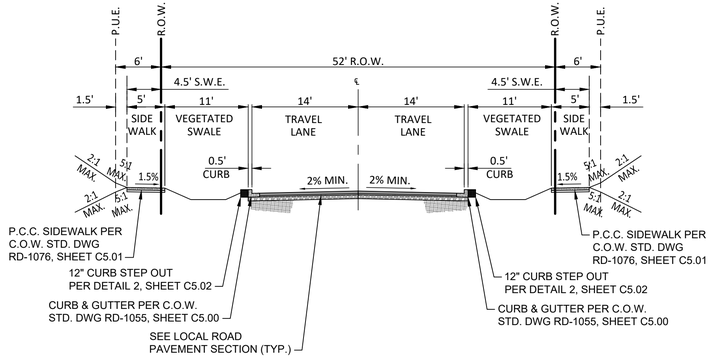
Plotted: Apr 26, 2023 - 10:32am Elizabeth.Oberley L:\Projects\21200\21249\04 CAD\CAD\Dwg\Revised Tentative Plat\C21249C110.dwg Layout Name: C1.10



A

SW WINDFLOWER ST (STA 10+00 TO 11+93; 12+73 TO 14+87)
(LOCAL STREET - PARKING ON BOTH SIDES)

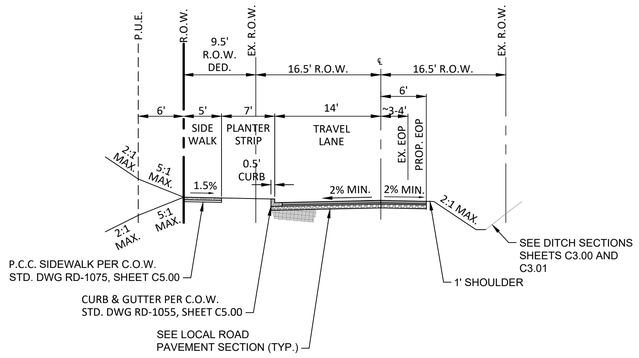
TOC = CL + 0.17
SCALE: 1" = 10'-0"



B

SW WINDFLOWER ST (STA 11+93 TO 12+73)
(LOCAL STREET - PARKING ON BOTH SIDES)

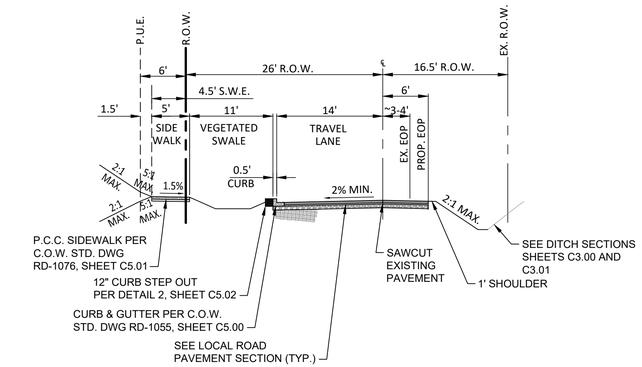
TOC = CL + 0.17
SCALE: 1" = 10'-0"



C

SW FROG POND LANE (STA 12+57 TO 16+72)
(LOCAL STREET - PARKING ON BOTH SIDES)

TOC LT = CL + 0.17
SCALE: 1" = 10'-0"



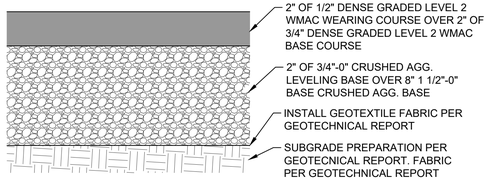
D

SW FROG POND LANE (STA 11+72 TO 12+57)
(LOCAL STREET - PARKING ON BOTH SIDES)

TOC LT = CL + 0.17
SCALE: 1" = 10'-0"

GENERAL NOTE:

1. FOR PAVEMENT SPECIFICATIONS AND COMPACTION REQUIREMENTS, SEE PAVEMENT SECTION ANALYSIS BY HGSI DATED APRIL 5, 2022.
2. WARM MIX AC (WMAC) SHALL BE USED ON ALL PAVEMENT SECTIONS.
3. SEE SHEET C1.10 FOR SECTION LOCATIONS.



LOCAL ROAD PAVEMENT SECTION

SCALE: NTS

STREET CROSS SECTIONS

SEE SHEET C1.10 FOR SECTION LOCATIONS

Otak
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STREET CROSS SECTIONS

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OTAK CAD — KJB
DRAWN BY — CHECKED BY

LAND USE SUBMITTAL
STATUS

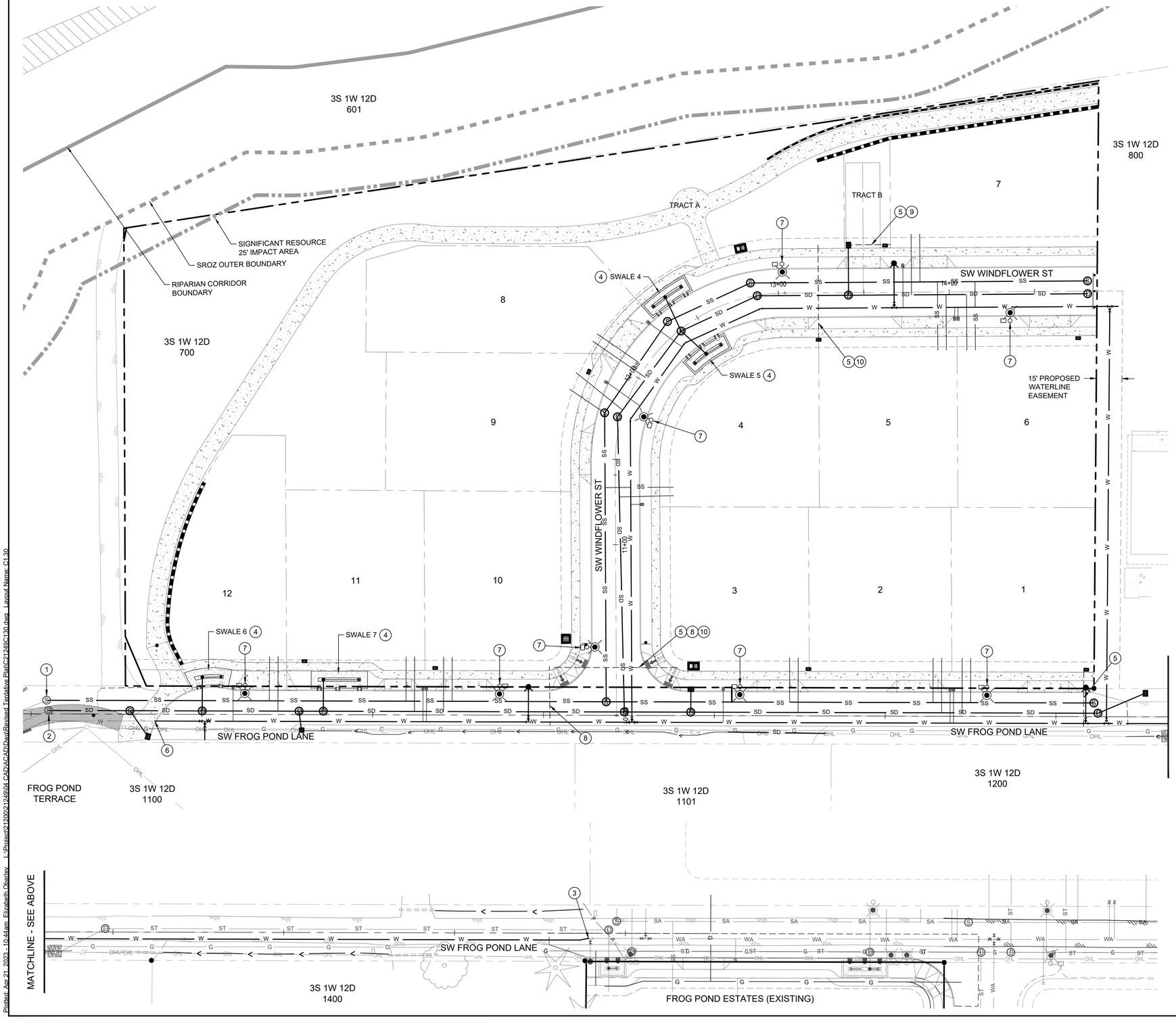
MARCH 15, 2023
DATE

21249
PROJECT NUMBER

C1.20

If this drawing is not 22" x 34", it has been reduced/enlarged. Scale accordingly.

Plotted: Apr 13, 2023 - 2:25pm Mike Havnes L:\Project\21200-21249\04 CAD\ACAD\Dwg\Revised Tentative Plat\C21249C1200.dwg Layout Name: C1.20



UTILITY KEY NOTES

1. CONNECT TO SANITARY SEWER PROPOSED WITH FROG POND TERRACE.
2. CONNECT TO STORM SEWER PROPOSED WITH FROG POND TERRACE.
3. CONNECT TO WATER LINE TO BE CONSTRUCTED WITH FROG POND ESTATES. CONNECTION CAN OCCUR WHEN FROG POND ESTATES WATER LINE HAS BEEN INSTALLED, INSPECTED, AND ACCEPTED BY THE CITY.
4. PROPOSED VEGETATED SWALE (CITY STD. DWG. ST-6045)
5. INSTALL 4-INCH CONDUIT CROSSING FOR NW NATURAL.
6. CONNECT TO WATER LINE TO BE CONSTRUCTED WITH FROG POND TERRACE.
7. PROPOSED STREET LIGHT - SEE LIGHTING PLANS.
8. INSTALL 2-INCH CONDUIT CROSSING FOR PGE.
9. INSTALL 3-INCH CONDUIT CROSSING FOR PGE.
10. INSTALL (2) 3-INCH CONDUIT CROSSING FOR PGE.

FRANCHISE UTILITY NOTES

1. SEE PGE PLAN M3289142 FOR SUBDIVISION BACKBONE.
2. SEE NW NATURAL GAS PLAN R00029374 FOR SUBDIVISION GAS AND REMOVAL OF GAS LINE IN FROG POND LANE.

LEGEND

SITE	PROPOSED	EXISTING
PROJECT BOUNDARY		
STORM DRAIN MANHOLE	D	D
STORM DRAIN CLEAN OUT	O	
LIDA FLOW CONTROL STRUCTURE (BEEHIVE: CITY STANDARD DWG. ST-6120)		
CATCH BASIN		
STORM DRAIN MAIN	SD	ST
STORM DRAIN LATERAL	SD	ST
SANITARY SEWER MANHOLE	S	S
SANITARY SEWER CLEAN OUT	S	
SANITARY SEWER MAIN	SS	SA
SANITARY SEWER LATERAL	SS	SA
WATER VALVE		
WATER BLOW-OFF		
WATER METER		
WATER FIRE HYDRANT		
WATER MAIN	W	WA
WATER LATERAL		
STREET LIGHT (SEE LIGHTING PLANS IL-1 THROUGH IL-4 FOR DETAILS)		
PGE VAULT		

SWALE TABLE

FACILITY	AREA (SF)
SWALE 4	221
SWALE 5	208
SWALE 6	183
SWALE 7	248

0 30 60
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OREGON
JUNE 11, 2008
KEITH BUISMAN
EXPIRES: 12/31/2023

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WEST HILLS LAND DEVELOPMENT
CONSULTANT

FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

COMPOSITE UTILITY PLAN

TITLE

#	DATE	DESCRIPTION

REVISIONS

NAVD88
DATUM

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LAND USE SUBMITTAL
STATUS

MARCH 15, 2023
DATE

21249
PROJECT NUMBER

C1.30

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Plotted: Apr 21, 2023 - 10:44am Elizabeth Oberlev L:\Project\21200\21249\04 CAD\ACAD\Dwg\Revised Tentative Plat\C21249C130.dwg Layout Name - C1.30

GENERAL NOTES:

1. TRACT A IS FOR OPEN SPACE, PEDESTRIAN ACCESS, AND NATURAL RESOURCE PURPOSES.
2. TRACT B IS FOR PRIVATE ACCESS TO LOT 7 AND ALSO INCLUDES A FIRE/SOLID WASTE HAULING TURNAROUND.

TRACT	TYPE
A	NATURAL RESOURCE
B	FIRE/SOLID WASTE HAULING TURNAROUND

LEGEND

	PROPOSED
RIGHT OF WAY	
CENTER LINE	
LOT LINE	
EASEMENT LINE	
LOT NUMBER	2

RIPARIAN CORRIDOR BOUNDARY
SROZ OUTER BOUNDARY
SIGNIFICANT RESOURCE 25' IMPACT AREA
3S 1W 12D 601
575.72'
LOT LINE ADJUSTMENT (PER SURVEY SN2023-029)
TRACT A 44694 SF
TRACT B 1599 SF
7 9019 SF
3S 1W 12D 800
6' P.U.E.
SW WINDFLOWER ST
WINDFLOWER ST STA:14+86.58
PT: 13+03.82
52' R/W
4.5' S.W.E.
8 9043 SF
3S 1W 12D 700
9 9145 SF
4 8094 SF
5 8088 SF
6 8151 SF
15' PROPOSED WATERLINE EASEMENT
PC: 13+46.82
SW WINDFLOWER ST
12 8096 SF
11 8539 SF
10 8984 SF
3 8315 SF
2 8039 SF
1 8080 SF
LOT LINE ADJUSTMENT (PER SURVEY SN2023-029)
6.24' S.W.E.
9.5' R/W DEDICATION
SW FROG POND LANE
S.W. FROG POND LANE STA:13+92.75= S.W. WINDFLOWER ST STA:10+00.06
3S 1W 12D 1100
3S 1W 12D 1101
3S 1W 12D 1200

0 30 60
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WEST HILLS LAND DEVELOPMENT CONSULTANT

FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

PRELIM. SUBDIVISION PLAT & HORIZONTAL CONTROL

TITLE

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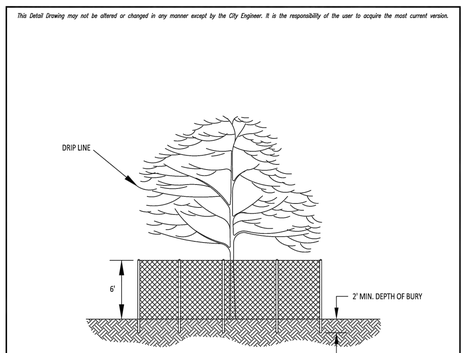
TREE PLAN LEGEND

SYMBOL	QTY	DESCRIPTION
53995 / 53994	109	EXISTING TREES TO BE REMOVED
TREE #	42	EXISTING TREES TO REMAIN
	4	EXISTING OFF-SITE TREES TO BE PROTECTED
TREE PROTECTION FENCING	495 LF	TREE PROTECTION FENCING

SEE PLANTING PLAN L2.00 STREET/SITE TREES TO BE PLANTED

NOTES:
1. CONTOURS ARE SHOWN FOR ROUGH FINISH GRADE DESIGN ONLY. SEE CIVIL PLANS FOR DETAILED GRADING.
2. MITIGATION:
   109 TREES REMOVED.
   38 TREES PROPOSED (17 STREET TREES AND 21 TREES IN TRACT A).
   PAY INTO TREE FUND FOR 71 TREES.



NOTES:
1. FENCE SHALL BE 6' IN HEIGHT AND SET AT TREE DRIP LINE.
2. FENCE MATERIALS SHALL CONSIST OF 2" MESH CHAIN LINKS SECURED TO A MINIMUM 1 1/2" DIA. STEEL OR ALUMINUM LINE POSTS.
3. POSTS SHALL BE SET TO A DEPTH OF NO LESS THAN 2 FEET IN NATIVE SOIL.
4. FENCE SHALL REMAIN IN PLACE UNTIL THE COMPLETION OF CONSTRUCTION ACTIVITIES. MOVEMENT OR REMOVAL OF FENCE REQUIRES APPROVAL BY CITY'S AUTHORIZED REPRESENTATIVE.

Tree Protection Fencing			CITY OF WILSONVILLE
DRAWING NUMBER: RD-1230	DRAWN BY: SR	SCALE: N.T.S.	PUBLIC WORKS STANDARDS
FILE NAME: RD-1230.DWG	APPROVED BY: NK	DATE: 4/2/14	

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FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

TREE PROTECTION PLAN

TITLE

#	DATE	DESCRIPTION

REVISIONS

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21249
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Plotted: Apr 26, 2023 - 10:26am Elizabeth Obetlev L:\Project\21200\21249\04 CAD\ACAD\Dwg\Revised Tentative Plat\L21249 100.dwg Layout Name: L1.00

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
30409	Sato Cherry	10"	18	2	assymetric crown - Offsite	10 ft.	Protect
30410	Sato Cherry	12"	18	2	assymetric crown - Offsite		Protect
31067	Douglas-fir	24"	18	2	on a berm, part of windrow; through 31102 crowded trees		Protect
31071	Douglas-fir	24"	12	2	2 stems at 20 ft. Many of these were topped at 30 ft.		Remove
31072	Douglas-fir	20"	12	2	Topped or broken in past; part of windrow		Remove
31073	Douglas-fir	20"	12	2	Topped or broken in past; part of windrow		Remove
31074	Douglas-fir	14"	12	2	Topped or broken in past; part of windrow		Remove
31075	Douglas-fir	22"	12	2	Topped or broken in past; part of windrow		Remove
31076	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31077	Douglas-fir	16"	12	2	Topped or broken in past; part of windrow		Remove
31078	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31079	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31080	Douglas-fir	20"	12	2	Topped or broken in past; part of windrow		Remove
31081	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31082	Douglas-fir	10"	12	2	Topped or broken in past; part of windrow		Remove
31083	Douglas-fir	20"	12	2	Topped or broken in past; part of windrow		Remove
31084	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31085	Douglas-fir	16"	12	2	Topped or broken in past; part of windrow		Remove
31086	Douglas-fir	18"	12	2	Topped or broken in past; part of windrow		Remove
31097	Gary oak	2X10"-14"	18	2	2 trunks from ground		Protect
31099	Gary oak	24"	20	2	2 trunks from ground		Protect
31102	Douglas-fir	36"	20	2	2 trunks from ground		Protect
31103	Gary oak	24"	12	2	assymetric crown		Protect
31104	Gary oak	14"	8	2	leans and assymetric crown		Protect

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31105	sweet cherry	14"	8	2	assymetric crown		Protect
31108	Gary oak	10"	12	2	assymetric crown		Protect
31109	Douglas-fir	26"	16	2	viable		Protect
31110	Douglas-fir	36"	16	2	viable		Protect
31111	Douglas-fir	24"	14	2	forks at 50 ft.		Protect
31141	Douglas-fir	40"	24	2	viable		Protect
31142	bigleaf maple	16"	12	1	ivy-infested		Protect
31143	bigleaf maple	24"	12	1	ivy-infested		Protect
31145	bigleaf maple	21"	12	1	ivy-infested		Protect
31146	Douglas-fir	24"	12	1	ivy-infested		Protect
31149	Douglas-fir	26"	16	2	ivy-infested		Protect
31155	red alder	14"	8	1	broken		Protect
31156	Douglas-fir	2X24"	16	2	ivy-infested		Protect
31159	Douglas-fir	32"	16	2	ivy-infested		Protect
31162	Douglas-fir	30"	16	2	ivy-infested		Protect
31164	red alder	8"	8	2	ivy-infested		Protect
31165	Cottonwood	24"	12	2	ivy-infested		Protect
31168	western redcedar	2X8"-22"	18	2	assymetric crown		Protect
31169	Douglas-fir	10"	6	2	assymetric crown		Protect
31170	Douglas-fir	12"	8	2	assymetric crown		Protect
31171	giant sequoia	18"	10	2	assymetric crown		Protect
31172	Douglas-fir	10"	10	2	assymetric crown		Protect
31173	Douglas-fir	14"	10	2	assymetric crown		Protect
31174	Douglas-fir	9"	8	2	assymetric crown		Protect

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31175	Douglas-fir	12"	10	2	assymetric crown		Protect
31176	Douglas-fir	13"	10	2	assymetric crown		Remove
31177	red alder	8"	8	2	assymetric crown		Protect
31178	red alder	8"	8	2	assymetric crown		Protect
31179	red alder	9"	8	2	assymetric crown		Protect
31180	red alder	10"	8	2	assymetric crown		Remove
31181	red alder	7"	8	2	assymetric crown		Remove
31182	red alder	9"	8	2	assymetric crown		Remove
31183	red alder	5"	8	2	assymetric crown		Remove
31184	red alder	10"	8	2	assymetric crown		Remove
31185	red alder	8"	8	2	assymetric crown		Remove
31186	red alder	6"	8	2	assymetric crown		Remove
31187	European birch	12"	12	1	dying likely from borer		Remove
31188	European birch	10"	10	1	dying likely from borer		Remove
31189	European birch	12"	12	1	dying likely from borer		Remove
31190	Sitka spruce	26"	18	2	within 10 ft. of building		Remove
31191	ponderosa pine	30"	24	2	within 10 ft. of building		Remove
31192	ponderosa pine	9"	6	2	viable		Remove
31197	red alder	2X10"-12"	12	2	ivy-infested		Protect
31199	red alder	8"	6	2	ivy-infested		Protect
31200	Douglas-fir	8"	8	2	assymetric crown		Protect
31204	Douglas-fir	13"	10	2	ivy-infested		Protect
31205	red alder	12"	10	2	ivy-infested		Protect
31207	red alder	6"	8	2	ivy-infested		Protect

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31208	Douglas-fir	7"	6	2	assymetric crown		Protect
31209	Scouler willow	2X14"-18"	16	2	the 14" stem is a cottonwood, the 14" stem is Scouler willow		Protect
31210	red alder	8"	12	2	assymetric crown		Remove
31216	red alder	9"	8	2	assymetric crown		Remove
31217	Douglas-fir	12"	10	2	assymetric crown		Remove
31218	red alder	7"	6	2	assymetric crown		Remove
31219	red alder	12"	8	2	assymetric crown		Remove
31220	red alder	9"	6	2	assymetric crown		Remove
31223	Douglas-fir	16"	12	2	assymetric crown		Remove
31230	red alder	18"	12	2	assymetric crown		Remove
31231	red alder	10"	8	2	assymetric crown		Remove
31232	red alder	10"	8	2	assymetric crown		Remove
31235	red alder	8"	8	2	assymetric crown		Remove
31236	red alder	6"	6	2	assymetric crown		Remove
31237	red alder	9"	8	2	assymetric crown		Remove
31259	red alder	6"	6	2	assymetric crown		Remove
31260	Douglas-fir	6"	6	2	assymetric crown		Remove
31261	Douglas-fir	15"	12	2	assymetric crown		Remove
31283	Douglas-fir	18"	12	2	on a berm with shallow roots; assymetric crown		Remove
31284	Douglas-fir	7"	10	2	on a berm with shallow roots; assymetric crown		Remove
31285	Douglas-fir	9"	10	2	on a berm with shallow roots; assymetric crown		Remove
31286	Douglas-fir	12"	12	2	on a berm with shallow roots; assymetric crown		Remove
31287	Douglas-fir	9"	10	2	on a berm with shallow roots; assymetric crown		Remove
31288	Douglas-fir	16"	16	2	on a berm with shallow roots; assymetric crown		Remove

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31289	Douglas-fir	16"	12	2	on a berm with shallow roots; assymetric crown		Remove
31290	blue spruce	10"	6	2	viable		Remove
31291	apple	14"	8	2	viable		Remove
31292	apple	6"	8	2	viable		Remove
31293	apple	8"	8	2	viable		Remove
31294	apple	8"	8	2	viable		Remove
31297	blue spruce	10"	8	2	viable		Remove
31298	apple	2X5"-8"	8	2	viable		Remove
31299	limber pine	9"	10	2	viable		Remove
31300	Sato Cherry	16"	12	2	viable		Remove
31301	Sato Cherry	8"	8	2	viable		Remove
31302	Sato Cherry	2X8"	10	2	viable		Remove
31303	ginkgo	6"	8	2	viable		Remove
31304	incense-cedar	20"	12	2	viable		Remove
31305	Norway maple	10"	8	2	ornamental variety		Remove
31306	Norway maple	12"	8	2	ornamental variety		Remove
31309	Norway maple	8"	8	2	ornamental variety		Remove
31310	paperbark maple	2X8"-9"	10	2	viable		Remove
31311	Deodar cedar	28"	16	2	viable		Remove
31312	Japanese maple	6X4"-7"	12	2	viable		Remove
31313	black oak	24"	24	2	viable		Remove
31314	black oak	18"	24	2	viable		Remove
31315	black oak	2X16"-18"	24	2	structural defect at grade		Remove
31316	red spruce	9"	8	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31317	incense-cedar	8"	6	1	on the berm at SW Frog Pond Lane; terminal dieback		Remove
31318	grand fir	6"	6	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31319	Douglas-fir	6"	8	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31320	Douglas-fir	8"	12	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31321	ponderosa pine	16"	14	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31322	Douglas-fir	16"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31323	Douglas-fir	16"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31324	Douglas-fir	24"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31325	sweet cherry	8"	12	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31326	Douglas-fir	10"	12	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31327	Cottonwood	12"	16	2	at berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31328	Cottonwood	2X20"	16	1	at berm; large dead braches		Remove
31329	Douglas-fir	2X14"-18"	14	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31330	Douglas-fir	13"	14	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31331	Cottonwood	22"	18	1	at berm; large dead braches		Remove
31332	Douglas-fir	16"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31333	Cottonwood	2X16"-28"	18	2	at berm at SW Frog Pond Lane		Remove
31334	Douglas-fir	16"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31335	Douglas-fir	16"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31336	Douglas-fir	18"	16	2	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31337	Lombardy poplar	20"	0	0	on berm at SW Frog Pond Lane; shallow roots, assymetrical crown		Remove
31338	Lombardy poplar	7"	6	1	on berm at SW Frog Pond Lane; root decay, assymetrical crown		Remove
31339	Lombardy poplar	6"	6	1	fungal infection in crown		Remove
31340	Lombardy poplar	4X3"-10"	8	1	fungal infection in crown - Offsite		Protect

Tag	Species	DBH	Dripline	Rating	Health & Structure	RPZ	Action
31341	Douglas-fir	17"	14	2	on a berm with shallow roots		Remove
31344	Portuguese laurel	3X4"-6"	6	2	invasive species		Remove
31345	Portuguese laurel	7"	6	2	invasive species		Remove
31346	Japanese maple	4X3"16"	8	2	within 10 ft. of building		Remove
31347	Japanese maple	2X3"-6"	8	2	within 10 ft. of building		Remove
31348	Japanese maple	2X8"	8	2	within 10 ft. of building		Remove
31349	Japanese maple	3X7"-8"	8	2	within 10 ft. of building		Remove
31350	Portuguese laurel	12"	8	2	within 10 ft. of building		Remove
31351	Japanese maple	12"	10	1	terminal decline		Remove
31676	ponderosa pine	18"	8	1	topped at 20 ft. for high-voltage lines - Offsite		Remove

Rating- 0/dead or hazardous, 1/decline, 2/average, 3/excellent health and structure

Species

apple- *Maus sylvestris*
bigleaf maple- *Acer macrophyllum*
black oak- *Quercus velutina*
blue spruce- *Picea pungens*
Cottonwood- *Populus tricarpa*
Deodar cedar- *Cedrus deodara*
Douglas fir- *Pseudotsuga menziesii*
European birch- *Betula pendula*
Gary oak- *Quercus garryana*
giant sequoia- *Sequoia giganteum*
ginkgo- *Gingko biloba*
grand fir- *Abies grandis*
incense-cedar- *Calocedrus decurrens*
Japanese maple- *Acer japonica*
limber pine- *Pinus flexilis*
Lombardy poplar- *Populus nigra*
Norway maple- *Acer platanoides*
paperbark maple- *Acer griseum*
Ponderosa pine- *Pinus ponderosa* var. *scopulorum*
Portuguese laurel- *Prunus lusitanica*
red alder- *Alnus rubra*
red spruce- *Picea rubens*
Sato Cherry- *Prunus* sp.
Scouler willow- *Salix scouleriana*
Sitka spruce- *Picea sitchensis*
sweet cherry- *Prunus avium*
western redcedar- *Thuja plicata*

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FROG POND OVERLOOK
12 DETACHED SINGLE FAMILY LOTS
CITY OF WILSONVILLE, OREGON

REVISED TENTATIVE PLAT

TREE INVENTORY

TITLE

#	DATE	DESCRIPTION

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MARCH 15, 2023
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Otak

Frog Pond Terrace, Frog Pond Overlook

Preliminary Storm Drainage Report

Land Use

Submitted to:

City of Wilsonville
29799 SW Town Center Loop E.
Wilsonville, OR 97070

Prepared by:

Otak, Inc.
808 SW Third Avenue, Suite 800
Portland, OR 97204

March 2023

Project No. 21249

Acknowledgements

Project Name:	Frog Pond Terrace, Frog Pond Overlook
Type of Report:	Preliminary
Submittal Level:	Land Use

Site Information

Subject Property:	31W12D Tax lots 700, 2800, 2801
Applicant Information:	Dan Grimberg West Hills Land Development 3330 NW Yeon St. Suite 200 Portland, OR 97210 503-789-0358

Project Development Team

Stormwater Lead:	Rose Horton, PE
Stormwater Designer:	Roger Tiffany, EIT

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Section 1. Introduction

The Frog Pond Terrace and Frog Pond Overlook sites are proposed residential developments located within the West Neighborhood of the Frog Pond Area Plan. The combined 8.81 acres of property and right-of-way are comprised of Tax map 31W12D lots 700 (Terrace), 2800 and 2801 (Overlook) in Clackamas County within the City of Wilsonville Urban Growth Boundary (UGB) (see Vicinity Map). The Frog Pond Terrace and Frog Pond Overlook developments will consist of 19 and 21 single-family residential dwellings respectively as well as associated public infrastructure improvements including SW Frog Pond Lane, resulting in 5.00 acres in new or replaced impervious surface area.

The purpose of this document is to demonstrate compliance of the Frog Pond Terrace and Frog Pond Overlook stormwater management system with the City of Wilsonville Stormwater and Surface Water Design and Construction Standards (2015). Descriptions of the existing and proposed hydrologic conditions, as well as documentation showing compliance of the proposed onsite stormwater management system with City of Wilsonville standards for water quality and quantity are included in this report.

Vicinity Map

Section 2. Project Description

The Frog Pond Terrace and Frog Pond Overlook proposed residential developments consist of 40 new single-family lots, local street extensions, as well as sidewalks, public roadway improvements, utilities, and stormwater management systems that discharge to Boeckman Creek. Additionally, this project will include frontage improvements to SW Frog Pond Lane.

Permitting

The following permit applications will be required for this project:

- City of Wilsonville Development Permit
- Section 401 water quality certification from DEQ

Existing Conditions

The project site, shown in Figure 1, is primarily agricultural with a home and outbuildings that comprise 0.66 areas of impervious area. The Frog Pond Terrace project site slopes west at about 5% while the Frog Pond Overlook project site slopes north at about 4%. The right-of-way (ROW) of SW Frog Pond Lane that fronts on the Frog Pond Overlook site includes 0.02 acres of impervious pavement. Both project sites slope towards Boeckman Creek. This proposed project will maintain drainage patterns.

Proposed Conditions

Site improvements will include construction of approximately 5.00 acres of new or replaced impervious surfaces in the form of roof, roadway, and sidewalk area. A detention pond and vegetated stormwater swales are proposed to be constructed within the right-of-way and tracts to provide low impact development water quality treatment and flow control throughout the proposed residential developments. Runoff from approximately 14.5 acres of undeveloped offsite area will be conveyed through the site's stormwater infrastructure.

Section 3. Hydrology

Rainfall Depth

The following rainfall depths listed in Table 1 are provided in the City of Wilsonville Public Works Standards (2015). These depths correspond to design recurrence intervals which are used in hydrologic calculations for various aspects of stormwater management design.

Table 1 24 Hour Precipitation Depths

Recurrence Interval (Years)	Total Precipitation Depth (inches)
2	2.50
10	3.45
25	3.90
100	4.50

Pollutants of Concern

The pollutants of concern are those typically found in roadway runoff. These include sediment, oil and grease, polycyclic aromatic hydrocarbons (PAHs), metals such as Copper, Zinc, and Lead as well as pesticides and other nutrients (DEQ, 2016). Table 2 lists each waterway affected by this project and DEQ listing status.

Table 2 Pollutants of Concern

Waterway	Parameter	Listing Status
Boeckman Creek	N/A	None
Willamette River (Middle)	Chlorophyll a	303(d), TMDL needed

Waterway	Parameter	Listing Status
Willamette River (Middle)	E. Coli	TMDL approved
Willamette River (Middle)	Mercury	303(d), TMDL needed
Willamette River (Middle)	Temperature	TMDL approved

Wetlands

Wetland and water boundaries were delineated by AKS Engineering and Forestry on December 2, 2021. Wetlands were delineated adjacent to Boeckman Creek. The project is not anticipated to impact wetlands or waters. The project will impact the Significant Resource Overlay Zone (SROZ). Discussion of the impacts to sensitive areas will be provided by the environmental consultant, AKS.

Soils

The Web Soil Survey published by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) was referenced to determine the soil names, symbols, and hydrologic soil groups found on the project site. The soil type identified within the project area is identified as Woodburn silt loam (91B/C). These soils are classified as hydrologic soil type C, which in an undrained condition generally exhibit slow infiltration rates when thoroughly wet. The USDA soil survey map and the corresponding hydrologic soil group (HSG) for the area of interest are provided in Appendix A.

A geotechnical investigation was conducted to determine the site strata and infiltration rates. The field exploration did not encounter the static groundwater table and well data indicates that the groundwater table is at least 20 feet below ground surface. Perched groundwater conditions may occur during the wet season. Infiltration testing at a depth of five to six feet below ground surface yielded infiltration rates between 0.6 to 1.2 inches/hour. The geotechnical engineer stated that the lower value is more representative of the site and that a safety factor of at least 2 be applied to the design infiltration rate. The onsite Geotechnical Memorandum by Hardman Geotechnical Services is included in Appendix B.

Flood Hazard

The proposed development for this site is located outside the 100-year floodplain boundary designated by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for Clackamas County, Oregon and Incorporated Areas, Panel 234, June 17, 2008. See Appendix A for the FIRMette of the proposed site.

Section 4. Methodology

The stormwater system for the proposed Frog Pond Terrace/Overlook development was modeled using the following methods and design standards:

- Water Quality: The City of Wilsonville requires capture and treatment of 80% of the average annual runoff (approximately 1-inch in 24 hours). The City of Wilsonville has adopted a BMP Sizing Tool that was developed to aid in the design of detention and water quality low impact development facilities. The City of Wilsonville BMP Sizing Tool was used to size the minimum facility footprint areas to meet the water quality treatment standard.

- Flow Control: The BMP sizing tool was also simultaneously used to calculate facility sizes to include flow control. This tool provides the necessary calculations to design a facility to meet the City's flow

duration matching standards whereby the “duration of peak flow rates from post development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42% of the 2-year storm peak flow rate up to the 10-year peak flow rate.”

- Conveyance: The Santa Barbara Urban Hydrograph (SBUH) method will be used to calculate design conveyance flow rates and XP-SWMM software will be used to size the project conveyance system. The City’s design event for pipe conveyance is the 25-year, 24-hour storm, requiring 1-foot of freeboard between the hydraulic grade line and finished grade at structure rims.

BMP Sizing Tool Hydrology

The BMP Sizing Tool was created to aid in designing low impact development facilities for both treating stormwater runoff and matching flow durations between target conditions and developed conditions. City standards consider target conditions to be pre-development, prior to any human settlement. City of Wilsonville standards stipulate that the pre-developed vegetation of Oak Savannah, which applies to the project site, should be modeled in the sizing tool as grass. Proposed conditions were set to paved conditions for roof, roadway, and sidewalk, and set to landscaped conditions for landscaped and other disturbed pervious areas within the project boundary.

A detention pond and vegetated filtration swales will function to provide both water quality and flow control mitigation. The BMP Sizing Tool provides minimum facility footprint areas for treatment and flow control. The BMP Sizing Tool also provides the required orifice sizes for incorporating the flow control component into these facilities.

Drainage

The developed site drains to Boeckman Creek over a mile north of its discharge point at the Willamette River. The Boeckman Creek drainage basin upstream of the project site is approximately 800 acres and the project area comprises less than 2% of the contributing drainage basin. Boeckman Creek is confined to a deep channel approximately 40 feet below the adjacent developments. A flow control structure on the creek exists in Boeckman Creek directly upstream of SW Boeckman Road (Wilsonville, 1992). Otak conducted a downstream impact analysis on the downstream section of Boeckman Creek per City of Wilsonville standards and the downstream impact analysis is included in Appendix C.

Conveyance

The proposed development will include a piped conveyance network that will convey flows to Boeckman Creek. Pipes draining the project site will be designed to meet City of Wilsonville conveyance standards.

The Santa Barbara Urban Hydrograph (SBUH) method will be used to calculate runoff rates generated under proposed developed conditions for contributing onsite areas as well as offsite upstream areas. The City of Wilsonville Public Works Standards (2015) identifies the 25-year, 24-hour storm to be used for conveyance design, maintaining 1-foot of clearance between the hydraulic grade line and conveyance structure rim elevations. The City also requires an assessment of the 100-year storm event impacts to the proposed system. Flow rates during the 100-year may be conveyed overland but are not expected to inundate existing structures. The stormwater conveyance network will be sized during final design.

Section 5. Water Quality Treatment

Low Impact Development

The City of Wilsonville promotes the use of Low Impact Development (LID) approaches to meet water quality treatment standards. Locations of LID facilities for water quality treatment for the Frog Pond Terrace and Frog Pond Overlook project site are shown on Figures 2 and 3.

Water Quality Facilities

Water quality treatment will be provided through a detention pond and filtration vegetated swales. The BMP Sizing Tool was used to calculate minimum facility sizes to satisfy water quality requirements. Facility sizing calculation reports from the BMP Sizing Tool are provided in Appendix D.

The Frog Pond Terrace project includes right-of-way improvements that complete the northern side of SW Brisband Street. The southern side of the street was developed with the Morgan Farm Phase 2 project located south of Frog Pond Terrace. Frog Pond Terrace Basins T14 and MF will drain to an existing swale on the Morgan Farm project (see Figure 3). The Morgan Farm storm report (PDG, 2019) shows that Basin MF, which is located south of the property line, was included in the design of Morgan Farm Swale 1. The existing Swale 1 and contributing drainage areas were modeled in the BMP tool based on the WES BMP Sizing Report appendix of the Morgan Farm storm report and Basin T14 was added to confirm that the swale is adequately sized to manage runoff from both sides of the street.

The proposed ten-foot wide pedestrian trail along the west end of the site is located adjacent to a steep slope where it is not feasible to install stormwater management facilities. Runoff from the trail will sheet flow through a vegetated area toward Boeckman Creek. The trail is located 100 to 250 feet away from the creek.

Section 6. Flow Control

City of Wilsonville Public Works Standards (2015) requires the use of flow attenuation when a proposed development increases impervious surface area by more than 5,000 square feet. Therefore, this project site will require flow control mitigation prior to discharging site runoff to downstream conveyance systems (open or closed channels or conduits). Per City requirements, the “post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42% of the 2-year storm peak flow rate up to the 10-year peak flow rate.”

Flow control structures will be located immediately downstream of the detention pond and vegetated filtration swales, per the City’s standard detail. These facilities provide flow control by installing orifices at the end of their corresponding underdrain pipes to backwater flows into the available storage and voids present in facility soil and rock layers. Water is released from the facility through the orifice, which is sized to meter flows at a rate that meets flow control standards. Certain swales are sized to only provide water quality treatment. All proposed swales flow to the pond which provides flow control and water quality treatment.

Orifices are provided for flow control purposes only; construction details of the flow control structures are provided on the plan sheets. A summary of facilities to serve this project is presented in Tables 3 and 4.

Table 3 Facility Summary Table

Basin ID	Facility ID	Function	LID Min. Size, BMP Output (sf)	LID Treatment Size, Site Plan (sf)	Orifice Diameter (in)
T11	Swale 1	WQ	150	294	0.6
T12	Swale 2	WQ, FC	157	336	0.6
T13	Swale 3	WQ, FC	274	336	0.8
O3	Swale 4	WQ	182	221	0.6
O4	Swale 5	WQ	184	208	0.6
FP2, FP3	Swale 6	WQ	89	183	0.4
T15	Swale 8	WQ	47	128	0.3
T3	Swale 9	WQ	82	124	0.4

Table 4 Detention Pond Summary Table

Basin ID	Facility ID	Function	Max Depth (ft)	Treatment Area (sf)
T1-T2, T4-T10, T16, O1, O2a/b, O5, FP1, FP4, FP5	Pond	WQ, FC	5.0	7,523

Section 7. Operations and Maintenance

Vegetated facilities will be maintained by the private development. Operations and Maintenance requirements are included in Appendix E in conjunction with corresponding standard details for each type of facility. The following representative will be responsible for ongoing maintenance of onsite facilities: Dan Grimberg, Director of Land Development at West Hills Development, 503-641-7342.

Section 8. Conclusion

The proposed Frog Pond Terrace and Frog Pond Overlook developments will include a stormwater management system designed to comply with standards set forth by the City of Wilsonville. The proposed development will create 5.00 acres of impervious area. Runoff from impervious areas will be treated by LID facilities, including a detention pond and vegetated filtration swales. Flow control requirements will also be met by adding orifices at the downstream end of underdrain to regulate outflows from the detention pond and vegetated swales. The BMP Sizing Tool was used to calculate minimum facility and orifice sizes to satisfy water quality and flow control requirements. In accordance with City of Wilsonville standards, the conveyance system will be sized to convey the 25-year, 24-hour storm event with a minimum of 1-foot of freeboard between the hydraulic grade line (HGL) and the finished grade elevation.

Section 9. References

AKS, 2021A. *Natural Resources Feasibility Map SW Frog Pond Lane Martin Properties*, AKS Engineering & Forestry, October 2021.

AKS, 2021B. *Natural Resources Feasibility Map SW Frog Pond Lane Ross Properties*, AKS Engineering & Forestry, October 2021.

AKS, 2021C. *Frog Pond Terrace Significant Resource Impact Report*, AKS Engineering & Forestry,

December 2021.

DEQ, 2016. *Section 401 Water Quality Certification*, State of Oregon Department of Environmental Quality, May 2016.

FEMA, 2017. *FEMA Map Service Center*. <http://msc.fema.gov/> Accessed: December 11, 2019.

Hardman, 2021. Geotechnical Engineering and Infiltration Testing Report – Frog Pond West-West – Martin, George and Ross Properties, Wilsonville, Oregon, Hardman Geotechnical Services Inc., December 15, 2021

National Resource Conservation Services, 2018. *United States Department of Agriculture. Web Soil Survey*. <http://websoilsurvey.nrcs.usda.gov/> Accessed: August 17, 2021.

PDG, 2019. *Final Storm Drainage Report: Morgan Farms – Phase 2*, Pioneer Design Group, January 2019.

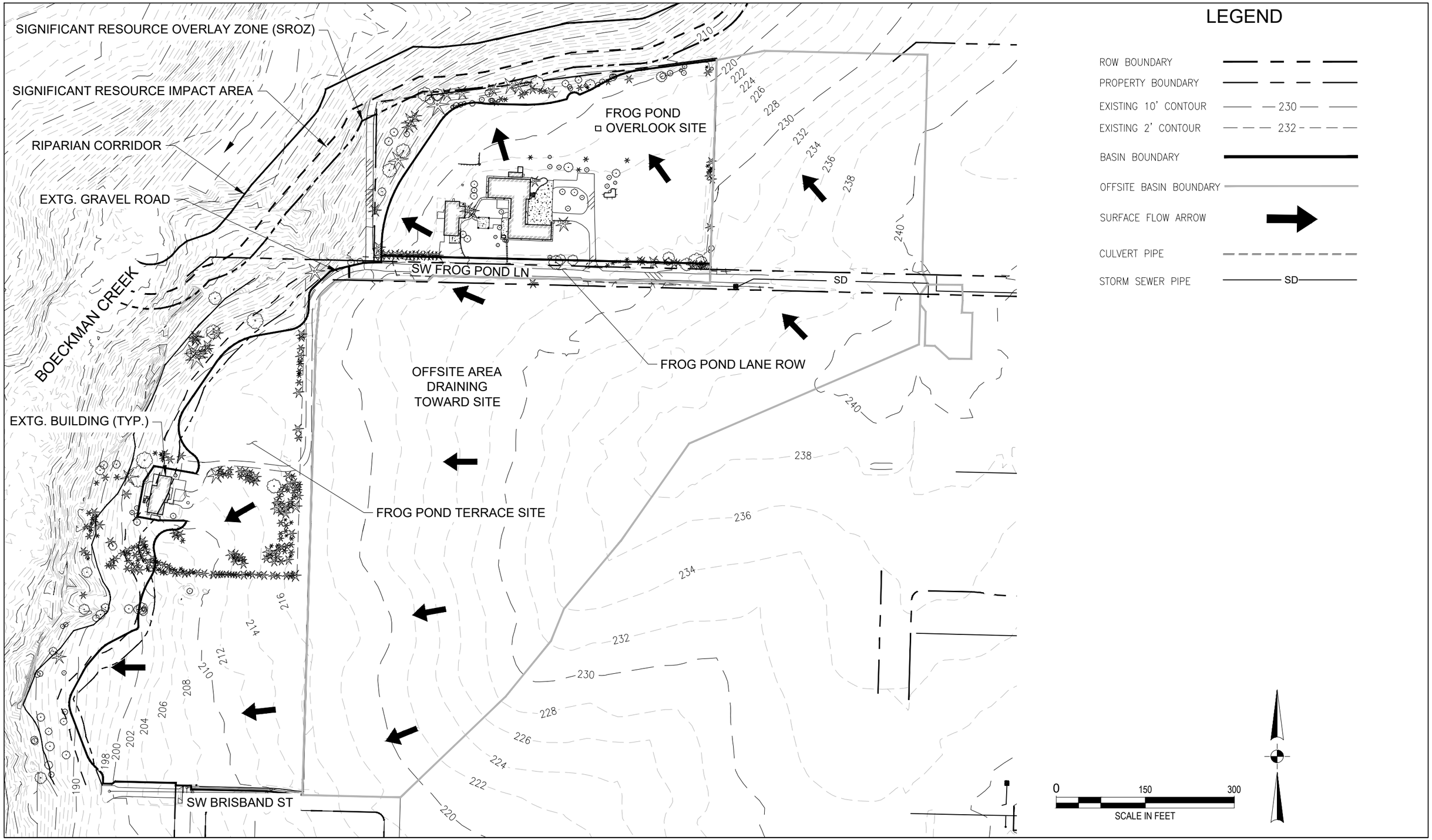
SCS, 1986. *Technical Release 55: Urban Hydrology for Small Watersheds*, United States Department of Agriculture Soil Conservation Service, June 1986.

USACE, 2014. Standard Local Operating Procedures for Endangered Species (*SLOPES V) to Administer Maintenance or Improvement of Stormwater, Transportation or Utility Actions*, United States Army Corps of Engineers, March 14, 2014.

Wilsonville, 1992. *Boeckman Creek Detention. Job No. 92-06-001,* City of Wilsonville, June 1992.

Wilsonville, 2015. *City of Wilsonville Public Works Standards. Section 3, Stormwater & Surface Water Design and Construction Standards 2015*; Revised December 2015.

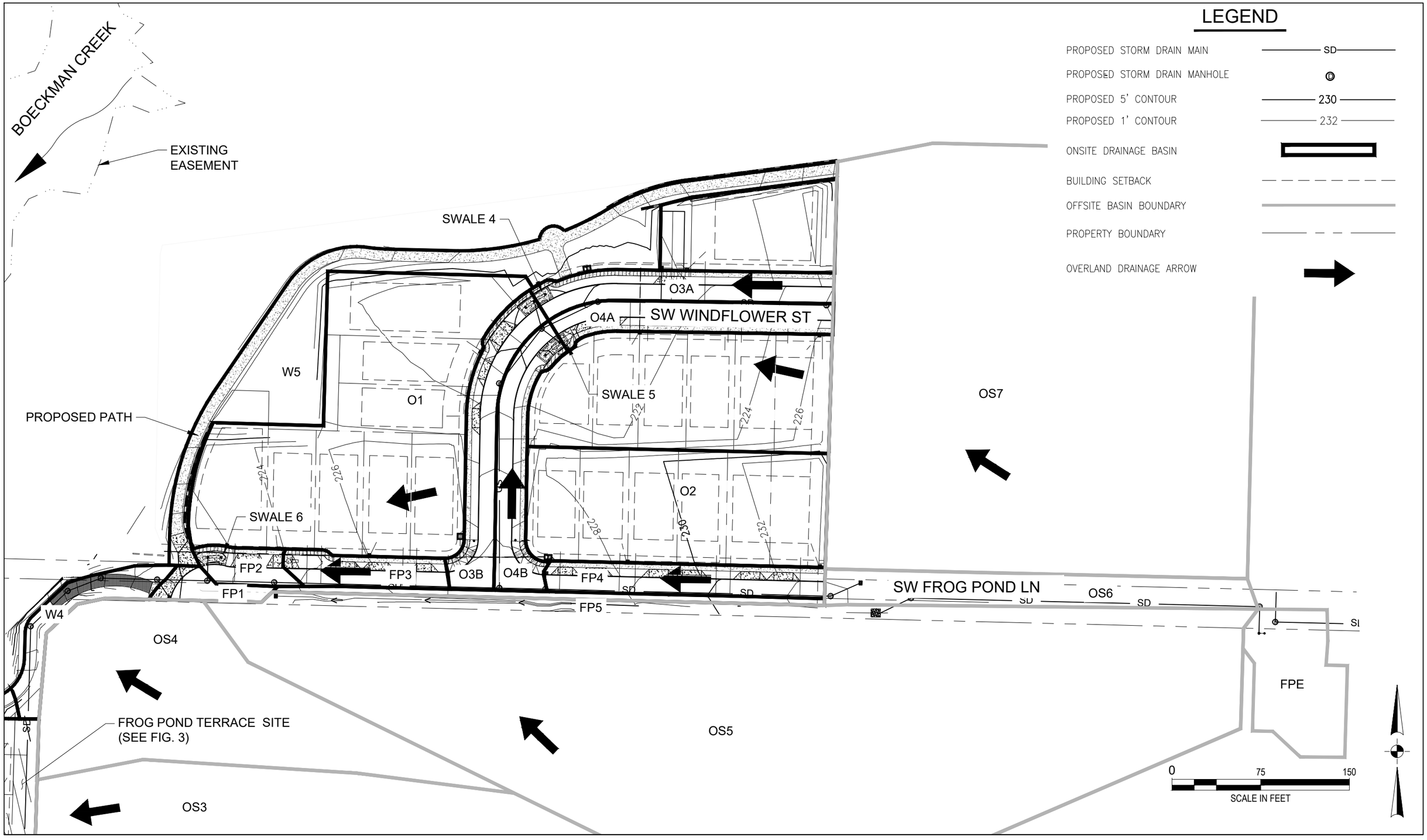
Figures



FROG POND TERRACE & OVERLOOK | PRELIMINARY DESIGN | EXISTING CONDITIONS

FIG 1 | AUGUST 2022 | PROJECT NUMBER: 20015

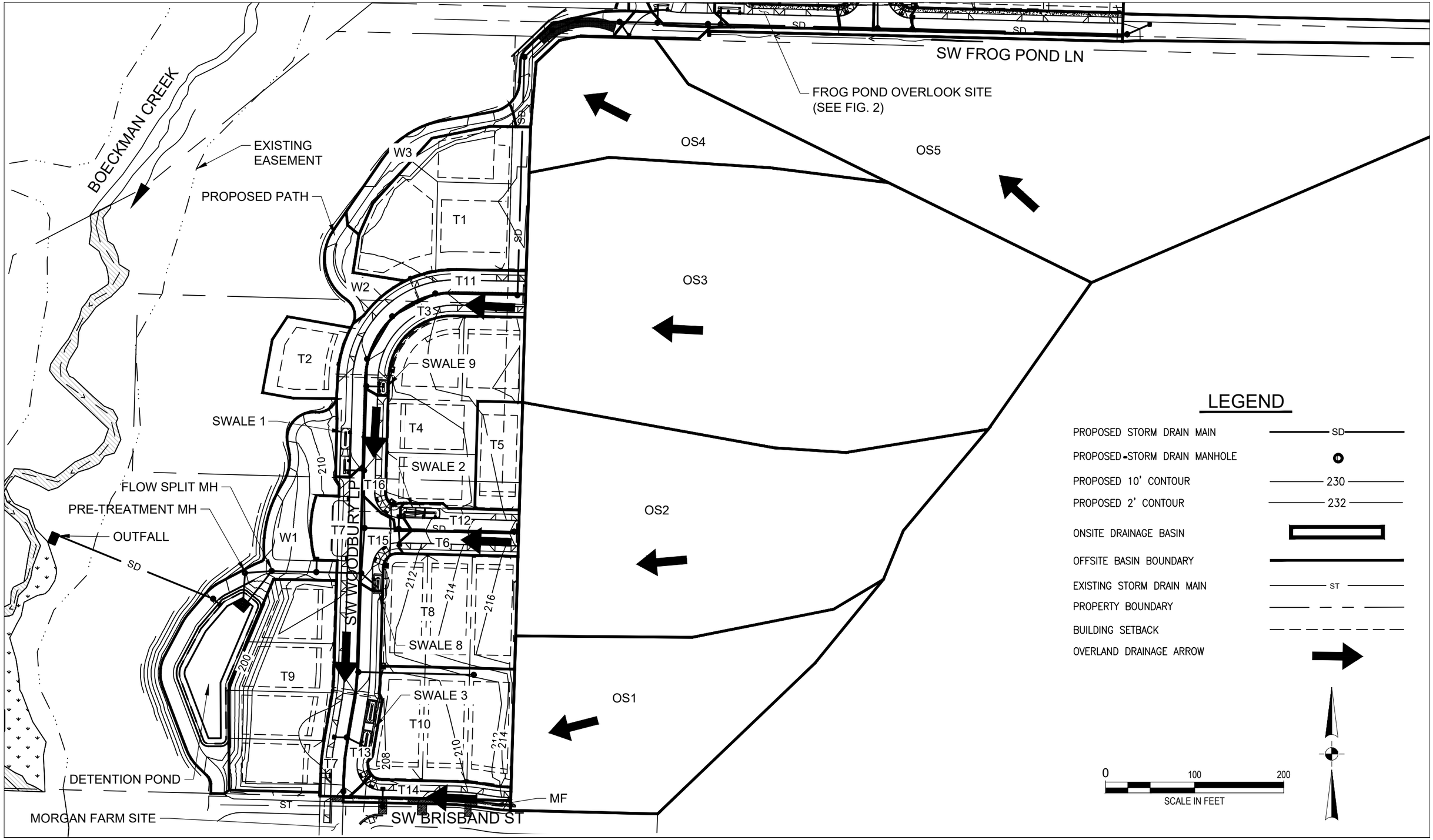
Otak



FROG POND OVERLOOK | PRELIMINARY DESIGN | PROPOSED CONDITIONS

FIG 2 | MARCH 2023 | PROJECT NUMBER: 20015/21249

Otak



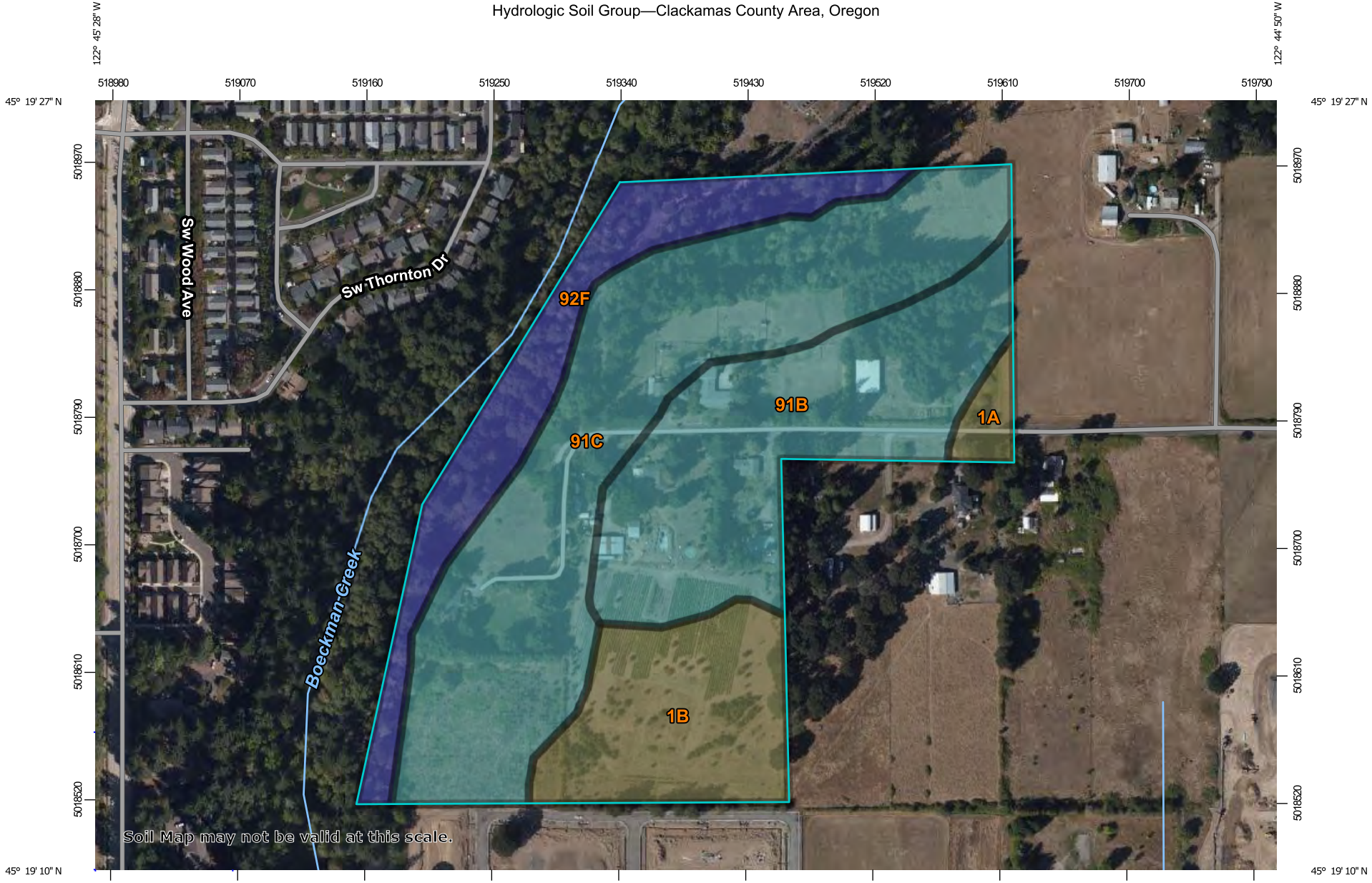
FROG POND TERRACE | PRELIMINARY DESIGN | PROPOSED CONDITIONS

FIG 3 | JANUARY 2023 | PROJECT NUMBER: 20015

Otak

Appendix A

Hydrology



Map Scale: 1:3,830 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 1:20,000.

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: Clackamas County Area, Oregon
Survey Area Data: Version 16, 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: Aug 1, 2019—Sep 12, 2019

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Aloha silt loam, 0 to 3 percent slopes	C/D	0.6	1.9%
1B	Aloha silt loam, 3 to 6 percent slopes	C/D	5.1	15.1%
91B	Woodburn silt loam, 3 to 8 percent slopes	C	8.9	26.7%
91C	Woodburn silt loam, 8 to 15 percent slopes	C	13.9	41.3%
92F	Xerochrepts and Haploxerolls, very steep	B	5.0	15.0%
Totals for Area of Interest			**33.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

MAP SCALE 1" = 500'

250 0 500 1000 FEET

MET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0234D

FIRM

FLOOD INSURANCE RATE MAP

CLACKAMAS COUNTY, OREGON

AND INCORPORATED AREAS

PANEL 234 OF 1175

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLACKAMAS COUNTY	415588	0234	D
WILSONVILLE, CITY OF	410025	0234	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41005C0234D

EFFECTIVE DATE
JUNE 17, 2008

Federal Emergency Management Agency

Drainage Basin Areas

20015 Frog Pond Terrace/Frog Pond Overlook

Existing Conditions:

	Impervious Area		Pervious Area		Total Area	
Basin Name	Total (sf)	Total (ac)	Total (sf)	Total (ac)	(sf)	(ac)
Site Total	**28588**	**0.66**	**357,220**	**8.20**	**385,808**	**8.86**
Terrace	3,451	0.08	214,018	4.91	217,469	4.99
Overlook	16,780	0.39	131,665	3.02	148,445	3.41
ROW	8,357	0.19	11,537	0.26	19,894	0.46
Offsite					**641,947**	**14.74**

Proposed Impervious Area per Lot 2,750 SF (2015 Public Works Stds 301.4.01)
Proposed Middle Housing Impervious Area per lot 2,420 SF (Overlook only)

Proposed Conditions: 40.0 lots HSG Type C

		Impervious Area				Pervious Area		Total Area	
Basin	Treated By	Roadway (sf)	Roof (sf)	Total (sf)	Total (ac)	(sf)	(ac)	(sf)	(ac)
Site Total		**113,750**	**104,060**	**217,810**	**5.00**	**167,991**	**3.86**	**385,801**	**8.86**
T1	Pond	2,281	8,250	10,531	0.24	15,541	0.36	26,072	0.60
T2	Pond	0	2,750	2,750	0.06	4,073	0.09	6,823	0.16
T3	Swale 9	5,035	0	5,035	0.12	851	0.02	5,886	0.14
T4	Pond	0	11,000	11,000	0.25	14,166	0.33	25,166	0.58
T5	Pond	0	2,750	2,750	0.06	3,313	0.08	6,063	0.14
T6	Pond	3,018	0	3,018	0.07	358	0.01	3,376	0.08
T7	Pond	11,203	0	11,203	0.26	358	0.01	11,561	0.27
T8	Pond	0	8,250	8,250	0.19	10,705	0.25	18,955	0.44
T9	Pond	0	11,000	11,000	0.25	13,021	0.30	24,021	0.55
T10**	Pond	0	8,250	8,250	0.19	11,390	0.26	19,640	0.45
T11	Swale 1	9,707	0	9,707	0.22	548	0.01	10,255	0.24
T12	Swale 2	2,693	0	2,693	0.06	889	0.02	3,582	0.08
T13	Swale 3	4,670	0	4,670	0.11	1,602	0.04	6,272	0.14
T14	MF Swale	2,924	0	2,924	0.07	386	0.01	3,310	0.08
T15	Swale 8	3,005	0	3,005	0.07	171	0.00	3,176	0.07
T16	Pond	3,439	0	3,439	0.08	348	0.01	3,787	0.09
O1	Pond	0	20,020	20,020	0.46	22,224	0.51	42,244	0.97
O2a	Pond	0	14,520	14,520	0.33	9,916	0.23	24,436	0.56
O2b	Pond	0	14,520	14,520	0.33	9,657	0.22	24,177	0.56
O3a	Swale 4	5,079	0	5,079	0.12	1,551	0.04	6,630	0.15
O3b	Swale 4	6,395	0	6,395	0.15	919	0.02	7,314	0.17
O4a	Swale 5	6,239	0	6,239	0.14	0	0.00	6,239	0.14
O4b	Swale 5	5,385	0	5,385	0.12	1,180	0.03	6,565	0.15
O5	Pond	1,101	2,750	3,851	0.09	6,347	0.15	10,198	0.23
MF	MF Swale	1,101	0	1,101	0.03	189	0.00	1,290	0.03
FP1	Pond	1,851	0	1,851	0.04	0	0.00	1,851	0.04
FP2	Swale 6	2,168	0	2,168	0.05	183	0.00	2,351	0.05
FP3	Swale 6	3,657	0	3,657	0.08	0	0.00	3,657	0.08
FP4	Pond	6,143	0	6,143	0.14	0	0.00	6,143	0.14
FP5	Pond	2,743	0	2,743	0.06	0	0.00	2,743	0.06
W1	Veg Corridor	9,862	0	9,862	0.23	16,617	0.38	26,479	0.61
W2	Veg Corridor	1,305	0	1,305	0.03	2,667	0.06	3,972	0.09
W3	Veg Corridor	2,398	0	2,398	0.06	2,472	0.06	4,870	0.11
W4	Veg Corridor	1,885	0	1,885	0.04	2,246	0.05	4,131	0.09
W5	Veg Corridor	8,463	0	8,463	0.19	14,103	0.32	22,566	0.52
Pond Total				**135,839**	**3.12**	**121,992**	**2.80**	**261,856**	**6.01**
Offsite Total				**349,770**	**8.03**	**292,177**	**6.71**	**641,947**	**14.74**
OS1	Offsite*			30,737	0.71	25,149	0.58	55,886	1.28
OS2	Offsite*			52,874	1.21	43,260	0.99	96,134	2.21
OS3	Offsite*			89,730	2.06	73,415	1.69	163,145	3.75
OS4	Offsite*			17,929	0.41	14,670	0.34	32,599	0.75
OS5	Offsite*			81,524	1.87	66,702	1.53	148,226	3.40
OS6	Offsite*			4,990	0.11	4,083	0.09	9,073	0.21
OS7	Offsite*			70,449	1.62	57,640	1.32	128,089	2.94
FPE	FPE RG/Swale			1,536	0.04	7,259	0.17	8,795	0.20

* For conveyance sizing offsite areas are assumed to be developed to 55% imperviousness

**Basin T10 pervious area drains to SDMH 2C and roofs drain to SDMH 6A

Appendix B

Geotechnical Report

HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Engineering Solutions

December 15, 2021
HGSI Project No. 21-2824

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West Hills Land Development
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Via e-mail (pdf format); hard copies mailed upon request

Subject: **GEOTECHNICAL ENGINEERING AND INFILTRATION TESTING REPORT**
FROG POND WEST-WEST
MARTIN, GEORGE AND ROSS PROPERTIES
WILSONVILLE, OREGON

This report presents the results of a geotechnical engineering study conducted by Hardman Geotechnical Services Inc. (HGSI) for Frog Pond West-West (Martin, George and Ross Properties) in Wilsonville, Oregon (Figure 1). The purpose of this study was to evaluate subsurface conditions at the site and to provide geotechnical recommendations for site development.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The project totals about 15.07 acres, as summarized below. Please note that the parcel addresses and acreages were taken from the Clackamas County GIS website and are only as accurate as the information provided.

Property	Tax Lot No.	Address	Acreage	House Constructed Date
Ross	31W12D 00700	7315 SW Frog Pond Ln	4.09	1964
George	31W12D 02801	7500 SW Frog Pond Ln	2.00	1972
Martin	31W12D 02800	No address	8.98	--

The Ross and George properties are currently occupied by residential homes, with several detached shops, garages and barns. Existing facilities are present only within the eastern, more flat-lying portion of the overall site. The areas surrounding the homes and other structures are landscaped with lawn, shrubbery and ornamental or fruit-bearing trees. No structures are present on the Martin property, which is overgrown with blackberries, etc. Along the western edge of the site is an area of steep slopes descending down to Boeckman Creek. The steep slope is vegetated with large deciduous and evergreen trees, and undergrowth.

Preliminary plans indicate the site will be developed into a 31-lot residential subdivision that will include two separate tracts with the intention of having one or both serve as water quality/detention facilities. The actual number of lots may vary as project design progresses. Site development will also include construction of on-site streets and underground utilities. All of the proposed development is within the eastern, flat to gently sloping portion of the site. The steep slopes in the western portion of the site are to remain open space.

In the northwest portion of the site, a temporary access easement extends near the top of the steep slope area. HGSI has studied potential landslide hazards and slope stability specific to this area, in a previous report (HGSI, 2021). The report concludes that the planned utility lines and temporary access way can be safely constructed, with a low-height soldier pile wall along the downslope (northwest) portion of the easement to protect against surficial soil sloughing/erosion.

REGIONAL GEOLOGY AND SEISMIC SETTING

The subject site lies within the heart of the Portland Basin, a broad structural depression situated between the Coast Range on the west and the Cascade Range on the east. The Portland Basin is a northwest-southwest trending structural basin produced by broad regional downwarping of the area. The Portland Basin is approximately 20 miles wide and 45 miles long and is filled with consolidated and unconsolidated sedimentary rocks of late Miocene, Pliocene and Pleistocene age.

Geologic maps indicate the subject site is underlain by Quaternary age (last 1.6 million years) Willamette Silt, fine flood deposits that mantles basalt bedrock (Madin, 1990). This generally consists of massive fine sand and silt deposited following repeated catastrophic flooding events in the Willamette Valley, the last of which occurred between 15,000 and 10,000 years ago. In localized areas, the light brown sandy silts include buried paleosols that developed between depositional events. Regionally, the total thickness of catastrophic flood deposits range from 5 feet to greater than 100 feet.

The Willamette Formation is underlain by residual soil formed by in place weathering of the underlying Columbia River Basalt Formation (Madin, 1990). The Miocene aged (about 14.5 to 16.5 million years ago) Columbia River Basalts are a thick sequence of lava flows which form the crystalline basement of the Tualatin Valley. The basalts are composed of dense, finely crystalline rock that is commonly fractured along blocky and columnar vertical joints. Individual basalt flow units typically range from 25 to 125 feet thick and interflow zones are typically vesicular, scoriaceous, brecciated, and sometimes include sedimentary rocks.

At least three major fault zones capable of generating damaging earthquakes are known to exist in the region. These include the Portland Hills Fault Zone, Gales Creek-Newberg-Mt. Angel Structural Zone, and the Cascadia Subduction Zone. These potential earthquake source zones are included in the determination of seismic design values for structures, as presented in the *Seismic Design* section. None of the known faults extend beneath the site.

FIELD EXPLORATION

Test Pits and Exploratory Hand Auger Borings

The site-specific exploration for this study was conducted on October 22, 2021 and December 3 and 9, 2021. On October 22, 2021 HGSI oversaw the excavation of two test pits using a medium-sized excavator in the area of the temporary easement (Figure 2). Test pits TP-3 through TP-11 were excavated on December 3, 2021, using a rubber-tired backhoe with extend-a-hoe attachment. Six hand auger borings (HA-1 through HA-6) were drilled on December 3 and 9, 2021 by HGSI staff using hand auger tools. Explorations were conducted at the approximate locations shown on the attached Site Plan, Figure 2.

Explorations were conducted under the full-time observation of HGSI personnel. Soil samples obtained from the borings were classified in the field and representative portions were placed in relatively air-tight plastic bags. These soil samples were then returned to the laboratory for further examination. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. Soils were classified in general accordance with the Unified Soil Classification System.

Summary exploration logs are attached to this report. The stratigraphic contacts shown on the individual exploration logs represent the approximate boundaries between soil types. The actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

Infiltration Testing

On December 3, 2021, HGSI performed falling head infiltration tests using the open-hole method in hand auger borings HA-1, HA-2 and HA-3. The infiltration testing was performed by measuring the water level at one-minute intervals using HOBO™ data loggers, which measures water pressure corrected for temperature and barometric pressure. See attached HOBO™ water level data logger plot. The infiltration rate was determined based on the slope of the water depth line near the end of the test. Table 1 presents the results of the falling head infiltration tests.

Table 1. Summary of Infiltration Test Results

Boring	Depth (feet)	Soil Type	Infiltration Rate (in/hr)	Hydraulic Head Range during Testing (inches)
HA-1	5	Silt with Clay (ML)	0.6	7.8 – 6.6
HA-2	6	Fine Sandy Silt (ML)	1.1	15 - 14
HA-3	6	Fine Sandy Silt (ML)	1.2	14 – 13

The average of the three infiltration tests is 1.0 inches/hour. Reported values are ultimate and should be adjusted using an appropriate factor of safety for design purposes.

SUBSURFACE CONDITIONS

The following discussion is a summary of subsurface conditions encountered in our explorations. For more detailed information regarding subsurface conditions at specific exploration locations, refer to the attached hand auger logs. Also, please note that subsurface conditions can vary between exploration locations, as discussed in the *Uncertainty and Limitations* section below.

Soil

On-site soils are anticipated to consist of undocumented fill, topsoil, colluvium, and Willamette Formation soils as described below.

> ***Undocumented Fill*** – In the northeast portion of the Ross Property, we encountered an area of undocumented fill. Test Pits TP-8, TP-9 and TP-10; and hand auger boring HA-3 encountered undocumented fill extending to 4.5 to 5 feet bgs. Between the fill and native soils a zone of old

topsoil was encountered in all three of the test pits. Undocumented fill consisted generally of soft silt with trace organics, and trace amounts of crushed rock and other erratic material.

Topsoil – Beginning at the surface level, all explorations encountered a zone of topsoil about 6 to 12 inches thick. The topsoil was generally comprised of soft, wet to moist dark brown organic silt. The upper roughly 6 inches of the topsoil appeared highly organic.

Colluvium – In TP-1 we encountered a zone of colluvium, comprised of stiff clayey silt with black and orange mottling. This material had a weathered, slightly disturbed appearance and extended to a depth of about 2.5 feet bgs. Colluvium, a zone of down-slope creep occurring due to weathering of surficial soils on natural slopes, was not encountered in the other test pits and hand auger borings.

Willamette Silt – Beneath the undocumented fill, topsoil and/or colluvium, all explorations encountered stiff to very stiff, moist to very moist, brown silt, clayey silt and silt with fine sand interpreted as Willamette Formation. The upper several feet of this unit exhibited orange and gray mottling. All explorations were terminated in the Willamette Silt unit, at depths ranging from 5 to 13 feet bgs.

Groundwater

Seepage was encountered in two of the deeper test pits, TP-4 and TP-7, at depths of about 13 and 10 feet respectively. During the field exploration, no seepage or static groundwater table was encountered in the other explorations. Based on nearby water well data, depth to static groundwater is at least 20 feet below the ground surface. Perched groundwater conditions often occur over fine-grained native deposits such as those beneath the site, particularly during the wet season. It is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in site utilization, and other factors. The perched groundwater conditions reported above are for the specific date and locations indicated, and therefore may not necessarily be indicative of other times and/or locations.

CONCLUSIONS AND RECOMMENDATIONS

Results of this study indicate that the proposed development is geotechnically feasible, provided that the recommendations of this report are incorporated into the design and construction phases of the project. The proposed development avoids the steep slope area to the west; slope stability impacts are considered minimal as discussed in the *Slope Stability and Landslide Hazards* section. Recommendations are presented below regarding site preparation and undocumented fill removal, engineered fill, fill slope keying and benching, wet weather earthwork, spread footing foundations, below grade structural retaining walls, concrete slabs-on-grade, perimeter footing drains, seismic design, excavating conditions and utility trench backfill, stormwater infiltration systems, and erosion control considerations.

Slope Stability and Landslide Hazards

For the purpose of evaluating slope stability, we reviewed published geologic and hazard mapping, reviewed regional site topography and LIDAR images, performed a field reconnaissance, and evaluated subsurface soil conditions in exploratory test pits and hand auger borings.

Reconnaissance observations indicate that slope geomorphology at the site is generally smooth and uniform, consistent with stable slope conditions. No geomorphic evidence of prior slope instability (such as hummocky topography, benches or old scarps) was observed. No seeps or springs were observed on site.

Regional geologic mapping and the Oregon Department of Geology and Mineral Industries online landslide database (SLIDO, 2017) shows a small mapped landslide in the western portion of the Martin/George

property (Figure 3). This feature is mapped with low (<10%) confidence level, and historical (<150 years) in age. In our opinion this mapped ancient slide is not indicative of a significant slope stability hazard to the site, and is located far enough away from the proposed development that slope stability impacts are not anticipated.

In the northwest portion of the site between the Ross and Martin Properties (Figures 2 and 3), a temporary access easement extends near the top of the steep slope area. HGSI has studied potential landslide hazards and slope stability specific to this area, in a previous report (HGSI, 2021). The report concludes that the planned utility lines and temporary access way can be safely constructed, with a low-height soldier pile wall along the downslope (northwest) portion of the easement to protect against surficial soil sloughing/erosion.

The planned development does not extend onto the steep slope areas in the western portion of the site. Based on our observations and results of the slope stability evaluation, it is our opinion that no special design or construction provisions are needed to address slope issues on the site, with the exception of the soldier pile wall planned in conjunction with the temporary access easement (HGSI, 2021). The project will be designed and constructed per current building codes, City of Wilsonville requirements, and the current standard-of-practice in geotechnical engineering. As such, it is our opinion that adequate slope stability factors of safety will be maintained for both temporary construction, and long-term conditions.

We understand that the proposed storm water management plan may consist of flow through planters, stormwater ponds or swales, with overflow to an approved outlet. Significant infiltration of stormwater via stormwater chambers or dry wells is not proposed for this site based on soil conditions and infiltration test results. The planned storm water facilities are not anticipated to impact slope stability on site, or to create any unstable conditions. Storm water management systems should be designed such that potential overflow is discharged in a controlled manner away from structures and slopes, and all systems should include an adequate factor of safety.

Site Preparation and Undocumented Fill Removal

The areas of the site to be graded should first be cleared of vegetation and any loose debris; and debris from clearing should be removed from the site. Organic-rich topsoil should then be removed to competent native soils. We anticipate that the average depth of topsoil stripping will be 6 to 12 inches over most of the site. Deeper stripping / root picking may be needed in areas that are or were formerly treed. The final depth of stripping removal may vary depending on local subsurface conditions and the contractor's methods, and should be determined on the basis of site observations after the initial stripping has been performed. Stripped organic soil should be stockpiled only in designated areas or removed from the site and stripping operations should be observed and documented by HGSI. Existing subsurface structures (tile drains, old utility lines, septic leach fields, etc.) beneath areas of proposed structures and pavement should be removed and the excavations backfilled with engineered fill.

Undocumented fill was encountered in the northeast portion of the Ross Property, in TP-8, TP-9 and TP-10; and HA-3, at depths of about 4.5 to 5 feet bgs. There is potential for old fills to be present on site in areas beyond our explorations. Where encountered beneath proposed structures, pavements, or other settlement-sensitive improvements, undocumented fill should be removed down to firm inorganic native soils and the removal area backfilled with engineered fill (see below). HGSI should observe removal excavations (if any) prior to fill placement to verify that overexcavations are adequate and an appropriate bearing stratum is exposed.

In construction areas, once stripping has been verified, the area should be ripped or tilled to a depth of 12 inches, moisture conditioned, and compacted in-place prior to the placement of engineered fill. Exposed subgrade soils should be evaluated by HGSI. For large areas, this evaluation is normally performed by

proof-rolling the exposed subgrade with a fully loaded scraper or dump truck. For smaller areas where access is restricted, the subgrade should be evaluated by probing the soil with a steel probe. Soft/loose soils identified during subgrade preparation should be compacted to a firm and unyielding condition or over-excavated and replaced with engineered fill, as described below. The depth of overexcavation, if required, should be evaluated by HGSI at the time of construction.

Engineered Fill

In general, we anticipate that on-site soils will be suitable for use as engineered fill in dry weather conditions, provided they are relatively free of organics and are properly moisture conditioned for compaction. Imported fill material must be approved by the geotechnical engineer prior to being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Engineered fill should be compacted in horizontal lifts not exceeding 8 inches using standard compaction equipment. We recommend that engineered fill be compacted to at least 90 percent of the maximum dry density determined by ASTM D1557 (Modified Proctor) or equivalent. On-site soils may be wet or dry of optimum; therefore, we anticipate that moisture conditioning of native soil will be necessary for compaction operations.

Proper test frequency and earthwork documentation usually requires daily observation and testing during stripping, rough grading, and placement of engineered fill. Field density testing should conform to ASTM D2922 and D3017, or D1556. Engineered fill should be periodically observed and tested by the project geotechnical engineer or his representative. Typically, one density test is performed for at least every 2 vertical feet of fill placed or every 500 yd^3, whichever requires more testing.

Fill Slope Keying and Benching

Engineered fill placed on slopes requires keying and benching. We recommend that cut and fill slopes for the project be planned no steeper than 2H:1V. Fill slopes constructed over sloping ground should be constructed in accordance with the Fill Slope Detail, Figure 4. For fill slopes constructed at 2H:1V or flatter, and comprised of engineered fill placed and compacted as recommended herein, we anticipate that adequate factors of safety against global failure will be maintained.

Prior to placing compacted fill against the existing natural slopes, all loose undocumented fill, topsoil, and soft soils must first be removed. Adequate benching must be maintained. Fill slope keyways should be constructed with a minimum depth of 2 feet and minimum width of H/3 (10 feet minimum), where H equals the vertical height between the base and top of the fill slope. Both benches and keyways should be roughly horizontal in the down slope direction. A subdrain should be incorporated in the fill slope keyway, and HGSI should observe the keyway excavations prior to the placement of fill.

Measures should be taken to prevent surficial instability and/or erosion of embankment material. This can be accomplished by conscientious compaction of the embankment fills all the way out to the slope face, by maintaining adequate drainage, and planting the slope face as soon as possible after construction. To achieve the specified relative compaction at the slope face, it may be necessary to overbuild the slopes several feet, and then trim back to design finish grade. In our experience, compaction of slope faces by "track-walking" is generally ineffective and is therefore not recommended.

Wet Weather Earthwork

The on-site soils are moisture sensitive and may be difficult to handle or traverse with construction equipment during periods of wet weather. Earthwork is typically most economical when performed under dry weather conditions. Earthwork performed during the wet-weather season will probably require

expensive measures such as cement treatment or imported granular material to compact fill to the recommended engineering specifications. If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean engineered fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Material used as engineered fill should consist of clean, granular soil containing less than about 7 percent fines. The fines should be non-plastic. Alternatively, cement treatment of on-site soils may be performed to facilitate wet weather placement;
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials;
- Excavation and placement of fill should be observed by the geotechnical engineer to verify that all unsuitable materials are removed and suitable compaction and site drainage is achieved; and
- Bales of straw and/or geotextile silt fences should be strategically located to control erosion.

If cement or lime treatment is used to facilitate wet weather construction, HGSI should be contacted to provide additional recommendations and field monitoring

Spread Footing Foundations

Shallow, conventional isolated or continuous spread footings may be used to support the proposed structures, provided they are founded on competent native soils, or compacted engineered fill placed directly upon the competent native soils. We recommend a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for designing spread footings bearing on undisturbed native soils or engineered fill. The recommended maximum allowable bearing pressure may be increased by a factor of 1.33 for short term transient conditions such as wind and seismic loading. Exterior footings should be founded at least 18 inches below the lowest adjacent finished grade. Minimum footing widths should be determined by the project engineer/architect in accordance with applicable design codes.

Assuming construction is accomplished as recommended herein, and for the foundation loads anticipated, we estimate total settlement of spread foundations of less than about 1 inch and differential settlement between two adjacent load-bearing components supported on competent soil of less than about ½ inch. We anticipate that the majority of the estimated settlement will occur during construction, as loads are applied.

Wind, earthquakes, and unbalanced earth loads will subject the proposed structure to lateral forces. Lateral forces on a structure will be resisted by a combination of sliding resistance of its base or footing on the underlying soil and passive earth pressure against the buried portions of the structure. For use in design, a coefficient of friction of 0.5 may be assumed along the interface between the base of the footing and subgrade soils. Passive earth pressure for buried portions of structures may be calculated using an equivalent fluid weight of 390 pounds per cubic foot (pcf), assuming footings are cast against dense, natural soils or engineered fill. The recommended coefficient of friction and passive earth pressure values do not include a

safety factor. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

Footing excavations should be trimmed neat and the bottom of the excavation should be carefully prepared. Loose, wet or otherwise softened soil should be removed from the footing excavation prior to placing reinforcing steel bars. HGSI should observe foundation excavations prior to placing crushed rock, to verify that adequate bearing soils have been reached. Due to the high moisture sensitivity of on-site soils, construction during wet weather may require overexcavation of footings and backfill with compacted, crushed aggregate.

Below-Grade Cantilever Concrete Retaining Walls

Recommendations are provided below for design of concrete retaining walls. Footings for below-grade cantilever concrete walls should be designed using the 2,000 psf allowable soil bearing pressure recommended in the *Spread Footing Foundations* section. Lateral earth pressures against below-grade retaining walls will depend upon the inclination of any adjacent slopes, type of backfill, degree of wall restraint, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any adjacent surcharge loads. At-rest soil pressure is exerted on a retaining wall when it is restrained against rotation. In contrast, active soil pressure will be exerted on a wall if its top is allowed to rotate or yield a distance of roughly 0.001 times its height or greater.

Table 2 below provides recommended lateral earth pressure values for unrestrained and restrained walls, for both level backfill conditions and 2H:1V (Horizontal:Vertical) sloping ground conditions at the top of the wall. These values assume that the recommended drainage provisions are incorporated, and hydrostatic pressures are not allowed to develop against the wall.

Table 2. Recommended Lateral Earth Pressures for Below-Grade Structural Walls

Earth Pressure Condition	Level at Top of Wall	2H:1V Slope at Top of Wall
Active (unrestrained wall)	35	54
At-rest (restrained wall)	55	74

During a seismic event, lateral earth pressures acting on below-grade structural walls will increase by an incremental amount that corresponds to the earthquake loading. Based on the Mononobe-Okabe equation and peak horizontal accelerations appropriate for the site location, seismic loading should be modeled using the active or at-rest earth pressures recommended above, plus an incremental rectangular-shaped seismic load of magnitude 5H, where H is the total height of the wall.

We assume relatively level ground surface below the base of the walls. As such, we recommend passive earth pressure of 390 pcf for use in design, assuming wall footings are cast against competent native soils or engineered fill. If the ground surface slopes down and away from the base of any of the walls, a lower passive earth pressure should be used and HGSI should be contacted for additional recommendations.

A coefficient of friction of 0.5 may be assumed along the interface between the base of the wall footing and subgrade soils. The recommended coefficient of friction and passive earth pressure values do not include a safety factor, and an appropriate safety factor should be included in design. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

The above recommendations for lateral earth pressures assume that the backfill behind the subsurface walls will consist of properly compacted structural fill, and no adjacent surcharge loading. If the walls will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the wall, the walls should be designed for the additional horizontal pressure. For uniform surcharge pressures, a uniformly distributed lateral pressure of 0.3 times the surcharge pressure should be added.

The recommended equivalent fluid densities assume a free-draining condition behind the walls so that hydrostatic pressures do not build up. This can be accomplished by placing a 12-inch wide zone of crushed drain rock containing less than 5 percent fines against the walls. A 3-inch minimum diameter perforated, plastic drain pipe should be installed at the base of the walls and connected to a sump to remove water from the crushed drain rock zone. The drain pipe should be wrapped in filter fabric (Mirafi 140N or other as approved by the geotechnical engineer) to minimize clogging. The above drainage measures are intended to remove water from behind the wall to prevent hydrostatic pressures from building up. Additional drainage measures may be specified by the project architect or structural engineer, for damp-proofing or other reasons.

HGSI should be contacted during construction to verify subgrade strength in wall keyway excavations, to verify that backslope soils are in accordance with our assumptions, and to take density tests on the wall backfill materials.

Concrete Slabs-on-Grade

Preparation of areas beneath concrete slab-on-grade floors should be performed as recommended in the *Site Preparation* section. Care should be taken during excavation for foundations and floor slabs, to avoid disturbing subgrade soils. If subgrade soils have been adversely impacted by wet weather or otherwise disturbed, the surficial soils should be scarified to a minimum depth of 8 inches, moisture conditioned to within about 3 percent of optimum moisture content, and compacted to engineered fill specifications. Alternatively, disturbed soils may be removed and the removal zone backfilled with additional crushed rock. For evaluation of the concrete slab-on-grade floors using the beam on elastic foundation method, a modulus of subgrade reaction of 200 kcf (115 pci) should be assumed for the soils anticipated at subgrade depth. This value assumes the concrete slab system is designed and constructed as recommended herein, with a minimum thickness of crushed rock of 8 inches beneath the slab.

Interior slab-on-grade floors should be provided with an adequate moisture break. The capillary break material should consist of ODOT open graded aggregate per ODOT Standard Specifications 02630-2. The minimum recommended thickness of capillary break materials on re-compacted soil subgrade is 8 inches. The total thickness of crushed aggregate will be dependent on the subgrade conditions at the time of construction, and should be verified visually by proof-rolling. Under-slab aggregate should be compacted to at least 90% of its maximum dry density as determined by ASTM D1557 or equivalent.

In areas where moisture will be detrimental to floor coverings or equipment inside the proposed structure, appropriate vapor barrier and damp-proofing measures should be implemented. A commonly applied vapor barrier system consists of a 10-mil polyethylene vapor barrier placed directly over the capillary break material. Other damp/vapor barrier systems may also be feasible. Appropriate design professionals should be consulted regarding vapor barrier and damp proofing systems, ventilation, building material selection, radon and mold prevention issues, which are outside HGSI's area of expertise.

Perimeter Footing Drains

Due to the potential for perched surface water above fine grained deposits such as those encountered at the site, we recommend the outside edge of perimeter footings be provided with a drainage system consisting of 3-inch minimum diameter perforated PVC pipe embedded in a minimum of 1 ft^3 per lineal foot of clean, free-draining sand and gravel or 1"- ¼" drain rock. The drain pipe and surrounding drain rock should be

wrapped in non-woven geotextile (Mirafi 140N, or approved equivalent) to minimize the potential for clogging and/or ground loss due to piping. Water collected from the footing drains should be directed into the local storm drain system or other suitable outlet. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. The footing drains should include clean-outs to allow periodic maintenance and inspection.

Down spouts and roof drains should collect roof water in a system separate from the footing drains in order to reduce the potential for clogging. Roof drain water should be directed to an appropriate discharge point well away from structural foundations. Grades should be sloped downward and away from buildings to reduce the potential for ponded water near structures.

Seismic Design

Structures should be designed to resist earthquake loading in accordance with the methodology described in the current Oregon Residential Specialty Code (ORSC). We recommend Site Class D (Stiff Soils) be used for design per the ORSC. Design values determined for the site using the ASCE 7-16 Hazard Tool are summarized on Table 3, for Risk Category II.

Table 3. Recommended Earthquake Ground Motion Parameters (ASCE 7-16)

Parameter	Value
Location (Lat, Long), degrees	45.3211, -122.7494
Mapped Spectral Acceleration Values (MCE, Site Class B):	
Short Period, S_s	0.82 g
1.0 Sec Period, S_1	0.381 g
Design Values for **Site Class D** (Stiff Soils):	
Peak Ground Acceleration PGA_M	0.458
F_a	1.172
$SD_s = 2/3 \times F_a \times S_s$	0.641 g
Seismic Design Category (2021 ORSC)	D_0

Soil liquefaction is a phenomenon wherein saturated soil deposits temporarily lose strength and behave as a liquid in response to earthquake shaking. Soil liquefaction is generally limited to loose, granular soils located below the water table. Following development, on-site soils will consist predominantly of stiff to very stiff silt which are not considered susceptible to liquefaction. Therefore, it is our opinion that special design or construction measures are not required to mitigate the effects of liquefaction.

Excavating Conditions and Utility Trench Backfill

We anticipate that on-site soils can be excavated using conventional heavy equipment such as scrapers and trackhoes to depths of 13 feet and likely greater. Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Actual slope inclinations at the time of construction should be determined based on safety requirements and actual soil and groundwater conditions. All temporary cuts in excess of 4 feet in height should be sloped in accordance with U.S. Occupational Safety and Health Administration (OSHA) regulations (29 CFR Part 1926), or be shored. The existing native soils classify as Type B Soil and temporary excavation side slope inclinations as steep as 1H:1V may be assumed for planning purposes. This cut slope inclination is applicable to excavations above the water table only.

Perched groundwater conditions often occur over fine-grained native deposits such as those beneath the site, particularly during the wet season. If encountered, the contractor should be prepared to implement an appropriate dewatering system for installation of the utilities. At this time, we anticipate that dewatering systems consisting of ditches, sumps and pumps would be adequate for control of groundwater where encountered during construction conducted during the dry season. Regardless of the dewatering system used, it should be installed and operated such that in-place soils are prevented from being removed along with the groundwater.

Vibrations created by traffic and construction equipment may cause some caving and raveling of excavation walls. In such an event, lateral support for the excavation walls should be provided by the contractor to prevent loss of ground support and possible distress to existing or previously constructed structural improvements.

Utility trench backfill should consist of ¾"-0 crushed rock, compacted to at least 95% of the maximum dry density obtained by Modified Proctor (ASTM D1557) or equivalent. Initial backfill lift thick nesses for a ¾"-0 crushed aggregate base may need to be as great as 4 feet to reduce the risk of flattening underlying flexible pipe. Subsequent lift thickness should not exceed 1 foot. If imported granular fill material is used, then the lifts for large vibrating plate-compaction equipment (e.g. hoe compactor attachments) may be up to 2 feet, provided that proper compaction is being achieved and each lift is tested. Use of large vibrating compaction equipment should be carefully monitored near existing structures and improvements due to the potential for vibration-induced damage.

Adequate density testing should be performed during construction to verify that the recommended relative compaction is achieved. Typically, one density test is taken for every 4 vertical feet of backfill on each 200-lineal-foot section of trench.

Stormwater Infiltration Facilities

Based on results of the soil infiltration testing, soils on site exhibit low infiltration rates especially in the presence of perched water or static groundwater. Infiltration rates ranged from 0.6 to 1.2 inches/hour as summarized on Table 1. We recommend shallow systems in the range of 2 to 5 feet bgs be designed using an infiltration rate of **0.6 inches/hour**. This is slightly less than the average test value of 1.0 inches/hour, but we feel 0.3 inches/hour is more representative of overall site conditions. Also, please note that the potential for infiltration of stormwater will be reduced during the wet season due to saturated soils / perched water conditions over much of the site. We do not believe the site is well suited for use of deeper infiltration facilities such as dry wells due to the very low-permeability site soils, and perched water conditions.

The designer should select an appropriate infiltration value based on our test results and the location of the proposed infiltration facility. The recommended infiltration rates do not incorporate a factor of safety. For the design infiltration rate, we recommend a factor of safety of at least 2.0. Greater factors of safety may be required by the governing agency.

Infiltration test methods and procedures attempt to simulate the as-built conditions of the planned disposal system. However, due to natural variations in soil properties, actual infiltration rates may vary from the measured and/or recommended design rates. All systems should be constructed such that potential overflow is discharged in a controlled manner away from structures, and all systems should include an adequate factor of safety. Infiltration rates presented in this report should not be applied to inappropriate or complex hydrological models such as a closed basin without extensive further studies.

Erosion Control Considerations

During our field exploration program, we did not observe soil types that would be considered highly susceptible to erosion. Erosion at the site during construction can be minimized by implementing the project erosion control plan, which should include judicious use of straw, bio-bags, silt fences, or other appropriate technology. Where used, erosion control devices should be in place and remain in place throughout site preparation and construction. Areas of exposed soil requiring immediate and/or temporary protection against exposure should be covered with either mulch or erosion control netting/blankets.

UNCERTAINTIES AND LIMITATIONS

We have prepared this report for the owner and his/her consultants for use in design of this project only. This report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HGSI should be notified for review of the recommendations of this report, and revision of such if necessary.

Sufficient geotechnical monitoring, testing and consultation should be provided during construction to confirm that the conditions encountered are consistent with those indicated by explorations. Recommendations for design changes will be provided should conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the contract plans and specifications.

Within the limitations of scope, schedule and budget, HGSI executed these services in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this site.

We appreciate this opportunity to be of service.

Sincerely,

HARDMAN GEOTECHNICAL SERVICES INC.

Scott L. Hardman, P.E., G.E.
Geotechnical Engineer

Attachments: References
Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – DOGAMI LiDAR Mapping
Figure 4 – Fill Slope Detail
Logs of Test Pits TP-1 through TP-11
Logs of Hand Auger Borings HA-1 through HA-6
Infiltration Test Data Plots (3 Pages)
ASCE Seismic Design Hazards Report (3 Pages)

REFERENCES

Hardman Geotechnical Services Inc., 2021, *Geotechnical Evaluation of Landslide Hazards and Slope Stability; Proposed Underground Utility Easement; Frog Pond West-West; Martin, George and Ross Properties; Wilsonville, Oregon*; consultant report dated October 28.

Madin, I.P., 1990, Earthquake hazard geology maps of the Portland metropolitan area, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report 0-90-2, scale 1:24,000, 22 p.

Schlicker, H.G. and Finlayson, C.T., 1979, Geology and geologic hazards of northwest Clackamas County, Oregon Department of Geology and Mineral Industries, Bulletin 99, 1:24,000

Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1996, Tectonics of the Willamette Valley, Oregon: in Assessing earthquake hazards and reducing risk in the Pacific Northwest, Vol. 1: U.S. Geological Survey Professional Paper 1560, P. 183-222, 5 plates, scale 1:100,000.

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VICINITY MAP

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2856	FIGURE 1

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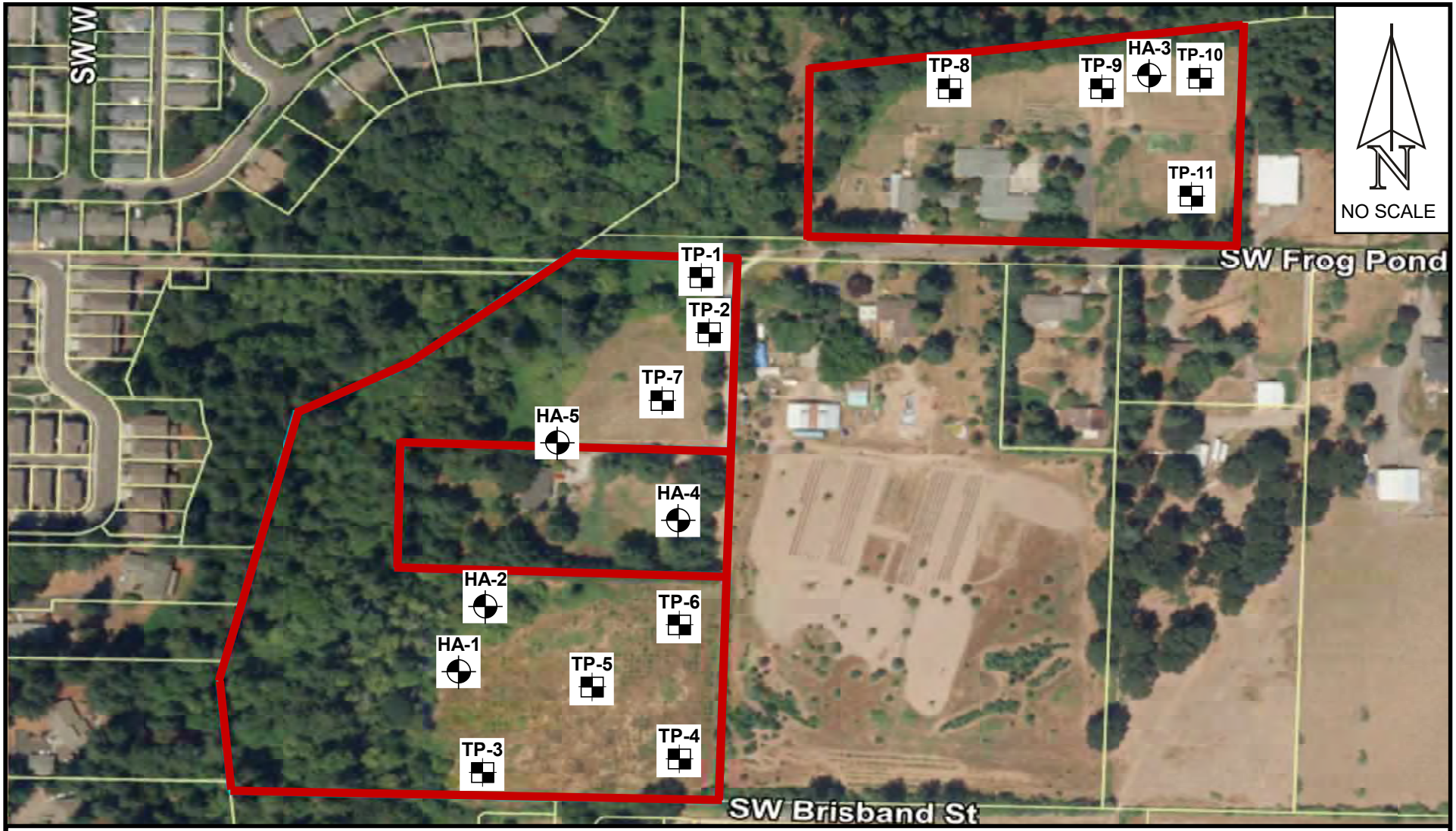
SITE PLAN AND EXPLORATION LOCATIONS



Legend

TP-X Backhoe Test Pit Designation and Approximate Location

Base Map by Portland Maps

Project: Frog Pond West West Wilsonville, Oregon	Project No. 20-2642	FIGURE 2

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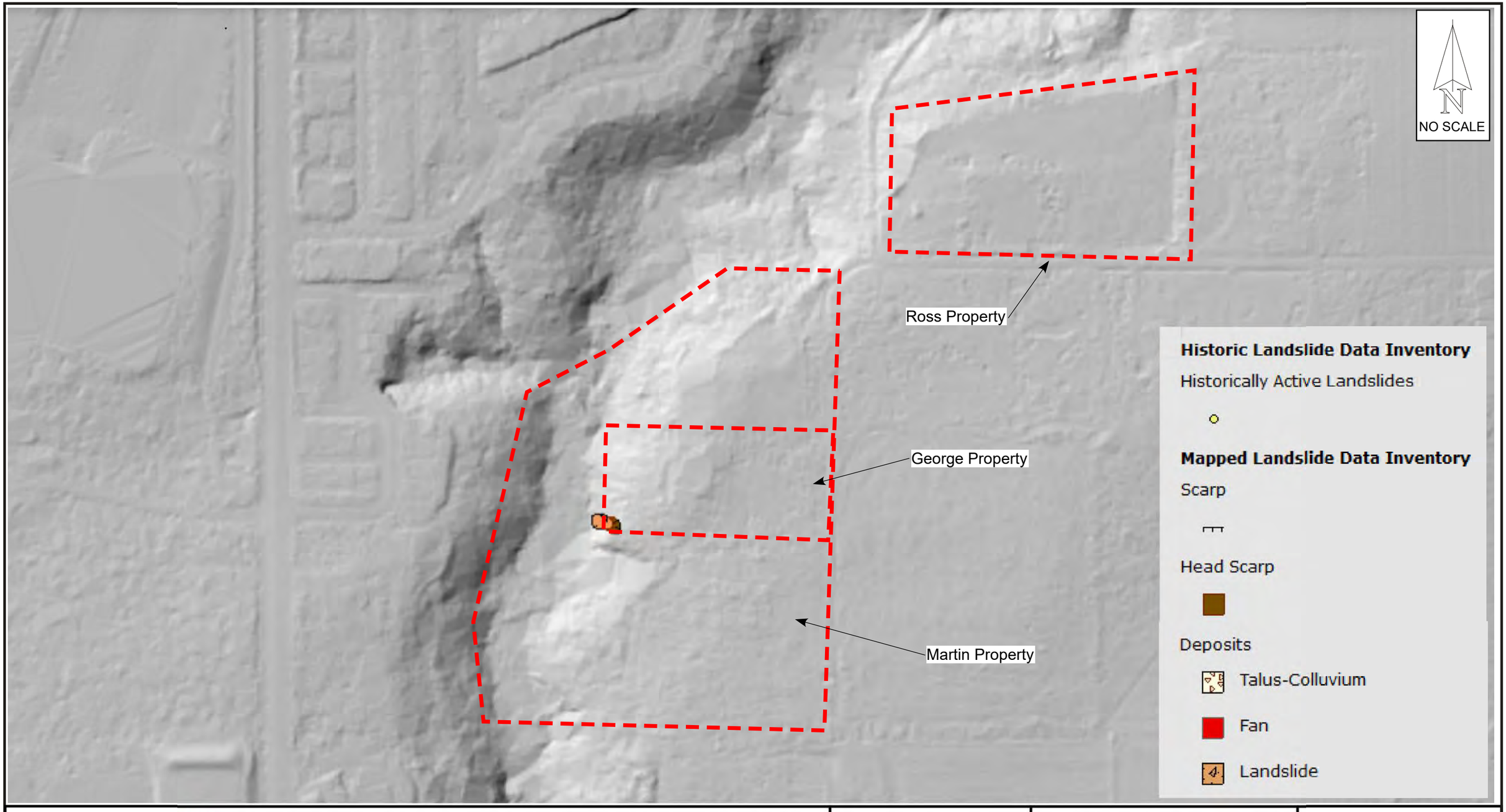
DOGAMI LiDAR MAPPING



LEGEND

Approximate Site Boundary

Base Map from DOGAMI SLIDO Website

Project No. 21-2824

Frog Pond West-West
Wilsonville, Oregon

FIGURE 3

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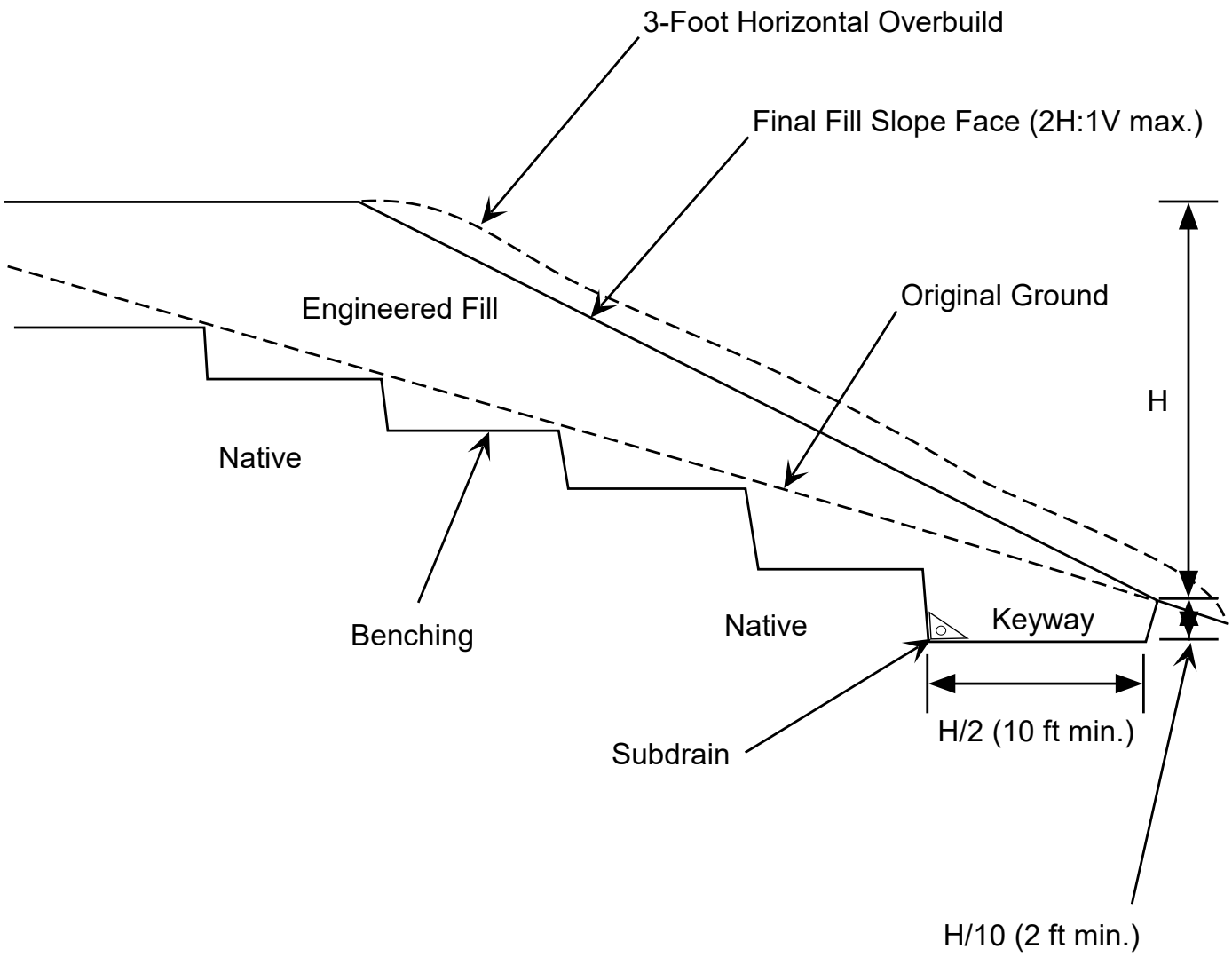
FILL SLOPE DETAIL

TYPICAL KEYWAY, BENCHING & FILL SLOPE DESIGN



Recommended subdrain is minimum 3-inch-diameter ADS Heavy Duty grade (or equivalent), perforated plastic pipe enveloped in a minimum of 3 cubic feet per lineal foot of 2" to 1/2" open-graded gravel drain rock wrapped with geotextile filter fabric (Mirafi 140N or equivalent).

Project: Frog Pond West-West Wilsonville, Oregon	Project No. 21-2824	FIGURE 4

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Soft, Organic SILT, dark brown, moist, many roots throughout (topsoil)
2	3.0 3.5					Stiff, Clayey SILT, light yellowish brown with black and orange mottling, moist, weathered (Colluvium)
3	>4.5					Very stiff to hard, Clayey SILT, yellowish brown with trace mottling in upper portion of unit only, slightly moist, unweathered and intact
4	>>4.5					
5						
6						
7						
8						Very difficult excavating at 8 feet due to hard materials.
9						Test pit terminated at 8 feet No caving of pit side walls No groundwater or seepage encountered
10						
11						
12						
13						
14						
15						
16						

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LEGEND

S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 10/22/2021

Logged By: SLH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Soft, Organic SILT, dark brown, moist, abundant grass roots (topsoil)
1						Dense, silty angular gravel, gray, moist (old driveway or pull-out area)
2						Very stiff to hard, Clayey SILT, yellowish brown with trace mottling in upper portion of unit only, slightly moist, unweathered and intact
8						Grades to Clayey Silt with some fine sand at 8 feet
10						Test pit terminated at 10 feet No caving of pit sidewalls No groundwater or seepage encountered

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 10/22/2021

Logged By: SLH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
3						
4						
5	4.2					Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, heavily micaceous. [Willamette Formation]
6						
7						
8		☒	S-1			
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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☒ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
11						Saturated, medium stiff, brown, sandy SILT (ML) with clay, heavily micaceous. [Willamette Formation]
13					▽	*Test Pit terminated at 13 feet* *Seepage observed in the bottom of the test pit* *No caving*

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☒ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown and light grey, silty CLAY (CL), orange and dark brown mottling. [Willamette Formation]
2	3.0					
3						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling. [Willamette Formation]
4						
5						
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						
3						
4						
5						
6						Sandiness increasing with depth
7						
8						Moist, stiff, brown, sandy SILT (ML), orange and dark brown mottling, slightly micaceous. [Willamette Formation]
9						
10						
11						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 7**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown and light grey, silty CLAY (CL), orange and dark brown mottling. [Willamette Formation]
2						
3						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling. [Willamette Formation]
4						
5						
6						
7						
8						
9						Very moist to saturated, medium stiff, brown, silty fine grained SAND (SM), heavily micaceous. [Willamette Formation]
10					▽	
11						
12						
13						*Test Pit terminated at 12 feet* *Seepage observed around 10 feet bgs* *No caving*
14						
15						
16						

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⊠ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, brown silt interbedded with dark brown silt and organics. Strata matrix is disturbed and there are some crushed rock fragments. [Undocumented Fill]
3						
4						Decomposing grass layer and buried topsoil
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, brown silt interbedded with dark brown silt and organics. Strata matrix is disturbed and there are some crushed rock fragments. [Undocumented Fill]
3						
4	1.8					Decomposing grass layer and buried topsoil
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 10**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, dark brown silt with organics and fractured rock. [Undocumented Fill]
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*

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Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021
Logged By: CSH
Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 11**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						
3						
4						
5						
6						Sandiness increasing with depth
7						
8						Moist, stiff, brown, sandy SILT (ML), orange and dark brown mottling, slightly micaceous. [Willamette Formation]
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
1						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
4						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, heavily micaceous. [Willamette Formation]
5						*Boring terminated at 5 feet* *No groundwater or seepage encountered* *No caving*
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021

Logged By: CSH

Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
1						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
2						
3						Moist, stiff to very stiff, brown, sandy SILT (ML), micaceous. [Willamette Formation]
4						
5						
6						*Boring terminated at 6 feet* *No groundwater or seepage encountered* *No caving*
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
						Moist, soft, dark brown silt with organics and fractured rock. [Undocumented Fill]
5						Moist, stiff to very stiff, brown, sandy SILT (ML) [Willamette Formation]
						Boring terminated at 5 feet *No groundwater or seepage encountered* *No caving*

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						Dry, very stiff, light brown, sandy SILT (ML), orange and dark brown mottling. [Willamette Formation]
3						
4						
5						
6						*Test Pit terminated at 6 feet* *No groundwater or seepage encountered* *No caving*
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
2						Moist, medium stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
3						
4						
5						*Test Pit terminated at 5 feet* *No groundwater or seepage encountered* *No caving*
6						
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021

Logged By: CSH

Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Slightly Moist, Medium Dense, Poorly Graded, Subangular, 1"-0" GRAVEL (GP) in Dark Brown Silty Matrix, Top 3" Highly Organic with Grass Roots *[Undocumented Fill]*
2						*Boring refusal on gravel at 1.1 feet (13 inches)* *No groundwater or seepage encountered* *No caving*
3						
4						
5						
6						
7						
8						
9						
10						

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Portland, OR 97223
(503) 530-8076

LEGEND

S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 11/09/2021

Logged By: CSH

Surface Elevation:

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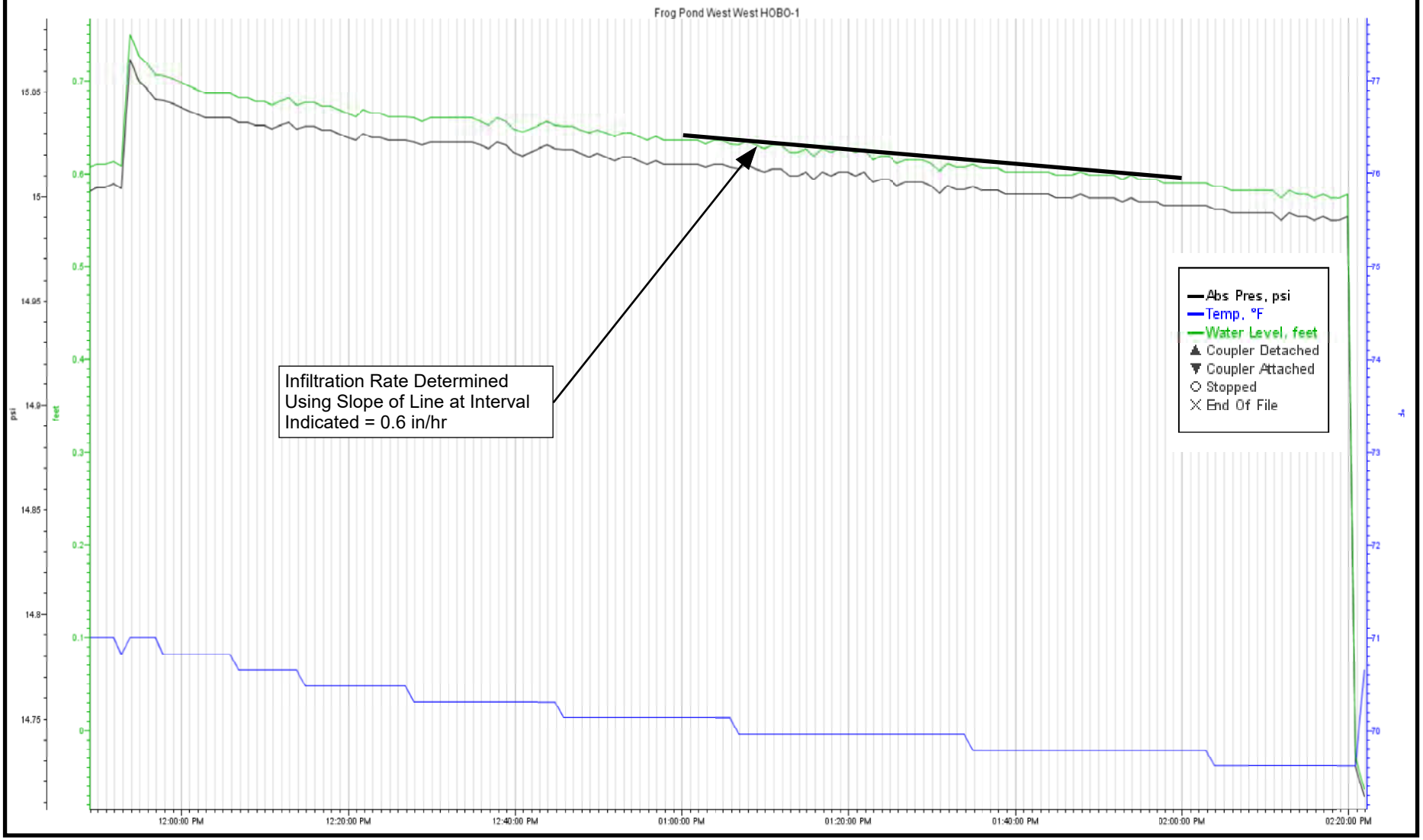
INFILTRATION TEST DATA



Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-1 Depth: 5 Feet

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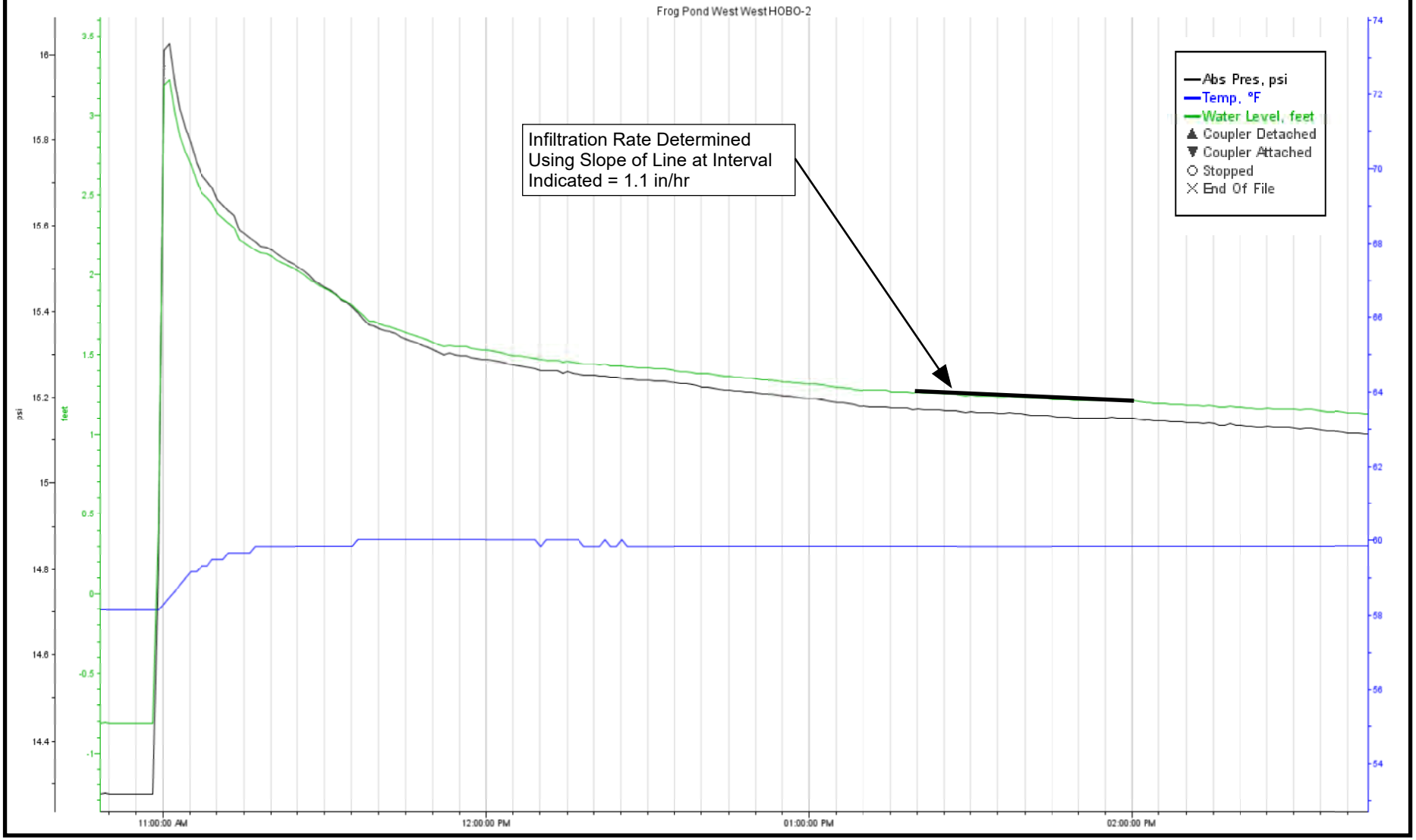

Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-2 Depth: 6 Feet

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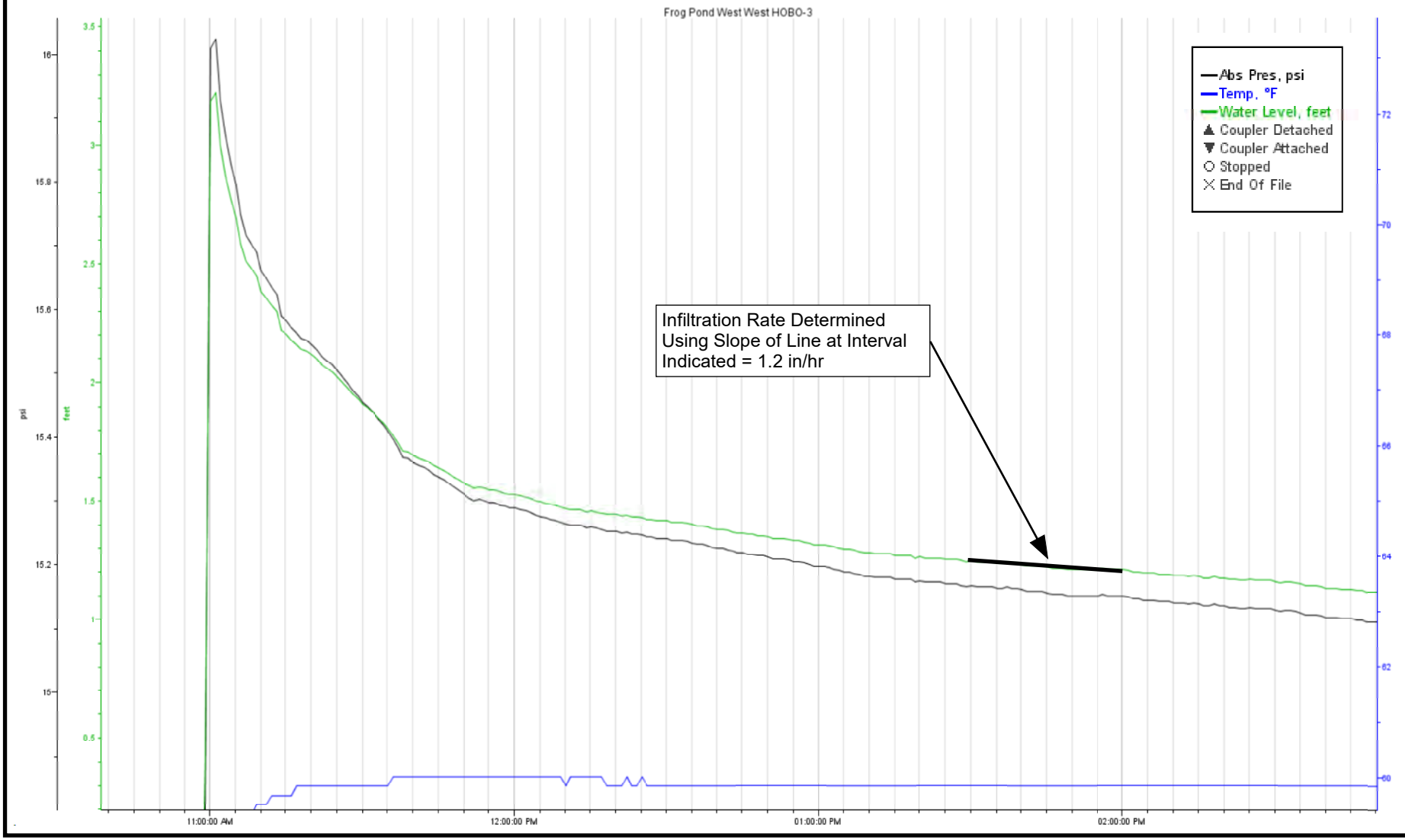


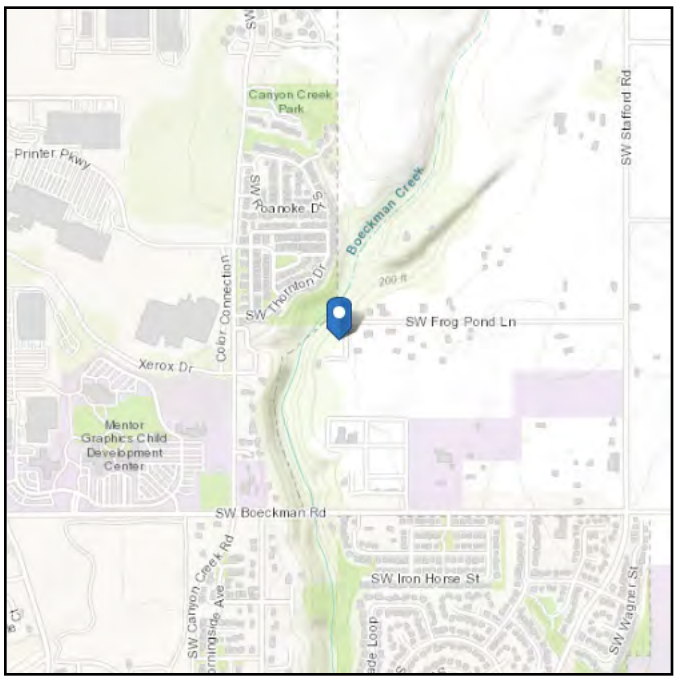
Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-3 Depth: 6 Feet

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Stiff Soil

Elevation: 216.52 ft (NAVD 88)
Latitude: 45.3218
Longitude: -122.754



Seismic

Site Soil Class: D - Stiff Soil

Results:

S_S :	0.82	S_{D1} :	N/A
S_1 :	0.381	T_L :	16
F_a :	1.172	PGA :	0.373
F_v :	N/A	PGA_M :	0.458
S_{MS} :	0.961	F_{PGA} :	1.227
S_{M1} :	N/A	I_e :	1
S_{DS} :	0.641	C_v :	1.21

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Tue Dec 14 2021

Date Source: USGS Seismic Design Maps

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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Appendix C

DownStream Analysis

Memorandum

To:	Keith Buisman, PE
From:	Roger Tiffany, EI and Rose Horton, PE
Copies:	File
Date:	May 17, 2022
Subject:	Downstream Impact Analysis of Boeckman Creek
Project No.:	20015

Introduction

Otak has conducted a downstream impact analysis on the downstream storm conveyance system for the proposed Frog Pond Terrace and Frog Pond Overlook developments, per City of Wilsonville 2015 standards. These proposed developments are located adjacent to Frog Pond Lane and east of Boeckman Creek, as shown on Figure 1.

Figure 1 Vicinity Map

The development will meet the City of Wilsonville Public Work Standards Section 301.4.04 which requires flow control from post-development conditions for peak flow rates generated by between 42% of the 2-year storm up to the 10-year storm.

To meet the requirements of City of Wilsonville Public Work Standards Section 301.5.01, a downstream analysis shall include:

- verifying that the downstream system has the capacity to convey the 25-year design storm.
- extending the analysis downstream to a point in the drainage system where the proposed development site contributes 10% or less of the total tributary drainage flow or for one-quarter mile downstream of the approved point of discharge.

Per email communications with Kerry Rappold on March 3, 2022, the downstream analysis should extend down to the flow control structure directly upstream of SW Boeckman Road.

Existing Conveyance System

The existing conveyance system used in this analysis is shown on Figure 2 (attached), which also includes the drainage basin delineation, time of concentration (Tc) flow paths, and runoff node locations represented in the hydraulic model. Cross sections of the open channel system were obtained from LiDAR and field observation. The proposed Frog Pond Terrace and Frog Pond Overlook developments will discharge runoff into the existing Boeckman Creek channel approximately 1,330 feet upstream of the existing flow control structure.

The stretch of channel downstream of the project site was visited on March 16, 2022. The purpose of the field visit was to observe and document existing channel conditions, outfalls, and contributing waterways. Visual documentation of the drainage system along the channel is included in the Photo Log in Appendix A.

Conveyance Hydrology

Peak runoff rates from the drainage basins delineated in Figure 2 during proposed conditions were calculated using XPSWMM V2021. The Santa Barbara Urban Hydrograph (SBUH) method was used to apply the conveyance design event (25-year recurrence interval, 24-hour duration, NRCS Type 1A rainfall distribution), per Section 301.5.01. Time of Concentration values were calculated for delineated drainage basin using TR-55 equations. Time of Concentration (Tc) flow paths are shown in Figure 2 and corresponding calculations for each drainage basin are included in Appendix B. A time of concentration of five minutes, the minimum allowable, was applied to steep and developed basins for a conservative estimate.

The study area is primarily comprised of Aloha silt loam categorized in the hydrologic soil groups (HSG) Type D and Woodburn silt loam categorized as HSG Type C. HSG D soils generally exhibit very slow infiltration rates when thoroughly wet. The steep area of the channel is Xerochrepts and Haploxerolls which is categorized as HSG Type B with moderate infiltration. A Curve Number (CN) of 98 was used for all impervious areas. The pervious areas were open space with good grass cover, thus a CN of 74 (HSG Type C) was used as applicable.

The basins downstream of the proposed project site are developed residential areas. Impervious percentages were estimated based on existing impervious surfaces captured in 2022 aerial imagery.

The upstream flow in Boeckman Creek was obtained from StreamStats (see Appendix B). It is not recommended to mix hydrologic methods and this data should not be used for design. In this case, the StreamStats data was used provide a rough order of magnitude flowrate for the large upstream basin in comparison with the flowrates generated from the proposed development. Table 1 summarizes the 25-year peak flowrates in Boeckman Creek for proposed project conditions calculated in XP-SWMM. The stationing represents the distance upstream from the existing Boeckman Road flow control structure. The existing flow control structure at the end of the analysis is 1,331 feet downstream from the project's proposed discharge location.

Table 1 Peak 25-Year Flowrates

Node	Station	Total Contributing Basin Area (ac)	Flow Rate (cfs)
Drainage Node 4	16+95	910	116.62
Drainage Node 3	13+31	978	158.38
Drainage Node 2	5+78	992	160.6
Drainage Node 1	2+00	1,025	173.6

Downstream Conveyance Modeling Analysis

The stormwater conveyance network was analyzed in XP-SWMM. The conveyance system was modeled to determine whether the existing downstream system has sufficient capacity to support the Frog Pond Overlook and Frog Pond Terrace developments runoff undetained during the 25-year, 24-hour storm event. The inverts are from as-builts of the flow control structure and LiDAR data. Manning's n values of 0.035 or 0.04 were applied to the channel of Boekman Creek depending on the amount of wood located in the channel along the reach. A Manning's n value of 0.1 was applied to the overbanks. A minimum of one-foot of freeboard between the hydraulic grade line (HGL) and the top of bank was confirmed. The model does not include the effect of the existing flow control structure on the system. Appendix C includes output information from the XP-SWMM model, summarizing the channel network characteristics and results of the hydraulic routing during the design storm.

Conclusions

The downstream stormwater conveyance system was analyzed to confirm conveyance capacity for the proposed development to Boeckman Road. The system consists entirely of open channel upstream of the existing flow control structure at Boeckman Road. A site visit along the downstream reach provided a qualitative assessment of the storm conveyance system and found no evidence of capacity restrictions under existing conditions. The channel was modeled using XP-SWMM software and shows adequate capacity for the proposed flows and the existing flow control structure creates ponding in the downstream reach.

References

Wilsonville, 2015. *City of Wilsonville Public Works Standards. Section 3, Stormwater & Surface Water Design and Construction Standards*, City of Wilsonville, Revised December 2015.

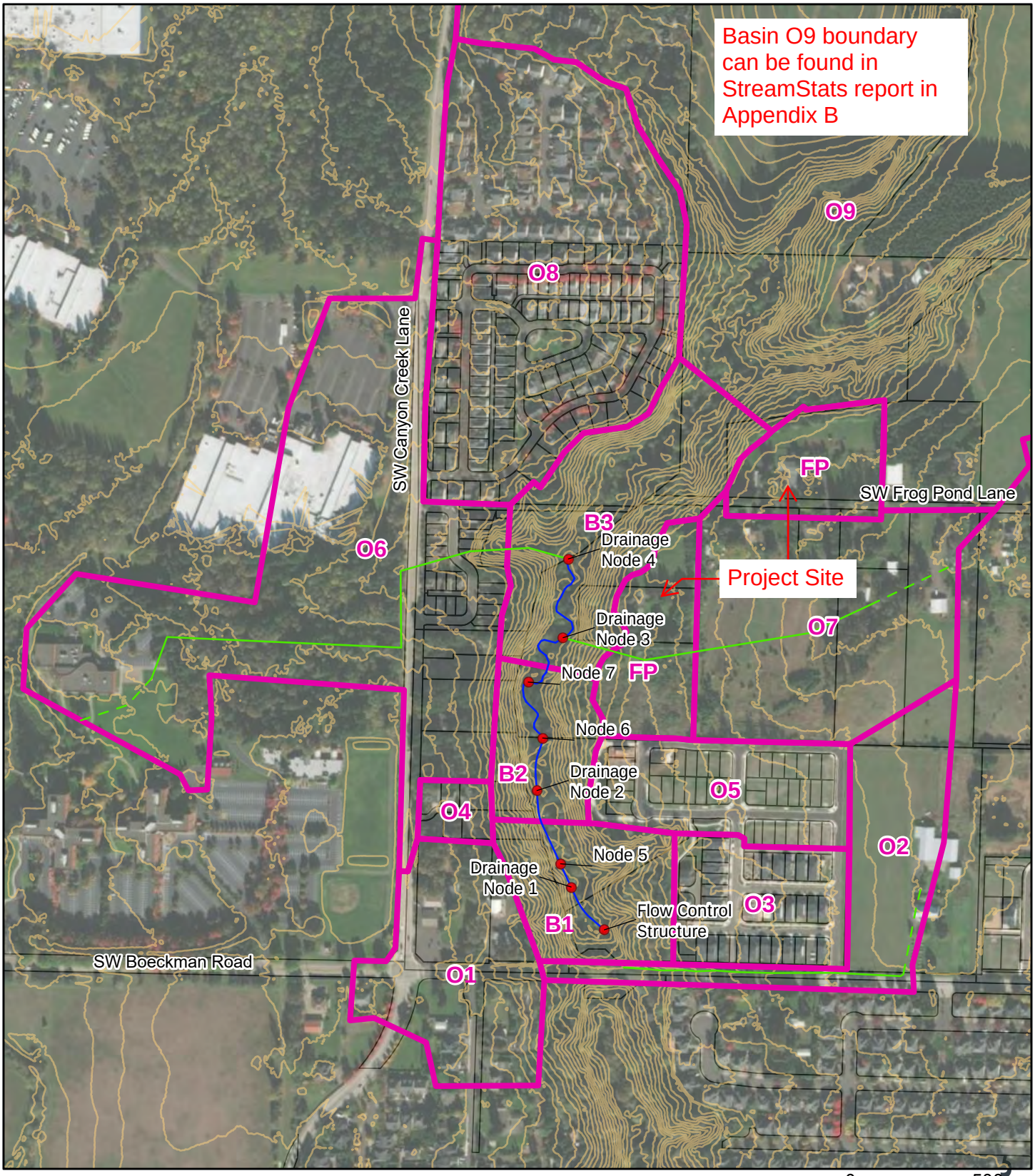


FIGURE 2

DOWNSTREAM ANALYSIS

BOECKMAN CREEK

WILSONVILLE, OREGON

Legend

- Nodes
- Stream Centerline (Analysis Extent)
- Drainage Basins
- Contours (5 ft)

Time of Concentration Path

- Shallow Concentrated Flow
- Sheet Flow

Data Sources:
Date: 4/18/2022
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

L:\Project\20000\20015\CADD\GIS\MXDs\20015-DSA Analysis\20015-DSA Analysis.aprx

Otak

Downstream Analysis of Boeckman Creek
Appendix A
Photo Log

20015 Frog Pond Terrace/Overlook DSA Photolog

Reach 1 - Flow Control Structure
Photo looking upstream

- Measured bank full depth – 52”
- Wide activated overbank floodplain
- Minimal wood and vegetation in channel

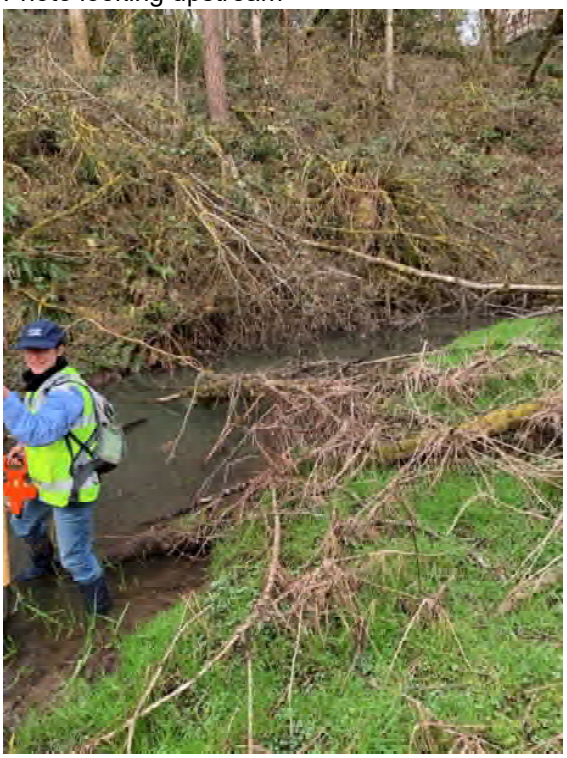
Reach 2
Photo looking upstream

- Measured bank full depth – 30”
- Activated overbank floodplain
- Higher density of wood in channel and beaver dams

Reach 3
Photo looking downstream

- Measured bank full depth – 48”
- More wood in channel than other reaches

Reach 4
Photo looking upstream



- Measured bank full depth – 32”
- More wood located in channel than other reaches

Reach 5

Photo looking downstream

- Measured bank full depth – 24”
- Scattered wood in channel

Reach 6 – Outfall General Location

Photo looking upstream

- Measured depth 2 ft
- Additional 14” above water surface to TOB at 1:1 slope
- Scattered wood in channel

Downstream Analysis of Boeckman Creek
Appendix B
Hydrology

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DSA Drainage Basin Areas

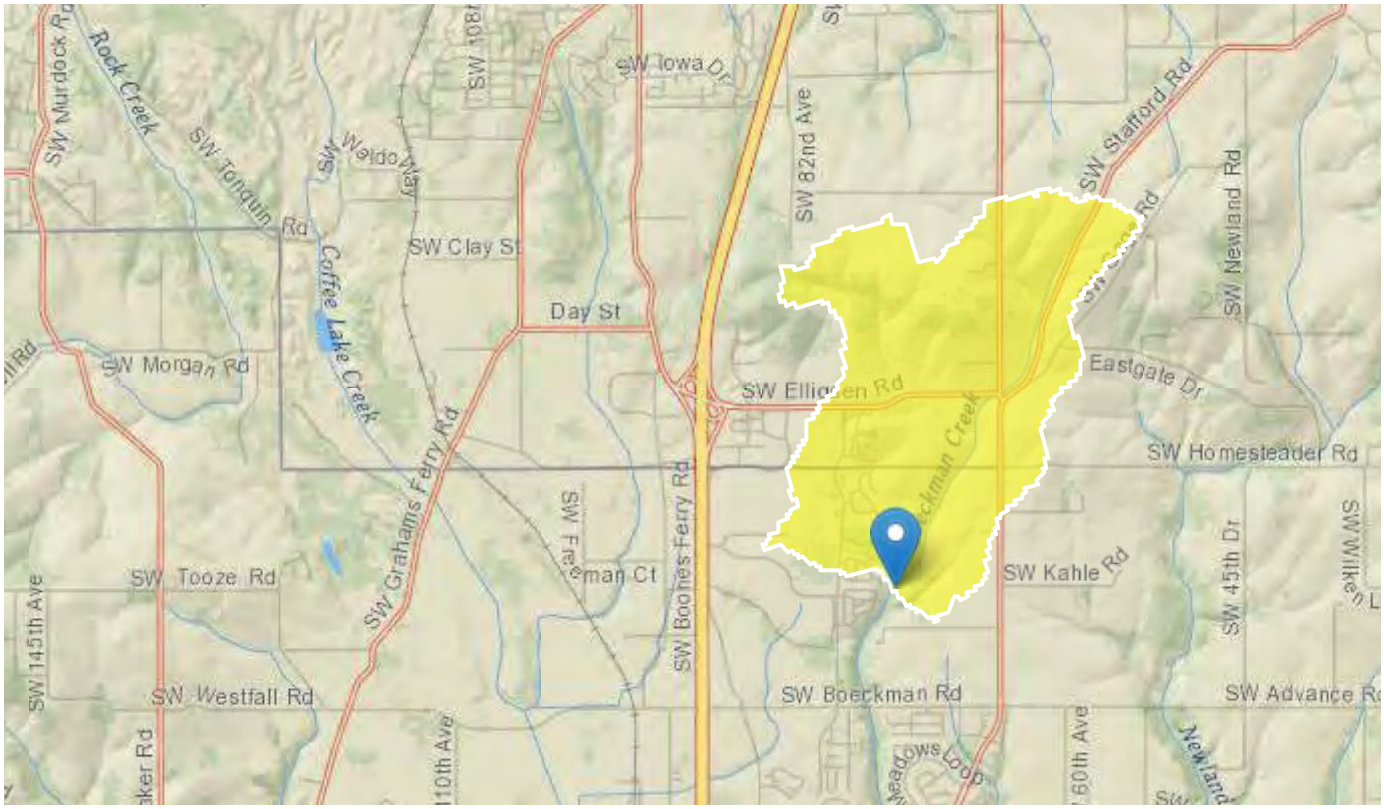
Boeckman Creek

Basin	XP-SWMM Node	Pervious Curve #	Impervious Area		Total Area	
			Tc	%	(sf)	(ac)
Site Total				390	44,646,105	1,025
O1	1	74	5	30	440,423	10.11
O3	1	74	5	50	288,301	6.62
O5	2	74	5	60	335,041	7.69
O4	2	74	5	30	58,509	1.34
O6	4	74	55.4	50	1,520,186	34.90
O8	3	74	5	80	1,250,809	28.71
B1	1	74	5	0	292,661	6.72
B2	2	74	5	0	206,554	4.74
B3	3	74	5	0	542,471	12.45
O9*	4	74			38,128,714	875.31
O2	1	74	28.2	20	405,690	9.31
O7	3	74	48.4	10	759,013	17.42
FP	3	74	5	60	417,733	9.59

*Modeled flow rates from Stream Stats

StreamStats Report - Boeckman Creek

Region ID: OR
Workspace ID: OR20220117180346388000
Clicked Point (Latitude, Longitude): 45.32457, -122.75288
Time: 2022-01-17 10:04:08 -0800



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.59	square miles
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	1.81	inches
SOILPERM	Average Soil Permeability	0.71	inches per hour
JANMAXT2K	Mean Maximum January Temperature from 2K resolution PRISM 1961-1990 data	46.2	degrees F

Parameter Code	Parameter Description	Value	Unit
WATCAPORC	Available water capacity from STATSGO data using methods from SIR 2005-5116	0.13	inches
ORREG2	Oregon Region Number	10001	dimensionless
BSLOPD	Mean basin slope measured in degrees	4.36	degrees
JANMINT2K	Mean Minimum January Temperature from 2K resolution PRISM PRISM 1961-1990 data	33.2	degrees F
ELEV	Mean Basin Elevation	338	feet
PRECIP	Mean Annual Precipitation	44.6	inches
DRNDENSITY	Basin drainage density defined as total stream length divided by drainage area.	0.63	dimensionless
MINBELEV	Minimum basin elevation	170	feet
MINTEMP	Mean annual minimum air temperature over basin surface area as defined in SIR 2008-5126	42.8	degrees F
JANMINTMP	Mean Minimum January Temperature	33.8	degrees F
MAXTEMP	Mean annual maximum air temperature over basin area from PRISM 1971-2000 800-m grid	62.4	degrees F
LC11DVOPN	Percentage of developed open area from NLCD 2011 class 21	13	percent
LC11WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2011	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	13.4	percent
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	1.62	miles

Peak-Flow Statistics Parameters [Reg 2B Western Interior LT 3000 ft Cooper]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	0.37	7270
BSLOPD	Mean Basin Slope degrees	4.36	degrees	5.62	28.3
I24H2Y	24 Hour 2 Year Precipitation	1.81	inches	1.53	4.48
ELEV	Mean Basin Elevation	338	feet		

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ORREG2	Oregon Region Number	10001	dimensionless		

Peak-Flow Statistics Disclaimers [Reg 2B Western Interior LT 3000 ft Cooper]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Reg 2B Western Interior LT 3000 ft Cooper]

Statistic	Value	Unit
50-percent AEP flood	45.8	ft^3/s
20-percent AEP flood	68.7	ft^3/s
10-percent AEP flood	84.7	ft^3/s
4-percent AEP flood	105	ft^3/s
2-percent AEP flood	121	ft^3/s
1-percent AEP flood	137	ft^3/s
0.2-percent AEP flood	174	ft^3/s

Peak-Flow Statistics Citations

Cooper, R.M.,2005, Estimation of Peak Discharges for Rural, Unregulated Streams in Western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 76 p. (http://pubs.usgs.gov/sir/2005/5116/pdf/sir2005-5116.pdf)

Monthly Flow Statistics Parameters [LowFlow Apr Region02 2008 5126]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	3.068	2025.868
PRECIP	Mean Annual Precipitation	44.6	inches	42.7355	101.2128
SOILPERM	Average Soil Permeability	0.71	inches per hour	0.502	3.724

Monthly Flow Statistics Parameters [LowFlow Aug Region02 2008 5126]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	3.068	2025.868
DRNDENSITY	Basin Drainage Density	0.63	dimensionless	0.118	0.876

Time of Concentration Calculations

Boeckman Creek Downstream Analysis

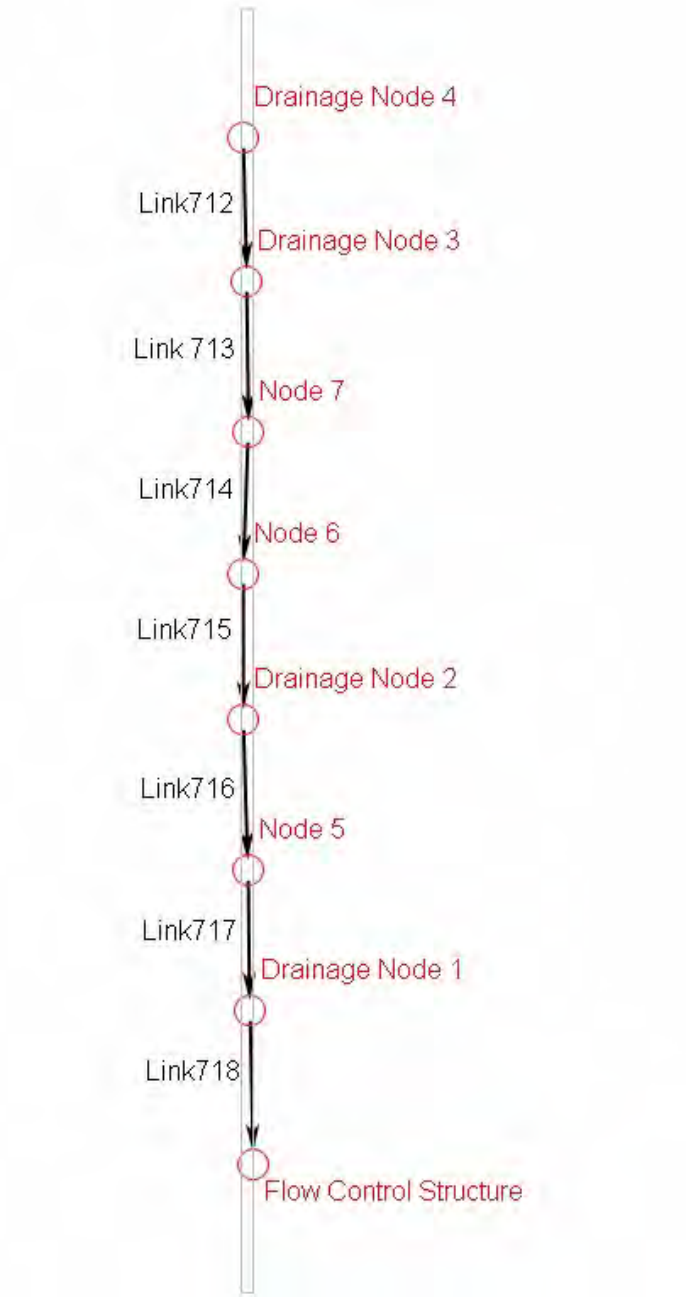
BASINS:		O7	O6	O2
SHEET FLOW				
INPUT				
Surface Description (from Table 3-1)		Short Grass/Woods mix	Short Grass	Short Grass
Manning's Roughness Coefficient		0.25	0.4	0.15
Flow Length , L (<300 ft)	ft	300	300	300
2-Year, 24-Hour Rainfall, P_2	in	2.5	2.5	2.5
Land Slope, s	ft/ft	0.016	0.027	0.025
OUTPUT				
Travel Time	hr	0.73	0.86	0.41
SHALLOW CONCENTRATED FLOW				
INPUT				
Surface Description (paved or unpaved)		Unpaved		Unpaved
Flow Length, L	ft	1200		900
Watercourse Slope, s	ft/ft	0.075		0.06
OUTPUT				
Average Velocity, V	ft/s	4.42		3.95
Travel Time	hr	0.08		0.06
CHANNEL FLOW				
INPUT				
Cross Sectional Flow Area, a	ft^2		1.23	
Wetted Perimeter, p_w	ft		3.93	
Channel Slope, s	ft/ft		0.03	
Manning's Roughness Coefficient			0.013	
Flow Length, L	ft		1925	
OUTPUT				
Average Velocity, V	ft/s		9.15	
Hydraulic Radius, r = a/p_w	ft		0.31	
Travel Time	hr		0.058	
Basin Time of Concentration, T_c	**hrs**	**0.81**	**0.92**	**0.47**
	min	**48.4**	**55.4**	**28.2**

Downstream Analysis of Boeckman Creek
Appendix C
Model Results

Otak

XP-SWMM Layout

Boeckman Creek Downstream Analysis



XP-SWMM RUNOFF DATA
Boeckman Creek Downstream Analysis
Proposed Conditions

SCS Type 1A 25-Year Storm Event							
XP-SWMM Input Data					XP-SWMM Output Data		
Node Name	Total Area (ac)	Impervious %	Pervious Curve Number	Tc (min)	Rainfall Depth (in)	Unit Hydrograph Method	Surface Runoff Flow (cfs)
Drainage Node 1	10.11	30	74	5	3.9	Santa Barbara	6.24
Drainage Node 1	6.62	50	74	5	3.9	Santa Barbara	5.19
Drainage Node 1	6.72	0	74	5	3.9	Santa Barbara	2.65
Drainage Node 1	9.31	20	74	28.2	3.9	Santa Barbara	2.78
Drainage Node 2	7.69	60	74	5	3.9	Santa Barbara	6.70
Drainage Node 2	1.34	30	74	5	3.9	Santa Barbara	0.83
Drainage Node 2	4.74	0	74	5	3.9	Santa Barbara	1.87
Drainage Node 3	28.71	80	74	5	3.9	Santa Barbara	29.94
Drainage Node 3	12.45	0	74	5	3.9	Santa Barbara	4.91
Drainage Node 3	17.42	10	74	48.4	3.9	Santa Barbara	3.43
Drainage Node 3	9.59	60	74	5	3.9	Santa Barbara	8.36
Drainage Node 4	34.90	50	74	55.4	3.9	Santa Barbara	11.55

XP-SWMM HYDRAULICS DATA

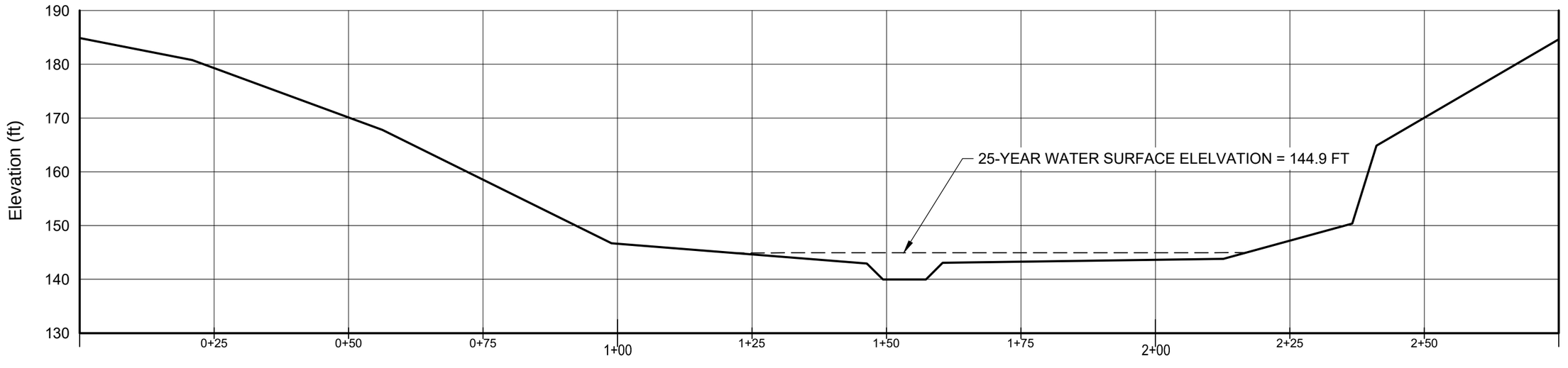
Boeckman Creek Downstream Analysis

Proposed Conditions

SCS Type 1A 25-Year Storm Event																
Location			Channel		Channel Profile								Channel Results			
Link Name	Node Limits		Length	Slope	Ground Elevation (ft)		Invert Elevation (ft)		Max. Water Elevation (ft)		Freeboard (ft)		Max. Flow	Max. Velocity	Max. Depth	y/d0
	From	To	ft	%	US	DS	US	DS	US	DS	US	DS	(cfs)	(ft/s)	(ft)	
Link712	Drainage Node 4	Drainage Node 3	364.00	0.6	188.19	186.12	143.27	141.20	146.53	144.90	41.66	41.22	116.62	3.66	3.70	0.08
Link 713	Drainage Node 3	Node 7	309.00	0.6	186.12	184.93	141.20	139.42	144.90	143.17	41.22	41.76	158.38	3.74	3.75	0.08
Link715	Node 6	Drainage Node 2	196.00	0.2	186.41	186.00	137.41	137.00	142.07	141.44	44.34	44.56	153.78	3.20	4.66	0.10
Link717	Node 5	Drainage Node 1	93.00	1.0	185.60	184.43	136.60	135.10	139.77	137.15	45.83	47.28	160.56	4.60	3.17	0.07
Link714	Node 7	Node 6	248.00	0.8	184.93	186.41	139.42	137.41	143.17	142.07	41.76	44.34	155.45	2.99	4.66	0.10
Link716	Drainage Node 2	Node 5	285.00	0.1	186.00	185.60	137.00	136.60	141.44	139.77	44.56	45.83	160.61	3.75	4.44	0.09
Link718	Drainage Node 1	Flow Control Structure	200.00	1.6	184.43	181.33	135.10	132.00	137.15	133.96	47.28	47.37	173.66	7.02	2.05	0.04

Boeckman Road surface is higher than elevation 176

Cross Section for Link 713 is directly downstream of the proposed development



Link 713 Cross Section

Appendix D

BMP Sizing Tool Output

WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Frog Pond Terrace & Frog Pond Overlook
Project Type	Subdivision
Location	7480 SW Frog Pond Lane
Stormwater Management Area	6500
Project Applicant	West Hills Development
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
O3 Perv	1,235	Grass	LandscapeCsoil	C	Swale 4
O3 Imp.	11,474	Grass	ConventionalConcrete	C	Swale 4
T13 Perv.	1,602	Grass	LandscapeCsoil	C	Swale 3
T13 Imp.	4,670	Grass	ConventionalConcrete	C	Swale 3
T11 Imp.	9,707	Grass	ConventionalConcrete	C	Swale 1
T11 Perv.	548	Grass	LandscapeCsoil	C	Swale 1
Pond Basins Imp.	135,839	Grass	ConventionalConcrete	C	Pond
Pond Basins Perv.	121,992	Grass	LandscapeCsoil	C	Pond
T12 Imp.	2,693	Grass	ConventionalConcrete	C	Swale 2
T12 Perv.	889	Grass	LandscapeCsoil	C	Swale 2
O4 Imp.	11,624	Grass	ConventionalConcrete	C	Swale 5
O4 Perv.	1,180	Grass	LandscapeCsoil	C	Swale 5
FP2 Imp.	2,168	Grass	ConventionalConcrete	C	Swale 6
FP2 Perv.	183	Grass	LandscapeCsoil	C	Swale 6
FP3 Imp	3,657	Grass	ConventionalConcrete	C	Swale 6
T15 Perv	170	Grass	LandscapeCsoil	C	Swale 8

T15 Imp	3,005	Grass	ConventionalConcrete	C	Swale 8
T3 Perv	851	Grass	LandscapeCsoil	C	Swale 9
T3 Imp	5,035	Grass	ConventionalConcrete	C	Swale 9

LID Facility Sizing Details

LID ID	Design Criteria	BMP Type	Facility Soil Type	Minimum Area (sq-ft)	Planned Areas (sq-ft)	Orifice Diameter (in)
Swale 2	FlowControlAndTreatment	Vegetated Swale - Filtration	C2	156.9	336.0	0.6
Swale 1	WaterQuality	Vegetated Swale - Filtration	C2	149.7	294.0	0.6
Swale 3	FlowControlAndTreatment	Vegetated Swale - Filtration	C2	273.6	336.0	0.8
Swale 4	WaterQuality	Vegetated Swale - Filtration	C2	181.4	221.0	0.6
Swale 5	WaterQuality	Vegetated Swale - Filtration	C2	183.2	208.0	0.6
Swale 6	WaterQuality	Vegetated Swale - Filtration	C2	88.7	183.0	0.4
Swale 8	WaterQuality	Vegetated Swale - Filtration	C2	46.4	128.0	0.3
Swale 9	WaterQuality	Vegetated Swale - Filtration	C2	81.9	124.0	0.4

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Pond	FCWQT	Lined	5.00	7,523.0	3	26,105.1	18,278.3	Yes

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

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

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

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Pond
Design: FlowControlAndTreatment

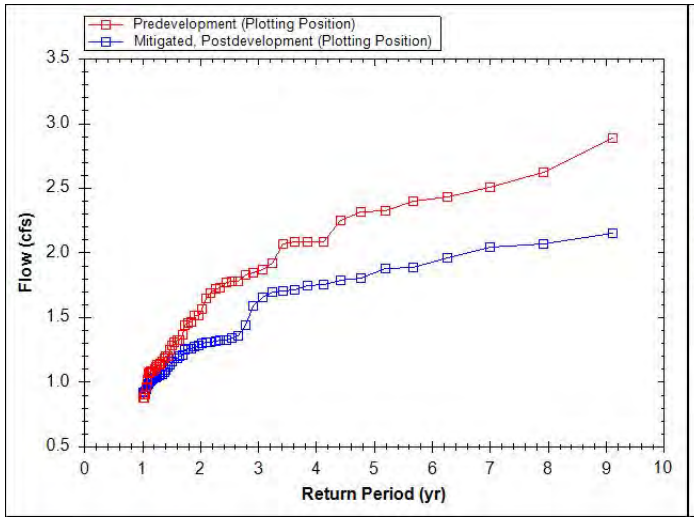
Shape Curve

Depth (ft)	Area (sq ft)
5.0	7,523.0

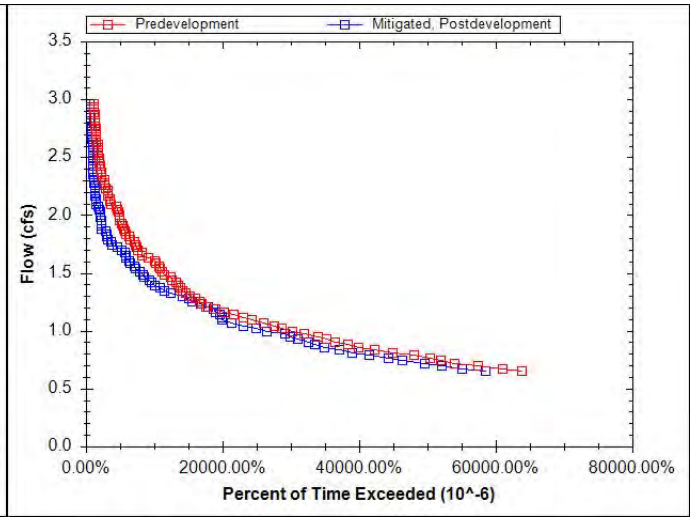
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	3.3
Upper Orifice Invert(ft)	3.4
Upper Orifice Dia (in)	8.3
Overflow Weir Invert(ft)	4.0
Overflow Weir Length (ft)	6.3

Flow Frequency Chart

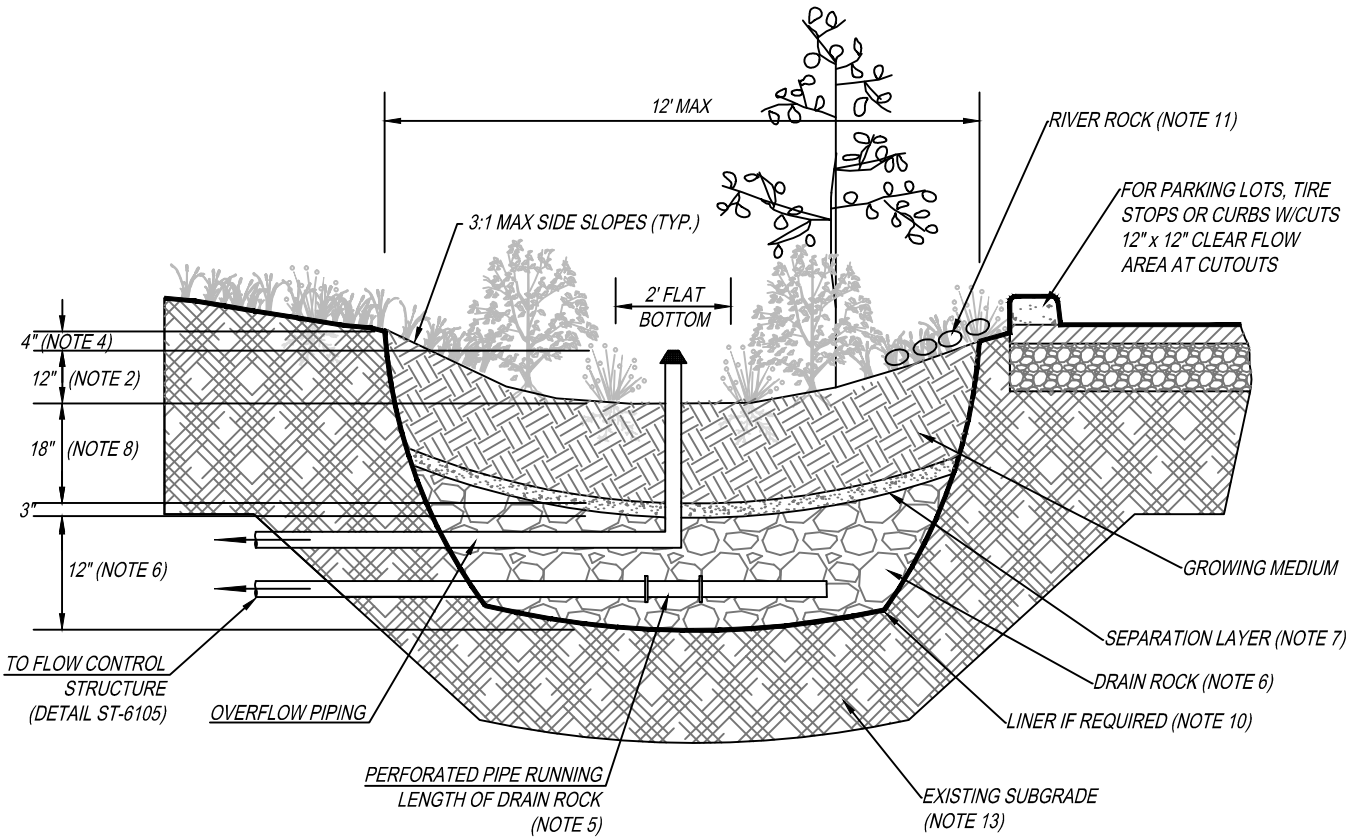


Flow Duration Chart



Appendix E

Operations and Maintenance Plans



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED SWALES ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION); 12"
   -LONGITUDINAL SLOPE OF SWALE:6.0% OR LESS
   -FLAT BOTTOM WIDTH: 2' MINIMUM
   -SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. **LOCATION/SETBACKS:**
   -FILTRATION SWALES SHALL BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL
4. **OVERFLOW:**
   -INLET ELEVATION SHALL ALLOW FOR 4" OF FREEBOARD, MIMIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. **PIPING:**
   -PERFORATED UNDER-DRAIN PIPING: SHALL BE ABS SCH. 40, CAST IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND. WRAP UNDER-DRAIN IN FILTER FABRIC TO REDUCE TRANSPORT OF FINES.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, CAST IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4" WASHED
   -DEPTH: 12"
7. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX C FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 25% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT.
11. **INSTALL RIVER ROCK** SPLASH PAD OVER A NON WOVEN GEO TEXTILE FABRIC TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3", 4 SQUARE FEET, 6" DEEP.
12. **CHECK DAMS:** SHALL BE PLACED ACCORDING TO FACILITY DESIGN. REFER TO DETAIL ST-6100 FOR PROFILE AND SPACING.
13. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.

Vegetated Swale - Filtration			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6045	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6045.DWG	APPROVED BY: NK	DATE: 6/3/16	PUBLIC WORKS STANDARDS

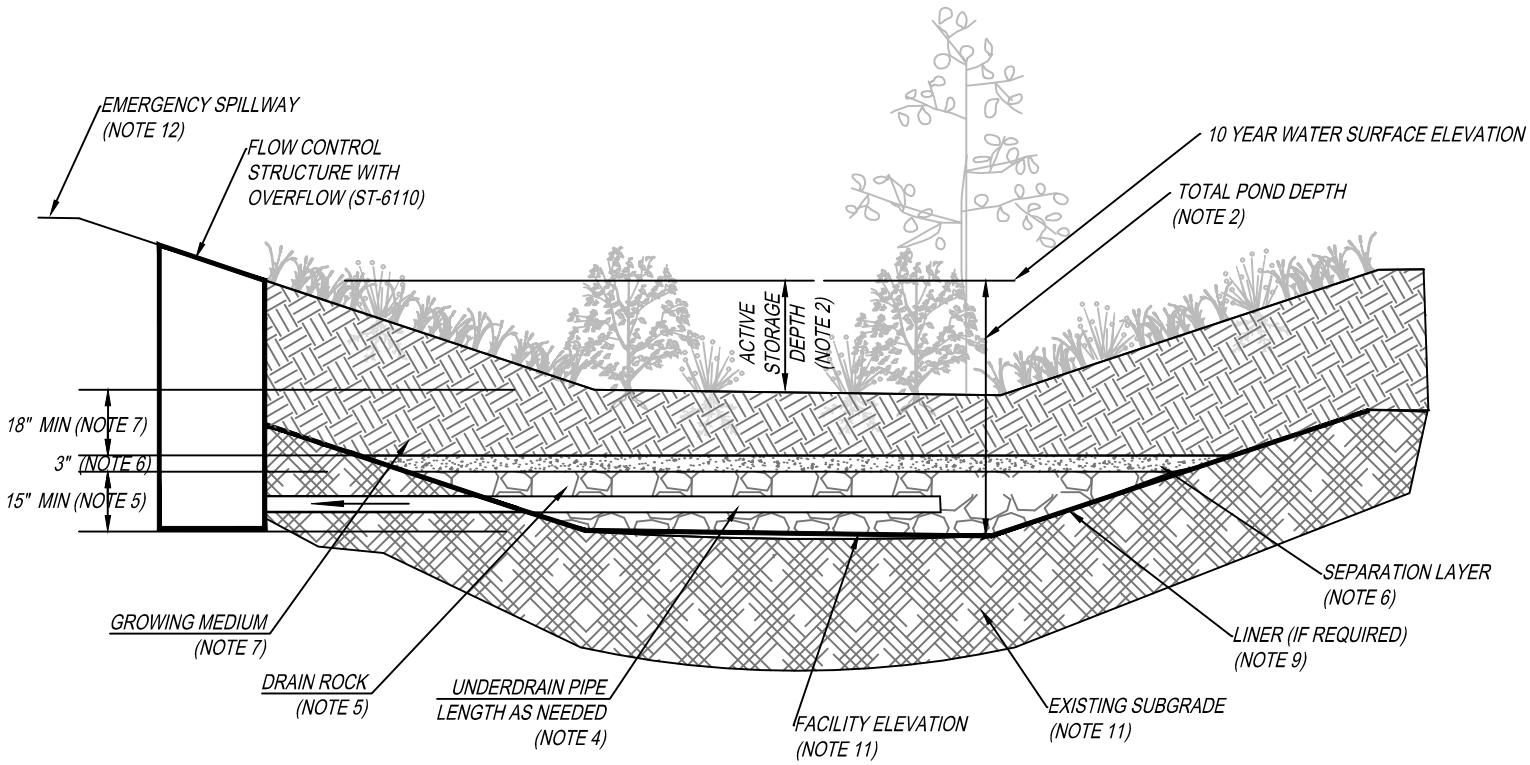
Vegetated Swales
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Replace/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 - 10 inch deep rock check dams at design intervals.
Vegetation	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back to 4-6 inches, 1-2 times per year. Remove cuttings
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Restore or create outfalls, checkdams, or splash blocks where necessary.
Slope Sippage	-Stabilize Slope.
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

Summer. Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.
Fall. Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Winter. Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.
All seasons. Weed as necessary.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact _____ for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

Vegetated Swale O & M Plan			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6055	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6055.DWG	APPROVED BY: NK	DATE: 10/8/14	PUBLIC WORKS STANDARDS



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED PONDS ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -ACTIVE STORAGE DEPTH: (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION); PER FACILITY SIZING MODEL
   -TOTAL POND DEPTH: 4' MINIMUM, PER FACILITY SIZING MODEL
   -BOTTOM SLOPE: 2.0% OR LESS
   -SIDE SLOPES OF DETENTION POND: 3:1 MAXIMUM
3. **LOCATION/SETBACKS:**
   -DETENTION POND SHALL BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. **PIPING:**
   -PERFORATED UNDER-DRAIN PIPING: SHALL BE ABS SCH. 40, CAST IRON OR PVC SCH. 40. 6" MINIMUM DIAMETER. PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND. WRAP UNDER-DRAIN PIPE IN FILTER FABRIC TO REDUCE TRANSPORT OF FINES.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, CAST IRON OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4"-0 WASHED
   -DEPTH: 15" MINIMUM
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX C FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT FOR DETENTION POND.
10. **INSTALL RIVER ROCK** SPLASH PAD OVER A NON WOVEN GEO TEXTILE FABRIC TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3", 4 SQUARE FEET 6" DEEP.
11. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.
12. **EMERGENCY SPILLWAY** SIZED TO CONVEY THE 100 YEAR DESIGN STORM (S-2275). SEE PUBLIC WORKS STANDARDS 301.4.09

Detention Pond			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6060	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6060.DWG	APPROVED BY: NK	DATE: 6/3/16	PUBLIC WORKS STANDARDS

Detention Pond
Operations & Maintenance Plan

Detention Pond removes pollutants through several processes: sedimentation, filtration, and biological processes. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 - 10 inch deep rock check dams at design intervals.
Vegetation shall cover 90% of the facility.	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back grass and prune overgrowth 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Replace splash blocks or inlet gravel/rock.
Slope Sippage	-Stabilize 3:1 Slopes/banks with plantings from Appendix A
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact _____ for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

Detention Pond O & M Plan			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6065	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6065.DWG	APPROVED BY: NK	DATE: 10/8/14	PUBLIC WORKS STANDARDS

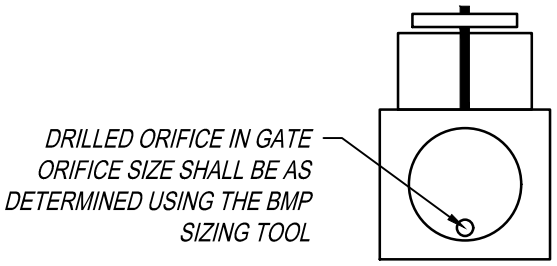
STORMWATER FACILITIES
OPERATIONS AND MAINTENANCE CHECKLIST

Problem	Frequency	Trigger	Preferred Condition
Sediment Accumulation in Treatment Area	Monthly from November through April Annually Required	Sediment depth exceeds 3 inches	Sediment removed from vegetated treatment area: level side to side and drains freely toward outlet; no standing water within 24 hours of any major storm (1" in 24 hours)
Erosion Scouring	Monthly from November through April Annually Required	Monthly from November through April Annually Required	Repair ruts or bare areas by filling with topsoil during dry season; regreade and replant large bare areas.
Standing Water	Monthly from November through April and after any major storm (1 inch in 24 hours)	Standing water in the planter between storms that does not drain freely	Remove sediment or trash blockages; improve end to end grade so there is no standing water 24 hours after any major storm (1 inch in 24 hours)
Flow not Distributed Evenly	Monthly from November through April Annually Required	Flows unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width
Settlement/ Misalignment	Annually Required	Failure of planters has created safety, function, or design problem	Planter replaced or repaired to design standards
Constant Baseflow	Monthly from November through April Annually Required	Small, continual flow of water through the planter even after weeks without rain; planter bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the planter or bypass the baseflow around the planter
Vegetation	Monthly from November through April Annually Required	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking the inlet pipe opening
Poor Vegetation Coverage	Monthly Annually Required	Grass or other vegetation is sparse, or bare in more than 10% of the planter area	Determine cause of poor growth and correct the condition; replant with plants (per Appendix A) as needed to meet facility standards
Invasive Vegetation	Monthly Annually Required	No invasive vegetation is planted or permitted to remain	no invasive vegetation present; remove excessive weeds. Control if complete eradication is not feasible
Rodents	Monthly Annually Required	Evidence of rodents or rodent damage	No rodents; functioning facility
Insects	Annually Required	Insects such as wasps and hornets that interfere with maintenance activities	Harmful Insects removed
Trash and Debris	Monthly and after any major storm (1 inch in 24 hours) Annually Required	Visual evidence of trash, debris or dumping	Trash and Debris removed from facility
Contamination and Pollution	Monthly from November through April Annually Required	Any evidence of oil, gasoline, contamination or other pollutants	No contaminants or pollutants present; coordinate removal/cleanup with local water quality response agency
Obstructed Inlet/Outlet	Monthly and after any major storm event (1 inch in 24 hours) Annually Required	Inlet/outlet areas clogged with sediment, vegetation or debris	Clear inlet and outlet; obstructions removed
Excessive Shading	Monthly from November through April Annually Required	Vegetation growth is poor because unlight does not reach planter	Trim over-hanging limbs and/or remove brushy vegetation as needed
Vegetation	Monthly from November through April Annually Required	Specified or approved grass grows so tall that if competes with shrubs and/or becomes a fire danger	String trim non-wetland grasses to 4 inch to 6 inch and remove clippings; protect woody vegetation

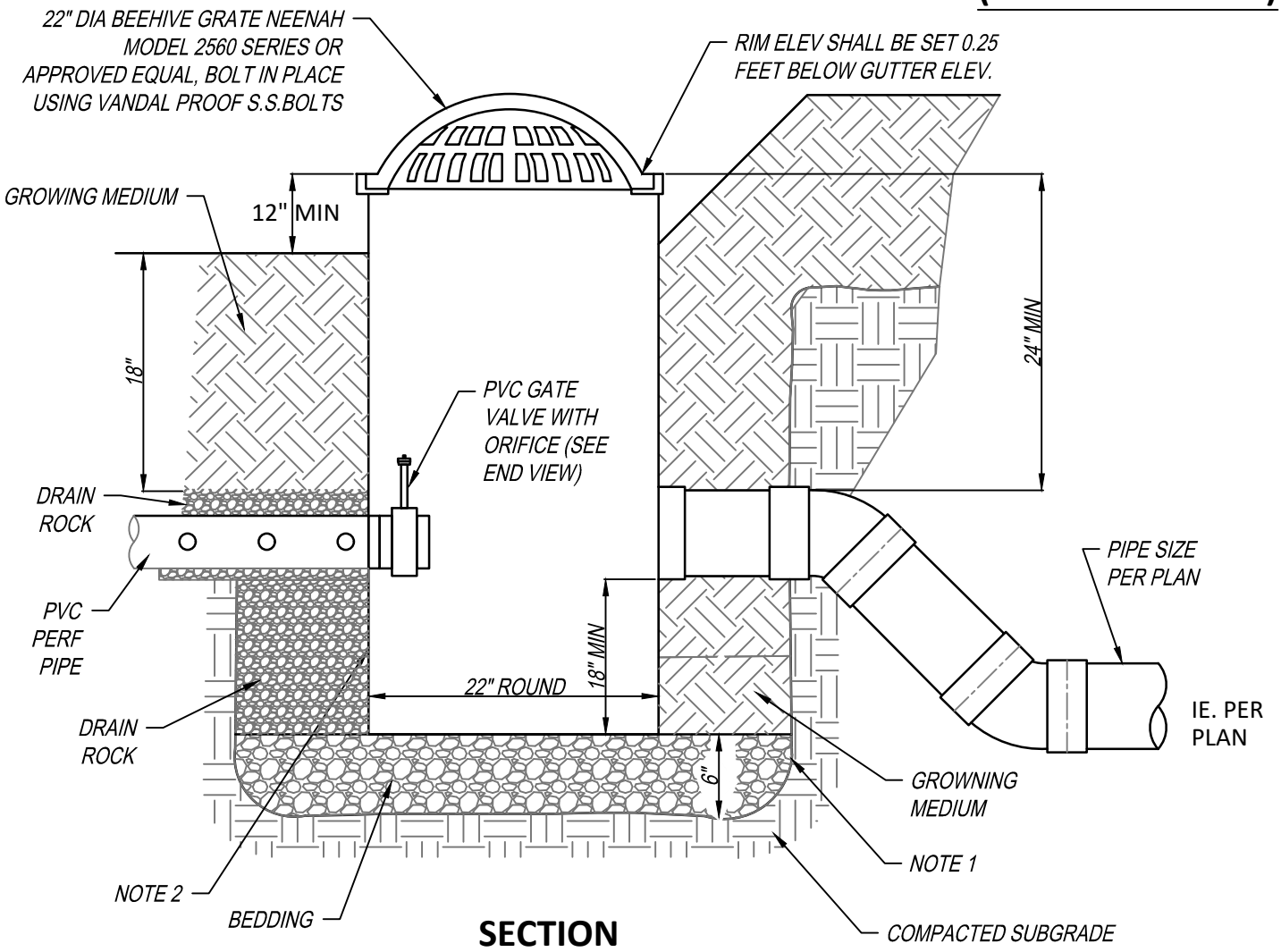
Stormwater Facilities Operations & Maintenance Checklist		
DRAWING NUMBER: ST-6115	DRAWN BY: SR	SCALE: N.T.S.
FILE NAME: ST-6115.DWG	APPROVED BY: NK	DATE: 10/3/14

CITY OF WILSONVILLE

PUBLIC WORKS STANDARDS



END VIEW
(PVC GATE VALVE)



SECTION

NOTES:
1. CONTRACTOR TO WIDEN EXCAVATION AS REQUIRED TO OBTAIN COMPACTION WITH CONTRACTORS COMPACTION EQUIPMENT.
2. 10 GA. STEEL PLATE, BITUMINOUS COATED BASIN AS MANUFACTURED BY GIBSON STEEL, GRATEMASTER OR APPROVED EQUAL.
3. BEDDING SHALL BE 6" OF COMPACTED 3/4"-0 CRUSHED ROCK BASE MATERIAL.

Beehive Overflow Inlet			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6120	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6120.dwg	APPROVED BY: NK	DATE: 2/15/18	PUBLIC WORKS STANDARDS

Otak

Frog Pond Terrace, Frog Pond Overlook

Preliminary Storm Drainage Report

Land Use

Submitted to:

City of Wilsonville
29799 SW Town Center Loop E.
Wilsonville, OR 97070

Prepared by:

Otak, Inc.
808 SW Third Avenue, Suite 800
Portland, OR 97204

March 2023

Project No. 21249

Acknowledgements

Project Name:	Frog Pond Terrace, Frog Pond Overlook
Type of Report:	Preliminary
Submittal Level:	Land Use

Site Information

Subject Property:	31W12D Tax lots 700, 2800, 2801
Applicant Information:	Dan Grimberg West Hills Land Development 3330 NW Yeon St. Suite 200 Portland, OR 97210 503-789-0358

Project Development Team

Stormwater Lead:	Rose Horton, PE
Stormwater Designer:	Roger Tiffany, EIT

TABLE OF CONTENTS

Section 1. Introduction

The Frog Pond Terrace and Frog Pond Overlook sites are proposed residential developments located within the West Neighborhood of the Frog Pond Area Plan. The combined 8.81 acres of property and right-of-way are comprised of Tax map 31W12D lots 700 (Terrace), 2800 and 2801 (Overlook) in Clackamas County within the City of Wilsonville Urban Growth Boundary (UGB) (see Vicinity Map). The Frog Pond Terrace and Frog Pond Overlook developments will consist of 19 and 21 single-family residential dwellings respectively as well as associated public infrastructure improvements including SW Frog Pond Lane, resulting in 5.00 acres in new or replaced impervious surface area.

The purpose of this document is to demonstrate compliance of the Frog Pond Terrace and Frog Pond Overlook stormwater management system with the City of Wilsonville Stormwater and Surface Water Design and Construction Standards (2015). Descriptions of the existing and proposed hydrologic conditions, as well as documentation showing compliance of the proposed onsite stormwater management system with City of Wilsonville standards for water quality and quantity are included in this report.

Vicinity Map

Section 2. Project Description

The Frog Pond Terrace and Frog Pond Overlook proposed residential developments consist of 40 new single-family lots, local street extensions, as well as sidewalks, public roadway improvements, utilities, and stormwater management systems that discharge to Boeckman Creek. Additionally, this project will include frontage improvements to SW Frog Pond Lane.

Permitting

The following permit applications will be required for this project:

- City of Wilsonville Development Permit
- Section 401 water quality certification from DEQ

Existing Conditions

The project site, shown in Figure 1, is primarily agricultural with a home and outbuildings that comprise 0.66 areas of impervious area. The Frog Pond Terrace project site slopes west at about 5% while the Frog Pond Overlook project site slopes north at about 4%. The right-of-way (ROW) of SW Frog Pond Lane that fronts on the Frog Pond Overlook site includes 0.02 acres of impervious pavement. Both project sites slope towards Boeckman Creek. This proposed project will maintain drainage patterns.

Proposed Conditions

Site improvements will include construction of approximately 5.00 acres of new or replaced impervious surfaces in the form of roof, roadway, and sidewalk area. A detention pond and vegetated stormwater swales are proposed to be constructed within the right-of-way and tracts to provide low impact development water quality treatment and flow control throughout the proposed residential developments. Runoff from approximately 14.5 acres of undeveloped offsite area will be conveyed through the site's stormwater infrastructure.

Section 3. Hydrology

Rainfall Depth

The following rainfall depths listed in Table 1 are provided in the City of Wilsonville Public Works Standards (2015). These depths correspond to design recurrence intervals which are used in hydrologic calculations for various aspects of stormwater management design.

Table 1 24 Hour Precipitation Depths

Recurrence Interval (Years)	Total Precipitation Depth (inches)
2	2.50
10	3.45
25	3.90
100	4.50

Pollutants of Concern

The pollutants of concern are those typically found in roadway runoff. These include sediment, oil and grease, polycyclic aromatic hydrocarbons (PAHs), metals such as Copper, Zinc, and Lead as well as pesticides and other nutrients (DEQ, 2016). Table 2 lists each waterway affected by this project and DEQ listing status.

Table 2 Pollutants of Concern

Waterway	Parameter	Listing Status
Boeckman Creek	N/A	None
Willamette River (Middle)	Chlorophyll a	303(d), TMDL needed

Waterway	Parameter	Listing Status
Willamette River (Middle)	E. Coli	TMDL approved
Willamette River (Middle)	Mercury	303(d), TMDL needed
Willamette River (Middle)	Temperature	TMDL approved

Wetlands

Wetland and water boundaries were delineated by AKS Engineering and Forestry on December 2, 2021. Wetlands were delineated adjacent to Boeckman Creek. The project is not anticipated to impact wetlands or waters. The project will impact the Significant Resource Overlay Zone (SROZ). Discussion of the impacts to sensitive areas will be provided by the environmental consultant, AKS.

Soils

The Web Soil Survey published by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) was referenced to determine the soil names, symbols, and hydrologic soil groups found on the project site. The soil type identified within the project area is identified as Woodburn silt loam (91B/C). These soils are classified as hydrologic soil type C, which in an undrained condition generally exhibit slow infiltration rates when thoroughly wet. The USDA soil survey map and the corresponding hydrologic soil group (HSG) for the area of interest are provided in Appendix A.

A geotechnical investigation was conducted to determine the site strata and infiltration rates. The field exploration did not encounter the static groundwater table and well data indicates that the groundwater table is at least 20 feet below ground surface. Perched groundwater conditions may occur during the wet season. Infiltration testing at a depth of five to six feet below ground surface yielded infiltration rates between 0.6 to 1.2 inches/hour. The geotechnical engineer stated that the lower value is more representative of the site and that a safety factor of at least 2 be applied to the design infiltration rate. The onsite Geotechnical Memorandum by Hardman Geotechnical Services is included in Appendix B.

Flood Hazard

The proposed development for this site is located outside the 100-year floodplain boundary designated by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for Clackamas County, Oregon and Incorporated Areas, Panel 234, June 17, 2008. See Appendix A for the FIRMette of the proposed site.

Section 4. Methodology

The stormwater system for the proposed Frog Pond Terrace/Overlook development was modeled using the following methods and design standards:

- Water Quality: The City of Wilsonville requires capture and treatment of 80% of the average annual runoff (approximately 1-inch in 24 hours). The City of Wilsonville has adopted a BMP Sizing Tool that was developed to aid in the design of detention and water quality low impact development facilities. The City of Wilsonville BMP Sizing Tool was used to size the minimum facility footprint areas to meet the water quality treatment standard.

- Flow Control: The BMP sizing tool was also simultaneously used to calculate facility sizes to include flow control. This tool provides the necessary calculations to design a facility to meet the City's flow

duration matching standards whereby the “duration of peak flow rates from post development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42% of the 2-year storm peak flow rate up to the 10-year peak flow rate.”

- Conveyance: The Santa Barbara Urban Hydrograph (SBUH) method will be used to calculate design conveyance flow rates and XP-SWMM software will be used to size the project conveyance system. The City’s design event for pipe conveyance is the 25-year, 24-hour storm, requiring 1-foot of freeboard between the hydraulic grade line and finished grade at structure rims.

BMP Sizing Tool Hydrology

The BMP Sizing Tool was created to aid in designing low impact development facilities for both treating stormwater runoff and matching flow durations between target conditions and developed conditions. City standards consider target conditions to be pre-development, prior to any human settlement. City of Wilsonville standards stipulate that the pre-developed vegetation of Oak Savannah, which applies to the project site, should be modeled in the sizing tool as grass. Proposed conditions were set to paved conditions for roof, roadway, and sidewalk, and set to landscaped conditions for landscaped and other disturbed pervious areas within the project boundary.

A detention pond and vegetated filtration swales will function to provide both water quality and flow control mitigation. The BMP Sizing Tool provides minimum facility footprint areas for treatment and flow control. The BMP Sizing Tool also provides the required orifice sizes for incorporating the flow control component into these facilities.

Drainage

The developed site drains to Boeckman Creek over a mile north of its discharge point at the Willamette River. The Boeckman Creek drainage basin upstream of the project site is approximately 800 acres and the project area comprises less than 2% of the contributing drainage basin. Boeckman Creek is confined to a deep channel approximately 40 feet below the adjacent developments. A flow control structure on the creek exists in Boeckman Creek directly upstream of SW Boeckman Road (Wilsonville, 1992). Otak conducted a downstream impact analysis on the downstream section of Boeckman Creek per City of Wilsonville standards and the downstream impact analysis is included in Appendix C.

Conveyance

The proposed development will include a piped conveyance network that will convey flows to Boeckman Creek. Pipes draining the project site will be designed to meet City of Wilsonville conveyance standards.

The Santa Barbara Urban Hydrograph (SBUH) method will be used to calculate runoff rates generated under proposed developed conditions for contributing onsite areas as well as offsite upstream areas. The City of Wilsonville Public Works Standards (2015) identifies the 25-year, 24-hour storm to be used for conveyance design, maintaining 1-foot of clearance between the hydraulic grade line and conveyance structure rim elevations. The City also requires an assessment of the 100-year storm event impacts to the proposed system. Flow rates during the 100-year may be conveyed overland but are not expected to inundate existing structures. The stormwater conveyance network will be sized during final design.

Section 5. Water Quality Treatment

Low Impact Development

The City of Wilsonville promotes the use of Low Impact Development (LID) approaches to meet water quality treatment standards. Locations of LID facilities for water quality treatment for the Frog Pond Terrace and Frog Pond Overlook project site are shown on Figures 2 and 3.

Water Quality Facilities

Water quality treatment will be provided through a detention pond and filtration vegetated swales. The BMP Sizing Tool was used to calculate minimum facility sizes to satisfy water quality requirements. Facility sizing calculation reports from the BMP Sizing Tool are provided in Appendix D.

The Frog Pond Terrace project includes right-of-way improvements that complete the northern side of SW Brisband Street. The southern side of the street was developed with the Morgan Farm Phase 2 project located south of Frog Pond Terrace. Frog Pond Terrace Basins T14 and MF will drain to an existing swale on the Morgan Farm project (see Figure 3). The Morgan Farm storm report (PDG, 2019) shows that Basin MF, which is located south of the property line, was included in the design of Morgan Farm Swale 1. The existing Swale 1 and contributing drainage areas were modeled in the BMP tool based on the WES BMP Sizing Report appendix of the Morgan Farm storm report and Basin T14 was added to confirm that the swale is adequately sized to manage runoff from both sides of the street.

The proposed ten-foot wide pedestrian trail along the west end of the site is located adjacent to a steep slope where it is not feasible to install stormwater management facilities. Runoff from the trail will sheet flow through a vegetated area toward Boeckman Creek. The trail is located 100 to 250 feet away from the creek.

Section 6. Flow Control

City of Wilsonville Public Works Standards (2015) requires the use of flow attenuation when a proposed development increases impervious surface area by more than 5,000 square feet. Therefore, this project site will require flow control mitigation prior to discharging site runoff to downstream conveyance systems (open or closed channels or conduits). Per City requirements, the “post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between 42% of the 2-year storm peak flow rate up to the 10-year peak flow rate.”

Flow control structures will be located immediately downstream of the detention pond and vegetated filtration swales, per the City’s standard detail. These facilities provide flow control by installing orifices at the end of their corresponding underdrain pipes to backwater flows into the available storage and voids present in facility soil and rock layers. Water is released from the facility through the orifice, which is sized to meter flows at a rate that meets flow control standards. Certain swales are sized to only provide water quality treatment. All proposed swales flow to the pond which provides flow control and water quality treatment.

Orifices are provided for flow control purposes only; construction details of the flow control structures are provided on the plan sheets. A summary of facilities to serve this project is presented in Tables 3 and 4.

Table 3 Facility Summary Table

Basin ID	Facility ID	Function	LID Min. Size, BMP Output (sf)	LID Treatment Size, Site Plan (sf)	Orifice Diameter (in)
T11	Swale 1	WQ	150	294	0.6
T12	Swale 2	WQ, FC	157	336	0.6
T13	Swale 3	WQ, FC	274	336	0.8
O3	Swale 4	WQ	182	221	0.6
O4	Swale 5	WQ	184	208	0.6
FP2, FP3	Swale 6	WQ	89	183	0.4
T15	Swale 8	WQ	47	128	0.3
T3	Swale 9	WQ	82	124	0.4

Table 4 Detention Pond Summary Table

Basin ID	Facility ID	Function	Max Depth (ft)	Treatment Area (sf)
T1-T2, T4-T10, T16, O1, O2a/b, O5, FP1, FP4, FP5	Pond	WQ, FC	5.0	7,523

Section 7. Operations and Maintenance

Vegetated facilities will be maintained by the private development. Operations and Maintenance requirements are included in Appendix E in conjunction with corresponding standard details for each type of facility. The following representative will be responsible for ongoing maintenance of onsite facilities: Dan Grimberg, Director of Land Development at West Hills Development, 503-641-7342.

Section 8. Conclusion

The proposed Frog Pond Terrace and Frog Pond Overlook developments will include a stormwater management system designed to comply with standards set forth by the City of Wilsonville. The proposed development will create 5.00 acres of impervious area. Runoff from impervious areas will be treated by LID facilities, including a detention pond and vegetated filtration swales. Flow control requirements will also be met by adding orifices at the downstream end of underdrain to regulate outflows from the detention pond and vegetated swales. The BMP Sizing Tool was used to calculate minimum facility and orifice sizes to satisfy water quality and flow control requirements. In accordance with City of Wilsonville standards, the conveyance system will be sized to convey the 25-year, 24-hour storm event with a minimum of 1-foot of freeboard between the hydraulic grade line (HGL) and the finished grade elevation.

Section 9. References

AKS, 2021A. *Natural Resources Feasibility Map SW Frog Pond Lane Martin Properties*, AKS Engineering & Forestry, October 2021.

AKS, 2021B. *Natural Resources Feasibility Map SW Frog Pond Lane Ross Properties*, AKS Engineering & Forestry, October 2021.

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SCS, 1986. *Technical Release 55: Urban Hydrology for Small Watersheds*, United States Department of Agriculture Soil Conservation Service, June 1986.

USACE, 2014. Standard Local Operating Procedures for Endangered Species (*SLOPES V) to Administer Maintenance or Improvement of Stormwater, Transportation or Utility Actions*, United States Army Corps of Engineers, March 14, 2014.

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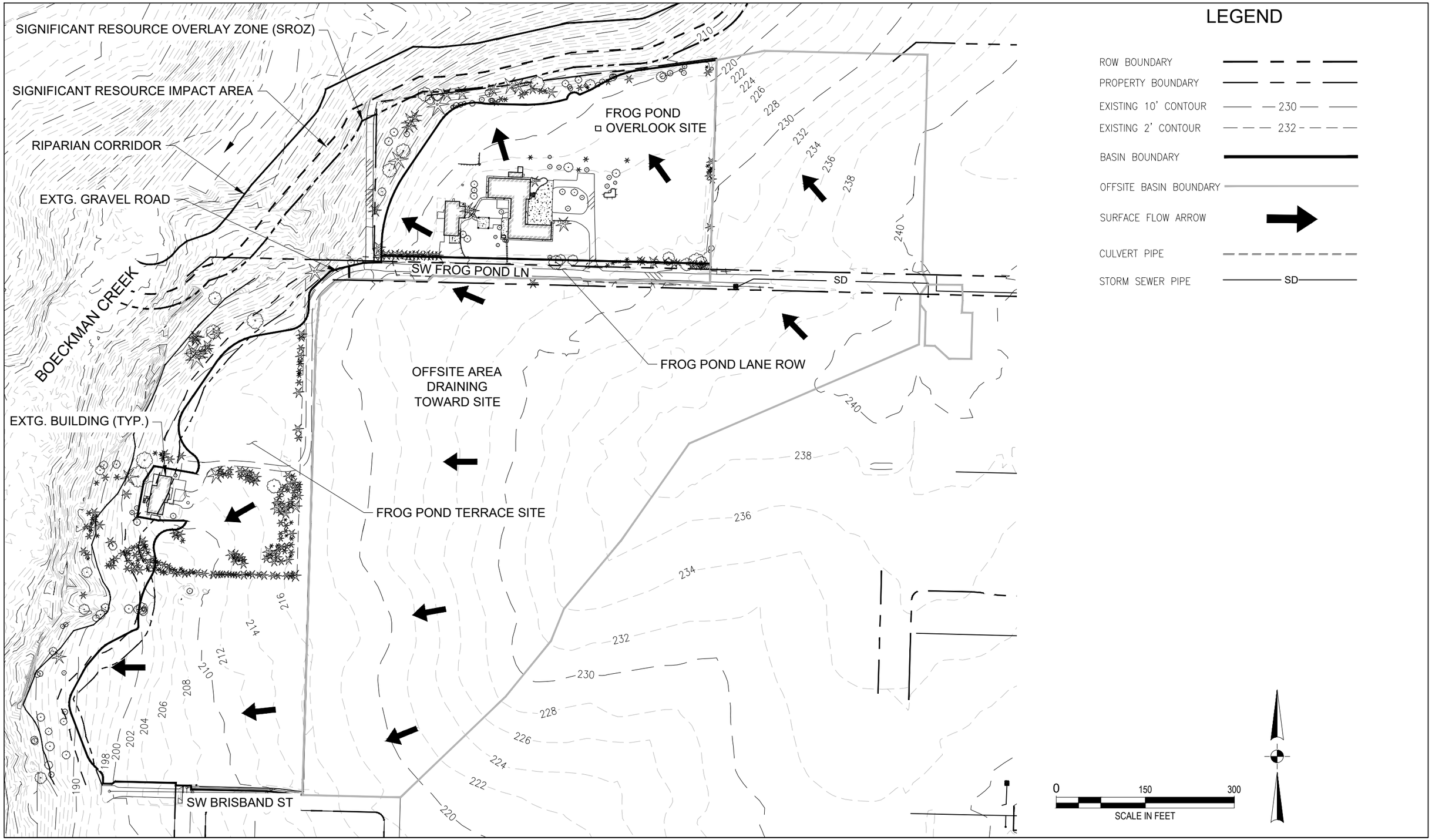
Wilsonville, 2015. *City of Wilsonville Public Works Standards. Section 3, Stormwater & Surface Water Design and Construction Standards 2015*; Revised December 2015.

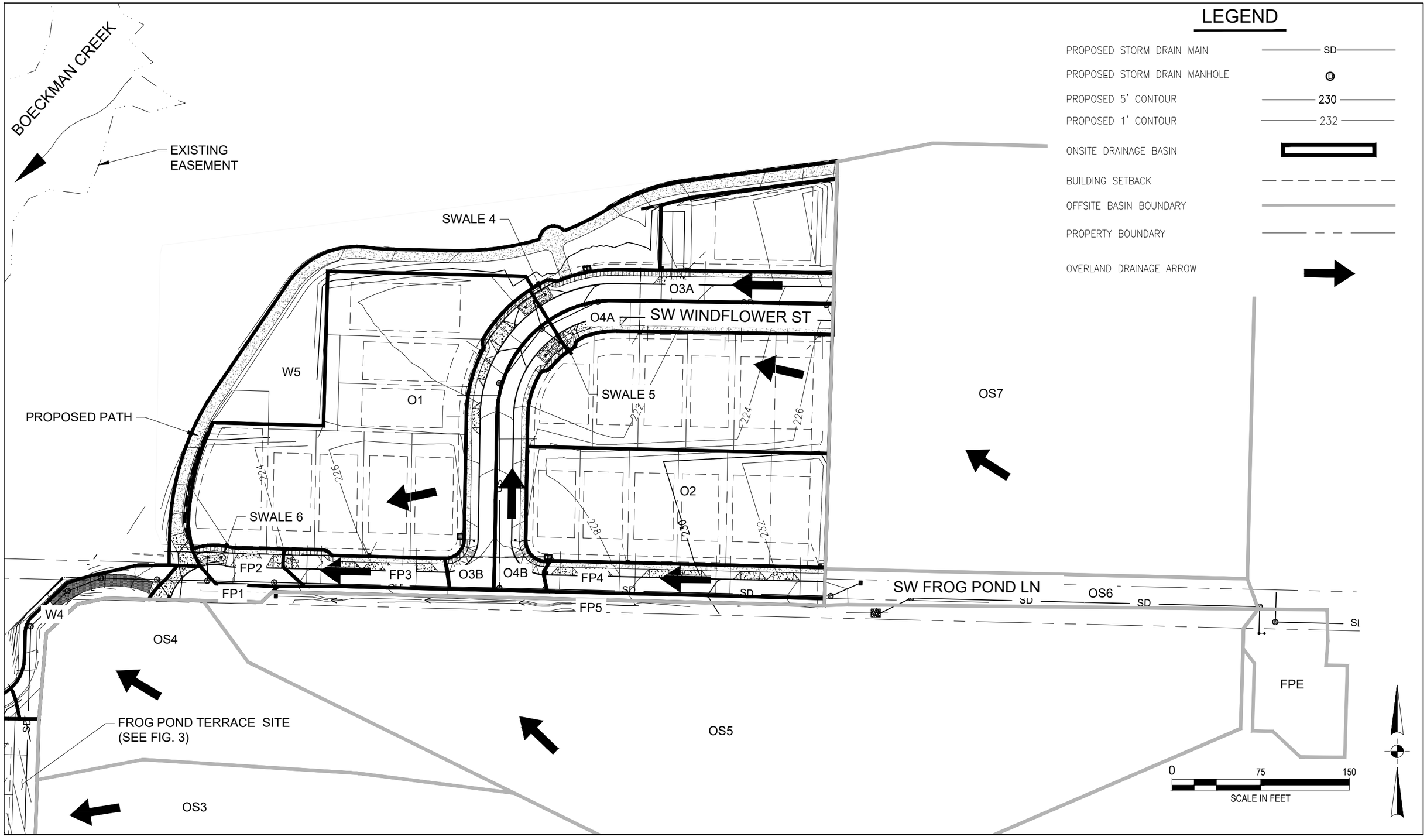
Figures



FROG POND TERRACE & OVERLOOK | PRELIMINARY DESIGN | EXISTING CONDITIONS

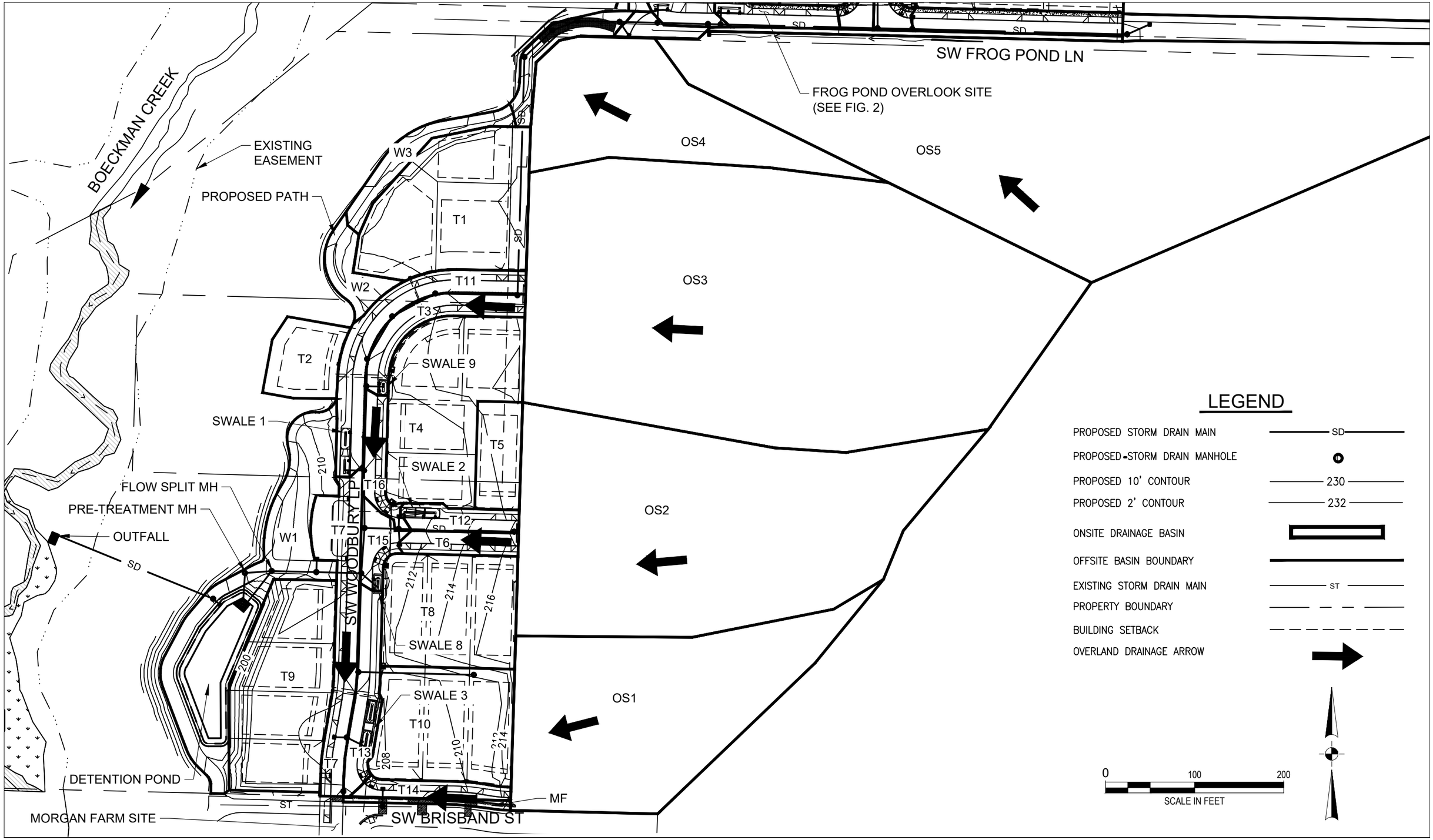
FIG 1 | AUGUST 2022 | PROJECT NUMBER: 20015

Otak



FROG POND OVERLOOK | PRELIMINARY DESIGN | PROPOSED CONDITIONS

FIG 2 | MARCH 2023 | PROJECT NUMBER: 20015/21249



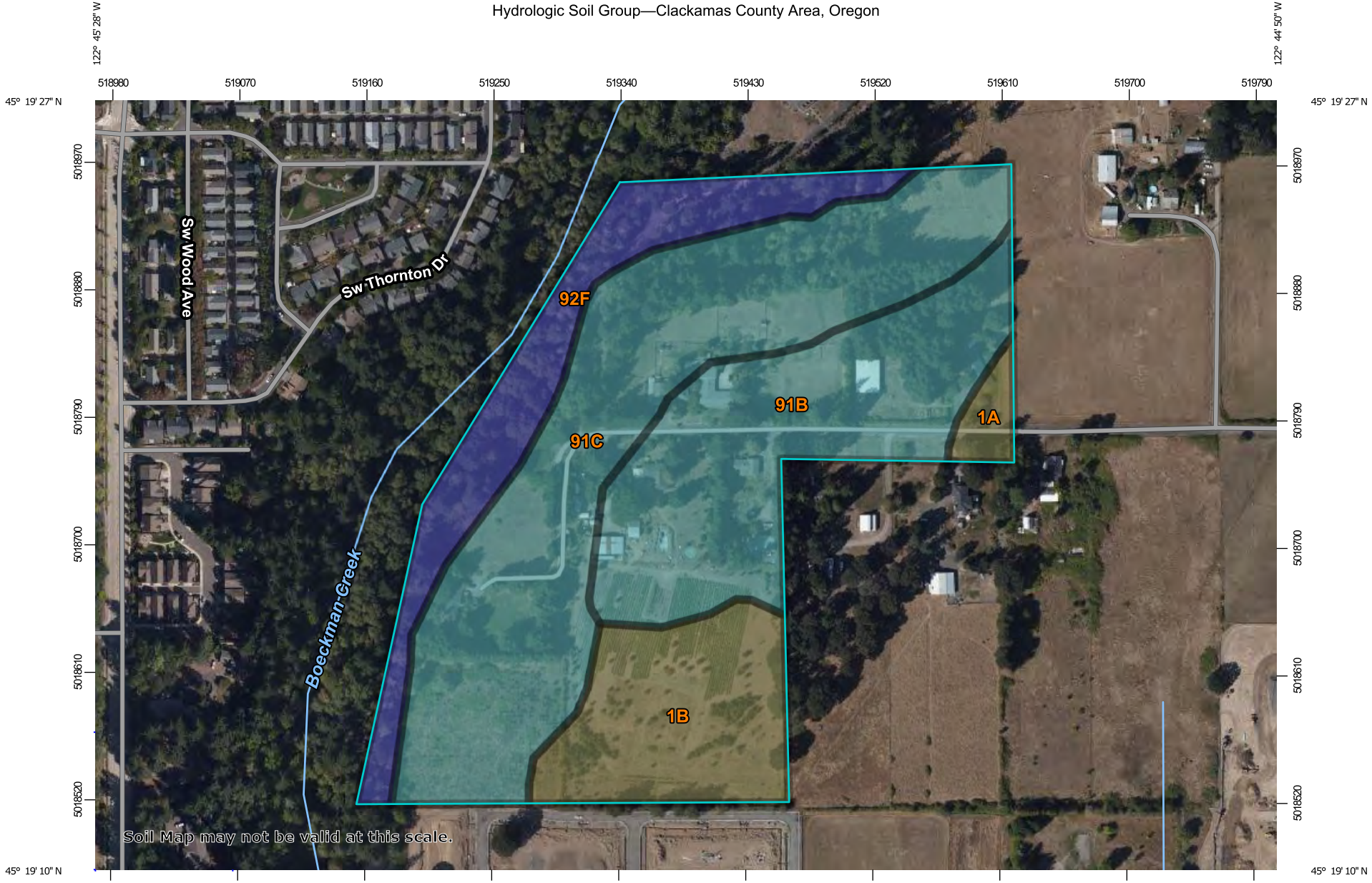
FROG POND TERRACE | PRELIMINARY DESIGN | PROPOSED CONDITIONS

FIG 3 | JANUARY 2023 | PROJECT NUMBER: 20015

Otak

Appendix A

Hydrology



Map Scale: 1:3,830 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 1:20,000.

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: Clackamas County Area, Oregon
Survey Area Data: Version 16, 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: Aug 1, 2019—Sep 12, 2019

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1A	Aloha silt loam, 0 to 3 percent slopes	C/D	0.6	1.9%
1B	Aloha silt loam, 3 to 6 percent slopes	C/D	5.1	15.1%
91B	Woodburn silt loam, 3 to 8 percent slopes	C	8.9	26.7%
91C	Woodburn silt loam, 8 to 15 percent slopes	C	13.9	41.3%
92F	Xerochrepts and Haploxerolls, very steep	B	5.0	15.0%
Totals for Area of Interest			**33.5**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

MAP SCALE 1" = 500'

250 0 500 1000 FEET

MET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0234D

FIRM

FLOOD INSURANCE RATE MAP

CLACKAMAS COUNTY, OREGON

AND INCORPORATED AREAS

PANEL 234 OF 1175

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CLACKAMAS COUNTY	415588	0234	D
WILSONVILLE, CITY OF	410025	0234	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
41005C0234D

EFFECTIVE DATE
JUNE 17, 2008

Federal Emergency Management Agency

Drainage Basin Areas

20015 Frog Pond Terrace/Frog Pond Overlook

Existing Conditions:

	Impervious Area		Pervious Area		Total Area	
Basin Name	Total (sf)	Total (ac)	Total (sf)	Total (ac)	(sf)	(ac)
Site Total	**28588**	**0.66**	**357,220**	**8.20**	**385,808**	**8.86**
Terrace	3,451	0.08	214,018	4.91	217,469	4.99
Overlook	16,780	0.39	131,665	3.02	148,445	3.41
ROW	8,357	0.19	11,537	0.26	19,894	0.46
Offsite					**641,947**	**14.74**

Proposed Impervious Area per Lot 2,750 SF (2015 Public Works Stds 301.4.01)
Proposed Middle Housing Impervious Area per lot 2,420 SF (Overlook only)

Proposed Conditions: 40.0 lots HSG Type C

		Impervious Area				Pervious Area		Total Area	
Basin	Treated By	Roadway (sf)	Roof (sf)	Total (sf)	Total (ac)	(sf)	(ac)	(sf)	(ac)
Site Total		**113,750**	**104,060**	**217,810**	**5.00**	**167,991**	**3.86**	**385,801**	**8.86**
T1	Pond	2,281	8,250	10,531	0.24	15,541	0.36	26,072	0.60
T2	Pond	0	2,750	2,750	0.06	4,073	0.09	6,823	0.16
T3	Swale 9	5,035	0	5,035	0.12	851	0.02	5,886	0.14
T4	Pond	0	11,000	11,000	0.25	14,166	0.33	25,166	0.58
T5	Pond	0	2,750	2,750	0.06	3,313	0.08	6,063	0.14
T6	Pond	3,018	0	3,018	0.07	358	0.01	3,376	0.08
T7	Pond	11,203	0	11,203	0.26	358	0.01	11,561	0.27
T8	Pond	0	8,250	8,250	0.19	10,705	0.25	18,955	0.44
T9	Pond	0	11,000	11,000	0.25	13,021	0.30	24,021	0.55
T10**	Pond	0	8,250	8,250	0.19	11,390	0.26	19,640	0.45
T11	Swale 1	9,707	0	9,707	0.22	548	0.01	10,255	0.24
T12	Swale 2	2,693	0	2,693	0.06	889	0.02	3,582	0.08
T13	Swale 3	4,670	0	4,670	0.11	1,602	0.04	6,272	0.14
T14	MF Swale	2,924	0	2,924	0.07	386	0.01	3,310	0.08
T15	Swale 8	3,005	0	3,005	0.07	171	0.00	3,176	0.07
T16	Pond	3,439	0	3,439	0.08	348	0.01	3,787	0.09
O1	Pond	0	20,020	20,020	0.46	22,224	0.51	42,244	0.97
O2a	Pond	0	14,520	14,520	0.33	9,916	0.23	24,436	0.56
O2b	Pond	0	14,520	14,520	0.33	9,657	0.22	24,177	0.56
O3a	Swale 4	5,079	0	5,079	0.12	1,551	0.04	6,630	0.15
O3b	Swale 4	6,395	0	6,395	0.15	919	0.02	7,314	0.17
O4a	Swale 5	6,239	0	6,239	0.14	0	0.00	6,239	0.14
O4b	Swale 5	5,385	0	5,385	0.12	1,180	0.03	6,565	0.15
O5	Pond	1,101	2,750	3,851	0.09	6,347	0.15	10,198	0.23
MF	MF Swale	1,101	0	1,101	0.03	189	0.00	1,290	0.03
FP1	Pond	1,851	0	1,851	0.04	0	0.00	1,851	0.04
FP2	Swale 6	2,168	0	2,168	0.05	183	0.00	2,351	0.05
FP3	Swale 6	3,657	0	3,657	0.08	0	0.00	3,657	0.08
FP4	Pond	6,143	0	6,143	0.14	0	0.00	6,143	0.14
FP5	Pond	2,743	0	2,743	0.06	0	0.00	2,743	0.06
W1	Veg Corridor	9,862	0	9,862	0.23	16,617	0.38	26,479	0.61
W2	Veg Corridor	1,305	0	1,305	0.03	2,667	0.06	3,972	0.09
W3	Veg Corridor	2,398	0	2,398	0.06	2,472	0.06	4,870	0.11
W4	Veg Corridor	1,885	0	1,885	0.04	2,246	0.05	4,131	0.09
W5	Veg Corridor	8,463	0	8,463	0.19	14,103	0.32	22,566	0.52
Pond Total				**135,839**	**3.12**	**121,992**	**2.80**	**261,856**	**6.01**
Offsite Total				**349,770**	**8.03**	**292,177**	**6.71**	**641,947**	**14.74**
OS1	Offsite*			30,737	0.71	25,149	0.58	55,886	1.28
OS2	Offsite*			52,874	1.21	43,260	0.99	96,134	2.21
OS3	Offsite*			89,730	2.06	73,415	1.69	163,145	3.75
OS4	Offsite*			17,929	0.41	14,670	0.34	32,599	0.75
OS5	Offsite*			81,524	1.87	66,702	1.53	148,226	3.40
OS6	Offsite*			4,990	0.11	4,083	0.09	9,073	0.21
OS7	Offsite*			70,449	1.62	57,640	1.32	128,089	2.94
FPE	FPE RG/Swale			1,536	0.04	7,259	0.17	8,795	0.20

* For conveyance sizing offsite areas are assumed to be developed to 55% imperviousness

**Basin T10 pervious area drains to SDMH 2C and roofs drain to SDMH 6A

Appendix B

Geotechnical Report

HARDMAN GEOTECHNICAL SERVICES INC.
Practical, Cost-Effective Engineering Solutions

December 15, 2021
HGSI Project No. 21-2824

Dan Grimberg / Kristi Hosea
West Hills Land Development
3330 NW Yeon Avenue, Suite 200
Portland, Oregon 97210

Via e-mail (pdf format); hard copies mailed upon request

Subject: **GEOTECHNICAL ENGINEERING AND INFILTRATION TESTING REPORT**
FROG POND WEST-WEST
MARTIN, GEORGE AND ROSS PROPERTIES
WILSONVILLE, OREGON

This report presents the results of a geotechnical engineering study conducted by Hardman Geotechnical Services Inc. (HGSI) for Frog Pond West-West (Martin, George and Ross Properties) in Wilsonville, Oregon (Figure 1). The purpose of this study was to evaluate subsurface conditions at the site and to provide geotechnical recommendations for site development.

SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The project totals about 15.07 acres, as summarized below. Please note that the parcel addresses and acreages were taken from the Clackamas County GIS website and are only as accurate as the information provided.

Property	Tax Lot No.	Address	Acreage	House Constructed Date
Ross	31W12D 00700	7315 SW Frog Pond Ln	4.09	1964
George	31W12D 02801	7500 SW Frog Pond Ln	2.00	1972
Martin	31W12D 02800	No address	8.98	--

The Ross and George properties are currently occupied by residential homes, with several detached shops, garages and barns. Existing facilities are present only within the eastern, more flat-lying portion of the overall site. The areas surrounding the homes and other structures are landscaped with lawn, shrubbery and ornamental or fruit-bearing trees. No structures are present on the Martin property, which is overgrown with blackberries, etc. Along the western edge of the site is an area of steep slopes descending down to Boeckman Creek. The steep slope is vegetated with large deciduous and evergreen trees, and undergrowth.

Preliminary plans indicate the site will be developed into a 31-lot residential subdivision that will include two separate tracts with the intention of having one or both serve as water quality/detention facilities. The actual number of lots may vary as project design progresses. Site development will also include construction of on-site streets and underground utilities. All of the proposed development is within the eastern, flat to gently sloping portion of the site. The steep slopes in the western portion of the site are to remain open space.

In the northwest portion of the site, a temporary access easement extends near the top of the steep slope area. HGSI has studied potential landslide hazards and slope stability specific to this area, in a previous report (HGSI, 2021). The report concludes that the planned utility lines and temporary access way can be safely constructed, with a low-height soldier pile wall along the downslope (northwest) portion of the easement to protect against surficial soil sloughing/erosion.

REGIONAL GEOLOGY AND SEISMIC SETTING

The subject site lies within the heart of the Portland Basin, a broad structural depression situated between the Coast Range on the west and the Cascade Range on the east. The Portland Basin is a northwest-southwest trending structural basin produced by broad regional downwarping of the area. The Portland Basin is approximately 20 miles wide and 45 miles long and is filled with consolidated and unconsolidated sedimentary rocks of late Miocene, Pliocene and Pleistocene age.

Geologic maps indicate the subject site is underlain by Quaternary age (last 1.6 million years) Willamette Silt, fine flood deposits that mantles basalt bedrock (Madin, 1990). This generally consists of massive fine sand and silt deposited following repeated catastrophic flooding events in the Willamette Valley, the last of which occurred between 15,000 and 10,000 years ago. In localized areas, the light brown sandy silts include buried paleosols that developed between depositional events. Regionally, the total thickness of catastrophic flood deposits range from 5 feet to greater than 100 feet.

The Willamette Formation is underlain by residual soil formed by in place weathering of the underlying Columbia River Basalt Formation (Madin, 1990). The Miocene aged (about 14.5 to 16.5 million years ago) Columbia River Basalts are a thick sequence of lava flows which form the crystalline basement of the Tualatin Valley. The basalts are composed of dense, finely crystalline rock that is commonly fractured along blocky and columnar vertical joints. Individual basalt flow units typically range from 25 to 125 feet thick and interflow zones are typically vesicular, scoriaceous, brecciated, and sometimes include sedimentary rocks.

At least three major fault zones capable of generating damaging earthquakes are known to exist in the region. These include the Portland Hills Fault Zone, Gales Creek-Newberg-Mt. Angel Structural Zone, and the Cascadia Subduction Zone. These potential earthquake source zones are included in the determination of seismic design values for structures, as presented in the *Seismic Design* section. None of the known faults extend beneath the site.

FIELD EXPLORATION

Test Pits and Exploratory Hand Auger Borings

The site-specific exploration for this study was conducted on October 22, 2021 and December 3 and 9, 2021. On October 22, 2021 HGSI oversaw the excavation of two test pits using a medium-sized excavator in the area of the temporary easement (Figure 2). Test pits TP-3 through TP-11 were excavated on December 3, 2021, using a rubber-tired backhoe with extend-a-hoe attachment. Six hand auger borings (HA-1 through HA-6) were drilled on December 3 and 9, 2021 by HGSI staff using hand auger tools. Explorations were conducted at the approximate locations shown on the attached Site Plan, Figure 2.

Explorations were conducted under the full-time observation of HGSI personnel. Soil samples obtained from the borings were classified in the field and representative portions were placed in relatively air-tight plastic bags. These soil samples were then returned to the laboratory for further examination. Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. Soils were classified in general accordance with the Unified Soil Classification System.

Summary exploration logs are attached to this report. The stratigraphic contacts shown on the individual exploration logs represent the approximate boundaries between soil types. The actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

Infiltration Testing

On December 3, 2021, HGSI performed falling head infiltration tests using the open-hole method in hand auger borings HA-1, HA-2 and HA-3. The infiltration testing was performed by measuring the water level at one-minute intervals using HOBO™ data loggers, which measures water pressure corrected for temperature and barometric pressure. See attached HOBO™ water level data logger plot. The infiltration rate was determined based on the slope of the water depth line near the end of the test. Table 1 presents the results of the falling head infiltration tests.

Table 1. Summary of Infiltration Test Results

Boring	Depth (feet)	Soil Type	Infiltration Rate (in/hr)	Hydraulic Head Range during Testing (inches)
HA-1	5	Silt with Clay (ML)	0.6	7.8 – 6.6
HA-2	6	Fine Sandy Silt (ML)	1.1	15 - 14
HA-3	6	Fine Sandy Silt (ML)	1.2	14 – 13

The average of the three infiltration tests is 1.0 inches/hour. Reported values are ultimate and should be adjusted using an appropriate factor of safety for design purposes.

SUBSURFACE CONDITIONS

The following discussion is a summary of subsurface conditions encountered in our explorations. For more detailed information regarding subsurface conditions at specific exploration locations, refer to the attached hand auger logs. Also, please note that subsurface conditions can vary between exploration locations, as discussed in the *Uncertainty and Limitations* section below.

Soil

On-site soils are anticipated to consist of undocumented fill, topsoil, colluvium, and Willamette Formation soils as described below.

> ***Undocumented Fill*** – In the northeast portion of the Ross Property, we encountered an area of undocumented fill. Test Pits TP-8, TP-9 and TP-10; and hand auger boring HA-3 encountered undocumented fill extending to 4.5 to 5 feet bgs. Between the fill and native soils a zone of old

topsoil was encountered in all three of the test pits. Undocumented fill consisted generally of soft silt with trace organics, and trace amounts of crushed rock and other erratic material.

Topsoil – Beginning at the surface level, all explorations encountered a zone of topsoil about 6 to 12 inches thick. The topsoil was generally comprised of soft, wet to moist dark brown organic silt. The upper roughly 6 inches of the topsoil appeared highly organic.

Colluvium – In TP-1 we encountered a zone of colluvium, comprised of stiff clayey silt with black and orange mottling. This material had a weathered, slightly disturbed appearance and extended to a depth of about 2.5 feet bgs. Colluvium, a zone of down-slope creep occurring due to weathering of surficial soils on natural slopes, was not encountered in the other test pits and hand auger borings.

Willamette Silt – Beneath the undocumented fill, topsoil and/or colluvium, all explorations encountered stiff to very stiff, moist to very moist, brown silt, clayey silt and silt with fine sand interpreted as Willamette Formation. The upper several feet of this unit exhibited orange and gray mottling. All explorations were terminated in the Willamette Silt unit, at depths ranging from 5 to 13 feet bgs.

Groundwater

Seepage was encountered in two of the deeper test pits, TP-4 and TP-7, at depths of about 13 and 10 feet respectively. During the field exploration, no seepage or static groundwater table was encountered in the other explorations. Based on nearby water well data, depth to static groundwater is at least 20 feet below the ground surface. Perched groundwater conditions often occur over fine-grained native deposits such as those beneath the site, particularly during the wet season. It is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in site utilization, and other factors. The perched groundwater conditions reported above are for the specific date and locations indicated, and therefore may not necessarily be indicative of other times and/or locations.

CONCLUSIONS AND RECOMMENDATIONS

Results of this study indicate that the proposed development is geotechnically feasible, provided that the recommendations of this report are incorporated into the design and construction phases of the project. The proposed development avoids the steep slope area to the west; slope stability impacts are considered minimal as discussed in the *Slope Stability and Landslide Hazards* section. Recommendations are presented below regarding site preparation and undocumented fill removal, engineered fill, fill slope keying and benching, wet weather earthwork, spread footing foundations, below grade structural retaining walls, concrete slabs-on-grade, perimeter footing drains, seismic design, excavating conditions and utility trench backfill, stormwater infiltration systems, and erosion control considerations.

Slope Stability and Landslide Hazards

For the purpose of evaluating slope stability, we reviewed published geologic and hazard mapping, reviewed regional site topography and LIDAR images, performed a field reconnaissance, and evaluated subsurface soil conditions in exploratory test pits and hand auger borings.

Reconnaissance observations indicate that slope geomorphology at the site is generally smooth and uniform, consistent with stable slope conditions. No geomorphic evidence of prior slope instability (such as hummocky topography, benches or old scarps) was observed. No seeps or springs were observed on site.

Regional geologic mapping and the Oregon Department of Geology and Mineral Industries online landslide database (SLIDO, 2017) shows a small mapped landslide in the western portion of the Martin/George

property (Figure 3). This feature is mapped with low (<10%) confidence level, and historical (<150 years) in age. In our opinion this mapped ancient slide is not indicative of a significant slope stability hazard to the site, and is located far enough away from the proposed development that slope stability impacts are not anticipated.

In the northwest portion of the site between the Ross and Martin Properties (Figures 2 and 3), a temporary access easement extends near the top of the steep slope area. HGSI has studied potential landslide hazards and slope stability specific to this area, in a previous report (HGSI, 2021). The report concludes that the planned utility lines and temporary access way can be safely constructed, with a low-height soldier pile wall along the downslope (northwest) portion of the easement to protect against surficial soil sloughing/erosion.

The planned development does not extend onto the steep slope areas in the western portion of the site. Based on our observations and results of the slope stability evaluation, it is our opinion that no special design or construction provisions are needed to address slope issues on the site, with the exception of the soldier pile wall planned in conjunction with the temporary access easement (HGSI, 2021). The project will be designed and constructed per current building codes, City of Wilsonville requirements, and the current standard-of-practice in geotechnical engineering. As such, it is our opinion that adequate slope stability factors of safety will be maintained for both temporary construction, and long-term conditions.

We understand that the proposed storm water management plan may consist of flow through planters, stormwater ponds or swales, with overflow to an approved outlet. Significant infiltration of stormwater via stormwater chambers or dry wells is not proposed for this site based on soil conditions and infiltration test results. The planned storm water facilities are not anticipated to impact slope stability on site, or to create any unstable conditions. Storm water management systems should be designed such that potential overflow is discharged in a controlled manner away from structures and slopes, and all systems should include an adequate factor of safety.

Site Preparation and Undocumented Fill Removal

The areas of the site to be graded should first be cleared of vegetation and any loose debris; and debris from clearing should be removed from the site. Organic-rich topsoil should then be removed to competent native soils. We anticipate that the average depth of topsoil stripping will be 6 to 12 inches over most of the site. Deeper stripping / root picking may be needed in areas that are or were formerly treed. The final depth of stripping removal may vary depending on local subsurface conditions and the contractor's methods, and should be determined on the basis of site observations after the initial stripping has been performed. Stripped organic soil should be stockpiled only in designated areas or removed from the site and stripping operations should be observed and documented by HGSI. Existing subsurface structures (tile drains, old utility lines, septic leach fields, etc.) beneath areas of proposed structures and pavement should be removed and the excavations backfilled with engineered fill.

Undocumented fill was encountered in the northeast portion of the Ross Property, in TP-8, TP-9 and TP-10; and HA-3, at depths of about 4.5 to 5 feet bgs. There is potential for old fills to be present on site in areas beyond our explorations. Where encountered beneath proposed structures, pavements, or other settlement-sensitive improvements, undocumented fill should be removed down to firm inorganic native soils and the removal area backfilled with engineered fill (see below). HGSI should observe removal excavations (if any) prior to fill placement to verify that overexcavations are adequate and an appropriate bearing stratum is exposed.

In construction areas, once stripping has been verified, the area should be ripped or tilled to a depth of 12 inches, moisture conditioned, and compacted in-place prior to the placement of engineered fill. Exposed subgrade soils should be evaluated by HGSI. For large areas, this evaluation is normally performed by

proof-rolling the exposed subgrade with a fully loaded scraper or dump truck. For smaller areas where access is restricted, the subgrade should be evaluated by probing the soil with a steel probe. Soft/loose soils identified during subgrade preparation should be compacted to a firm and unyielding condition or over-excavated and replaced with engineered fill, as described below. The depth of overexcavation, if required, should be evaluated by HGSI at the time of construction.

Engineered Fill

In general, we anticipate that on-site soils will be suitable for use as engineered fill in dry weather conditions, provided they are relatively free of organics and are properly moisture conditioned for compaction. Imported fill material must be approved by the geotechnical engineer prior to being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Engineered fill should be compacted in horizontal lifts not exceeding 8 inches using standard compaction equipment. We recommend that engineered fill be compacted to at least 90 percent of the maximum dry density determined by ASTM D1557 (Modified Proctor) or equivalent. On-site soils may be wet or dry of optimum; therefore, we anticipate that moisture conditioning of native soil will be necessary for compaction operations.

Proper test frequency and earthwork documentation usually requires daily observation and testing during stripping, rough grading, and placement of engineered fill. Field density testing should conform to ASTM D2922 and D3017, or D1556. Engineered fill should be periodically observed and tested by the project geotechnical engineer or his representative. Typically, one density test is performed for at least every 2 vertical feet of fill placed or every 500 yd^3, whichever requires more testing.

Fill Slope Keying and Benching

Engineered fill placed on slopes requires keying and benching. We recommend that cut and fill slopes for the project be planned no steeper than 2H:1V. Fill slopes constructed over sloping ground should be constructed in accordance with the Fill Slope Detail, Figure 4. For fill slopes constructed at 2H:1V or flatter, and comprised of engineered fill placed and compacted as recommended herein, we anticipate that adequate factors of safety against global failure will be maintained.

Prior to placing compacted fill against the existing natural slopes, all loose undocumented fill, topsoil, and soft soils must first be removed. Adequate benching must be maintained. Fill slope keyways should be constructed with a minimum depth of 2 feet and minimum width of H/3 (10 feet minimum), where H equals the vertical height between the base and top of the fill slope. Both benches and keyways should be roughly horizontal in the down slope direction. A subdrain should be incorporated in the fill slope keyway, and HGSI should observe the keyway excavations prior to the placement of fill.

Measures should be taken to prevent surficial instability and/or erosion of embankment material. This can be accomplished by conscientious compaction of the embankment fills all the way out to the slope face, by maintaining adequate drainage, and planting the slope face as soon as possible after construction. To achieve the specified relative compaction at the slope face, it may be necessary to overbuild the slopes several feet, and then trim back to design finish grade. In our experience, compaction of slope faces by "track-walking" is generally ineffective and is therefore not recommended.

Wet Weather Earthwork

The on-site soils are moisture sensitive and may be difficult to handle or traverse with construction equipment during periods of wet weather. Earthwork is typically most economical when performed under dry weather conditions. Earthwork performed during the wet-weather season will probably require

expensive measures such as cement treatment or imported granular material to compact fill to the recommended engineering specifications. If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean engineered fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Material used as engineered fill should consist of clean, granular soil containing less than about 7 percent fines. The fines should be non-plastic. Alternatively, cement treatment of on-site soils may be performed to facilitate wet weather placement;
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials;
- Excavation and placement of fill should be observed by the geotechnical engineer to verify that all unsuitable materials are removed and suitable compaction and site drainage is achieved; and
- Bales of straw and/or geotextile silt fences should be strategically located to control erosion.

If cement or lime treatment is used to facilitate wet weather construction, HGSI should be contacted to provide additional recommendations and field monitoring

Spread Footing Foundations

Shallow, conventional isolated or continuous spread footings may be used to support the proposed structures, provided they are founded on competent native soils, or compacted engineered fill placed directly upon the competent native soils. We recommend a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for designing spread footings bearing on undisturbed native soils or engineered fill. The recommended maximum allowable bearing pressure may be increased by a factor of 1.33 for short term transient conditions such as wind and seismic loading. Exterior footings should be founded at least 18 inches below the lowest adjacent finished grade. Minimum footing widths should be determined by the project engineer/architect in accordance with applicable design codes.

Assuming construction is accomplished as recommended herein, and for the foundation loads anticipated, we estimate total settlement of spread foundations of less than about 1 inch and differential settlement between two adjacent load-bearing components supported on competent soil of less than about ½ inch. We anticipate that the majority of the estimated settlement will occur during construction, as loads are applied.

Wind, earthquakes, and unbalanced earth loads will subject the proposed structure to lateral forces. Lateral forces on a structure will be resisted by a combination of sliding resistance of its base or footing on the underlying soil and passive earth pressure against the buried portions of the structure. For use in design, a coefficient of friction of 0.5 may be assumed along the interface between the base of the footing and subgrade soils. Passive earth pressure for buried portions of structures may be calculated using an equivalent fluid weight of 390 pounds per cubic foot (pcf), assuming footings are cast against dense, natural soils or engineered fill. The recommended coefficient of friction and passive earth pressure values do not include a

safety factor. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

Footing excavations should be trimmed neat and the bottom of the excavation should be carefully prepared. Loose, wet or otherwise softened soil should be removed from the footing excavation prior to placing reinforcing steel bars. HGSI should observe foundation excavations prior to placing crushed rock, to verify that adequate bearing soils have been reached. Due to the high moisture sensitivity of on-site soils, construction during wet weather may require overexcavation of footings and backfill with compacted, crushed aggregate.

Below-Grade Cantilever Concrete Retaining Walls

Recommendations are provided below for design of concrete retaining walls. Footings for below-grade cantilever concrete walls should be designed using the 2,000 psf allowable soil bearing pressure recommended in the *Spread Footing Foundations* section. Lateral earth pressures against below-grade retaining walls will depend upon the inclination of any adjacent slopes, type of backfill, degree of wall restraint, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any adjacent surcharge loads. At-rest soil pressure is exerted on a retaining wall when it is restrained against rotation. In contrast, active soil pressure will be exerted on a wall if its top is allowed to rotate or yield a distance of roughly 0.001 times its height or greater.

Table 2 below provides recommended lateral earth pressure values for unrestrained and restrained walls, for both level backfill conditions and 2H:1V (Horizontal:Vertical) sloping ground conditions at the top of the wall. These values assume that the recommended drainage provisions are incorporated, and hydrostatic pressures are not allowed to develop against the wall.

Table 2. Recommended Lateral Earth Pressures for Below-Grade Structural Walls

Earth Pressure Condition	Level at Top of Wall	2H:1V Slope at Top of Wall
Active (unrestrained wall)	35	54
At-rest (restrained wall)	55	74

During a seismic event, lateral earth pressures acting on below-grade structural walls will increase by an incremental amount that corresponds to the earthquake loading. Based on the Mononobe-Okabe equation and peak horizontal accelerations appropriate for the site location, seismic loading should be modeled using the active or at-rest earth pressures recommended above, plus an incremental rectangular-shaped seismic load of magnitude 5H, where H is the total height of the wall.

We assume relatively level ground surface below the base of the walls. As such, we recommend passive earth pressure of 390 pcf for use in design, assuming wall footings are cast against competent native soils or engineered fill. If the ground surface slopes down and away from the base of any of the walls, a lower passive earth pressure should be used and HGSI should be contacted for additional recommendations.

A coefficient of friction of 0.5 may be assumed along the interface between the base of the wall footing and subgrade soils. The recommended coefficient of friction and passive earth pressure values do not include a safety factor, and an appropriate safety factor should be included in design. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

The above recommendations for lateral earth pressures assume that the backfill behind the subsurface walls will consist of properly compacted structural fill, and no adjacent surcharge loading. If the walls will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the wall, the walls should be designed for the additional horizontal pressure. For uniform surcharge pressures, a uniformly distributed lateral pressure of 0.3 times the surcharge pressure should be added.

The recommended equivalent fluid densities assume a free-draining condition behind the walls so that hydrostatic pressures do not build up. This can be accomplished by placing a 12-inch wide zone of crushed drain rock containing less than 5 percent fines against the walls. A 3-inch minimum diameter perforated, plastic drain pipe should be installed at the base of the walls and connected to a sump to remove water from the crushed drain rock zone. The drain pipe should be wrapped in filter fabric (Mirafi 140N or other as approved by the geotechnical engineer) to minimize clogging. The above drainage measures are intended to remove water from behind the wall to prevent hydrostatic pressures from building up. Additional drainage measures may be specified by the project architect or structural engineer, for damp-proofing or other reasons.

HGSI should be contacted during construction to verify subgrade strength in wall keyway excavations, to verify that backslope soils are in accordance with our assumptions, and to take density tests on the wall backfill materials.

Concrete Slabs-on-Grade

Preparation of areas beneath concrete slab-on-grade floors should be performed as recommended in the *Site Preparation* section. Care should be taken during excavation for foundations and floor slabs, to avoid disturbing subgrade soils. If subgrade soils have been adversely impacted by wet weather or otherwise disturbed, the surficial soils should be scarified to a minimum depth of 8 inches, moisture conditioned to within about 3 percent of optimum moisture content, and compacted to engineered fill specifications. Alternatively, disturbed soils may be removed and the removal zone backfilled with additional crushed rock. For evaluation of the concrete slab-on-grade floors using the beam on elastic foundation method, a modulus of subgrade reaction of 200 kcf (115 pci) should be assumed for the soils anticipated at subgrade depth. This value assumes the concrete slab system is designed and constructed as recommended herein, with a minimum thickness of crushed rock of 8 inches beneath the slab.

Interior slab-on-grade floors should be provided with an adequate moisture break. The capillary break material should consist of ODOT open graded aggregate per ODOT Standard Specifications 02630-2. The minimum recommended thickness of capillary break materials on re-compacted soil subgrade is 8 inches. The total thickness of crushed aggregate will be dependent on the subgrade conditions at the time of construction, and should be verified visually by proof-rolling. Under-slab aggregate should be compacted to at least 90% of its maximum dry density as determined by ASTM D1557 or equivalent.

In areas where moisture will be detrimental to floor coverings or equipment inside the proposed structure, appropriate vapor barrier and damp-proofing measures should be implemented. A commonly applied vapor barrier system consists of a 10-mil polyethylene vapor barrier placed directly over the capillary break material. Other damp/vapor barrier systems may also be feasible. Appropriate design professionals should be consulted regarding vapor barrier and damp proofing systems, ventilation, building material selection, radon and mold prevention issues, which are outside HGSI's area of expertise.

Perimeter Footing Drains

Due to the potential for perched surface water above fine grained deposits such as those encountered at the site, we recommend the outside edge of perimeter footings be provided with a drainage system consisting of 3-inch minimum diameter perforated PVC pipe embedded in a minimum of 1 ft^3 per lineal foot of clean, free-draining sand and gravel or 1"- ¼" drain rock. The drain pipe and surrounding drain rock should be

wrapped in non-woven geotextile (Mirafi 140N, or approved equivalent) to minimize the potential for clogging and/or ground loss due to piping. Water collected from the footing drains should be directed into the local storm drain system or other suitable outlet. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. The footing drains should include clean-outs to allow periodic maintenance and inspection.

Down spouts and roof drains should collect roof water in a system separate from the footing drains in order to reduce the potential for clogging. Roof drain water should be directed to an appropriate discharge point well away from structural foundations. Grades should be sloped downward and away from buildings to reduce the potential for ponded water near structures.

Seismic Design

Structures should be designed to resist earthquake loading in accordance with the methodology described in the current Oregon Residential Specialty Code (ORSC). We recommend Site Class D (Stiff Soils) be used for design per the ORSC. Design values determined for the site using the ASCE 7-16 Hazard Tool are summarized on Table 3, for Risk Category II.

Table 3. Recommended Earthquake Ground Motion Parameters (ASCE 7-16)

Parameter	Value
Location (Lat, Long), degrees	45.3211, -122.7494
Mapped Spectral Acceleration Values (MCE, Site Class B):	
Short Period, S_s	0.82 g
1.0 Sec Period, S_1	0.381 g
Design Values for **Site Class D** (Stiff Soils):	
Peak Ground Acceleration PGA_M	0.458
F_a	1.172
$SD_s = 2/3 \times F_a \times S_s$	0.641 g
Seismic Design Category (2021 ORSC)	D_0

Soil liquefaction is a phenomenon wherein saturated soil deposits temporarily lose strength and behave as a liquid in response to earthquake shaking. Soil liquefaction is generally limited to loose, granular soils located below the water table. Following development, on-site soils will consist predominantly of stiff to very stiff silt which are not considered susceptible to liquefaction. Therefore, it is our opinion that special design or construction measures are not required to mitigate the effects of liquefaction.

Excavating Conditions and Utility Trench Backfill

We anticipate that on-site soils can be excavated using conventional heavy equipment such as scrapers and trackhoes to depths of 13 feet and likely greater. Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Actual slope inclinations at the time of construction should be determined based on safety requirements and actual soil and groundwater conditions. All temporary cuts in excess of 4 feet in height should be sloped in accordance with U.S. Occupational Safety and Health Administration (OSHA) regulations (29 CFR Part 1926), or be shored. The existing native soils classify as Type B Soil and temporary excavation side slope inclinations as steep as 1H:1V may be assumed for planning purposes. This cut slope inclination is applicable to excavations above the water table only.

Perched groundwater conditions often occur over fine-grained native deposits such as those beneath the site, particularly during the wet season. If encountered, the contractor should be prepared to implement an appropriate dewatering system for installation of the utilities. At this time, we anticipate that dewatering systems consisting of ditches, sumps and pumps would be adequate for control of groundwater where encountered during construction conducted during the dry season. Regardless of the dewatering system used, it should be installed and operated such that in-place soils are prevented from being removed along with the groundwater.

Vibrations created by traffic and construction equipment may cause some caving and raveling of excavation walls. In such an event, lateral support for the excavation walls should be provided by the contractor to prevent loss of ground support and possible distress to existing or previously constructed structural improvements.

Utility trench backfill should consist of ¾"-0 crushed rock, compacted to at least 95% of the maximum dry density obtained by Modified Proctor (ASTM D1557) or equivalent. Initial backfill lift thick nesses for a ¾"-0 crushed aggregate base may need to be as great as 4 feet to reduce the risk of flattening underlying flexible pipe. Subsequent lift thickness should not exceed 1 foot. If imported granular fill material is used, then the lifts for large vibrating plate-compaction equipment (e.g. hoe compactor attachments) may be up to 2 feet, provided that proper compaction is being achieved and each lift is tested. Use of large vibrating compaction equipment should be carefully monitored near existing structures and improvements due to the potential for vibration-induced damage.

Adequate density testing should be performed during construction to verify that the recommended relative compaction is achieved. Typically, one density test is taken for every 4 vertical feet of backfill on each 200-lineal-foot section of trench.

Stormwater Infiltration Facilities

Based on results of the soil infiltration testing, soils on site exhibit low infiltration rates especially in the presence of perched water or static groundwater. Infiltration rates ranged from 0.6 to 1.2 inches/hour as summarized on Table 1. We recommend shallow systems in the range of 2 to 5 feet bgs be designed using an infiltration rate of **0.6 inches/hour**. This is slightly less than the average test value of 1.0 inches/hour, but we feel 0.3 inches/hour is more representative of overall site conditions. Also, please note that the potential for infiltration of stormwater will be reduced during the wet season due to saturated soils / perched water conditions over much of the site. We do not believe the site is well suited for use of deeper infiltration facilities such as dry wells due to the very low-permeability site soils, and perched water conditions.

The designer should select an appropriate infiltration value based on our test results and the location of the proposed infiltration facility. The recommended infiltration rates do not incorporate a factor of safety. For the design infiltration rate, we recommend a factor of safety of at least 2.0. Greater factors of safety may be required by the governing agency.

Infiltration test methods and procedures attempt to simulate the as-built conditions of the planned disposal system. However, due to natural variations in soil properties, actual infiltration rates may vary from the measured and/or recommended design rates. All systems should be constructed such that potential overflow is discharged in a controlled manner away from structures, and all systems should include an adequate factor of safety. Infiltration rates presented in this report should not be applied to inappropriate or complex hydrological models such as a closed basin without extensive further studies.

Erosion Control Considerations

During our field exploration program, we did not observe soil types that would be considered highly susceptible to erosion. Erosion at the site during construction can be minimized by implementing the project erosion control plan, which should include judicious use of straw, bio-bags, silt fences, or other appropriate technology. Where used, erosion control devices should be in place and remain in place throughout site preparation and construction. Areas of exposed soil requiring immediate and/or temporary protection against exposure should be covered with either mulch or erosion control netting/blankets.

UNCERTAINTIES AND LIMITATIONS

We have prepared this report for the owner and his/her consultants for use in design of this project only. This report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HGSI should be notified for review of the recommendations of this report, and revision of such if necessary.

Sufficient geotechnical monitoring, testing and consultation should be provided during construction to confirm that the conditions encountered are consistent with those indicated by explorations. Recommendations for design changes will be provided should conditions revealed during construction differ from those anticipated, and to verify that the geotechnical aspects of construction comply with the contract plans and specifications.

Within the limitations of scope, schedule and budget, HGSI executed these services in accordance with generally accepted professional principles and practices in the field of geotechnical engineering at the time the report was prepared. No warranty, expressed or implied, is made. The scope of our work did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous or toxic substances in the soil, surface water, or groundwater at this site.

We appreciate this opportunity to be of service.

Sincerely,

HARDMAN GEOTECHNICAL SERVICES INC.

Scott L. Hardman, P.E., G.E.
Geotechnical Engineer

Attachments: References
Figure 1 – Vicinity Map
Figure 2 – Site Plan
Figure 3 – DOGAMI LiDAR Mapping
Figure 4 – Fill Slope Detail
Logs of Test Pits TP-1 through TP-11
Logs of Hand Auger Borings HA-1 through HA-6
Infiltration Test Data Plots (3 Pages)
ASCE Seismic Design Hazards Report (3 Pages)

REFERENCES

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Madin, I.P., 1990, Earthquake hazard geology maps of the Portland metropolitan area, Oregon: Oregon Department of Geology and Mineral Industries Open-File Report 0-90-2, scale 1:24,000, 22 p.

Schlicker, H.G. and Finlayson, C.T., 1979, Geology and geologic hazards of northwest Clackamas County, Oregon Department of Geology and Mineral Industries, Bulletin 99, 1:24,000

Yeats, R.S., Graven, E.P., Werner, K.S., Goldfinger, C., and Popowski, T., 1996, Tectonics of the Willamette Valley, Oregon: in Assessing earthquake hazards and reducing risk in the Pacific Northwest, Vol. 1: U.S. Geological Survey Professional Paper 1560, P. 183-222, 5 plates, scale 1:100,000.

HARDMAN GEOTECHNICAL SERVICES INC.

Practical, Cost-Effective Geotechnical Solutions

VICINITY MAP

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2856	FIGURE 1

HARDMAN GEOTECHNICAL SERVICES INC.
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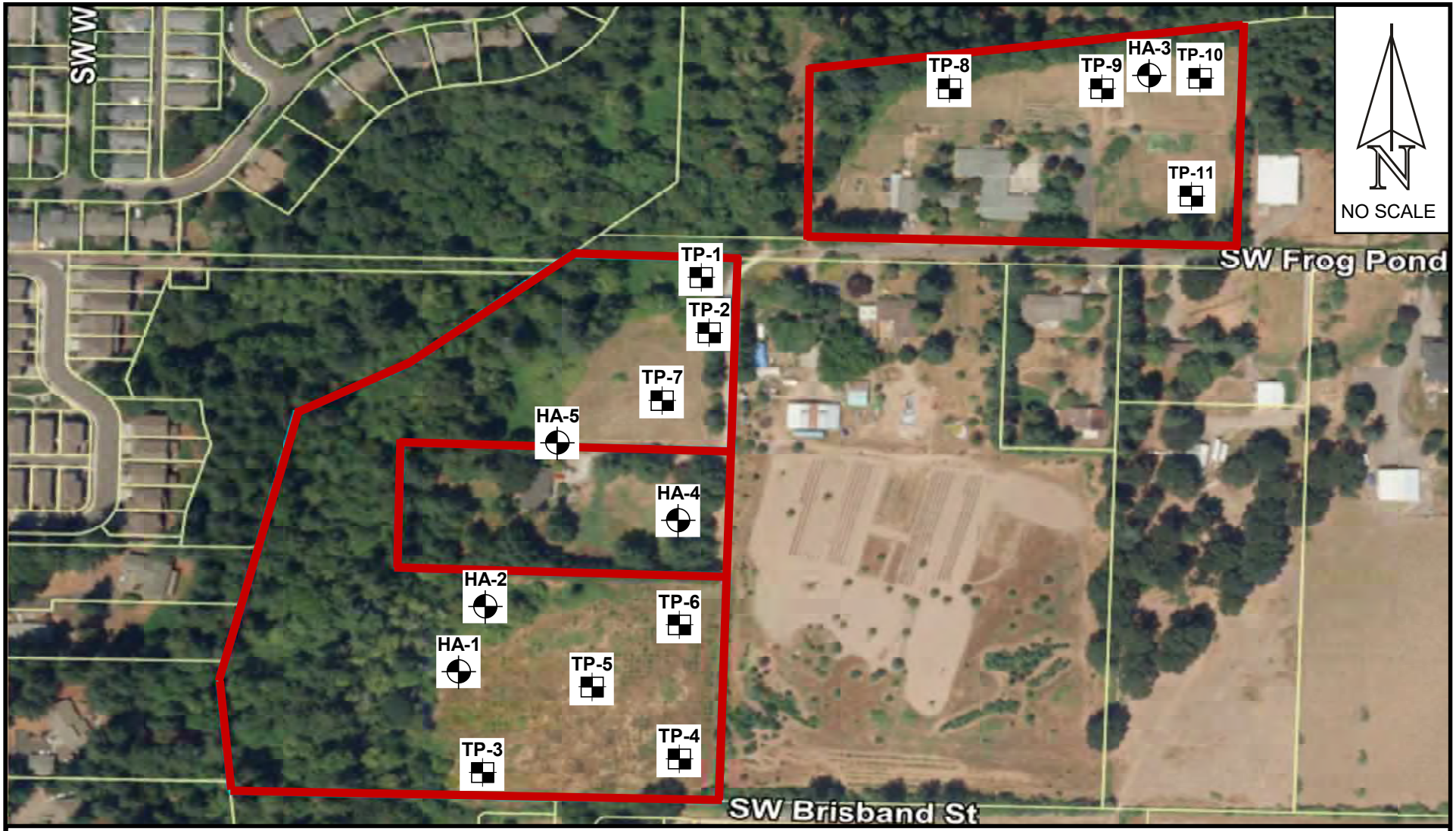
SITE PLAN AND EXPLORATION LOCATIONS



Legend

TP-X Backhoe Test Pit Designation and Approximate Location

Base Map by Portland Maps

Project: Frog Pond West West Wilsonville, Oregon	Project No. 20-2642	FIGURE 2

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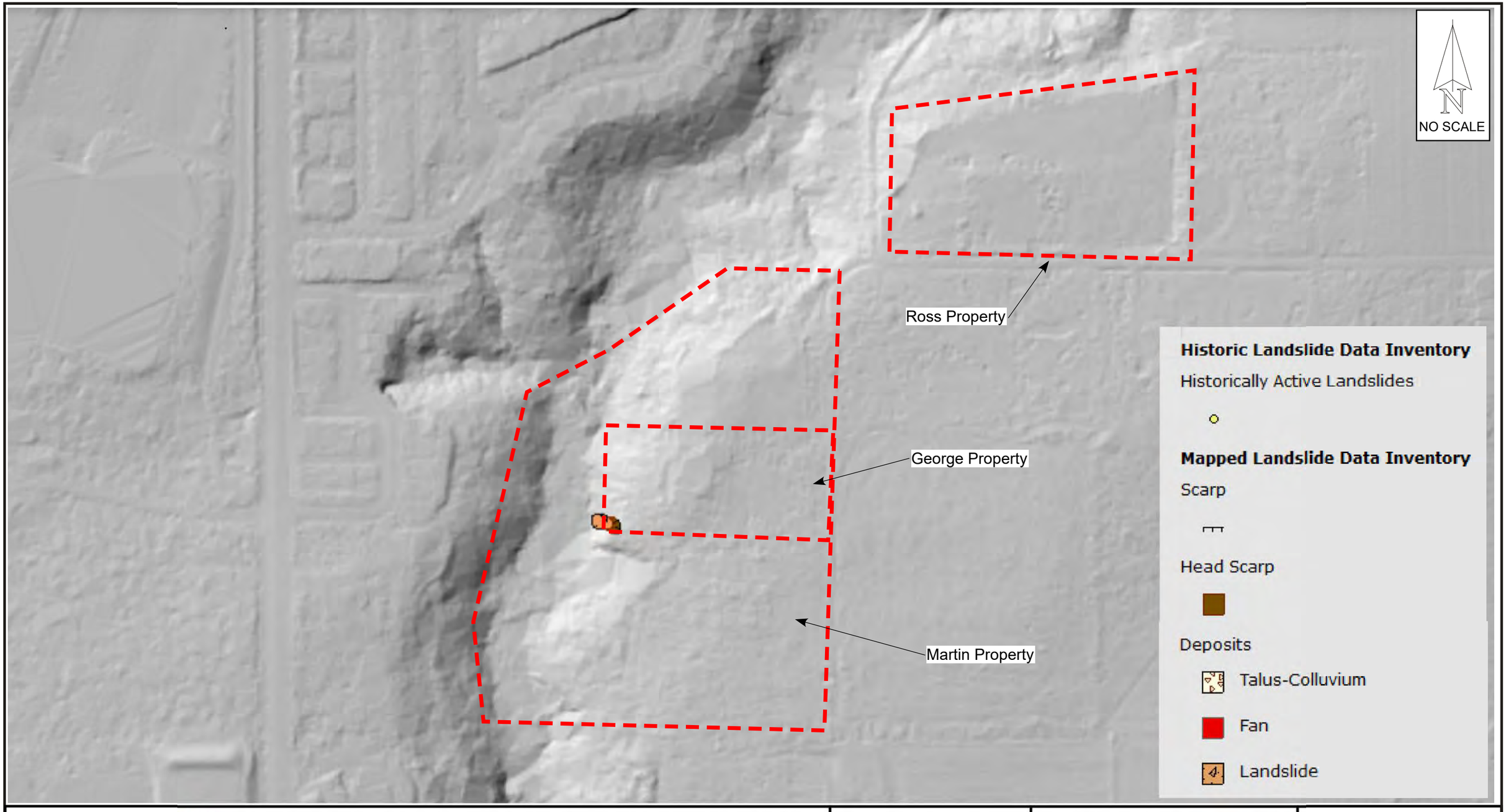
Practical, Cost-Effective Geotechnical Solutions

10110 SW Nimbus Avenue, Suite B-5
Portland, Oregon 97223
Tel: (503) 530-8076

DOGAMI LiDAR MAPPING



LEGEND

Approximate Site Boundary

Base Map from DOGAMI SLIDO Website

Project No. 21-2824

Frog Pond West-West
Wilsonville, Oregon

FIGURE 3

HARDMAN GEOTECHNICAL SERVICES INC.
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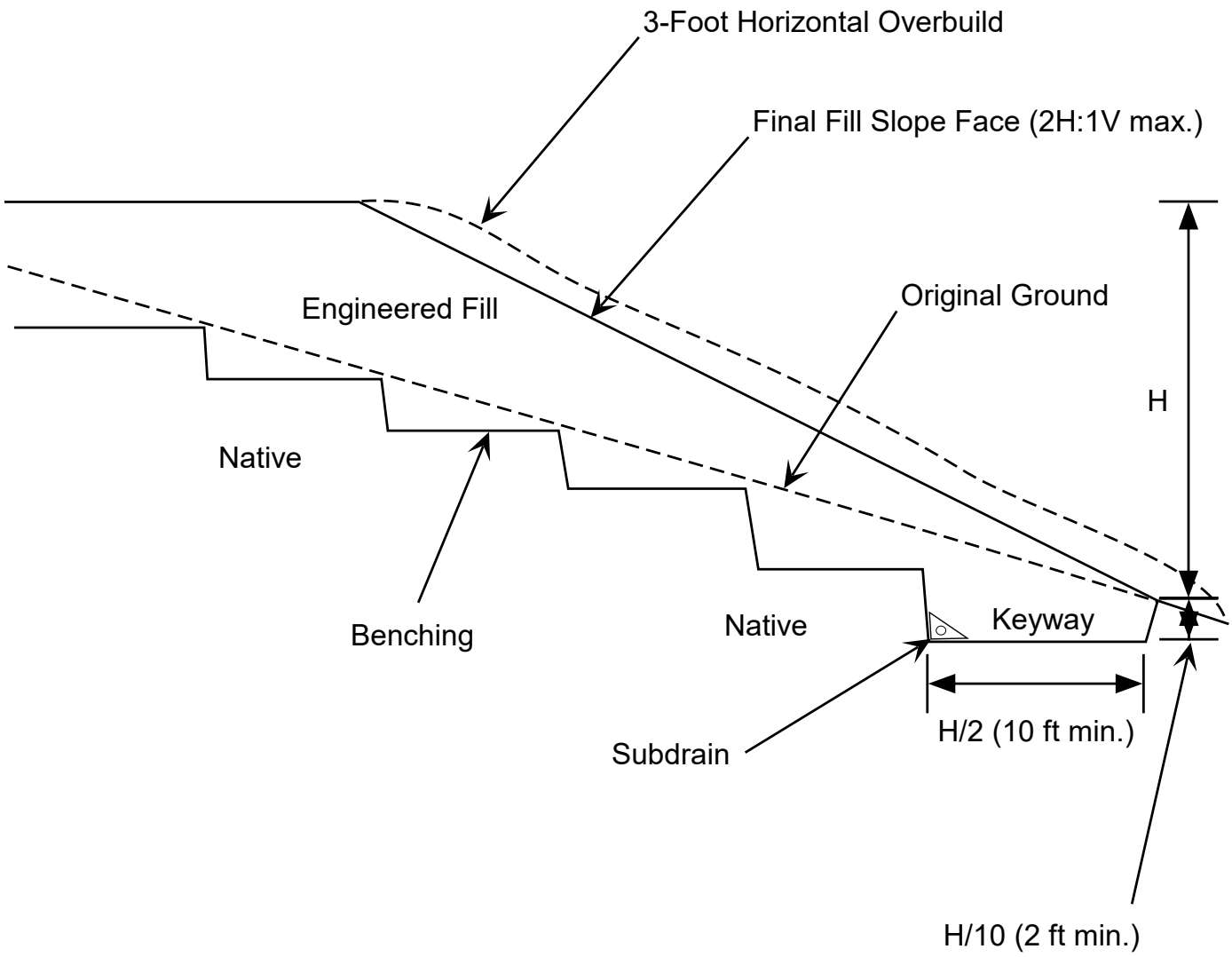
FILL SLOPE DETAIL

TYPICAL KEYWAY, BENCHING & FILL SLOPE DESIGN



Recommended subdrain is minimum 3-inch-diameter ADS Heavy Duty grade (or equivalent), perforated plastic pipe enveloped in a minimum of 3 cubic feet per lineal foot of 2" to 1/2" open-graded gravel drain rock wrapped with geotextile filter fabric (Mirafi 140N or equivalent).

Project: Frog Pond West-West Wilsonville, Oregon	Project No. 21-2824	FIGURE 4

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Soft, Organic SILT, dark brown, moist, many roots throughout (topsoil)
2	3.0 3.5					Stiff, Clayey SILT, light yellowish brown with black and orange mottling, moist, weathered (Colluvium)
3	>4.5					Very stiff to hard, Clayey SILT, yellowish brown with trace mottling in upper portion of unit only, slightly moist, unweathered and intact
4	>>4.5					
5						
6						
7						
8						Very difficult excavating at 8 feet due to hard materials.
9						Test pit terminated at 8 feet No caving of pit side walls No groundwater or seepage encountered
10						
11						
12						
13						
14						
15						
16						

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LEGEND

S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 10/22/2021

Logged By: SLH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Soft, Organic SILT, dark brown, moist, abundant grass roots (topsoil)
1						Dense, silty angular gravel, gray, moist (old driveway or pull-out area)
2						Very stiff to hard, Clayey SILT, yellowish brown with trace mottling in upper portion of unit only, slightly moist, unweathered and intact
8						Grades to Clayey Silt with some fine sand at 8 feet
10						Test pit terminated at 10 feet No caving of pit sidewalls No groundwater or seepage encountered

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 10/22/2021

Logged By: SLH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
3						
4						
5	4.2					Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, heavily micaceous. [Willamette Formation]
6						
7						
8		☒	S-1			
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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☒ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
11						Saturated, medium stiff, brown, sandy SILT (ML) with clay, heavily micaceous. [Willamette Formation]
13					▽	*Test Pit terminated at 13 feet* *Seepage observed in the bottom of the test pit* *No caving*

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☒ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown and light grey, silty CLAY (CL), orange and dark brown mottling. [Willamette Formation]
2	3.0					
3						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling. [Willamette Formation]
4						
5						
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						
3						
4						
5						
6						Sandiness increasing with depth
7						
8						Moist, stiff, brown, sandy SILT (ML), orange and dark brown mottling, slightly micaceous. [Willamette Formation]
9						
10						
11						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 7**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown and light grey, silty CLAY (CL), orange and dark brown mottling. [Willamette Formation]
2						
3						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling. [Willamette Formation]
4						
5						
6						
7						
8						
9						Very moist to saturated, medium stiff, brown, silty fine grained SAND (SM), heavily micaceous. [Willamette Formation]
10					▽	
11						
12						
13						*Test Pit terminated at 12 feet* *Seepage observed around 10 feet bgs* *No caving*
14						
15						
16						

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⊠ S-# — Soil Sample Depth Interval and Designation

▽ — Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, brown silt interbedded with dark brown silt and organics. Strata matrix is disturbed and there are some crushed rock fragments. [Undocumented Fill]
3						
4						Decomposing grass layer and buried topsoil
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, brown silt interbedded with dark brown silt and organics. Strata matrix is disturbed and there are some crushed rock fragments. [Undocumented Fill]
3						
4	1.8					Decomposing grass layer and buried topsoil
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
6						
7						
8						
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021

Logged By: CSH

Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 10**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
2						Moist, soft, dark brown silt with organics and fractured rock. [Undocumented Fill]
5						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, micaceous. [Willamette Formation]
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*

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Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021
Logged By: CSH
Surface Elevation: Unknown

LOG OF BACKHOE TEST PIT

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Test Pit No. **TP - 11**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						
3						
4						
5						
6						Sandiness increasing with depth
7						
8						Moist, stiff, brown, sandy SILT (ML), orange and dark brown mottling, slightly micaceous. [Willamette Formation]
9						
10						*Test Pit terminated at 10 feet* *No groundwater or seepage encountered* *No caving*
11						
12						
13						
14						
15						
16						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Excavated: 12/3/2021
Logged By: CSH
Surface Elevation: Unknown

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
1						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
4						Moist, stiff to very stiff, brown, sandy SILT (ML) with clay, orange and dark brown mottling, heavily micaceous. [Willamette Formation]
5						*Boring terminated at 5 feet* *No groundwater or seepage encountered* *No caving*
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021

Logged By: CSH

Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
1						Moist, medium stiff, brown and light grey, clayey SILT (ML), orange and dark brown mottling. [Willamette Formation]
2						
3						Moist, stiff to very stiff, brown, sandy SILT (ML), micaceous. [Willamette Formation]
4						
5						
6						*Boring terminated at 6 feet* *No groundwater or seepage encountered* *No caving*
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics with grass and roots in the top 6 inches. [Topsoil]
						Moist, soft, dark brown silt with organics and fractured rock. [Undocumented Fill]
5						Moist, stiff to very stiff, brown, sandy SILT (ML) [Willamette Formation]
						Boring terminated at 5 feet *No groundwater or seepage encountered* *No caving*

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
0						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
1						Moist, medium stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
2						Dry, very stiff, light brown, sandy SILT (ML), orange and dark brown mottling. [Willamette Formation]
3						
4						
5						
6						*Test Pit terminated at 6 feet* *No groundwater or seepage encountered* *No caving*
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021
Logged By: CSH
Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Moist, soft, dark brown, SILT (OL), heavy organics [Topsoil]
2						Moist, medium stiff, brown, clayey SILT (ML) with sand, orange and dark brown mottling. [Willamette Formation]
3						
4						
5						*Test Pit terminated at 5 feet* *No groundwater or seepage encountered* *No caving*
6						
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 12/9/2021

Logged By: CSH

Surface Elevation:

LOG OF HAND AUGER BORING

Project: Frog Pond West West Wilsonville, Oregon	Project No. 21-2824	Boring No. **HA - 6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Interval	Sample Designation	Moisture Content (%)	Groundwater	Material Description
1						Slightly Moist, Medium Dense, Poorly Graded, Subangular, 1"-0" GRAVEL (GP) in Dark Brown Silty Matrix, Top 3" Highly Organic with Grass Roots *[Undocumented Fill]*
2						*Boring refusal on gravel at 1.1 feet (13 inches)* *No groundwater or seepage encountered* *No caving*
3						
4						
5						
6						
7						
8						
9						
10						

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S-# Soil Sample Depth Interval and Designation

Water Level at Time of Excavation

Date Bored: 11/09/2021

Logged By: CSH

Surface Elevation:

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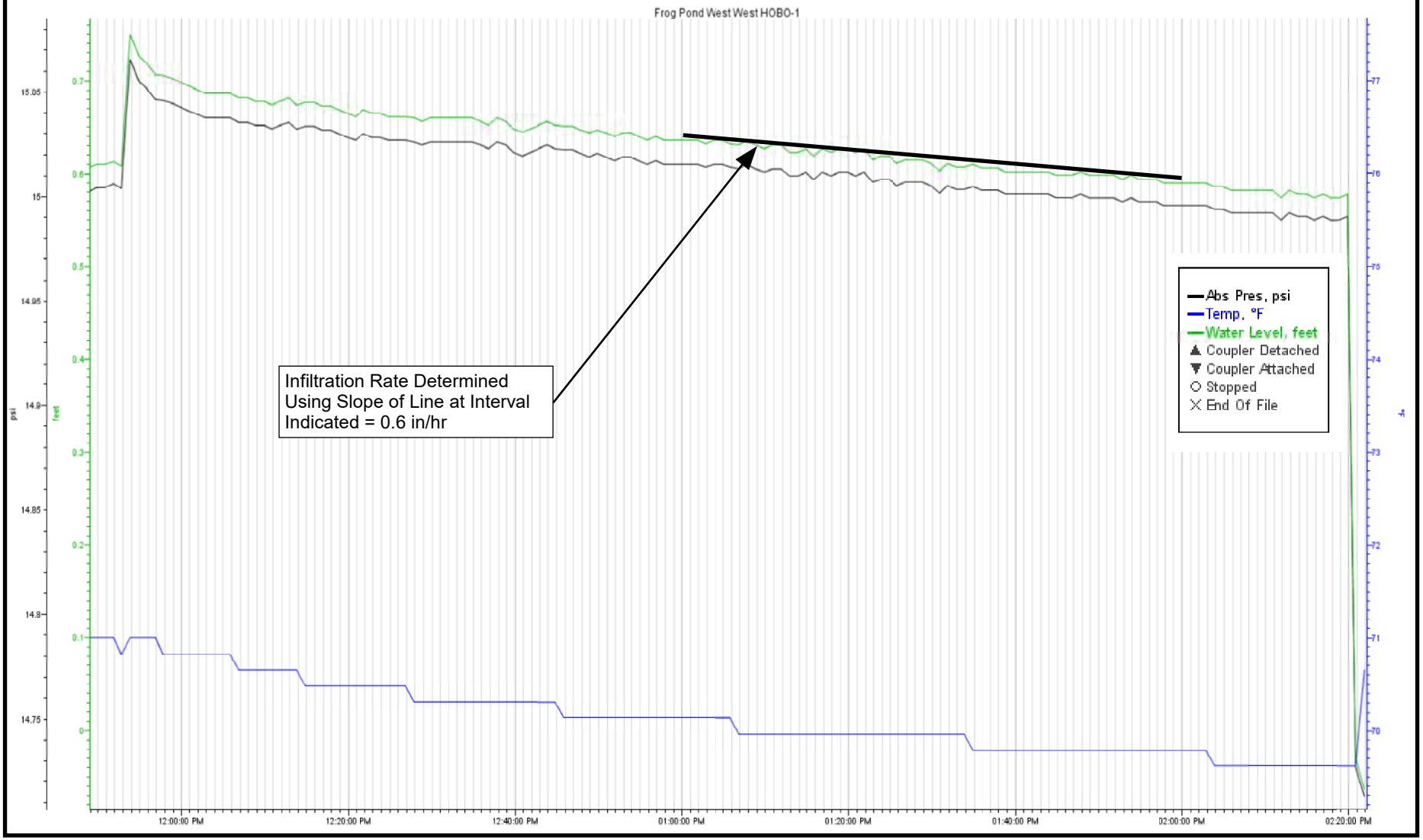
INFILTRATION TEST DATA



Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-1 Depth: 5 Feet

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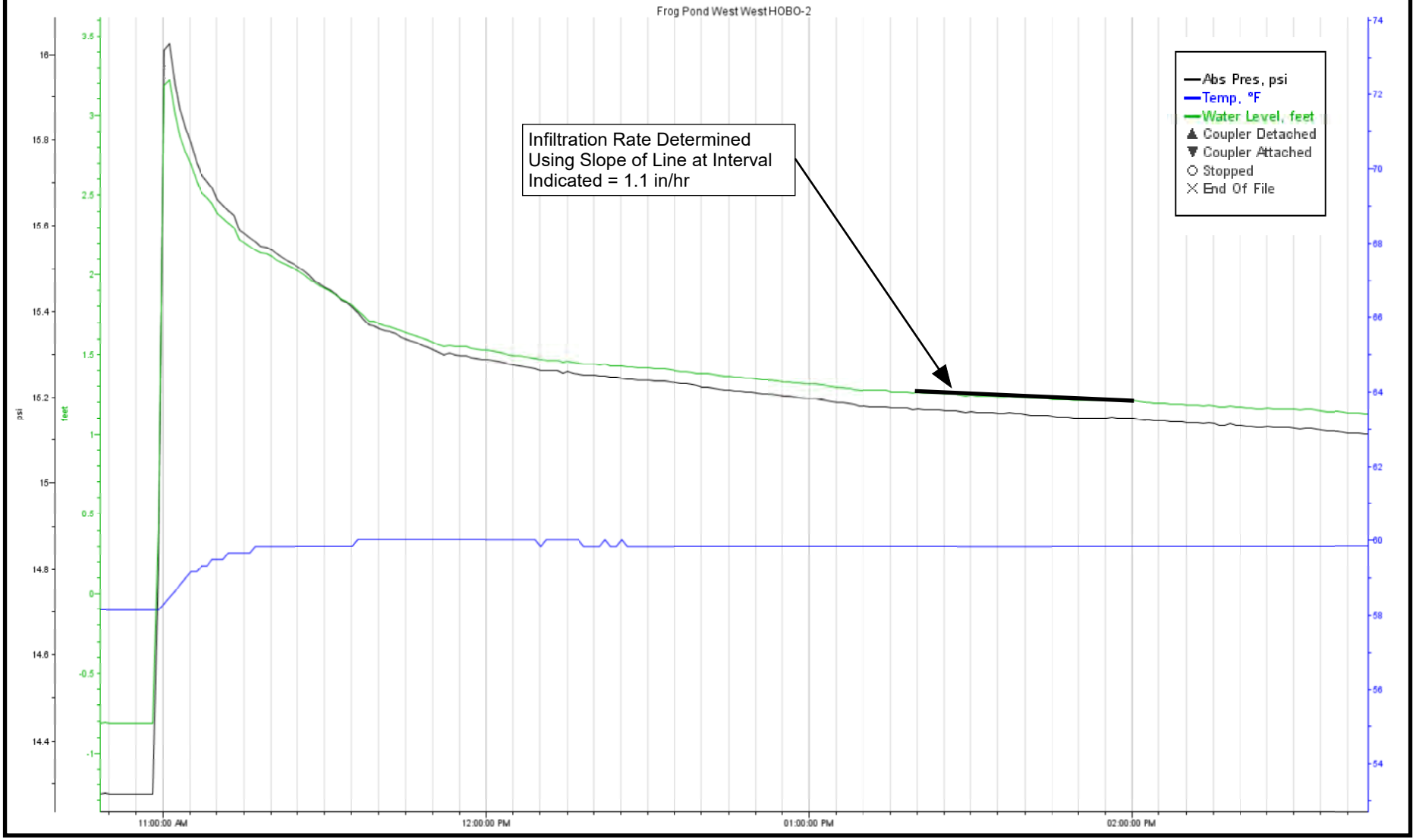
INFILTRATION TEST DATA



Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-2 Depth: 6 Feet

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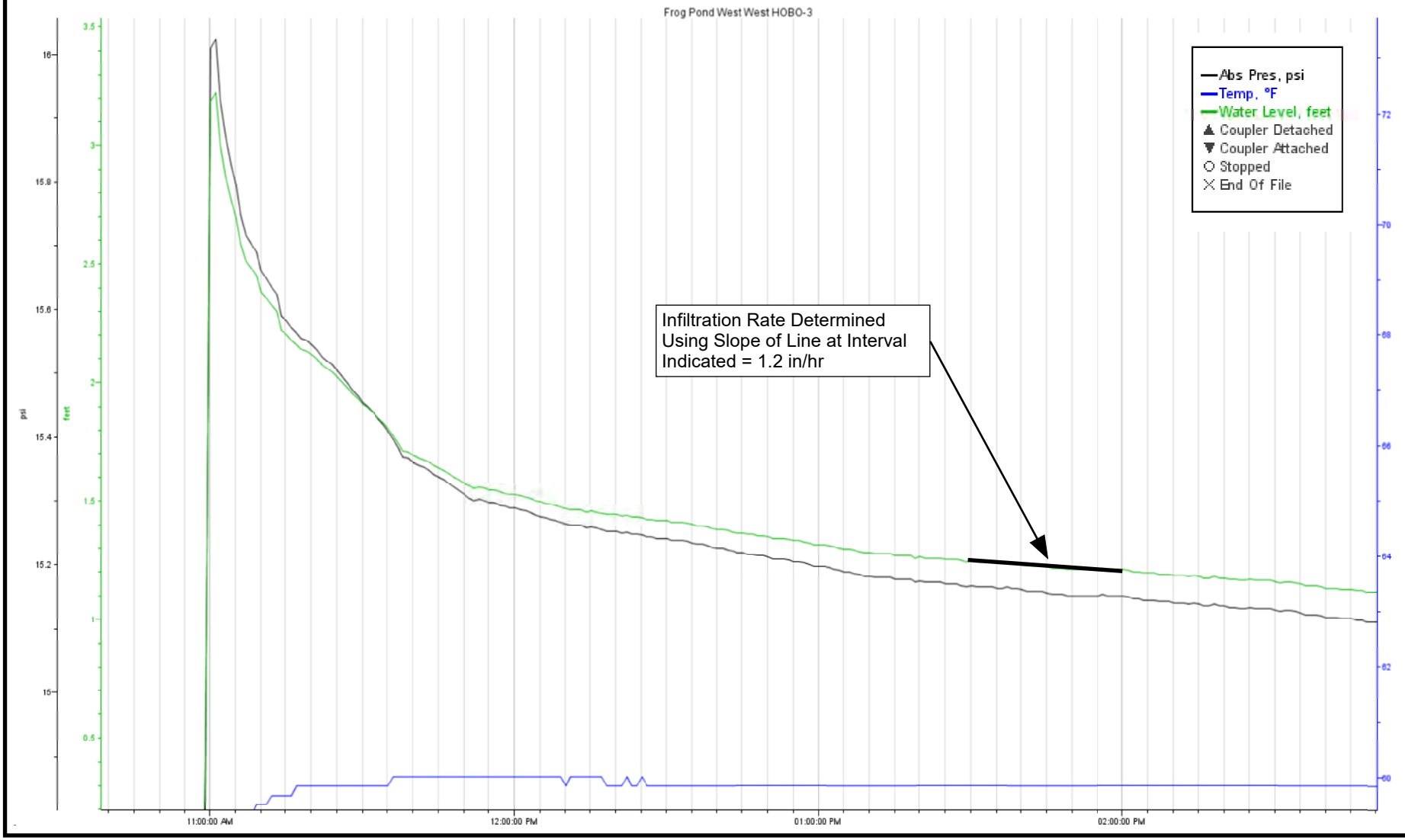
INFILTRATION TEST DATA



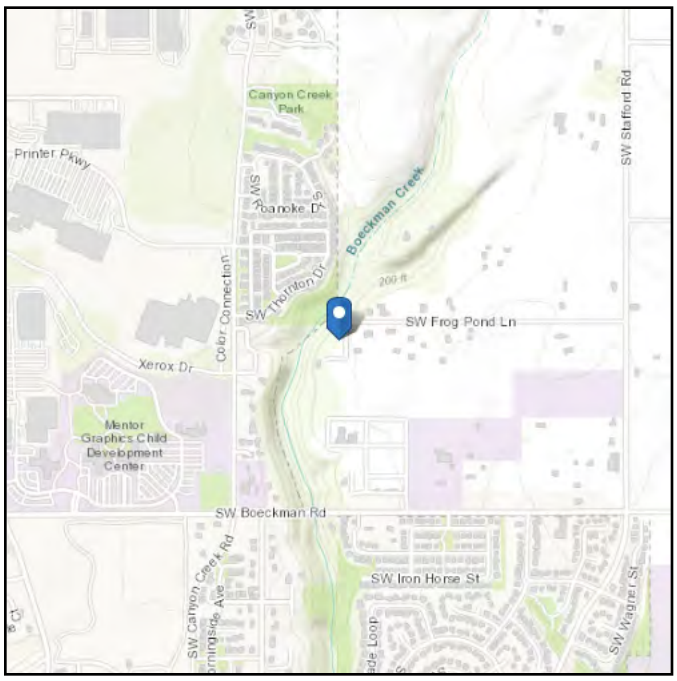
Project: Frog Pond West West Wilsonville, Oregon	Date Tested: 12/7/2021 Tested By: CSH Project No: 21-2824	Boring: HA-3 Depth: 6 Feet

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Stiff Soil

Elevation: 216.52 ft (NAVD 88)
Latitude: 45.3218
Longitude: -122.754



Seismic

Site Soil Class: D - Stiff Soil

Results:

S_S :	0.82	S_{D1} :	N/A
S_1 :	0.381	T_L :	16
F_a :	1.172	PGA :	0.373
F_v :	N/A	PGA_M :	0.458
S_{MS} :	0.961	F_{PGA} :	1.227
S_{M1} :	N/A	I_e :	1
S_{DS} :	0.641	C_v :	1.21

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Tue Dec 14 2021

Date Source: USGS Seismic Design Maps

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided “as is” and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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Appendix C

DownStream Analysis

Memorandum

To:	Keith Buisman, PE
From:	Roger Tiffany, EI and Rose Horton, PE
Copies:	File
Date:	May 17, 2022
Subject:	Downstream Impact Analysis of Boeckman Creek
Project No.:	20015

Introduction

Otak has conducted a downstream impact analysis on the downstream storm conveyance system for the proposed Frog Pond Terrace and Frog Pond Overlook developments, per City of Wilsonville 2015 standards. These proposed developments are located adjacent to Frog Pond Lane and east of Boeckman Creek, as shown on Figure 1.

Figure 1 Vicinity Map

The development will meet the City of Wilsonville Public Work Standards Section 301.4.04 which requires flow control from post-development conditions for peak flow rates generated by between 42% of the 2-year storm up to the 10-year storm.

To meet the requirements of City of Wilsonville Public Work Standards Section 301.5.01, a downstream analysis shall include:

- verifying that the downstream system has the capacity to convey the 25-year design storm.
- extending the analysis downstream to a point in the drainage system where the proposed development site contributes 10% or less of the total tributary drainage flow or for one-quarter mile downstream of the approved point of discharge.

Per email communications with Kerry Rappold on March 3, 2022, the downstream analysis should extend down to the flow control structure directly upstream of SW Boeckman Road.

Existing Conveyance System

The existing conveyance system used in this analysis is shown on Figure 2 (attached), which also includes the drainage basin delineation, time of concentration (Tc) flow paths, and runoff node locations represented in the hydraulic model. Cross sections of the open channel system were obtained from LiDAR and field observation. The proposed Frog Pond Terrace and Frog Pond Overlook developments will discharge runoff into the existing Boeckman Creek channel approximately 1,330 feet upstream of the existing flow control structure.

The stretch of channel downstream of the project site was visited on March 16, 2022. The purpose of the field visit was to observe and document existing channel conditions, outfalls, and contributing waterways. Visual documentation of the drainage system along the channel is included in the Photo Log in Appendix A.

Conveyance Hydrology

Peak runoff rates from the drainage basins delineated in Figure 2 during proposed conditions were calculated using XPSWMM V2021. The Santa Barbara Urban Hydrograph (SBUH) method was used to apply the conveyance design event (25-year recurrence interval, 24-hour duration, NRCS Type 1A rainfall distribution), per Section 301.5.01. Time of Concentration values were calculated for delineated drainage basin using TR-55 equations. Time of Concentration (Tc) flow paths are shown in Figure 2 and corresponding calculations for each drainage basin are included in Appendix B. A time of concentration of five minutes, the minimum allowable, was applied to steep and developed basins for a conservative estimate.

The study area is primarily comprised of Aloha silt loam categorized in the hydrologic soil groups (HSG) Type D and Woodburn silt loam categorized as HSG Type C. HSG D soils generally exhibit very slow infiltration rates when thoroughly wet. The steep area of the channel is Xerochrepts and Haploxerolls which is categorized as HSG Type B with moderate infiltration. A Curve Number (CN) of 98 was used for all impervious areas. The pervious areas were open space with good grass cover, thus a CN of 74 (HSG Type C) was used as applicable.

The basins downstream of the proposed project site are developed residential areas. Impervious percentages were estimated based on existing impervious surfaces captured in 2022 aerial imagery.

The upstream flow in Boeckman Creek was obtained from StreamStats (see Appendix B). It is not recommended to mix hydrologic methods and this data should not be used for design. In this case, the StreamStats data was used provide a rough order of magnitude flowrate for the large upstream basin in comparison with the flowrates generated from the proposed development. Table 1 summarizes the 25-year peak flowrates in Boeckman Creek for proposed project conditions calculated in XP-SWMM. The stationing represents the distance upstream from the existing Boeckman Road flow control structure. The existing flow control structure at the end of the analysis is 1,331 feet downstream from the project's proposed discharge location.

Table 1 Peak 25-Year Flowrates

Node	Station	Total Contributing Basin Area (ac)	Flow Rate (cfs)
Drainage Node 4	16+95	910	116.62
Drainage Node 3	13+31	978	158.38
Drainage Node 2	5+78	992	160.6
Drainage Node 1	2+00	1,025	173.6

Downstream Conveyance Modeling Analysis

The stormwater conveyance network was analyzed in XP-SWMM. The conveyance system was modeled to determine whether the existing downstream system has sufficient capacity to support the Frog Pond Overlook and Frog Pond Terrace developments runoff undetained during the 25-year, 24-hour storm event. The inverts are from as-builts of the flow control structure and LiDAR data. Manning's n values of 0.035 or 0.04 were applied to the channel of Boekman Creek depending on the amount of wood located in the channel along the reach. A Manning's n value of 0.1 was applied to the overbanks. A minimum of one-foot of freeboard between the hydraulic grade line (HGL) and the top of bank was confirmed. The model does not include the effect of the existing flow control structure on the system. Appendix C includes output information from the XP-SWMM model, summarizing the channel network characteristics and results of the hydraulic routing during the design storm.

Conclusions

The downstream stormwater conveyance system was analyzed to confirm conveyance capacity for the proposed development to Boeckman Road. The system consists entirely of open channel upstream of the existing flow control structure at Boeckman Road. A site visit along the downstream reach provided a qualitative assessment of the storm conveyance system and found no evidence of capacity restrictions under existing conditions. The channel was modeled using XP-SWMM software and shows adequate capacity for the proposed flows and the existing flow control structure creates ponding in the downstream reach.

References

Wilsonville, 2015. *City of Wilsonville Public Works Standards. Section 3, Stormwater & Surface Water Design and Construction Standards*, City of Wilsonville, Revised December 2015.

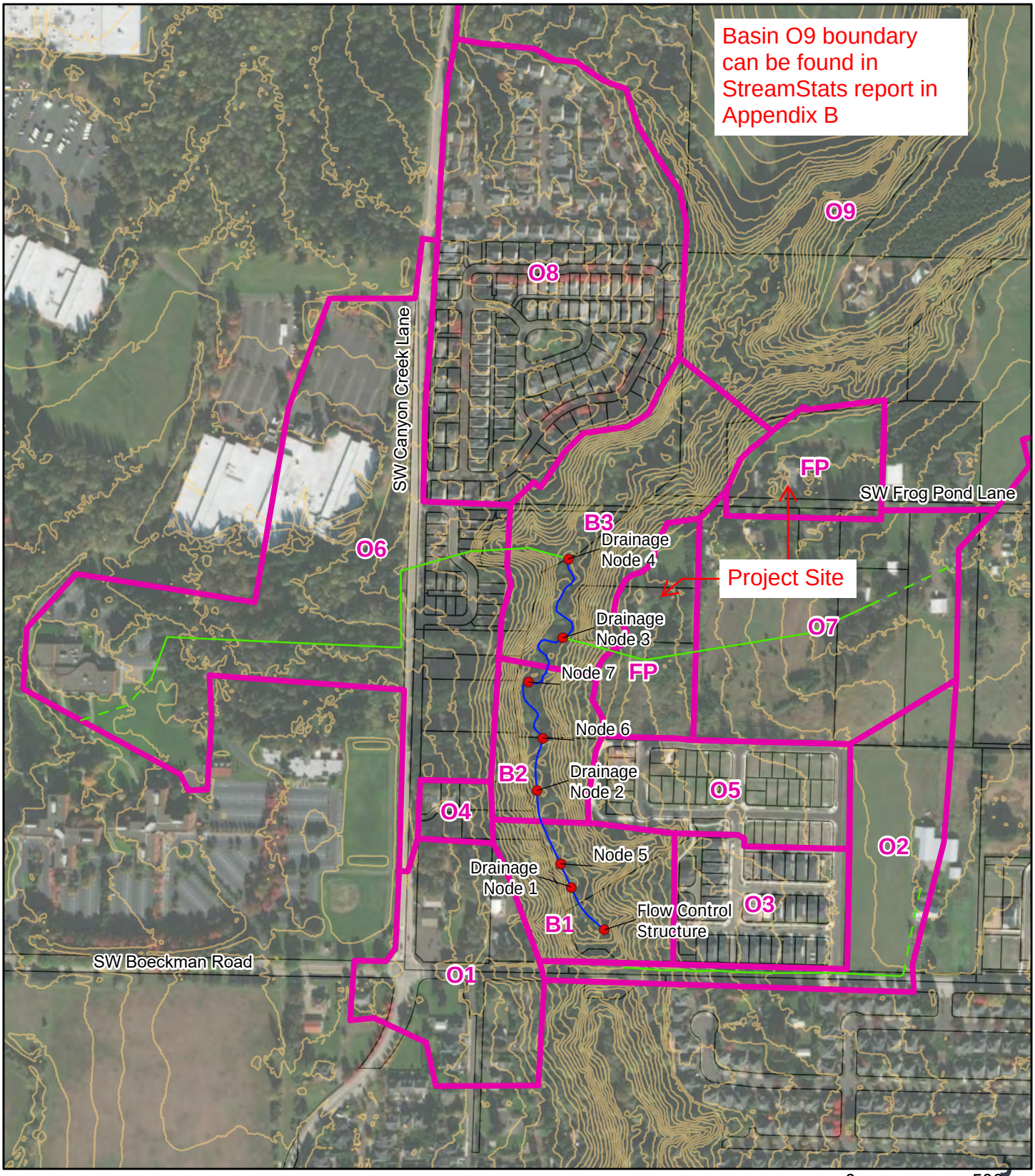

FIGURE 2

DOWNSTREAM ANALYSIS

BOECKMAN CREEK

WILSONVILLE, OREGON

Legend

- Nodes
- Stream Centerline (Analysis Extent)
- Drainage Basins
- Contours (5 ft)

Time of Concentration Path

- Shallow Concentrated Flow
- Sheet Flow

Data Sources:
Date: 4/18/2022
Disclaimer: This data is not to survey accuracy and is meant for planning purposes only.

L:\Project\20000\20015\CADD\GIS\MXDs\20015-DSA Analysis\20015-DSA Analysis.aprx

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Downstream Analysis of Boeckman Creek
Appendix A
Photo Log

20015 Frog Pond Terrace/Overlook DSA Photolog

Reach 1 - Flow Control Structure
Photo looking upstream

- Measured bank full depth – 52”
- Wide activated overbank floodplain
- Minimal wood and vegetation in channel

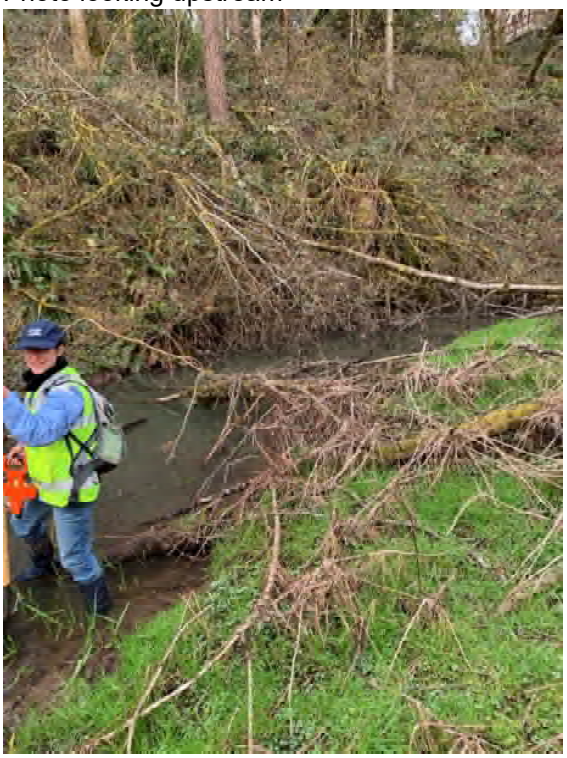
Reach 2
Photo looking upstream

- Measured bank full depth – 30”
- Activated overbank floodplain
- Higher density of wood in channel and beaver dams

Reach 3
Photo looking downstream

- Measured bank full depth – 48”
- More wood in channel than other reaches

Reach 4
Photo looking upstream



- Measured bank full depth – 32”
- More wood located in channel than other reaches

Reach 5

Photo looking downstream

- Measured bank full depth – 24”
- Scattered wood in channel

Reach 6 – Outfall General Location

Photo looking upstream

- Measured depth 2 ft
- Additional 14” above water surface to TOB at 1:1 slope
- Scattered wood in channel

Downstream Analysis of Boeckman Creek
Appendix B
Hydrology

Otak

DSA Drainage Basin Areas

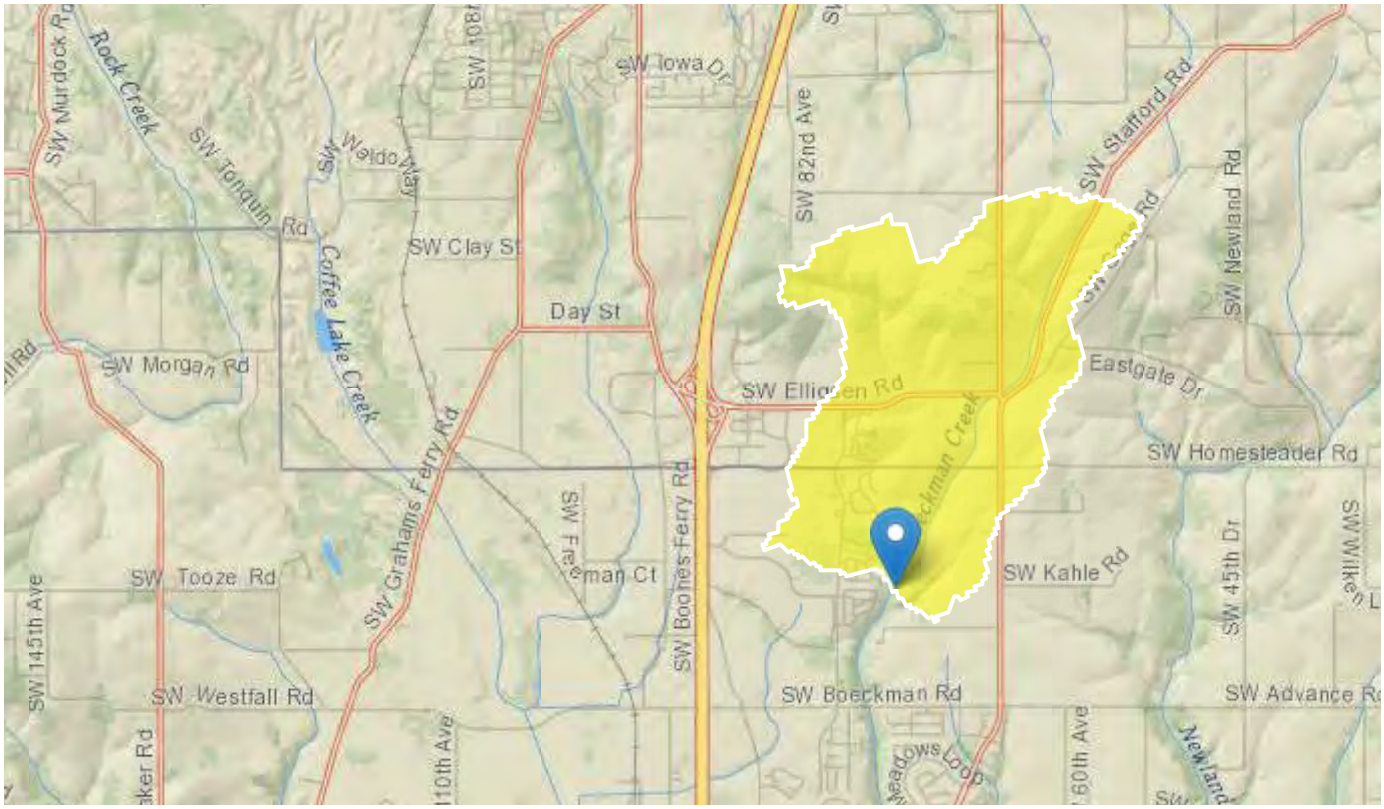
Boeckman Creek

Basin	XP-SWMM Node	Pervious Curve #	Impervious Area		Total Area	
			Tc	%	(sf)	(ac)
Site Total				390	44,646,105	1,025
O1	1	74	5	30	440,423	10.11
O3	1	74	5	50	288,301	6.62
O5	2	74	5	60	335,041	7.69
O4	2	74	5	30	58,509	1.34
O6	4	74	55.4	50	1,520,186	34.90
O8	3	74	5	80	1,250,809	28.71
B1	1	74	5	0	292,661	6.72
B2	2	74	5	0	206,554	4.74
B3	3	74	5	0	542,471	12.45
O9*	4	74			38,128,714	875.31
O2	1	74	28.2	20	405,690	9.31
O7	3	74	48.4	10	759,013	17.42
FP	3	74	5	60	417,733	9.59

*Modeled flow rates from Stream Stats

StreamStats Report - Boeckman Creek

Region ID: OR
Workspace ID: OR20220117180346388000
Clicked Point (Latitude, Longitude): 45.32457, -122.75288
Time: 2022-01-17 10:04:08 -0800



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.59	square miles
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	1.81	inches
SOILPERM	Average Soil Permeability	0.71	inches per hour
JANMAXT2K	Mean Maximum January Temperature from 2K resolution PRISM 1961-1990 data	46.2	degrees F

Parameter Code	Parameter Description	Value	Unit
WATCAPORC	Available water capacity from STATSGO data using methods from SIR 2005-5116	0.13	inches
ORREG2	Oregon Region Number	10001	dimensionless
BSLOPD	Mean basin slope measured in degrees	4.36	degrees
JANMINT2K	Mean Minimum January Temperature from 2K resolution PRISM PRISM 1961-1990 data	33.2	degrees F
ELEV	Mean Basin Elevation	338	feet
PRECIP	Mean Annual Precipitation	44.6	inches
DRNDENSITY	Basin drainage density defined as total stream length divided by drainage area.	0.63	dimensionless
MINBELEV	Minimum basin elevation	170	feet
MINTEMP	Mean annual minimum air temperature over basin surface area as defined in SIR 2008-5126	42.8	degrees F
JANMINTMP	Mean Minimum January Temperature	33.8	degrees F
MAXTEMP	Mean annual maximum air temperature over basin area from PRISM 1971-2000 800-m grid	62.4	degrees F
LC11DVOPN	Percentage of developed open area from NLCD 2011 class 21	13	percent
LC11WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2011	0	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	13.4	percent
STRMTOT	total length of all mapped streams (1:24,000-scale) in the basin	1.62	miles

Peak-Flow Statistics Parameters [Reg 2B Western Interior LT 3000 ft Cooper]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	0.37	7270
BSLOPD	Mean Basin Slope degrees	4.36	degrees	5.62	28.3
I24H2Y	24 Hour 2 Year Precipitation	1.81	inches	1.53	4.48
ELEV	Mean Basin Elevation	338	feet		

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ORREG2	Oregon Region Number	10001	dimensionless		

Peak-Flow Statistics Disclaimers [Reg 2B Western Interior LT 3000 ft Cooper]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report [Reg 2B Western Interior LT 3000 ft Cooper]

Statistic	Value	Unit
50-percent AEP flood	45.8	ft^3/s
20-percent AEP flood	68.7	ft^3/s
10-percent AEP flood	84.7	ft^3/s
4-percent AEP flood	105	ft^3/s
2-percent AEP flood	121	ft^3/s
1-percent AEP flood	137	ft^3/s
0.2-percent AEP flood	174	ft^3/s

Peak-Flow Statistics Citations

Cooper, R.M.,2005, Estimation of Peak Discharges for Rural, Unregulated Streams in Western Oregon: U.S. Geological Survey Scientific Investigations Report 2005-5116, 76 p. (http://pubs.usgs.gov/sir/2005/5116/pdf/sir2005-5116.pdf)

Monthly Flow Statistics Parameters [LowFlow Apr Region02 2008 5126]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	3.068	2025.868
PRECIP	Mean Annual Precipitation	44.6	inches	42.7355	101.2128
SOILPERM	Average Soil Permeability	0.71	inches per hour	0.502	3.724

Monthly Flow Statistics Parameters [LowFlow Aug Region02 2008 5126]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.59	square miles	3.068	2025.868
DRNDENSITY	Basin Drainage Density	0.63	dimensionless	0.118	0.876

Time of Concentration Calculations

Boeckman Creek Downstream Analysis

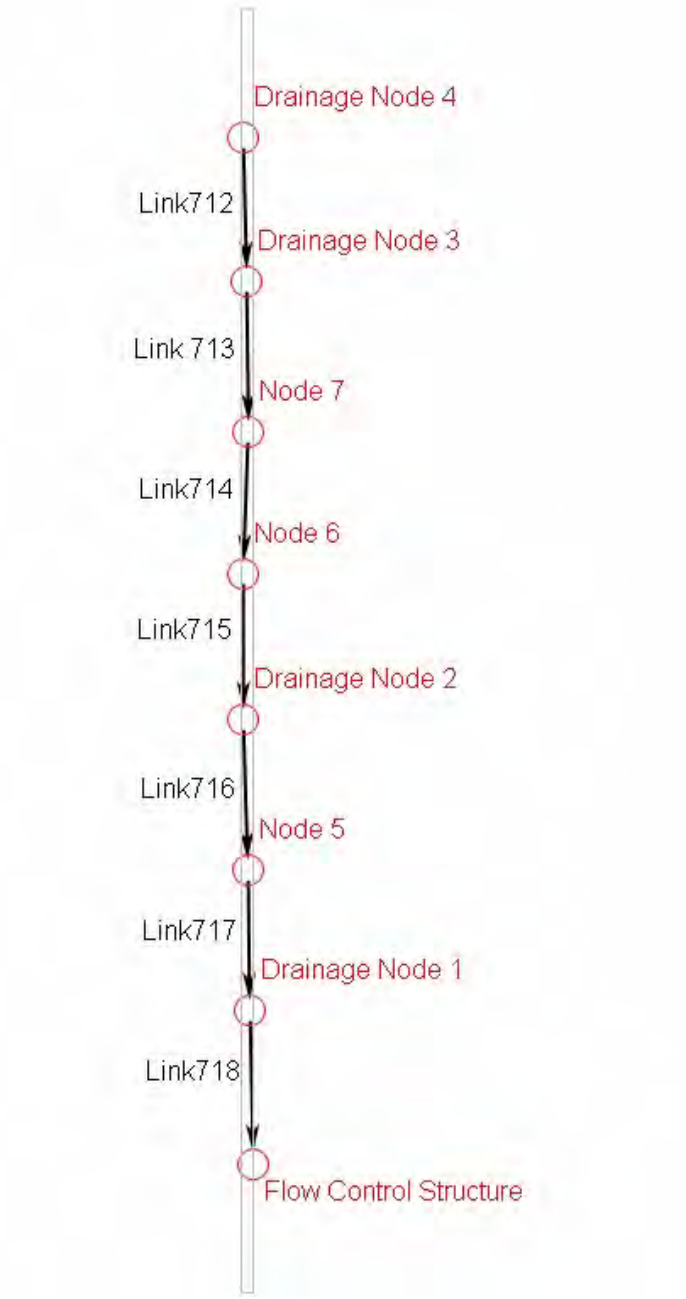
BASINS:		O7	O6	O2
SHEET FLOW				
INPUT				
Surface Description (from Table 3-1)		Short Grass/Woods mix	Short Grass	Short Grass
Manning's Roughness Coefficient		0.25	0.4	0.15
Flow Length , L (<300 ft)	ft	300	300	300
2-Year, 24-Hour Rainfall, P_2	in	2.5	2.5	2.5
Land Slope, s	ft/ft	0.016	0.027	0.025
OUTPUT				
Travel Time	hr	0.73	0.86	0.41
SHALLOW CONCENTRATED FLOW				
INPUT				
Surface Description (paved or unpaved)		Unpaved		Unpaved
Flow Length, L	ft	1200		900
Watercourse Slope, s	ft/ft	0.075		0.06
OUTPUT				
Average Velocity, V	ft/s	4.42		3.95
Travel Time	hr	0.08		0.06
CHANNEL FLOW				
INPUT				
Cross Sectional Flow Area, a	ft^2		1.23	
Wetted Perimeter, p_w	ft		3.93	
Channel Slope, s	ft/ft		0.03	
Manning's Roughness Coefficient			0.013	
Flow Length, L	ft		1925	
OUTPUT				
Average Velocity, V	ft/s		9.15	
Hydraulic Radius, r = a/p_w	ft		0.31	
Travel Time	hr		0.058	
Basin Time of Concentration, T_c	**hrs**	**0.81**	**0.92**	**0.47**
	min	**48.4**	**55.4**	**28.2**

Downstream Analysis of Boeckman Creek
Appendix C
Model Results

Otak

XP-SWMM Layout

Boeckman Creek Downstream Analysis



XP-SWMM RUNOFF DATA
Boeckman Creek Downstream Analysis
Proposed Conditions

SCS Type 1A 25-Year Storm Event							
XP-SWMM Input Data					XP-SWMM Output Data		
Node Name	Total Area (ac)	Impervious %	Pervious Curve Number	Tc (min)	Rainfall Depth (in)	Unit Hydrograph Method	Surface Runoff Flow (cfs)
Drainage Node 1	10.11	30	74	5	3.9	Santa Barbara	6.24
Drainage Node 1	6.62	50	74	5	3.9	Santa Barbara	5.19
Drainage Node 1	6.72	0	74	5	3.9	Santa Barbara	2.65
Drainage Node 1	9.31	20	74	28.2	3.9	Santa Barbara	2.78
Drainage Node 2	7.69	60	74	5	3.9	Santa Barbara	6.70
Drainage Node 2	1.34	30	74	5	3.9	Santa Barbara	0.83
Drainage Node 2	4.74	0	74	5	3.9	Santa Barbara	1.87
Drainage Node 3	28.71	80	74	5	3.9	Santa Barbara	29.94
Drainage Node 3	12.45	0	74	5	3.9	Santa Barbara	4.91
Drainage Node 3	17.42	10	74	48.4	3.9	Santa Barbara	3.43
Drainage Node 3	9.59	60	74	5	3.9	Santa Barbara	8.36
Drainage Node 4	34.90	50	74	55.4	3.9	Santa Barbara	11.55

XP-SWMM HYDRAULICS DATA

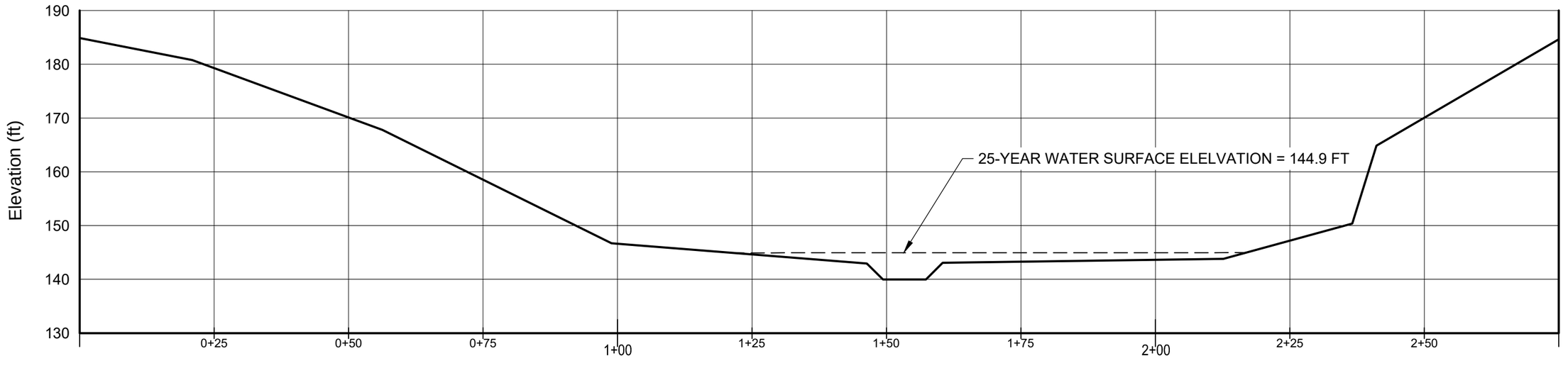
Boeckman Creek Downstream Analysis

Proposed Conditions

SCS Type 1A 25-Year Storm Event																
Location			Channel		Channel Profile								Channel Results			
Link Name	Node Limits		Length	Slope	Ground Elevation (ft)		Invert Elevation (ft)		Max. Water Elevation (ft)		Freeboard (ft)		Max. Flow	Max. Velocity	Max. Depth	y/d0
	From	To	ft	%	US	DS	US	DS	US	DS	US	DS	(cfs)	(ft/s)	(ft)	
Link712	Drainage Node 4	Drainage Node 3	364.00	0.6	188.19	186.12	143.27	141.20	146.53	144.90	41.66	41.22	116.62	3.66	3.70	0.08
Link 713	Drainage Node 3	Node 7	309.00	0.6	186.12	184.93	141.20	139.42	144.90	143.17	41.22	41.76	158.38	3.74	3.75	0.08
Link715	Node 6	Drainage Node 2	196.00	0.2	186.41	186.00	137.41	137.00	142.07	141.44	44.34	44.56	153.78	3.20	4.66	0.10
Link717	Node 5	Drainage Node 1	93.00	1.0	185.60	184.43	136.60	135.10	139.77	137.15	45.83	47.28	160.56	4.60	3.17	0.07
Link714	Node 7	Node 6	248.00	0.8	184.93	186.41	139.42	137.41	143.17	142.07	41.76	44.34	155.45	2.99	4.66	0.10
Link716	Drainage Node 2	Node 5	285.00	0.1	186.00	185.60	137.00	136.60	141.44	139.77	44.56	45.83	160.61	3.75	4.44	0.09
Link718	Drainage Node 1	Flow Control Structure	200.00	1.6	184.43	181.33	135.10	132.00	137.15	133.96	47.28	47.37	173.66	7.02	2.05	0.04

Boeckman Road surface is higher than elevation 176

Cross Section for Link 713 is directly downstream of the proposed development



Link 713 Cross Section

Appendix D

BMP Sizing Tool Output

WES BMP Sizing Software Version 1.6.0.2, May 2018

WES BMP Sizing Report

Project Information

Project Name	Frog Pond Terrace & Frog Pond Overlook
Project Type	Subdivision
Location	7480 SW Frog Pond Lane
Stormwater Management Area	6500
Project Applicant	West Hills Development
Jurisdiction	OutofDistrict

Drainage Management Area

Name	Area (sq-ft)	Pre-Project Cover	Post-Project Cover	DMA Soil Type	BMP
O3 Perv	1,235	Grass	LandscapeCsoil	C	Swale 4
O3 Imp.	11,474	Grass	ConventionalConcrete	C	Swale 4
T13 Perv.	1,602	Grass	LandscapeCsoil	C	Swale 3
T13 Imp.	4,670	Grass	ConventionalConcrete	C	Swale 3
T11 Imp.	9,707	Grass	ConventionalConcrete	C	Swale 1
T11 Perv.	548	Grass	LandscapeCsoil	C	Swale 1
Pond Basins Imp.	135,839	Grass	ConventionalConcrete	C	Pond
Pond Basins Perv.	121,992	Grass	LandscapeCsoil	C	Pond
T12 Imp.	2,693	Grass	ConventionalConcrete	C	Swale 2
T12 Perv.	889	Grass	LandscapeCsoil	C	Swale 2
O4 Imp.	11,624	Grass	ConventionalConcrete	C	Swale 5
O4 Perv.	1,180	Grass	LandscapeCsoil	C	Swale 5
FP2 Imp.	2,168	Grass	ConventionalConcrete	C	Swale 6
FP2 Perv.	183	Grass	LandscapeCsoil	C	Swale 6
FP3 Imp	3,657	Grass	ConventionalConcrete	C	Swale 6
T15 Perv	170	Grass	LandscapeCsoil	C	Swale 8

T15 Imp	3,005	Grass	ConventionalConcrete	C	Swale 8
T3 Perv	851	Grass	LandscapeCsoil	C	Swale 9
T3 Imp	5,035	Grass	ConventionalConcrete	C	Swale 9

LID Facility Sizing Details

LID ID	Design Criteria	BMP Type	Facility Soil Type	Minimum Area (sq-ft)	Planned Areas (sq-ft)	Orifice Diameter (in)
Swale 2	FlowControlAndTreatment	Vegetated Swale - Filtration	C2	156.9	336.0	0.6
Swale 1	WaterQuality	Vegetated Swale - Filtration	C2	149.7	294.0	0.6
Swale 3	FlowControlAndTreatment	Vegetated Swale - Filtration	C2	273.6	336.0	0.8
Swale 4	WaterQuality	Vegetated Swale - Filtration	C2	181.4	221.0	0.6
Swale 5	WaterQuality	Vegetated Swale - Filtration	C2	183.2	208.0	0.6
Swale 6	WaterQuality	Vegetated Swale - Filtration	C2	88.7	183.0	0.4
Swale 8	WaterQuality	Vegetated Swale - Filtration	C2	46.4	128.0	0.3
Swale 9	WaterQuality	Vegetated Swale - Filtration	C2	81.9	124.0	0.4

Pond Sizing Details

Pond ID	Design Criteria(1)	Facility Soil Type	Max Depth (ft)(2)	Top Area (sq-ft)	Side Slope (1:H)	Facility Vol. (cu-ft)(3)	Water Storage Vol. (cu-ft)(4)	Adequate Size?
Pond	FCWQT	Lined	5.00	7,523.0	3	26,105.1	18,278.3	Yes

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

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

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

4. Maximum water storage volume of the facility. Includes water storage in the three feet of soil media assuming a 40 percent porosity.

Simple Pond Geometry Configuration

Pond ID: Pond
Design: FlowControlAndTreatment

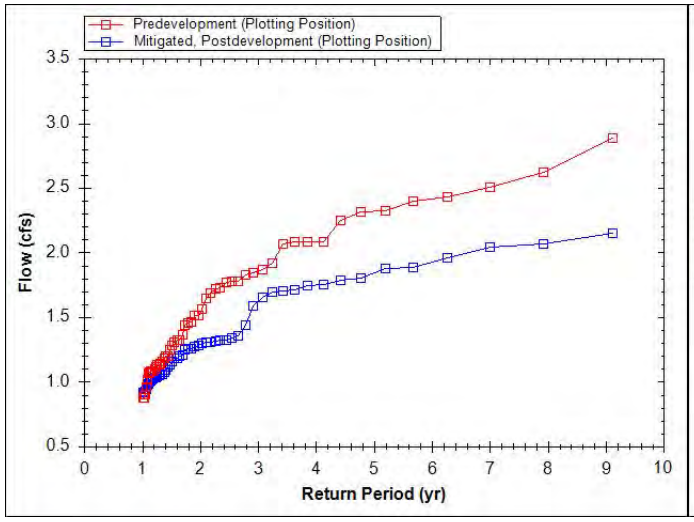
Shape Curve

Depth (ft)	Area (sq ft)
5.0	7,523.0

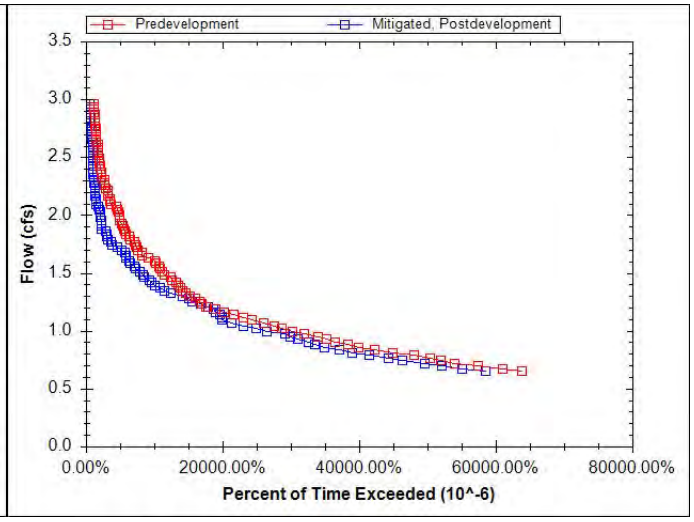
Outlet Structure Details

Lower Orifice Invert (ft)	0.0
Lower Orifice Dia (in)	3.3
Upper Orifice Invert(ft)	3.4
Upper Orifice Dia (in)	8.3
Overflow Weir Invert(ft)	4.0
Overflow Weir Length (ft)	6.3

Flow Frequency Chart

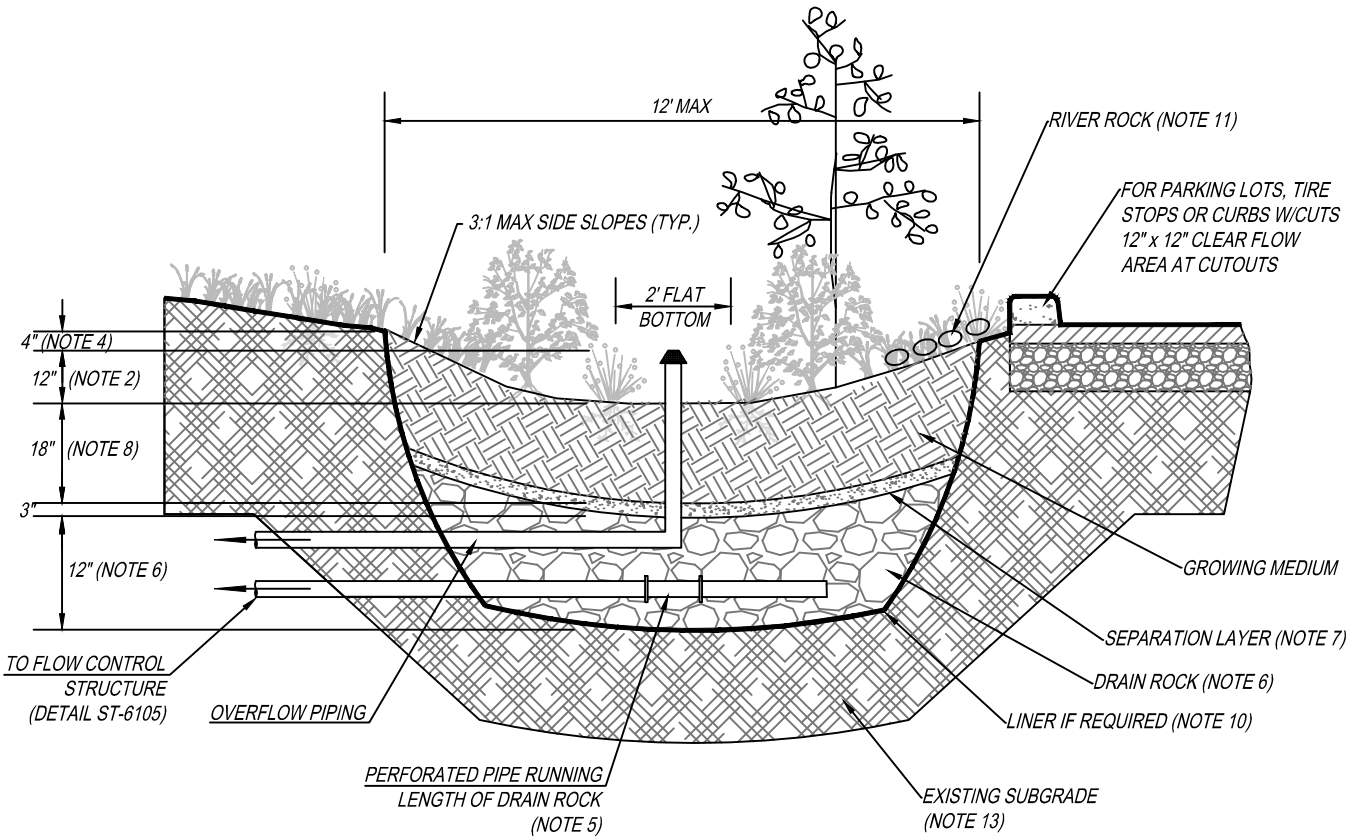


Flow Duration Chart



Appendix E

Operations and Maintenance Plans



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED SWALES ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION); 12"
   -LONGITUDINAL SLOPE OF SWALE:6.0% OR LESS
   -FLAT BOTTOM WIDTH: 2' MINIMUM
   -SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. **LOCATION/SETBACKS:**
   -FILTRATION SWALES SHALL BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL
4. **OVERFLOW:**
   -INLET ELEVATION SHALL ALLOW FOR 4" OF FREEBOARD, MIMIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
5. **PIPING:**
   -PERFORATED UNDER-DRAIN PIPING: SHALL BE ABS SCH. 40, CAST IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND. WRAP UNDER-DRAIN IN FILTER FABRIC TO REDUCE TRANSPORT OF FINES.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, CAST IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
6. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4" WASHED
   -DEPTH: 12"
7. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
8. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX C FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
   -FACILITY SURFACE AREA MAY BE REDUCED BY 25% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
10. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT.
11. **INSTALL RIVER ROCK** SPLASH PAD OVER A NON WOVEN GEO TEXTILE FABRIC TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3", 4 SQUARE FEET, 6" DEEP.
12. **CHECK DAMS:** SHALL BE PLACED ACCORDING TO FACILITY DESIGN. REFER TO DETAIL ST-6100 FOR PROFILE AND SPACING.
13. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.

Vegetated Swale - Filtration			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6045	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6045.DWG	APPROVED BY: NK	DATE: 6/3/16	PUBLIC WORKS STANDARDS

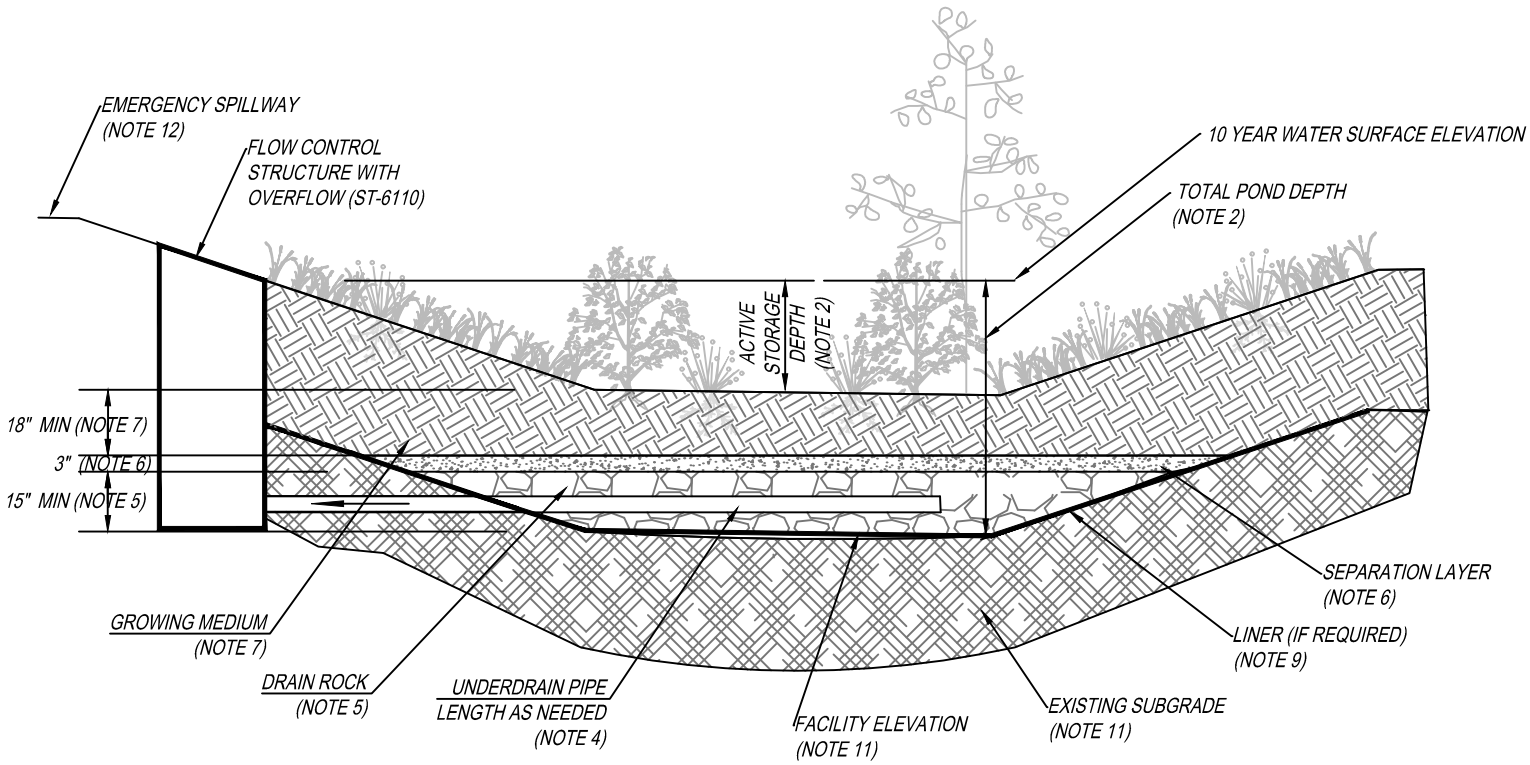
Vegetated Swales
Operations & Maintenance Plan

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Replace/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 - 10 inch deep rock check dams at design intervals.
Vegetation	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back to 4-6 inches, 1-2 times per year. Remove cuttings
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Restore or create outfalls, checkdams, or splash blocks where necessary.
Slope Sippage	-Stabilize Slope.
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

Summer. Make any structural repairs. Improve filter medium as needed. Clear drain. Irrigate as needed.
Fall. Replant exposed soil and replace dead plants. Remove sediment and plant debris.
Winter. Monitor infiltration/flow-through rates. Clear inlets and outlets/overflows to maintain conveyance.
Spring. Remove sediment and plant debris. Replant exposed soil and replace dead plants. Mulch.
All seasons. Weed as necessary.
Maintenance Records: Record date, description, and contractor (if applicable) for all structural repairs, landscape maintenance, and facility cleanout activities. Keep work orders and invoices on file and make available upon request of the inspector.
Access: Maintain ingress/egress to design standards.
Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.
Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact _____ for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.
Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

Vegetated Swale O & M Plan			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6055	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6055.DWG	APPROVED BY: NK	DATE: 10/8/14	PUBLIC WORKS STANDARDS



GENERAL NOTES:

1. **PROVIDE PROTECTION** FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED PONDS ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. **DIMENSIONS:**
   -ACTIVE STORAGE DEPTH: (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION); PER FACILITY SIZING MODEL
   -TOTAL POND DEPTH: 4' MINIMUM, PER FACILITY SIZING MODEL
   -BOTTOM SLOPE: 2.0% OR LESS
   -SIDE SLOPES OF DETENTION POND: 3:1 MAXIMUM
3. **LOCATION/SETBACKS:**
   -DETENTION POND SHALL BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. **PIPING:**
   -PERFORATED UNDER-DRAIN PIPING: SHALL BE ABS SCH. 40, CAST IRON OR PVC SCH. 40. 6" MINIMUM DIAMETER. PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND. WRAP UNDER-DRAIN PIPE IN FILTER FABRIC TO REDUCE TRANSPORT OF FINES.
   -OVERFLOW PIPING: SHALL BE ABS SCH. 40, CAST IRON OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PIPING SHALL HAVE 1% GRADE AND FOLLOW THE UNIFORM PLUMBING CODE. PVC NOT ALLOWED ABOVE GROUND.
5. **DRAIN ROCK:**
   -SIZE: 1 1/2" - 3/4"-0 WASHED
   -DEPTH: 15" MINIMUM
6. **SEPARATION** BETWEEN DRAIN ROCK AND GROWING MEDIUM: SHALL BE A 3" LAYER OF 3/4" - 1/4" OPEN GRADED AGGREGATE.
7. **GROWING MEDIUM:**
   -18" MINIMUM
   -SEE APPENDIX C FOR SPECIFICATION OR USE SAND/LOAM/COMPOST 3-WAY MIX.
8. **VEGETATION:** FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX A.
9. **WATERPROOF LINER (IF REQUIRED):** SHALL BE 30 MIL PVC OR EQUIVALENT FOR DETENTION POND.
10. **INSTALL RIVER ROCK** SPLASH PAD OVER A NON WOVEN GEO TEXTILE FABRIC TO TRANSITION FROM INLETS TO GROWING MEDIUM. SIZE OF ROCK SHALL BE 1" TO 3", 4 SQUARE FEET 6" DEEP.
11. **SEASONAL HIGH GROUNDWATER SEPARATION:**
    -SEPARATION DISTANCE AS REQUIRED BY CITY.
12. **EMERGENCY SPILLWAY** SIZED TO CONVEY THE 100 YEAR DESIGN STORM (S-2275). SEE PUBLIC WORKS STANDARDS 301.4.09

Detention Pond			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6060	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6060.DWG	APPROVED BY: NK	DATE: 6/3/16	PUBLIC WORKS STANDARDS

Detention Pond
Operations & Maintenance Plan

Detention Pond removes pollutants through several processes: sedimentation, filtration, and biological processes. The facility owner must keep a log, recording all inspection dates, observations, and maintenance activities. The following items shall be inspected and maintained as stated:

What to Look For	What to Do
Structural Components, including inlets and outlets/overflows, shall freely convey stormwater.	
Clogged inlets or outlets	-Remove sediment and debris from catch basins, trench drains, curb inlets and pipes to maintain at least 50% conveyance capacity at all times.
Cracked Drain Pipes	-Repair/seal cracks. Replace when repair is insufficient.
Check Dams	-Maintain 4 - 10 inch deep rock check dams at design intervals.
Vegetation shall cover 90% of the facility.	
Dead or strained vegetation	-Replant per original planting plan, or substitute from Appendix A. -Irrigate as needed. Mulch banks annually. DO NOT apply fertilizers, herbicides, or pesticides.
Tall Grass and Vegetation	-Cut back grass and prune overgrowth 1-2 times per year. Remove cuttings.
Weeds	-Manually remove weeds. Remove all plant debris.
Growing/Filter Medium, including soil and gravels, shall sustain healthy plant cover and infiltrate within 72 hours.	
Gullies	-Fill, lightly compact, and plant vegetation to disperse flow.
Erosion	-Replace splash blocks or inlet gravel/rock.
Slope Sippage	-Stabilize 3:1 Slopes/banks with plantings from Appendix A
Ponding	-Rake, till, or amend to restore infiltration rate.

Annual Maintenance Schedule:

All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, and 2 times per year thereafter, and within 48 hours after each major storm event.

Access: Maintain ingress/egress to design standards.

Infiltration/Flow Control: All facilities shall drain within 72 hours. Record time/date, weather, and site conditions when ponding occurs.

Pollution Prevention: All sites shall implement best management practices to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater. Contact _____ for immediate assistance responding to spills. Record time/date, weather, and site conditions if site activities contaminate stormwater.

Vectors (Mosquitoes & Rodents): Stormwater facilities shall not harbor mosquito larvae or rats that pose a threat to public health or that undermine the facility structure. Monitor standing water for small wiggling sticks perpendicular to the water's surface. Note holes/burrows in and around facilities. Call Clackamas County Vector Control for immediate assistance to eradicate vectors. Record time/date, weather, and site conditions when vector activity observed.

Detention Pond O & M Plan			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6065	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6065.DWG	APPROVED BY: NK	DATE: 10/8/14	PUBLIC WORKS STANDARDS

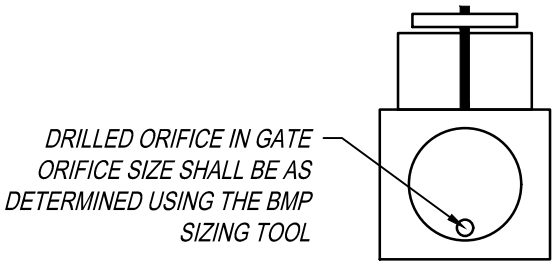
STORMWATER FACILITIES
OPERATIONS AND MAINTENANCE CHECKLIST

Problem	Frequency	Trigger	Preferred Condition
Sediment Accumulation in Treatment Area	Monthly from November through April Annually Required	Sediment depth exceeds 3 inches	Sediment removed from vegetated treatment area: level side to side and drains freely toward outlet; no standing water within 24 hours of any major storm (1" in 24 hours)
Erosion Scouring	Monthly from November through April Annually Required	Monthly from November through April Annually Required	Repair ruts or bare areas by filling with topsoil during dry season; regreade and replant large bare areas.
Standing Water	Monthly from November through April and after any major storm (1 inch in 24 hours)	Standing water in the planter between storms that does not drain freely	Remove sediment or trash blockages; improve end to end grade so there is no standing water 24 hours after any major storm (1 inch in 24 hours)
Flow not Distributed Evenly	Monthly from November through April Annually Required	Flows unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width
Settlement/ Misalignment	Annually Required	Failure of planters has created safety, function, or design problem	Planter replaced or repaired to design standards
Constant Baseflow	Monthly from November through April Annually Required	Small, continual flow of water through the planter even after weeks without rain; planter bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the planter or bypass the baseflow around the planter
Vegetation	Monthly from November through April Annually Required	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking the inlet pipe opening
Poor Vegetation Coverage	Monthly Annually Required	Grass or other vegetation is sparse, or bare in more than 10% of the planter area	Determine cause of poor growth and correct the condition; replant with plants (per Appendix A) as needed to meet facility standards
Invasive Vegetation	Monthly Annually Required	No invasive vegetation is planted or permitted to remain	no invasive vegetation present; remove excessive weeds. Control if complete eradication is not feasible
Rodents	Monthly Annually Required	Evidence of rodents or rodent damage	No rodents; functioning facility
Insects	Annually Required	Insects such as wasps and hornets that interfere with maintenance activities	Harmful Insects removed
Trash and Debris	Monthly and after any major storm (1 inch in 24 hours) Annually Required	Visual evidence of trash, debris or dumping	Trash and Debris removed from facility
Contamination and Pollution	Monthly from November through April Annually Required	Any evidence of oil, gasoline, contamination or other pollutants	No contaminants or pollutants present; coordinate removal/cleanup with local water quality response agency
Obstructed Inlet/Outlet	Monthly and after any major storm event (1 inch in 24 hours) Annually Required	Inlet/outlet areas clogged with sediment, vegetation or debris	Clear inlet and outlet; obstructions removed
Excessive Shading	Monthly from November through April Annually Required	Vegetation growth is poor because unlight does not reach planter	Trim over-hanging limbs and/or remove brushy vegetation as needed
Vegetation	Monthly from November through April Annually Required	Specified or approved grass grows so tall that if competes with shrubs and/or becomes a fire danger	String trim non-wetland grasses to 4 inch to 6 inch and remove clippings; protect woody vegetation

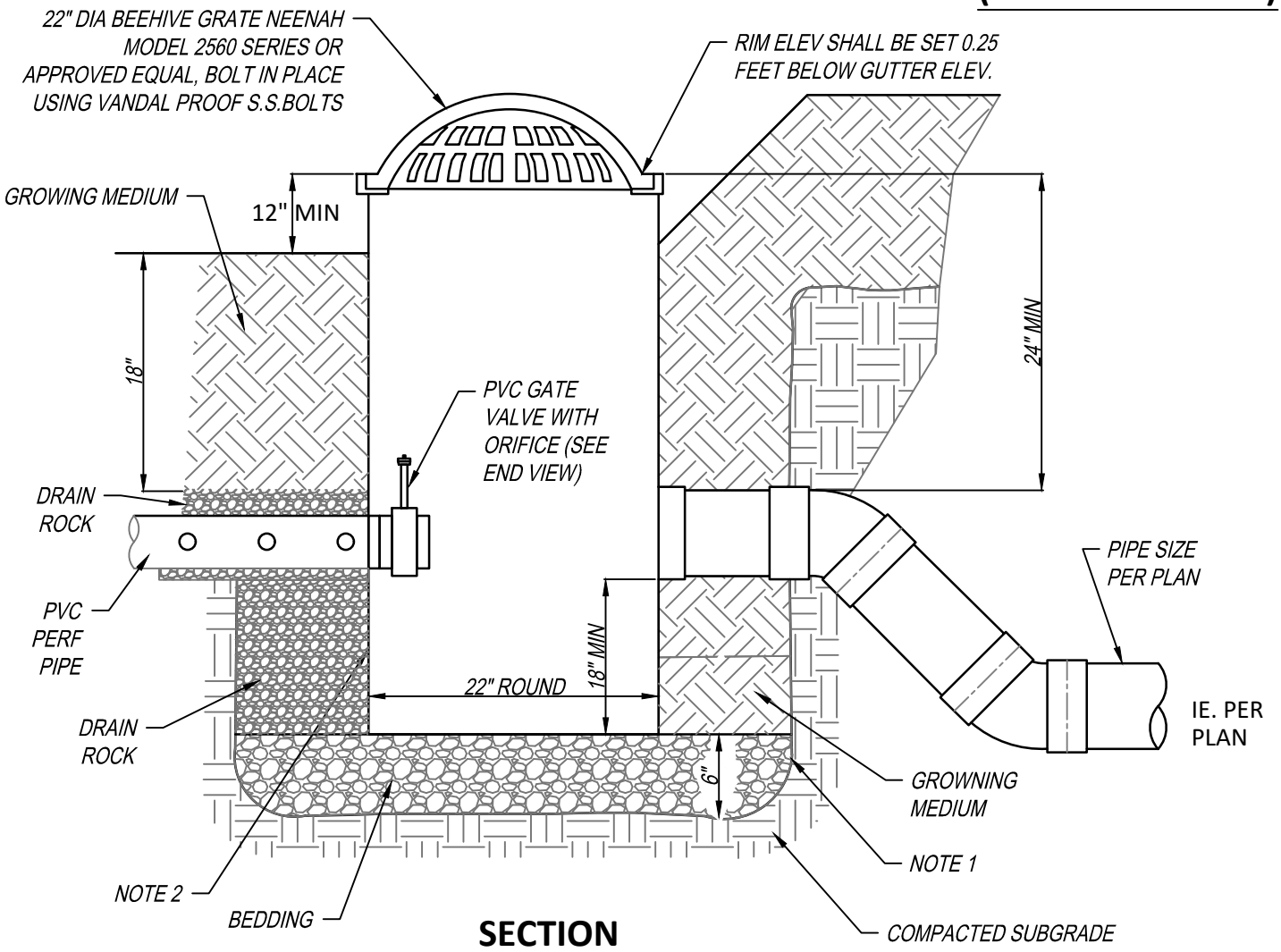
Stormwater Facilities Operations & Maintenance Checklist		
DRAWING NUMBER: ST-6115	DRAWN BY: SR	SCALE: N.T.S.
FILE NAME: ST-6115.DWG	APPROVED BY: NK	DATE: 10/3/14

CITY OF WILSONVILLE

PUBLIC WORKS STANDARDS



END VIEW
(PVC GATE VALVE)



SECTION

NOTES:
1. CONTRACTOR TO WIDEN EXCAVATION AS REQUIRED TO OBTAIN COMPACTION WITH CONTRACTORS COMPACTION EQUIPMENT.
2. 10 GA. STEEL PLATE, BITUMINOUS COATED BASIN AS MANUFACTURED BY GIBSON STEEL, GRATEMASTER OR APPROVED EQUAL.
3. BEDDING SHALL BE 6" OF COMPACTED 3/4"-0 CRUSHED ROCK BASE MATERIAL.

Beehive Overflow Inlet			CITY OF WILSONVILLE
DRAWING NUMBER: ST-6120	DRAWN BY: SR	SCALE: N.T.S.	
FILE NAME: ST-6120.dwg	APPROVED BY: NK	DATE: 2/15/18	PUBLIC WORKS STANDARDS