Northplace Apartments Phase 2
Salem, Oregon

Preliminary Stormwater Report

Date:	August 4th, 2023
Client:	I & E Construction 27375 SW Parkway Ave. Wilsonville, OR 97070
Engineering Contact:	Tyler D. Roth, PE rotht@aks-eng.com
Prepared By:	Madison Margolis
Engineering Firm:	AKS Engineering & Forestry, LLC 3700 River RD N, Suite 1 Keizer, OR 97303
AKS Job Number:	8321

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1.0 Purpose of Report

The purpose of this report is to demonstrate compliance with the City of Salem stormwater criteria for land use and site plan review applications. This report is an analysis of the effects the proposed development will have on the existing stormwater conveyance system; document the criteria, methodology, and informational sources used to design the proposed stormwater system; and present the results of the analysis.

2.0 Project Overview and Description

2.1. Project Location/Executive Summary

The total project site subject to this stormwater report is approximately 15.6 acres and is located at 4680 and 4650 Hazelgreen Road NE Salem, Marion County, Oregon, Tax Lot 400 and 500 of Marion County Assessor's Map 06 2W 32C.

The property is zoned as RM-2 (Multiple Family Residential) and MU-1 (Mixed Use). The proposed development involves new multifamily buildings and associated landscaped areas, utilities, and infrastructure.

2.2. Watershed Description

Current site runoff flows through an existing onsite drainage ditch that conveys runoff to the adjacent Bridges RV Storage site and the existing stormwater system in Moon Avenue NE.

2.3. Existing Site Conditions

The foundation of a previous residential home is located on the northwest corner of the site. The rest of the site is a flat grass field with an existing drainage path running from the south side of the site to the middle of the east side. Slopes vary from 0 percent to 25 percent. The site slopes from a high point of ±182 to a low point of ±170 at the stormwater discharge point.

2.4. Existing Trees and Native Vegetation Impact/Preservation

The site is relatively clear of vegetation with the exception of field crops. No tree removal is proposed with the development.

2.5. Green Stormwater Infrastructure to the Maximum Extent Feasible (GSI/MEF)

This project is classified as a large project because it contains over 10,000 square feet of proposed impervious area. As specified in Section 4.3 of the 2016 City of Salem *Public Works Design Standards*, large projects are required to use GSI to the Maximum Extent Feasible (GSI/MEF) to meet flow control and water quality treatment performance standards. City of Salem *Public Works Design Standards* Section 4.3 provides a list of combined stormwater flow control and treatment facilities. Several rain garden facilities are proposed to meet GSI/MEF criteria for the proposed site.

This preliminary report is provided to address this requirement by demonstrating the onsite rain garden or planter facilities will be used to meet the GSI/MEF criteria for the proposed site. This report is provided to demonstrate that the project is treating over 80 percent of the new or replaced impervious surface and therefore meets the GSI/MEF requirement by using the discretionary approach outlined in Section 4E.7 of the *Public Works Design Standards.*

The proposed offsite (Lunar Drive and Hazelgreen Road) stormwater facilities represent 10 percent of the area dedicated for new and replaced impervious surface flow, therefore meeting the GSI/MEF requirement by utilizing the non-discretionary approach outlined in Section 4E.6 of the *Public Works Design Standards*.

2.6. Regulatory Permits Required

Building and site work permits through the City of Salem will be required for the project. A DEQ 1200-C permit will be required due to the disturbed area exceeding 5 acres. Additionally, a design exception may be warranted due to extended draw down or release rates for the site. This can be provided at the time of site development permit submittal.

2.7. Emergency Overflow Escape Route

The stormwater system has been designed to convey stormwater runoff from storms with intensities higher than the 100-year design storm through an overflow in the flow control structures that discharges directly to the public system. Emergency overland overflow, should the stormwater system be overwhelmed, is out through various driveway approaches, to Hazelgreen Road, or through a spillway provided within the detention facility that abuts the Bridges RV Storage site. This mimics the existing drainage patterns as the site currently conveys runoff directly to the Bridges RV Storage site.

3.0 Methodology

3.1. Depth to Groundwater

A final geotechnical investigation by Redmond Geotechnical Services (Appendix A) was completed on June 7, 2021. During field investigations groundwater was not encountered in the test pits at the time of excavation to depths of at least 8 feet beneath existing surface grades. Refer to page 4 of the Geotechnical Report for additional depth to groundwater discussion.

3.2. Infiltration

Infiltration testing was performed by Redmond Geotechnical Services at two locations on-site. Testing was performed at a depth of about 4-5 feet beneath existing site grades. The subgrade soil encountered within the test holes consisted of native clayey, sandy silt to silty fine sand. The infiltration testing resulted in an infiltration rate of ±1.6 inches per hour, for a recommended design infiltration rate of ±0.8 inches per hour (given a safety factor of 2). An average of the recommended range of 0.7 inches per hour was used in this analysis.

3.3. Soils and Geologic Features

The pre-developed site contains Concord Silt Loam and Woodburn Silt Loam, belonging to Hydrologic Soil Groups C/D and C respectively, per the Natural Resources Conservation Service (NRCS) Soil Resource Web Survey (Appendix B).

3.4. Hazardous Materials

We are not aware of any existing hazardous material contamination onsite. A phase 2 environmental report has not been prepared, and the geotechnical report does not note any contaminants on site.

4.0 Analysis

4.1. Computational Methods and Software Used

The Santa Barbara Urban Hydrography (SBUH) method was used to analyze stormwater runoff from the site. This method uses the Soil Conservation Service (SCS) Type 1A 24-hour design storm for the region. HydroCAD 10.0-22 computer software aided in the analysis.

4.2. Design Assumptions

The stormwater runoff was analyzed based on the City of Salem standards for the water quality, one half of the 2-year 24-hour, the 10-year 24-hour, the 25-year 24-hour, and the 100-year 24-hour design storm events.

The following 24-hour rainfall intensities were used for the design storm for the recurrence interval:

Table 4-1: Rainfall Intensities

Recurrence Interval (years)	Total Precipitation Depth (inches)
Water Quality	1.38
½ of 2-year	1.10
10-year	3.20
25-year	3.60
100-year	4.40

Onsite soils within the associated drainage basins are classified as Concord Silt Loam and Woodburn Silt Loam, according to the NRCS Web Soil Survey (Appendix B).

The following table outlines the Hydrologic Soil Group rating for the soil type:

Table 4-2: Hydrologic Soil Group Ratings

NRCS Map Unit Identification	NRCS Soil Classification (Percentage of Site)	Hydrologic Soil Group Rating
Co	Concord Silt Loam (7.9%)	C/D
WuA	Woodburn Silt Loam 0 to 3 percent slopes (76.2%)	C
WuC	Woodburn Silt Loam 3 to 12 percent slopes (15.8%)	C

The following runoff curve numbers (CNs) were used for this analysis:

- Pre-Developed - City of Salem Pre-Development CN=72
- Post-Developed – CN=98 was used for all impervious area; CN=74 for landscaping and open space
- Design Infiltration Rate = 0.7 inches per hour

Due to most of the onsite water flowing through the natural drainage ditch, a time of concentration of 32.5 minutes was used for pre-developed hydrograph routing based on a flow length of 900 feet and an average slope across the site of 1.0 percent.

The northwest portion of the site drains to an existing ditch along Hazelgreen Road, and therefore requires a second time of concentration path and analysis. A time of concentration of 47.6 minutes was used for the offsite pre-developed hydrograph routing based on a flow length of 882 feet and an average slope across the site of 0.5 percent.

A minimum time of concentration (Tc) of 6 minutes was used as a direct entry in the stormwater system model for post-developed hydrograph routing, per the 1986 NRCS Technical Release 55: Urban Hydrology for Small Watersheds (TR-55).

A City public storm line (36" diameter) will be constructed and routed through the site to convey flows currently draining into the ditch system. This flow is considered a bypassed flow and is not included in determining the allowed release rate for the associated storms.

4.3. Hydrology Calculations

The tables in the following sections summarize tributary areas to each facility and the calculated elevations within each facility for post-developed peak flow rates of the water quality and 100-year design storm events. Supporting HydroCAD calculations are provided in Appendix C. To simplify this initial analysis, one hydroCAD model is utilized to ensure the rain gardens have sufficient capacity to treat the water quality storm event runoff and then a second model is utilized to verify detention volume is sufficient.

Runoff associated with Lunar Drive and Hazelgreen Road runoff are not included in the hydrocad calculations as 10% of the new or replaced impervious area has been set aside for a planter / rain garden. These facilities will be designed with the final report included at the time site development permits are pulled.

4.4. Conveyance Capacity Calculations

The proposed onsite drainage conveyance system has been designed per City of Salem *Public Works Design Standards* to convey the peak flows from local street classifications for the 10-year 24-hour storm event.

4.5. Treatment Sizing

Multiple water quality facilities will be constructed to treat new impervious areas for the development by filtering stormwater runoff through growing medium in a combined facility. Under drains will be used to convey the treated runoff due to the design infiltration rate of 0.7 inches per hour for the site.

Water quality calculations are provided in Appendix C and summarized in Tables 4-3 and 4-4 below. Figure 3 provides a site map showing a breakdown of the impervious areas.

Table 4-3: Impervious Area Conveyed to Facility

Subbasin ID	Source (roof, road, other)	Impervious Area (square feet)	Facility Type and Ownership (private/public)	Facility Size Top Contour (square feet)
10S	Roof drain, hardscapes, & landscape	358,264	Rain Garden Private	17,910
11S	Roof drain, hardscapes, & landscape	20,296	Rain Garden Private	3,469
12S	Roof drain, hardscapes, & landscape	30,274	Rain Garden Private	3,178
13S	Roof drain, hardscapes, & landscape	10,115	Rain Garden Private	817
P	Public Runoff	78,607	Planters Public (Designed Later)	8,042 sf (10.25% of Impervious Area)

Table 4-4: Water Quality Event Summary

Facility ID	Facility Elevations (feet)	Facility Peak Elevation (Water Quality Event) (feet)	Ditch Inlet / Beehive Overflow Elevation
RGA	180.00 (Facility Top) 174.00 (Above Ground) 170.00 (Rock Storage)	174.93	175.50
RGB	180.00 (Facility Top) 178.70 (Above Ground) 175.70 (Rock Storage)	178.71	178.75
RGC	180.00 (Facility Top) 178.00 (Above Ground) 175.25 (Rock Storage)	178.03	178.03
RGD	182.72 (Facility Top) 178.72 (Above Ground) 175.72 (Rock Storage)	179.21	179.21

4.6. Flow Control Sizing

Post-developed peak flow HydroCAD calculations are shown in Appendix C and are summarized below.

The rain garden is designed with a flow control manhole and overflow inlet. Each water quality facility is designed to treat the runoff via filtration through the growing medium. An underdrain system is provided to convey runoff to the flow control manhole along with a ditch inlet or beehive overflow being provided to convey storm events greater than the WQ design storm to the flow control manhole. Within the manhole is an orifice for low flow and another higher orifice for the high flow. The orifices are sized to meet the flow control requirements in accordance with the City of Salem standards.

Table 4-5 shows the peak elevation summary for the stormwater facility during half of the 2-year, 10-year, 25-year, and 100-year design storm events. The facility is modeled utilizing storage from RGA, RGB, and RGC. Water will be held in these facilities until it is released at the allowed release rate.

Table 4-5: Detention Basin Peak Elevation Summary

Facility ID	Orifice Diameter & Elevation	Top of Storage and Bottom of Pond Elevation (feet)	Overflow (feet)	Peak Elevation, ½ the 2-year Event (feet)	Peak Elevation, 10-year Event (feet)	Peak Elevation, 25-year Event (feet)	Peak Elevation, 100 Year Event (feet)
19P (RGA + RGB + RGC)	5.3-inch diameter at 170.25 feet 12-inch diameter at 177.00 feet	Top: 180.00 Bot: 170.00	175.50	174.64	176.58	177.12	177.66

4.7. Pre- Vs. Post-Developed Condition Results

Stormwater from replaced and newly created impervious areas will be routed into the proposed rain garden.

The following table summarizes the calculated runoff for pre- and post-developed peak flow rates for half the 2-year, 10-year, 25-year, and 100-year design storm events. See Figure 3 for the post-developed basin map. Supporting HydroCAD calculations are provided in Appendix C.

Table 4-6: Pre- Vs. Post-Developed Flow Rates

	Peak Flow Rate (cubic feet per second)							
Facility ID	Half of the 2-Year Storm		10-Year Storm		25-Year Storm		100-Year Storm	
Project Site	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Onsite	0.05	0.00*	1.93	1.93	2.76	2.04	4.62	3.61

*Half of the 2-year design storm has been designed to be fully infiltrated under post-developed conditions to maximum extent feasible.

5.0 Conclusion

This stormwater report summarizes the design of the stormwater facility for this project. The GSI facility has been designed in compliance with the City of Salem. Supporting HydroCAD calculations are included in Appendix C.

Runoff from the multifamily buildings, driveways, roadways, and immediate surrounding areas will be conveyed to the rain gardens (GSI).

Runoff from the Hazelgreen Road widening and the northwestern portion of Lunar Drive will be conveyed to planters. At this time, these planters are only sized based on 10 percent of the impervious area draining to them to meet the applicable GSI/MEF criteria outlined in Section 4E.6 of the *Public Works Design Standards*. A full design will be provided at the time of permit submittal.

The onsite proposed storm system has been designed to treat over 80 percent of the new or replaced impervious surface and therefore meets the GSI/MEF requirement by using the discretionary approach outlined in Section 4E.7 of the *Public Works Design Standards*. Detention has been provided in accordance with the *Public Works Design standards* to detain half of the 2-year, 10-year, 25-year, and 100-year design storm events.

Figure 1: Vicinity Map

NORTHPLACE APARTMENTS
PHASE 2
VICINITY MAP

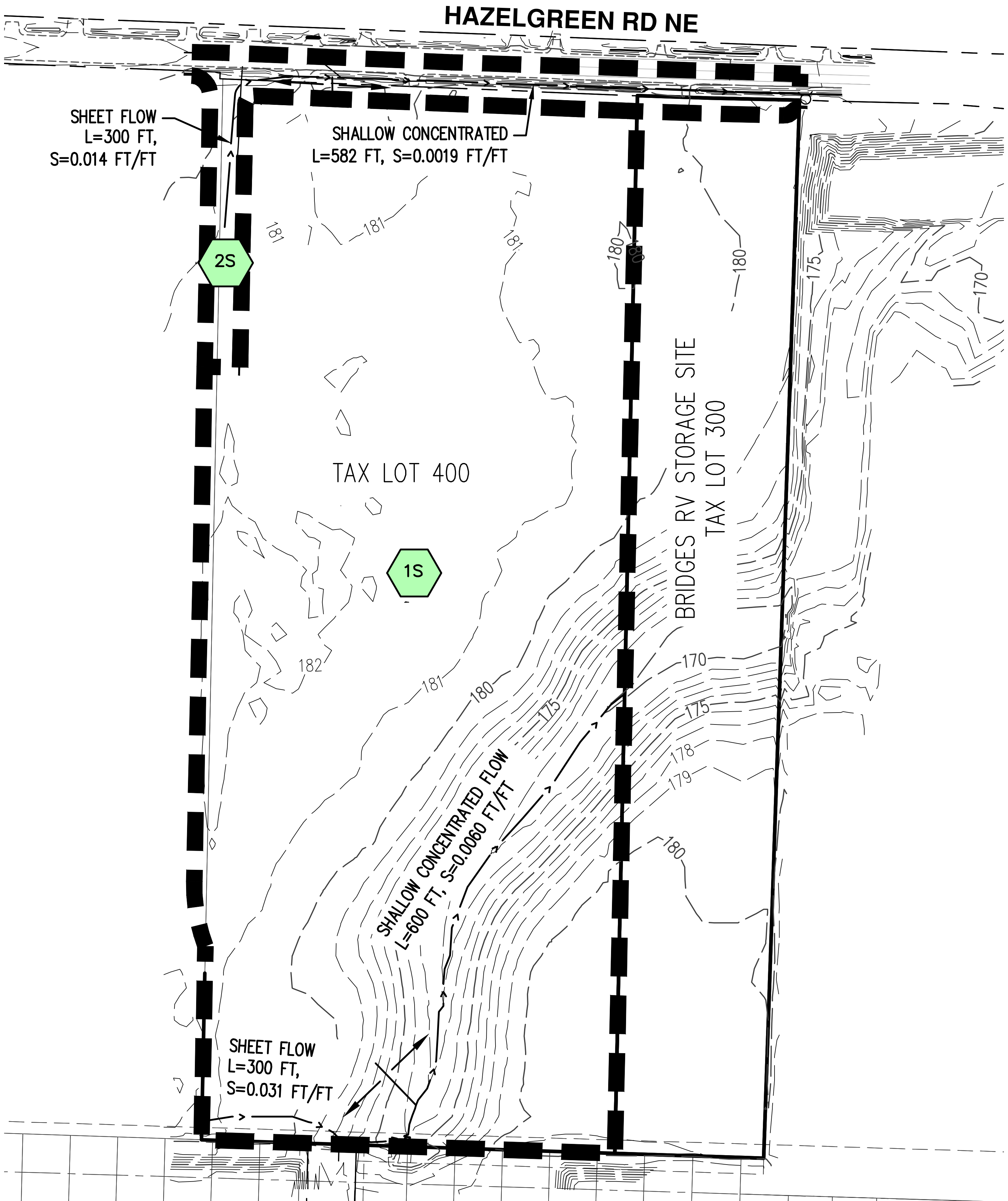
DATE: 06/30/2023	
DRWN: MJM	CHKD: TDR
AKS JOB: 8321	FIGURE 1

AKS

AKS ENGINEERING & FORESTRY, LLC
3700 RIVER RD N, STE 1
KEIZER, OR 97303
503.400.6028 WWW.AKS-ENG.COM

DWG: 8321 VICINITY MAP | LETTER-L

Figure 2: Pre-Developed Basin Map



TIME OF CONCENTRATION

1S BASIN:

SHEET FLOW:
L = 300 FT
S = 0.031 FT/FT
N = GRASS SHORT = 0.15
SHEET FLOW = 23.9 MIN

SHALLOW CONCENTRATED FLOW:
L = 600 FT
S = 0.0060 FT/FT
V = GRASSED WATERWAY = 15.0 FT/S
SHALLOW CONCENTRATED FLOW = 8.6 MIN

TOTAL T_C = 32.5

2S BASIN:

SHEET FLOW:
L = 300 FT
S = 0.014 FT/FT
N = GRASS SHORT = 0.15
SHEET FLOW = 32.8 MIN

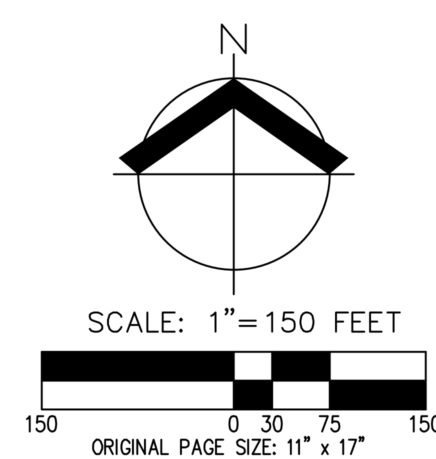
SHALLOW CONCENTRATED FLOW:
L = 582 FT
S = 0.0019 FT/FT
V = GRASSED WATERWAY = 15.0 FT/S
SHALLOW CONCENTRATED FLOW = 14.8 MIN

TOTAL T_C = 47.6

LEGEND

BASIN ID #S

BASIN BOUNDARY



DATE: 06/29/2023

PRE-DEVELOPED BASIN MAP

NORTHPLACE APARTMENTS PHASE 2

FIGURE **2**

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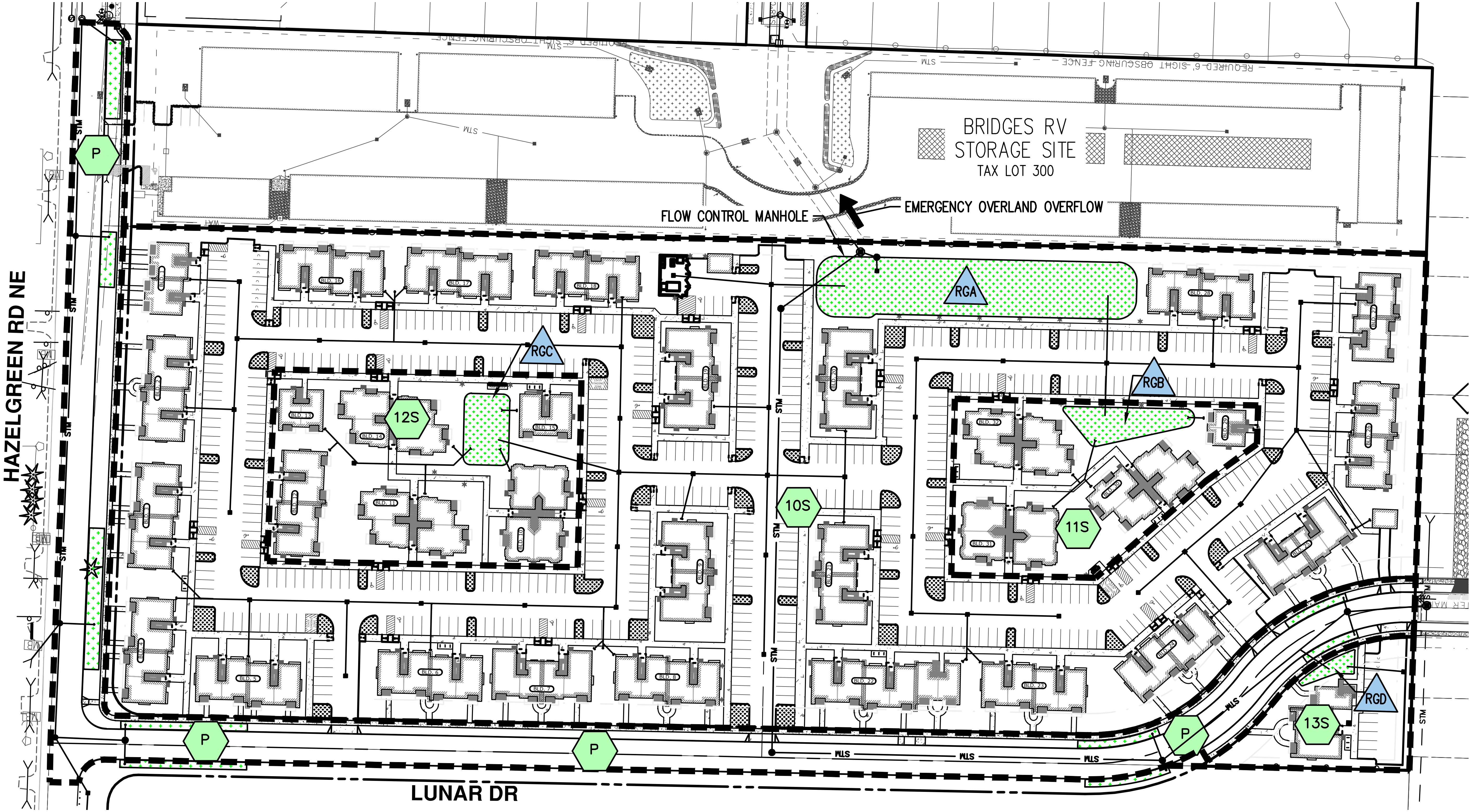
DRWN: MDT
CHKD: MTA
AKS JOB: 8321

DWG: 8321 PRE BASIN | LAYOUT1

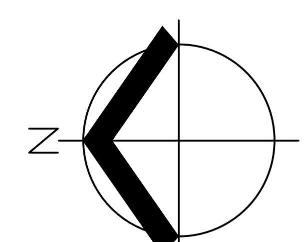
Figure 3: Post-Developed Basin Map



LEGEND

SUBCATCHMENT #S

STORMWATER FACILITY RG#



SCALE: 1"=100 FEET

100 0 20 50 100

ORIGINAL PAGE SIZE: 11" x 17"

DATE: 08/01/2023

POST-DEVELOPED BASIN MAP	FIGURE
NORTHPLACE APARTMENTS PHASE 2	3
AKS ENGINEERING & FORESTRY, LLC 3700 RIVER RD N, STE 1 KEIZER, OR 97303 503.400.6028 WWW.AKS-ENG.COM	DRWN: MJM CHKD: TDR AKS JOB: 8321

DWG: 8321 20230802 WQ BASINS | LAYOUT1

Appendix A: Geotechnical Report

REDMOND GEOTECHNICAL SERVICES

Geotechnical Investigation and Consultation Services

Proposed Northstar Phase 8 Residential Development Site

Tax Lot No. 400

4680 Hazelgreen Road NE

Salem (Marion County), Oregon

for

Northstar Homes, LLC

Project No. 1017.029.G
June 7, 2021

REDMOND GEOTECHNICAL SERVICES

June 7, 2021

Mr. Jeffrey Bivens
Northstar Homes, LLC
27375 SW Parkway Avenue
Wilsonville, Oregon 97070

Dear Mr. Bivens:

Re: Geotechnical Investigation and Consultation Services, Proposed Northstar Phase 8 Residential Development Site, Tax Lot No. 400, 4680 Hazelgreen Road NE, Salem (Marion County), Oregon

Submitted herewith is our report entitled "Geotechnical Investigation and Consultation Services, Proposed Northstar Phase 8 Residential Development Site, Tax Lot No. 400, 4680 Hazelgreen Road NE, Salem (Marion County), Oregon". The scope of our services was outlined in our formal proposal to Mr. Mark AuClair of AKS Engineering & Forestry, LLC dated April 26, 2021. Written authorization of our services was provided by Mr. Jeffrey Bivens of Northstar Homes, LLC on May 10, 2021.

During the course of our investigation, we have kept you and/or others advised of our schedule and preliminary findings. We appreciate the opportunity to assist you with this phase of the project. Should you have any questions regarding this report, please do not hesitate to call.

Sincerely,

Daniel M. Redmond, P.E., G.E.
President/Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
12,309
OREGON
July 15, 1983
DANIEL M. REDMOND
Exp. 12-31-22

PO Box 20547 • Portland, Oregon 97294 • Fax 503/286-7176 • Phone 503/285-0598

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GEOTECHNICAL INVESTIGATION AND CONSULTATION SERVICES PROPOSED NORTHSTAR PHASE 8 RESIDENTIAL DEVELOPMENT SITE TAX LOT NO. 400, 4680 HAZELGREEN ROAD NE SALEM (MARION COUNTY), OREGON

INTRODUCTION

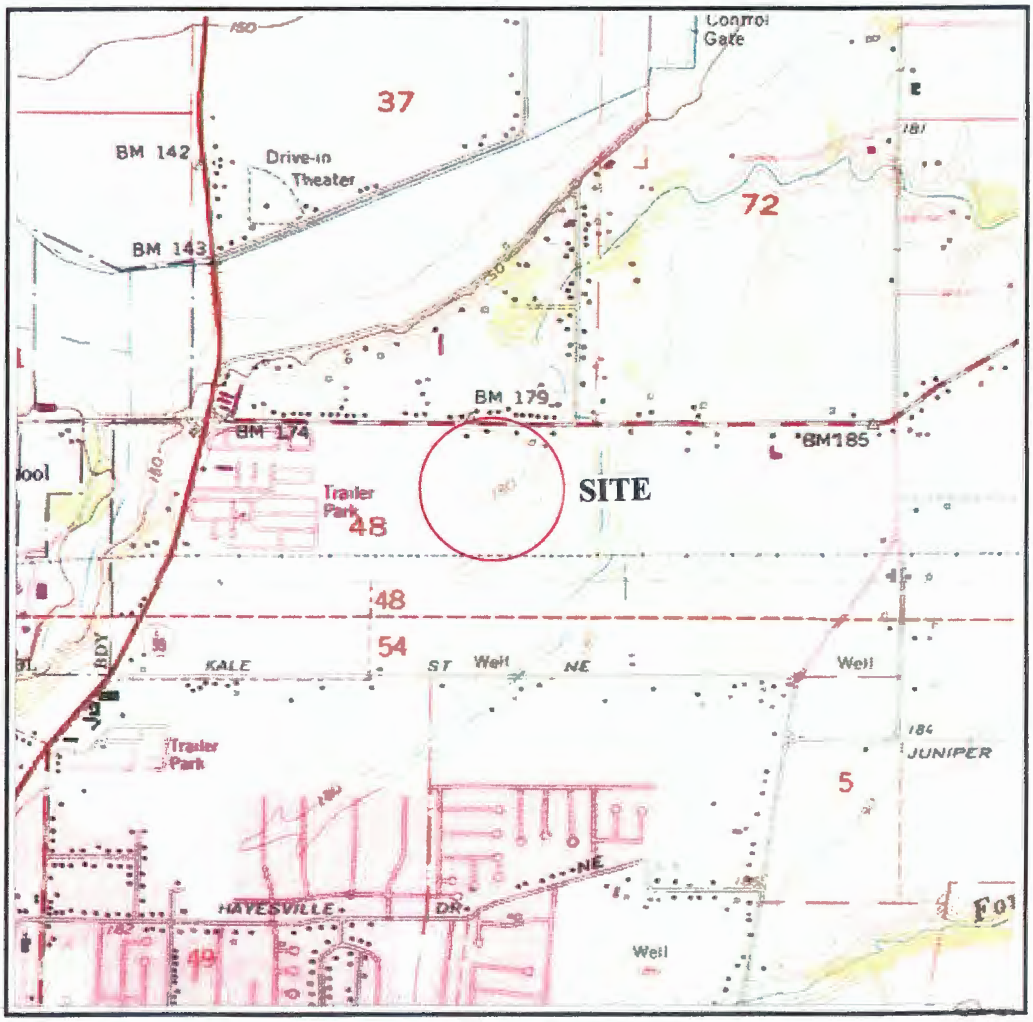
Redmond Geotechnical Services, LLC is please to submit to you the results of our Geotechnical Investigation and Consultation Services at the site of the proposed new Northstar Phase 8 residential development located to the south of Hazelgreen Road NE and to the east of the intersection with Ebony Lane NE in Salem (Marion County), Oregon. The general location of the subject site is shown on the Site Vicinity Map, Figure No. 1. The purpose of our geotechnical investigation and consultation services at this time was to explore the existing subsurface soils and/or groundwater conditions across the subject site and to evaluate any potential concerns with regard to development at the site as well as to develop and/or provide appropriate geotechnical design and construction recommendations for the proposed new residential development project.

PROJECT DESCRIPTION

We understand that present plans are to develop the subject property by constructing eighty-six (86) new single-family residential homes at the site. Reportedly, the proposed new single-family residential homes will be two- and/or three-story wood-frame structures with a raised wooden post and beam floor system. Support of the new single-family residential structures is anticipated to consist primarily of conventional shallow strip (continuous) footings although some individual (spread) column-type footings may also be required. Structural loading information, although unavailable at this time, is anticipated to be fairly typical and light for this type of two- and/or three-story wood-frame residential structure and is expected to result in maximum dead plus live continuous (strip) and individual (column) footing loads on the order of about 2.0 to 3.0 kips per lineal foot (klf) and 10 to 35 kips, respectively.

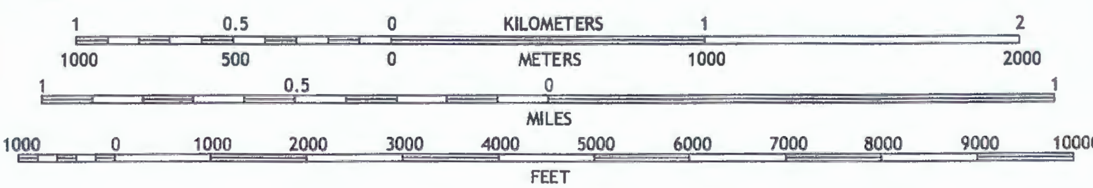
Other associated site improvements for the project will include construction of new public streets. Additionally, the project will include the construction of new underground utility services as well as new concrete curbs and sidewalks. Further, we anticipate that storm water from hard and/or impervious surfaces (i.e., roofs and pavements) will be collected for on-site treatment and possible disposal within two (2) or more storm water facilities.

Although a site grading plan is not available at this time, we understand that both cuts and fills are presently planned for the residential project. In general, cuts and/or fills of at least five (5) feet are generally anticipated across the proposed residential lots as well as the proposed new public streets.



SALEM EAST QUADRANGLE
OREGON-MARION CO.
7.5-MINUTE SERIES

SCALE 1:24 000



CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

SITE VICINITY MAP		
Project No. 1017.029.G	NORTHSTAR PHASE 8 TL 400, 4680 HAZELGREEN RD NE	Figure No. 1

SCOPE OF WORK

The purpose of our geotechnical studies was to evaluate the overall subsurface soil and/or groundwater conditions underlying the subject site with regard to the proposed new residential development and construction at the site and any associated impacts or concerns with respect to proposed new single-family residential development at the site as well as provide appropriate geotechnical design and construction recommendations for the project. Specifically, our geotechnical investigation and consultation services included the following scope of work items:

1. Review of available and relevant geologic and/or geotechnical investigation reports for the subject site and/or area.

2. A detailed field reconnaissance and subsurface exploration program of the soil and ground water conditions underlying the site by means of seven (7) exploratory test pit excavations. The exploratory test pits were excavated to depths ranging from about six (6) to eight (8) feet beneath existing site grades at the approximate locations as shown on the Site Exploration Plan, Figure No. 2. Additionally, field infiltration testing was also performed within two (2) of the exploratory test pit excavations (TH-#6 and TH-#7) in general conformance with the EPA Encased Falling Head and/or City of Salem Public Works Standards.

3. Laboratory testing to evaluate and identify pertinent physical and engineering properties of the subsurface soils encountered relative to the planned site development and construction at the site. The laboratory testing program included tests to help evaluate the natural (field) moisture content and dry density, maximum dry density and optimum moisture content, gradational characteristics and Atterberg Limits as well as "R"-value tests.

4. A literature review and engineering evaluation and assessment of the regional seismicity to evaluate the potential ground motion hazard(s) at the subject site. The evaluation and assessment included a review of the regional earthquake history and sources such as potential seismic sources, maximum credible earthquakes, and reoccurrence intervals as well as a discussion of the possible ground response to the selected design earthquake(s), fault rupture, landsliding, liquefaction, and tsunami and seiche flooding.

5. Engineering analyses utilizing the field and laboratory data as a basis for furnishing recommendations for foundation support of the proposed new residential structure(s). Recommendations include maximum design allowable contact bearing pressure(s), depth of footing embedment, estimates of foundation settlement, lateral soil resistance, and foundation subgrade preparation. Additionally, construction and/or permanent subsurface water drainage considerations have also been prepared. Further, our report includes recommendations regarding site preparation, placement and compaction of structural fill materials, suitability of the on-site soils for use as structural fill, criteria for import fill materials, and preparation of foundation, pavement and/or floor slab subgrades.

6. Flexible pavement design and construction recommendations for the proposed new paved public street improvements.

SITE CONDITIONS

Site Geology

Available geologic mapping of the area and/or subject site indicates that the near surface soils consist of lacustrine and fluvial (alluvium) sedimentary deposits (Qtg) of Pleistocene age. Characteristics include unconsolidated to semi-consolidated lacustrine clay, silt, sand and gravel; in places includes mudflow and related deposits of Piper (1942), Willamette Valley Silt (Allison, 1953; Wells and Peck, 1961), alluvial silt, sand and gravel that form terrace deposits of Wells and others (1983). These upper (surficial) unconsolidated to semi-consolidated alluvial sedimentary deposits are generally several tens of feet in thickness and are underlain at depth by semi-consolidated to well consolidated conglomerate gravels of Pleistocene age.

Surface Conditions

The subject proposed new residential development property consists of one (1) rectangular shaped tax lot (TL 400) which encompass a total plan area of approximately 15.26 acres. The proposed new residential development property is roughly located to the south of Hazelgreen Road NE and to the east of the intersection with Ebony Lane NE. The subject proposed residential development site is generally unimproved. However, the northwesterly corner of the subject site contains an existing single-family residential home. Surface vegetation across the site generally consists of a light growth of grass and weeds.

Topographically, most of the site is characterized as relatively flat-lying to gently sloping terrain and lies between about Elevation 180 to 190 feet. Additionally, a seasonal tributary to the Little Pudding River traverses the central portion of the site.

Subsurface Soil Conditions

Our understanding of the subsurface soil conditions underlying the site was developed by means of seven (7) exploratory test pits excavated to depths ranging from about six (6) to eight (8) feet beneath existing site grades on May 6, 2021 with a John Deere 200C track-mounted excavator. The location of the exploratory test pits were located in the field by marking off distances from existing and/or known site features and are shown in relation to the existing and/or proposed new site improvements on the Site Exploration Plan, Figure No. 2. Detailed logs of the test pit explorations, presenting conditions encountered at each location explored, are presented in the Appendix, Figure No's. A-4 through A-7.

The exploratory test pit excavations were observed by staff from Redmond Geotechnical Services, LLC who logged each of the test pit explorations and obtained representative samples of the subsurface soils encountered across the site. All subsurface soils encountered at the site and/or within the exploratory test pit excavations were logged and classified in general conformance with the Unified Soil Classification System (USCS) which is outlined on Figure No. A-3.

The test pit explorations revealed that the subject site is generally underlain by native soil deposits comprised of lacustrine and fluvial soil deposits of Pleistocene age. Specifically, the site was found to be underlain by a surficial layer of topsoil materials comprised of dark brown, very moist to wet, soft, organic to highly organic, sandy, clayey silt to depths of approximately 10 to 16 inches. These topsoil materials were inturn underlain by medium to olive-brown with gray mottling, very moist, soft to medium stiff, clayey, sandy silt to silty fine sand subgrade soils to the maximum depth explored of about eight (8.0) feet beneath existing site grades. These clayey, sandy silt to silty fine sand subgrade soils become sandier with depth and are best characterized by low to moderate strength and compressibility.

Groundwater

Groundwater was not encountered within any of the exploratory test pit explorations (TH-#1 through TH-#7) at the time of excavation to depths of at least eight (8) feet beneath existing surface grades. However, a seasonal drainage basin associated with the Little Pudding River traverses the central portion of the subject property.

In this regard, although groundwater elevations at the site may fluctuate seasonally in accordance with rainfall conditions as well as changes in site utilization, we are generally of the opinion that the level of the existing seasonal drainage basin generally reflect the seasonal groundwater level(s) at and/or beneath the site.

INFILTRATION TESTING

Two (2) field infiltration tests were performed at the site on May 6, 2021. The infiltration tests were performed in test pits TH-#6 and TH-#7 at depths of about four (4) to five (5) feet beneath existing site grades. The subgrade soils encountered in TH-#6 and TH-#7 consisted of native clayey, sandy silt to silty fine sand.

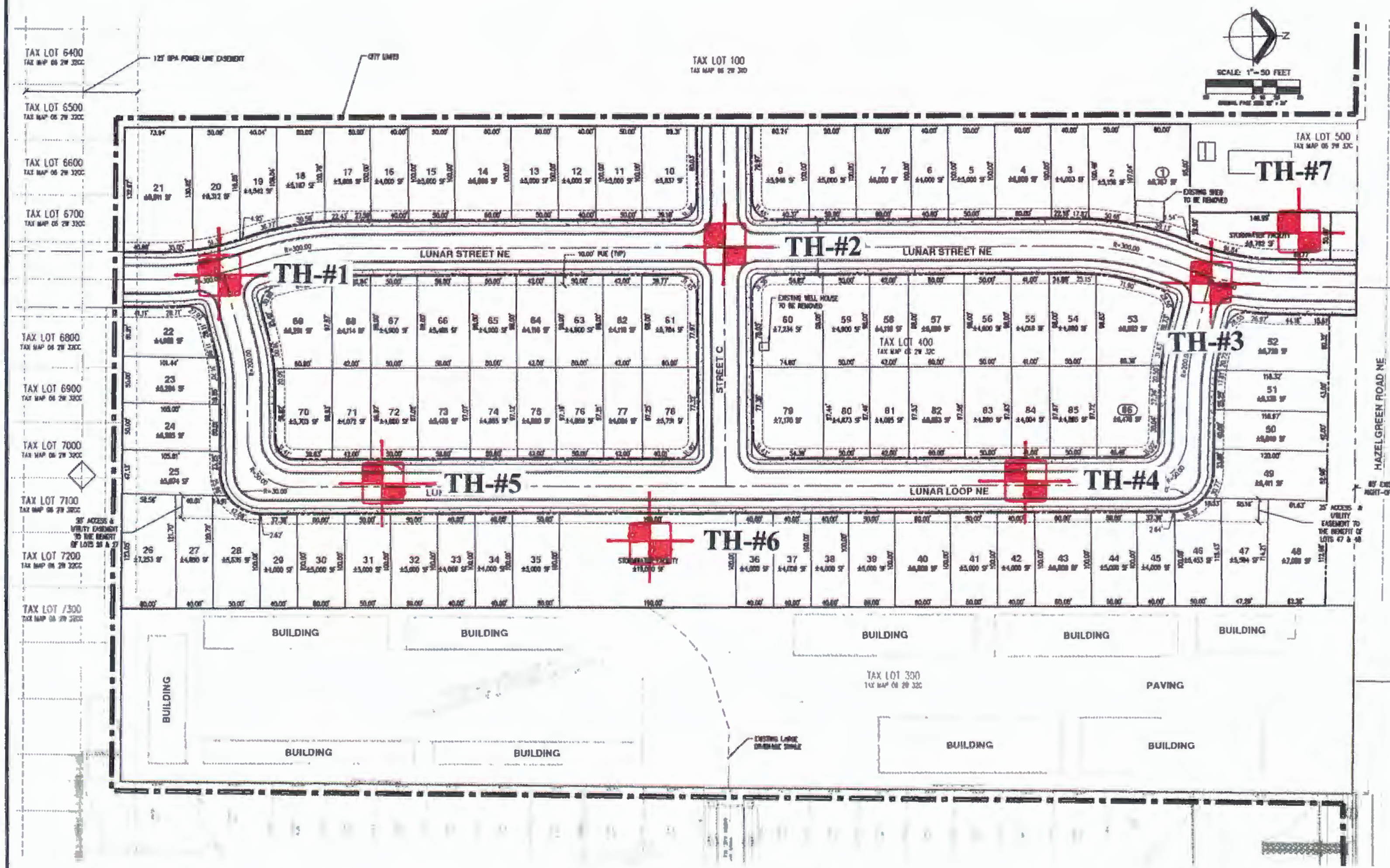
The field infiltration testing was performed in general conformance with the EPA Falling Head Method and/or City of Salem Department of Public Works. Specifically, water was discharged into the test hole excavation and allowed to penetrate the exposed subgrade soils at depth within the test hole excavation. The water level was adjusted over a two (2) hour period and allowed to achieve a saturated subgrade soil condition consistent with the bottom twelve (12) inches of the surrounding test pit excavation. Following the required saturation period, water was again added into the test hole and the time and/or rate at which the water level dropped was monitored and recorded. The water level drop was recorded until a consistent infiltration rate was observed and/or repeated.

SITE EXPLORATION PLAN

NORTHSTAR PHASE 8

TL 400, 4680 HAZELGREEN RD NE

Project No. 1017.029.G



LEGEND

TH-#7 Indicates approximate location of exploratory test hole

Figure No. 2

Based on the results of the field infiltration testing (see Field Infiltration Test Results, Figure No's. A-12 and A-13), we have found that the underlying native clayey, sandy silt to silty fine sand subgrade soil deposits possess an ultimate infiltration rate of about 1.4 to 1.8 inches per hour (in/hr).

LABORATORY TESTING

Representative samples of the on-site subsurface soils were collected at selected depths and intervals from various test pit excavations and returned to our laboratory for further examination and testing and/or to aid in the classification of the subsurface soils as well as to help evaluate and identify their engineering strength and compressibility characteristics. The laboratory testing consisted of visual and textural sample inspection, moisture content and dry density determinations, maximum dry density and optimum moisture content, Atterberg Limits and gradation analyses as well as "R"-value tests. Results of the various laboratory tests are presented in the Appendix, Figure No's. A-8 through A-11.

SEISMICITY AND EARTHQUAKE SOURCES

The seismicity of the southwest Washington and northwest Oregon area, and hence the potential for ground shaking, is controlled by three separate fault mechanisms. These include the Cascadia Subduction Zone (CSZ), the mid-depth intraplate zone, and the relatively shallow crustal zone. Descriptions of these potential earthquake sources are presented below.

The CSZ is located offshore and extends from northern California to British Columbia. Within this zone, the oceanic Juan de Fuca Plate is being subducted beneath the continental North American Plate to the east. The interface between these two plates is located at a depth of approximately 15 to 20 kilometers (km). The seismicity of the CSZ is subject to several uncertainties, including the maximum earthquake magnitude and the recurrence intervals associated with various magnitude earthquakes. Anecdotal evidence of previous CSZ earthquakes has been observed within coastal marshes along the Washington and Oregon coastlines. Sequences of interlayered peat and sands have been interpreted to be the result of large Subduction zone earthquakes occurring at intervals on the order of 300 to 500 years, with the most recent event taking place approximately 300 years ago. A study by Geomatrix (1995) and/or USGS (2008) suggests that the maximum earthquake associated with the CSZ is moment magnitude (Mw) 8 to 9. This is based on an empirical expression relating moment magnitude to the area of fault rupture derived from earthquakes that have occurred within Subduction zones in other parts of the world. An Mw 9 earthquake would involve a rupture of the entire CSZ. As discussed by Geomatrix (1995) this has not occurred in other subduction zones that have exhibited much higher levels of historical seismicity than the CSZ. However, the 2008 USGS report has assigned a probability of 0.67 for a Mw 9 earthquake and a probability of 0.33 for a Mw 8.3 earthquake. For the purpose of this study an earthquake of Mw 9.0 was assumed to occur within the CSZ.

The intraplate zone encompasses the portion of the subducting Juan de Fuca Plate located at a depth of approximately 30 to 50 km below western Washington and western Oregon. Very low levels of seismicity have been observed within the intraplate zone in western Oregon and western Washington. However, much higher levels of seismicity within this zone have been recorded in Washington and California. Several reasons for this seismic quiescence were suggested in the Geomatrix (1995) study and include changes in the direction of Subduction between Oregon, Washington, and British Columbia as well as the effects of volcanic activity along the Cascade Range. Historical activity associated with the intraplate zone includes the 1949 Olympia magnitude 7.1 and the 1965 Puget Sound magnitude 6.5 earthquakes. Based on the data presented within the Geomatrix (1995) report, an earthquake of magnitude 7.25 has been chosen to represent the seismic potential of the intraplate zone.

The third source of seismicity that can result in ground shaking within the Vancouver and southwest Washington area is near-surface crustal earthquakes occurring within the North American Plate. The historical seismicity of crustal earthquakes in this area is higher than the seismicity associated with the CSZ and the intraplate zone. The 1993 Scotts Mills (magnitude 5.6) and Klamath Falls (magnitude 6.0), Oregon earthquakes were crustal earthquakes.

Liquefaction

Seismic induced soil liquefaction is a phenomenon in which lose, granular soils and some silty soils, located below the water table, develop high pore water pressures and lose strength due to ground vibrations induced by earthquakes. Soil liquefaction can result in lateral flow of material into river channels, ground settlements and increased lateral and uplift pressures on underground structures. Buildings supported on soils that have liquefied often settle and tilt and may displace laterally. Soils located above the ground water table cannot liquefy, but granular soils located above the water table may settle during the earthquake shaking.

Our review of the subsurface soil test pit logs from our exploratory field explorations (TH-#1 through TH-#7) and laboratory test results indicate that the site is generally underlain at depth by medium stiff alluvial soil deposits to depths of at least 8.0 feet beneath existing site grades. Additionally, groundwater was not encountered within any of the exploratory test pit excavations (TH-#1 through TH-#7) at the site during our field exploration work to depths of at least 8.0 feet. As such, due to the medium stiff characteristics of the alluvial soil deposits beneath the site, it is our opinion that the native subgrade soil deposits located beneath the subject site have a low potential for liquefaction during the design earthquake motions previously described.

Landslides

No ancient and/or active landslides were observed or are known to be present on the subject site. Additionally, the subject site is characterized as relatively flat-lying terrain. As such, the risk of landsliding does not present a potential geologic hazard with regard to the proposed residential development of the site.

Surface Rupture

Although the site is generally located within a region of the country known for seismic activity, no known faults exist on and/or immediately adjacent to the subject site. As such, the risk of surface rupture due to faulting is considered negligible.

Tsunami and Seiche

A tsunami, or seismic sea wave, is produced when a major fault under the ocean floor moves vertically and shifts the water column above it. A seiche is a periodic oscillation of a body of water resulting in changing water levels, sometimes caused by an earthquake. Tsunami and seiche are not considered a potential hazard at this site because the site is not near to the coast and/or there are no adjacent significant bodies of water.

Flooding and Erosion

Stream flooding is a potential hazard that should be considered in lowland areas of Marion County and Salem. The FEMA (Federal Emergency Management Agency) flood maps should be reviewed as part of the design for the proposed new residential structures and site improvements. Elevations of structures on the site should be designed based upon consultants reports, FEMA (Federal Emergency Management Agency), and Marion County requirements for the 100-year flood levels of any nearby creeks and/or streams such as the existing seasonal drainage basin.

CONCLUSIONS AND RECOMMENDATIONS

General

Based on the results of our field explorations, laboratory testing, and engineering analyses, it is our opinion that the site is generally suitable for the proposed new Northstar Phase 8 single-family residential development and its associated site improvements provided that the recommendations contained within this report are properly incorporated into the design and construction of the project.

The primary features of concern at the site are 1) the presence of the organic topsoil layer across the site and 2) the presence of the moisture sensitive clayey silt subgrade soils beneath the site.

In regards to the presence of the organic topsoil layer across the site, we anticipate that clearing and stripping depths of at least 8 to 12 inches should be anticipated across the site and/or deeper stripping and clearing in areas where undocumented fills and/or deleterious materials are encountered. With regard to the moisture sensitive clayey silt subgrade soils beneath the site, we recommend that all site grading and earthwork operations be scheduled for the drier summer months which are typically June through September.

The following sections of this report provide specific recommendations regarding subgrade preparation and grading as well as foundation and floor slab design and construction for the new Northstar Phase 8 residential development project.

Site Preparation

As an initial step in site preparation, we recommend that the proposed new residential development site as well as its associated structural and/or site improvement area(s) be stripped and cleared of all existing improvements, any existing unsuitable fill materials, surface debris, existing vegetation, topsoil materials, and/or any other deleterious materials present at the time of construction. In general, we envision that the site stripping to remove existing vegetation will generally be about 8 to 12 inches. However, localized areas requiring deeper removals, such as any existing undocumented and/or unsuitable fill materials as well as old foundation remnants, will likely be encountered and should be evaluated at the time of construction by the Geotechnical Engineer. The stripped and cleared materials should be properly disposed of as they are generally considered unsuitable for use/reuse as fill materials.

Following the completion of the site stripping and clearing work and prior to the placement of any required structural fill materials and/or structural improvements, the exposed subgrade soils within the planned structural improvement area(s) should be inspected and approved by the Geotechnical Engineer and possibly proof-rolled with a half and/or fully loaded dump truck. Areas found to be soft or otherwise unsuitable should be over-excavated and removed or scarified and recompacted as structural fill. During wet and/or inclement weather conditions, proof rolling and/or scarification and recompaction as noted above may not be appropriate.

The on-site native sandy, clayey silt to silty sand subgrade soil materials are generally considered suitable for use/reuse as structural fill materials provided that they are free of organic materials, debris, and rock fragments in excess of about 6 inches in dimension. However, if site grading is performed during wet or inclement weather conditions, the use of some of the on-site native soil materials which contain significant silt and clay sized particles will be difficult at best. In this regard, during wet or inclement weather conditions, we recommend that an import structural fill material be utilized which should consist of a free-draining (clean) granular fill (sand & gravel) containing no more than about 5 percent fines. Representative samples of the materials which are to be used as structural fill materials should be submitted to the Geotechnical Engineer and/or laboratory for approval and determination of the maximum dry density and optimum moisture content for compaction.

In general, all site earthwork and grading activities should be scheduled for the drier summer months (June through September) if possible. However, if wet weather site preparation and grading is required, it is generally recommended that the stripping of topsoil materials be accomplished with a tracked excavator utilizing a large smooth-toothed bucket working from areas yet to be excavated. Additionally, the loading of strippings into trucks and/or protection of moisture sensitive subgrade soils will also be required during wet weather grading and construction.

In this regard, we recommend that areas in which construction equipment will be traveling be protected by covering the exposed subgrade soils with a woven geotextile fabric such as Mirafi FW404 followed by at least 12 inches or more of crushed aggregate base rock. Further, the geotextile fabric should have a minimum Mullen burst strength of at least 250 pounds per square inch for puncture resistance and an apparent opening size (AOS) between the U.S. Standard No. 70 and No. 100 sieves.

All structural fill materials placed within the new residential structures and/or pavement areas should be moistened or dried as necessary to near (within 3 percent) optimum moisture conditions and compacted by mechanical means to a minimum of 92 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Structural fill materials should be placed in lifts (layers) such that when compacted do not exceed about 8 inches. Additionally, all fill materials placed within three (3) lineal feet of the perimeter (limits) of the proposed new residential structures and/or pavements should be considered structural fill.

Foundation Support

Based on the results of our investigation, it is our opinion that the site of the proposed new Northstar Phase 8 residential development is suitable for support of the two- and/or three-story wood-frame residential structure(s) provided that the following foundation design recommendations are followed. The following sections of this report present specific foundation design and construction recommendations for the planned new single-family structures.

Shallow Foundations

In general, conventional shallow continuous (strip) footings and individual (spread) column footings may be supported by approved native (untreated) subgrade soil materials and/or new structural fill soils based on an allowable contact bearing pressure of about 2,000 pounds per square foot (psf). This recommended allowable contact bearing pressure is intended for dead loads and sustained live loads and may be increased by one-third for the total of all loads including short-term wind or seismic loads. However, due to the presence of the highly weathered bedrock deposits beneath the site, we anticipate that some disturbance may occur during the footing excavations. Additionally, deterioration of the exposed bearing surfaces may occur where foundations are constructed during wet and/or inclement weather conditions and expose moisture sensitive clayey silt subgrade bearing soils. In this regard, we recommend that consideration be given to placing a 2-to 4-inch layer of compacted crushed rock above the moisture sensitive native clayey, sandy silt subgrade bearing surfaces.

In general, continuous strip footings should have a minimum width of at least 16 inches and be embedded at least 18 inches below the lowest adjacent finish grade (includes frost protection). Individual column footings (where required) should be embedded at least 18 inches below grade and have a minimum width of at least 24 inches.

Total and differential settlements of foundations constructed as recommended above and supported by approved native subgrade soils or by properly compacted structural fill materials are expected to be well within the tolerable limits for this type of lightly loaded single- and/or two-story wood-frame structure and should generally be less than about 1-inch and 1/2-inch, respectively.

Allowable lateral frictional resistance between the base of the footing element and the supporting subgrade bearing soil can be expressed as the applied vertical load multiplied by a coefficient of friction of 0.35 and 0.45 for native silty subgrade soils and/or import gravel fill materials, respectively. In addition, lateral loads may be resisted by passive earth pressures on footings poured "neat" against in-situ (native) subgrade soils or properly backfilled with structural fill materials based on an equivalent fluid density of 300 pounds per cubic foot (pcf). This recommended value includes a factor of safety of approximately 1.5 which is appropriate due to the amount of movement required to develop full passive resistance.

Floor Slab Support

In order to provide uniform subgrade reaction beneath concrete slab-on-grade floors, we recommend that the floor slab area be underlain by a minimum of 4 inches of free-draining (less than 5 percent passing the No. 200 sieve), well-graded, crushed rock. The crushed rock should help provide a capillary break to prevent migration of moisture through the slab. However, additional moisture protection can be provided by using a 10-mil polyolefin geo-membrane sheet such as StegoWrap.

The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Where floor slab subgrade materials are undisturbed, firm and stable and where the underslab aggregate base rock section has been prepared and compacted as recommended above, we recommend that a modulus of subgrade reaction of 150 pci be used for design.

Retaining/Below Grade Walls

Retaining and/or below grade walls should be designed to resist lateral earth pressures imposed by native soils or granular backfill materials as well as any adjacent surcharge loads. For walls which are unrestrained at the top and free to rotate about their base, we recommend that active earth pressures be computed on the basis of the following equivalent fluid densities:

Non-Restrained Retaining Wall Pressure Design Recommendations

Slope Backfill (Horizontal/Vertical)	Equivalent Fluid Density/Silt (pcf)	Equivalent Fluid Density/Gravel (pcf)
Level	35	30
3H:1V	60	50
2H:1V	90	80

For walls which are fully restrained at the top and prevented from rotation about their base, we recommend that at-rest earth pressures be computed on the basis of the following equivalent fluid densities:

Restrained Retaining Wall Pressure Design Recommendations

Slope Backfill (Horizontal/Vertical)	Equivalent Fluid Density/Silt (pcf)	Equivalent Fluid Density/Gravel (pcf)
Level	55	50
3H:1V	75	70
2H:1V	95	90

The above recommended values assume that the walls will be adequately drained to prevent the buildup of hydrostatic pressures. Where wall drainage will not be present and/or if adjacent surcharge loading is present, the above recommended values will be significantly higher. For seismic loading, we recommend an additional uniform pressure of 6H where H is the height of the wall in feet.

Backfill materials behind walls should be compacted to 90 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. Special care should be taken to avoid over-compaction near the walls which could result in higher lateral earth pressures than those indicated herein. In areas within three (3) to five (5) feet behind walls, we recommend the use of hand-operated compaction equipment.

Pavements

Flexible pavement design for the proposed new street improvements for the residential development project was determined in accordance with the City of Salem Department of Public Works Administrative Rules Chapter 109-006 (Street Design Standards) Section 6 dated January 1, 2014.

Specifically, on May 6, 2021, samples of the subgrade soils from the proposed public streets were collected by means of test hole excavations. The subgrade soils encountered in the test holes located across the proposed residential subdivision site generally consisted of native soils comprised of medium to olive-brown, medium stiff, clayey, sandy SILT to silty fine SAND (ML/SM).

The subgrade soil samples collected at the site were tested in the laboratory in accordance with the ASTM Vol. 4.08 Part D-2844-69 (AASHTO T-190-93) test method for the determination of the subgrade soil "R"-value and expansion pressure. The results of the "R"-value testing was then converted to an equivalent Resilient Modulus (M_{RSG}) in accordance with current AASHTO methodology. The results of the laboratory "R"-value tests revealed that the subgrade soils have an apparent "R"-value of between 27 and 30 with an average "R"-value of 29 (see Figure No. A-11).

Using the current AASHTO methodology for converting "R"-value to Resilient Modulus (M_{RSG}), the subgrade soils have a Resilient Modulus (M_{RSG}) of between 5,476 psi and 6,070 psi which is classified a "Fair" (M_{RSG} = 5,000 psi to 10,000 psi).

In addition to the above, Dynamic Cone Penetration (DCP) tests were performed along the proposed new interior public street alignment at approximate 100-feet intervals. The results of the DCP tests found that the underlying native sandy, clayey silt subgrade soils have a DCP value of between 2 to 3 blows per 2-inches which correlates to a California Bearing Ratio (CBR) of between 5 and 12. Using current AASHTO methodology for converting CBR to Resilient Modulus (M_{RSG}), the subgrade soils have a Resilient Modulus (M_{RSG}) of between 5,842 and 10,637 psi with an average M_{RSG} of 7,150 psi which is classified as "Fair" (M_{RSG} = 5,000 psi to 10,000 psi).

Collector Streets

The following documents and/or design input parameters were used to help determine the flexible pavement section design for improvements to new and/or existing Collector Streets:

. **Street Classification:** Collector Street

. **Design Life:** 20 years

. **Serviceability:** 4.2 initial, 2.5 terminal

. **Traffic Loading Data:** 1,000,000 18-kip EAL's

. **Reliability Level:** 90%

. **Drainage Coefficient:** 1.0 (asphalt), 0.8 (aggregate)

. **Asphalt Structural Coefficient:** 0.41

. **Aggregate Structural Coefficient:** 0.10

Based on the above design input parameters and using the design procedures contained within the AASHTO 1993 Design of Pavement Structures Manual, a Structural Number (SN) of 4.1 was determined.

In this regard, we recommend the following flexible pavement section for the new improvements to new and/or existing Collector Streets:

Material Type	Pavement Section (inches)
Asphaltic Concrete	5.0
Aggregate Base Rock	14.0

Local Residential Streets

The following documents and/or design input parameters were used to help determine the flexible pavement section design for new local residential streets:

- **Street Classification:** Local Residential Street
- **Design Life:** 25 years
- **Serviceability:** 4.2 initial, 2.5 terminal
- **Traffic Loading Data:** 100,000 18-kip EAL's
- **Reliability Level:** 90%
- **Drainage Coefficient:** 1.0 (asphalt), 0.8 (aggregate)
- **Asphalt Structural Coefficient:** 0.41
- **Aggregate Structural Coefficient:** 0.10

Based on the above design input parameters and using the design procedures contained within the AASHTO 1993 Design of Pavement Structures Manual, a Structural Number (SN) of 2.6 was determined.

In this regard, we recommend the following flexible pavement section for the construction of new Local Residential Streets:

Material Type	Pavement Section (inches)
Asphaltic Concrete	4.0
Aggregate Base Rock	10.0

Pavement Subgrade, Base Course & Asphalt Materials

The above recommended pavement section(s) were based on the design assumptions listed herein and on the assumption that construction of the pavement section(s) will be completed during an extended period of reasonably dry weather. All thicknesses given are intended to be the minimum acceptable. Increased base rock sections and the use of a woven geotextile fabric may be required during wet and/or inclement weather conditions and/or in order to adequately support construction traffic and protect the subgrade during construction. Additionally, the above recommended pavement section(s) assume that the subgrade will be prepared as recommended herein, that the exposed subgrade soils will be properly protected from rain and construction traffic, and that the subgrade is firm and unyielding at the time of paving. Further, it assumes that the subgrade is graded to prevent any ponding of water which may tend to accumulate in the base course.

Pavement base course materials should consist of well-graded 1-1/2 inch and/or 3/4-inch minus crushed base rock having less than 5 percent fine materials passing the No. 200 sieve. The base course and asphaltic concrete materials should conform to the requirements set forth in the latest edition of the Oregon Department of Transportation, Standard Specifications for Highway Construction. The base course materials should be compacted to at least 95 percent of the maximum dry density as determined by the ASTM D-1557 (AASHTO T-180) test procedures. The asphaltic concrete paving materials should be compacted to at least 92 percent of the theoretical maximum density as determined by the ASTM D-2041 (Rice Gravity) test method.

Wet Weather Grading and Soft Spot Mitigation

Construction of the proposed new site improvements is generally recommended during dry weather. However, during wet weather grading and construction, excavation to subgrade can proceed during periods of light to moderate rainfall provided that the subgrade remains covered with aggregate. A total aggregate thickness of 12-inches may be necessary to protect the subgrade soils from heavy construction traffic. Construction traffic should not be allowed directly on the exposed subgrade but only atop a sufficient compacted base rock thickness to help mitigate subgrade pumping. If the subgrade becomes wet and pumps, no construction traffic shall be allowed on the road alignment. Positive site drainage away from the pavement subgrade shall be maintained if site paving will not occur before the on-set of the wet season.

Depending on the timing for the project, any soft subgrade found during proof-rolling or by visual observations can either be removed and replaced with properly dried and compacted fill soils or removed and replaced with compacted crushed aggregate. However, and where approved by the Geotechnical Engineer, the soft area may be covered with a bi-axial geogrid and covered with compacted crushed aggregate.

Soil Shrink-Swell and Frost Heave

The results of the laboratory "R"-value testing indicate that the native subgrade soils possess a low expansion potential. As such, the exposed subgrade soils should not be allowed to completely dry and should be moistened to near optimum moisture content (plus or minus 3 percent) at the time of the placement of the crushed aggregate base rock materials. Additionally, exposure of the subgrade soils to freezing weather may result in frost heave and softening of the subgrade. As such, all subgrade soils exposed to freezing weather should be evaluated and approved by the Geotechnical Engineer prior to the placement of the crushed aggregate base rock materials.

Excavation/Slopes

Temporary excavations of up to about four (4) feet in depth may be constructed with near vertical inclinations. Temporary excavations greater than about four (4) feet but less than eight (8) feet should be excavated with inclinations of at least 1 to 1 (horizontal to vertical) or properly braced/shored. Where excavations are planned to exceed about eight (8) feet, this office should be consulted.

All shoring systems and/or temporary excavation bracing for the project should be the responsibility of the excavation contractor. Permanent slopes should be constructed no steeper than about 2H to 1V unless approved by the Geotechnical Engineer.

Depending on the time of year in which trench excavations occur, trench dewatering may be required in order to maintain dry working conditions if the invert elevations of the proposed utilities are located at and/or below the groundwater level. If groundwater is encountered during utility excavation work, we recommend placing trench stabilization materials along the base of the excavation.

Trench stabilization materials should consist of 1-foot of well-graded gravel, crushed gravel, or crushed rock with a maximum particle size of 4 inches and less than 5 percent fines passing the No. 200 sieve. The material should be free of organic matter and other deleterious material and placed in a single lift and compacted until well keyed.

Surface Drainage/Groundwater

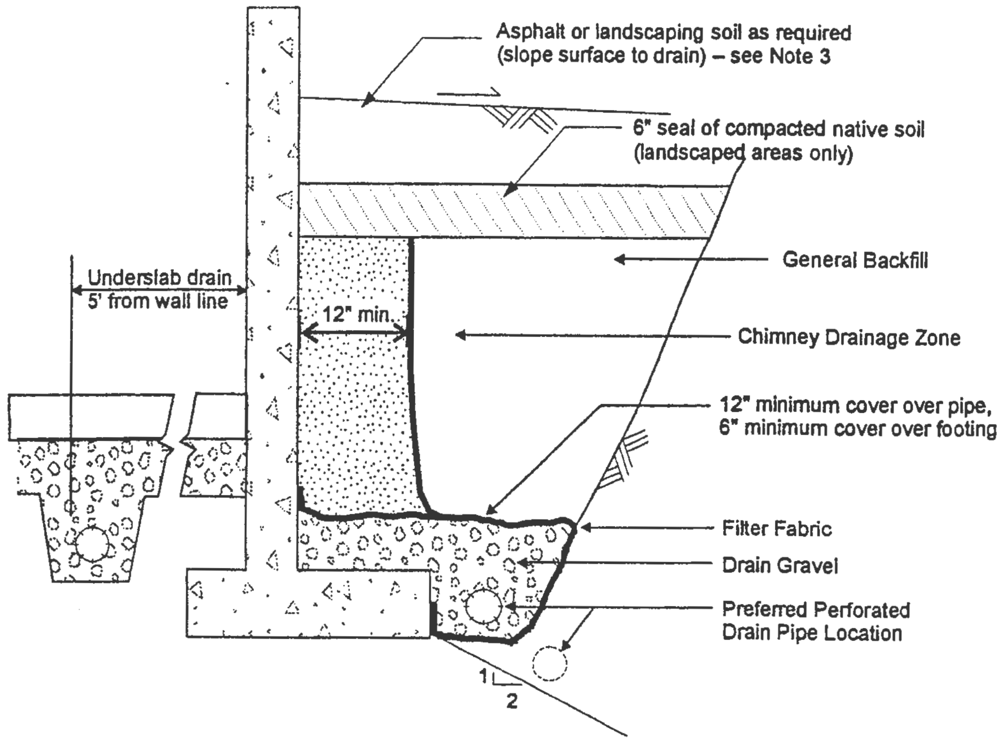
We recommend that positive measures be taken to properly finish grade the site so that drainage waters from the single-family residential structures and landscaping areas as well as adjacent properties or buildings are directed away from the new single-family residential structures foundations and/or floor slabs. All roof drainage should be directed into conduits that carry runoff water away from the residential structure(s) to a suitable outfall. Roof downspouts should not be connected to foundation drains. A minimum ground slope of about 2 percent is generally recommended in unpaved areas around the proposed new residential structure(s).

Groundwater was generally not encountered at the site in any of the exploratory test pits (TH-#1 through TH-#7) at the time of excavation to depths of at least eight (8) feet beneath existing site grades. Additionally, surface water ponding was not observed at the site during our field exploration work. However, a seasonal drainage basin associated with the Little Pudding River traverses the central portion of the site.

As such, based on our current understand that site grading required to bring the subject site and/or building pad grade(s) to finish design grade(s), we are of the opinion that an underslab drainage system is not required for the proposed new single-family residential structure(s). However, a perimeter and/or foundation drain is recommended for the proposed new single-family residential structures and/or any below grade retaining wall(s). A typical recommended perimeter footing/retaining wall drain detail is shown on Figure No. 3.

Design Infiltration Rates

In general, infiltration into the silty subgrade soils was found to be poor. Based on the results of our field infiltration testing, we recommend using the following infiltration rate(s) to design a storm water infiltration and/or disposal system for the project:



SCHEMATIC - NOT TO SCALE

NOTES:

1. Filter Fabric to be non-woven geotextile (Amoco 4545, Mirafi 140N, or equivalent)
2. Lay perforated drain pipe on minimum 0.5% gradient, widening excavation as required. Maintain pipe above 2:1 slope, as shown.
3. All-granular backfill is recommended for support of slabs, pavements, etc. (see text for structural fill).
4. Drain gravel to be clean, washed ¾" to 1½" gravel.
5. General backfill to be on-site gravels, or ¾""-0 or 1½"-0 crushed rock compacted to 92% Modified Proctor (AASHTO T-180).
6. Chimney drainage zone to be 12" wide (minimum) zone of clean washed, medium to coarse sand or drain gravel if protected with filter fabric. Alternatively, prefabricated drainage structures (Miradrain 6000 or similar) may be used.

TYPICAL PERIMETER FOOTING/RETAINING WALL DRAIN DETAIL		
Project No. 1017.029.G	NORTHSTAR PHASE 8 TL 400, 4680 HAZELGREEN RD NE	Figure No. 3

Subgrade Soil Type	Recommended Infiltration Rate
Clayey, sandy SILT/silty fine SAND (ML/SM)	0.7 to 0.9 inches per hour (in/hr)

Note: A safety factor of two (2) was used to calculate the above recommended design infiltration rate. Additionally, given the gradational variability of the subgrade soils beneath the site, it is generally recommended that field testing be performed during and/or following construction of the on-site storm water infiltration system in order to confirm that the above recommended design infiltration rates are appropriate.

Seismic Design Considerations

Structures at the site should be designed to resist earthquake loading in accordance with the methodology described in the 2019 and/or latest edition of the State of Oregon Structural Specialty Code (OSSC), ASCE 7-16 and/or Amendments to the 2018 International Building Code (IBC). The maximum considered earthquake ground motion for short period and 1.0 period spectral response may be determined from the Oregon Structural Specialty Code, ASCE 7-16 and/or from the 2015 National Earthquake Hazard Reduction Program (NEHRP) "Recommended Provisions for Seismic Regulations for New Buildings and Other Structures" published by the Building Seismic Safety Council. We recommend Site Class "D" be used for design. Using this information, the structural engineer can select the appropriate site coefficient values (F_a and F_v) from ASCE 7-16 or the 2018 IBC to determine the maximum considered earthquake spectral response acceleration for the project. However, we have assumed the following response spectrum for the project:

Table 1. ASCE 7-16 Recommended Seismic Design Parameters

Site Class	S_S	S_1	F_a	F_v	S_{MS}	S_{M1}	S_{DS}	S_{D1}
D	0.811	0.401	1.176	1.899	0.953	0.762	0.636	0.508

Notes: 1. S_S and S_1 were established based on the USGS 2015 mapped maximum considered earthquake spectral acceleration maps for 2% probability of exceedence in 50 years.

2. F_a and F_v were established based on ASCE 7-16using the selected S_S and S_1 values.

CONSTRUCTION MONITORING AND TESTING

We recommend that **Redmond Geotechnical Services, LLC** be retained to provide construction monitoring and testing services during all earthwork operations for the proposed new Northstar Phase 8 residential development. The purpose of our monitoring services would be to confirm that the site conditions reported herein are as anticipated, provide field recommendations as required based on the actual conditions encountered, document the activities of the grading contractor and assess his/her compliance with the project specifications and recommendations.

It is important that our representative meet with the contractor prior to any site grading to help establish a plan that will minimize costly over-excavation and site preparation work. Of primary importance will be observations made during site preparation and stripping, structural fill placement, footing excavations and construction as well as retaining wall backfill.

CLOSURE AND LIMITATIONS

This report is intended for the exclusive use of the addressee and/or their representative(s) to use to design and construct the proposed new single-family residential structure(s) and its/their associated site improvements described herein as well as to prepare any related construction documents. The conclusions and recommendations contained in this report are based on site conditions as they presently exist and assume that the explorations are representative of the subsurface conditions between the explorations and/or at other locations across the study area. The data, analyses, and recommendations herein may not be appropriate for other structures and/or purposes. We recommend that parties contemplating other structures and/or purposes contact our office. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. Additionally, the above recommendations are contingent on Redmond Geotechnical Services, LLC being retained to provide all site inspections and constriction monitoring services for this project. Redmond Geotechnical Services, LLC will not assume any responsibility and/or liability for any engineering judgment, inspection and/or testing services performed by others.

It is the owners/developers responsibility for insuring that the project designers and/or contractors involved with this project implement our recommendations into the final design plans, specifications and/or construction activities for the project. Further, in order to avoid delays during construction, we recommend that the final design plans and specifications for the project be reviewed by our office to evaluate as to whether our recommendations have been properly interpreted and incorporated into the project.

If during any future site grading and construction, subsurface conditions different from those encountered in the explorations are observed or appear to be present beneath excavations, we should be advised immediately so that we may review these conditions and evaluate whether modifications of the design criteria are required. We also should be advised if significant modifications of the proposed site development are anticipated so that we may review our conclusions and recommendations.

LEVEL OF CARE

The services performed by the Geotechnical Engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in the area under similar budget and time restraints. No warranty or other conditions, either expressed or implied, is made.

REFERENCES

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Appendix "A"

Test Pit Logs and Laboratory Test Data

APPENDIX

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATION

Subsurface conditions at the site were explored by excavating seven (7) exploratory test pits (TH-#1 through TH-#7) on May 6, 2021. The approximate location of the test pit explorations are shown in relation to the existing site features and/or proposed new site improvements on the Site Exploration Plan, Figure No. 2.

The test pits were excavated using track-mounted excavating equipment in general conformance with ASTM Methods in Vol. 4.08, D-1586-94 and D-1587-83. The test pits were excavated to depths ranging from about 6.0 to 8.0 feet beneath existing site grades. Detailed logs of the test pits are presented on the Log of Test Pits, Figure No's. A-4 through A-7. The soils were classified in accordance with the Unified Soil Classification System (USCS), which is outlined on Figure No. A-3.

The exploration program was coordinated by a field engineer who monitored the excavating and exploration activity, obtained representative samples of the subsurface soils encountered, classified the soils by visual and textural examination, and maintained continuous logs of the subsurface conditions. Disturbed and/or undisturbed samples of the subsurface soils were obtained at appropriate depths and/or intervals and placed in plastic bags and/or with a thin walled ring sample.

Groundwater was generally not encountered in any of the exploratory test pits (TH-#1 through TH-#7) at the time of excavating to depths of at least 8.0 feet beneath existing surface grades.

LABORATORY TESTING

Pertinent physical and engineering characteristics of the soils encountered during our subsurface investigation were evaluated by a laboratory testing program to be used as a basis for selection of soil design parameters and for correlation purposes. Selected tests were conducted on representative soil samples. The program consisted of tests to evaluate the existing (in-situ) moisture-density, maximum dry density and optimum moisture content, gradational characteristics, and Atterberg Limits as well as "R"-value tests.

Dry Density and Moisture Content Determinations

Density and moisture content determinations were performed on both disturbed and relatively undisturbed samples from the test pit explorations in general conformance with ASTM Vol. 4.08 Part D-216. The results of these tests were used to calculate existing overburden pressures and to correlate strength and compressibility characteristics of the soils. Test results are shown on the test pit logs at the appropriate sample depths.

Maximum Dry Density

One (1) Maximum Dry Density and Optimum Moisture Content test was performed on a representative sample of the on-site clayey, sandy silt to silty sand subgrade soils in accordance with ASTM Vol. 4.08 Part D-1557. This test was conducted to help establish various engineering properties for use as structural fill. The test results are presented on Figure No. A-8.

Atterberg Limits

One (1) Liquid Limit (LL) and Plastic Limit (PL) test was performed on a representative sample of the clayey, sandy silt to silty sand subgrade soils in accordance with ASTM Vol. 4.08 Part D-4318-85. These tests were conducted to facilitate classification of the soils and for correlation purposes. The test results appear on Figure No. A-9.

Gradation Analysis

One (1) Gradation analyses was performed on a representative sample of the clayey, sandy silt to silty sand subsurface soils in accordance with ASTM Vol. 4.08 Part D-422. The test results were used to classify the soil in accordance with the Unified Soil Classification System (USCS). The test results are shown graphically on Figure No. A-10.

"R"-Value Tests

One (1) "R"-value test was performed on a remolded subgrade soil sample in accordance with ASTM Vol. 4.08 Part D-2844. The test results were used to help evaluate the subgrade soils supporting and performance capabilities when subjected to traffic loading. The test results are shown on Figure No. A-11.

The following figures are attached and complete the Appendix:

Figure No. A-3	Key To Exploratory Test Pit Logs
Figure No's. A-4 through A-7	Log of Test Pits
Figure No. A-8	Maximum Dry Density
Figure No. A-9	Atterberg Limits Test Results
Figure No. A-10	Gradation Test Results
Figure No. A-11	Results of "R"-Value Tests
Figure No's. A-12 and A-13	Field Infiltration Test Results

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
		GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)	SW	Well graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS — LIQUID LIMIT IS LESS THAN 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS — LIQUID LIMIT IS GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soils.

DEFINITION OF TERMS

U.S. STANDARD SERIES SIEVE — 200, 40, 10, 4; CLEAR SQUARE SIEVE OPENINGS — 3/4", 3", 12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

GRAIN SIZES

SANDS, GRAVELS AND NON-PLASTIC SILTS	BLOWS/FOOT†
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	30 - 50
VERY DENSE	OVER 50

RELATIVE DENSITY

CLAYS AND PLASTIC SILTS	STRENGTH‡	BLOWS/FOOT†
VERY SOFT	0 - 1/4	0 - 2
SOFT	1/4 - 1/2	2 - 4
FIRM	1/2 - 1	4 - 8
STIFF	1 - 2	8 - 16
VERY STIFF	2 - 4	16 - 32
HARD	OVER 4	OVER 32

CONSISTENCY

†Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) split spoon (ASTM D-1586).
‡Unconfined compressive strength in tons/sq. ft. as determined by laboratory testing or approximated by the standard penetration test (ASTM D-1586), pocket penetrometer, torvane, or visual observation.

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KEY TO EXPLORATORY TEST PIT LOGS
Unified Soil Classification System (ASTM D-2487)

NORTHSTAR PHASE 8
TL 400, 4680 Hazelgreen Road NE

PROJECT NO.	DATE	
1017.029.G	6/07/21	Figure A-3

BACKHOE COMPANY: I & E | BUCKET SIZE: 24 inches | DATE: 5/06/21

SOIL DESCRIPTION

TEST PIT NO. TH-#1 ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			19.9	ML/ SM	Medium to olive-brown, moist to very moist, medium stiff to loose, clayey, sandy SILT to silty fine SAND
5	X			21.4		
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#2 ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			19.3	ML/ SM	Medium to olive-brown, moist to very moist, medium stiff to loose, clayey, sandy SILT to silty fine SAND
5						
						Total Depth = 7.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1017.029.G | NORTHSTAR PHASE 8 | FIGURE NO. A-4

REDMOND GEOTECHNICAL SERVICES

BACKHOE COMPANY: I & E BUCKET SIZE: 24 inches DATE: 5/06/21

TEST PIT NO. TH-#3 ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			18.9	ML/ SM	Medium to olive-brown, moist to very moist, medium stiff to loose, clayey, sandy SILT to silty fine SAND
5	X			20.7		
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#4 ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML/ SM	Medium to olive-brown, moist to very moist, medium stiff to loose, clayey, sandy SILT to silty fine SAND
5						
						Total Depth = 6.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1017.029.G NORTHSTAR PHASE 8 FIGURE NO. A-5

BACKHOE COMPANY: I & E   BUCKET SIZE: 24 inches   DATE: 5/06/21

TEST PIT NO. TH-#5   ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
	X			20.3	ML/ SM	Medium to olive-brown, moist to very moist, medium stiff to loose, clayey, sandy SILT to silty fine SAND
5						
						Total Depth = 7.0 feet No groundwater encountered at time of exploration
10						
15						

TEST PIT NO. TH-#6   ELEVATION

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML/ SM	Medium to olive-brown, very moist to wet, soft to loose, clayey, fine sandy SILT to silty fine SAND
5						
						Total Depth = 8.0 feet No groundwater encountered at time of exploration
10						
15						

LOG OF TEST PITS

PROJECT NO. 1017.029.G   NORTHSTAR PHASE 8   FIGURE NO. A-6

BACKHOE COMPANY: I & E   BUCKET SIZE: 24 inches   DATE: 5/06/21

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	SOIL DESCRIPTION TEST PIT NO. TH-#7 ELEVATION
0					ML	Dark brown, very moist, soft, organic, sandy, clayey SILT (Topsoil)
					ML/ SM	Medium to olive-brown, very moist to wet, soft to loose, clayey, fine sandy SILT to silty fine SAND
5						
						Total Depth = 8.0 feet No groundwater encountered at time of exploration
10						
15						

DEPTH (FEET)	BAG SAMPLE	DENSITY TEST	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	SOIL CLASS. (U.S.C.S.)	TEST PIT NO. ELEVATION
0						
5						
10						
15						

LOG OF TEST PITS

PROJECT NO. 1017.029.G   NORTHSTAR PHASE 8   FIGURE NO. A-7

MAXIMUM DENSITY TEST RESULTS

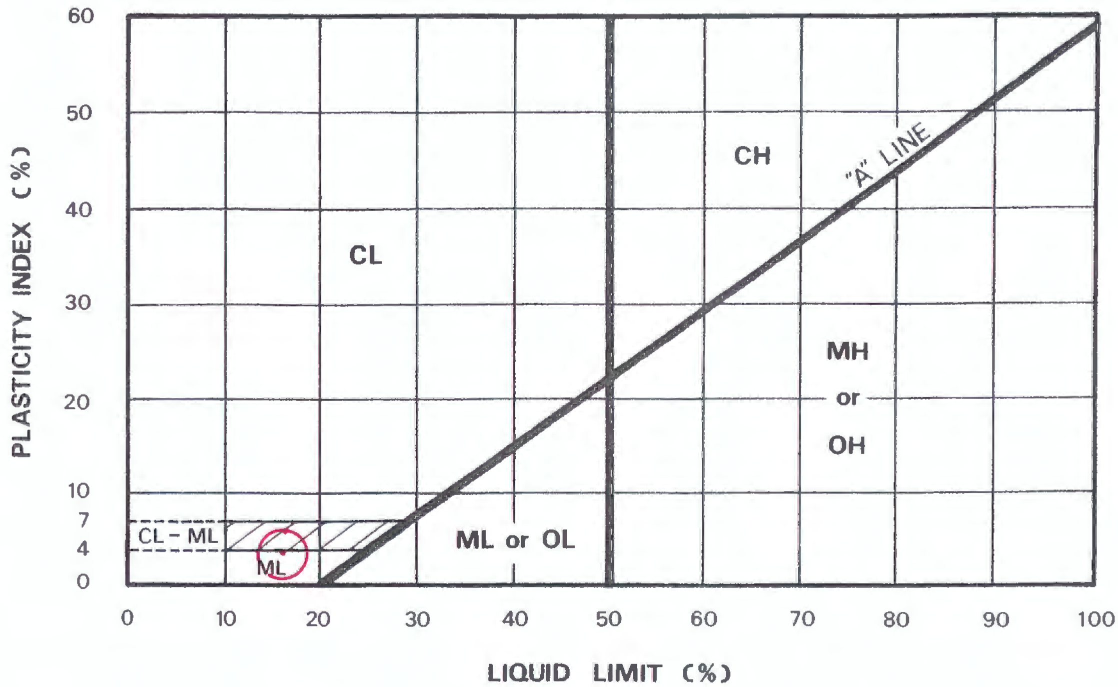
SAMPLE LOCATION	SOIL DESCRIPTION	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)
TH-#2 @ 2.0'	Medium to olive-brown, clayey, sandy SILT to silty fine SAND	110.0	15.0

EXPANSION INDEX TEST RESULTS

SAMPLE LOCATION	INITIAL MOISTURE (%)	COMPACTED DRY DENSITY (pcf)	FINAL MOISTURE (%)	VOLUMETRIC SWELL (%)	EXPANSION INDEX	EXPANSIVE CLASS.

MAXIMUM DENSITY & EXPANSION INDEX TEST RESULTS

PROJECT NO.: 1017.029.G | NORTHSTAR PHASE 8 | FIGURE NO.: A-8



KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	NATURAL WATER CONTENT %	LIQUID LIMIT %	PLASTICITY INDEX %	PASSING NO. 200 SIEVE %	LIQUIDITY INDEX	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TH-#2	2.0	19.3	16.6	3.9	58.1		ML/SM

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PLASTICITY CHART AND DATA

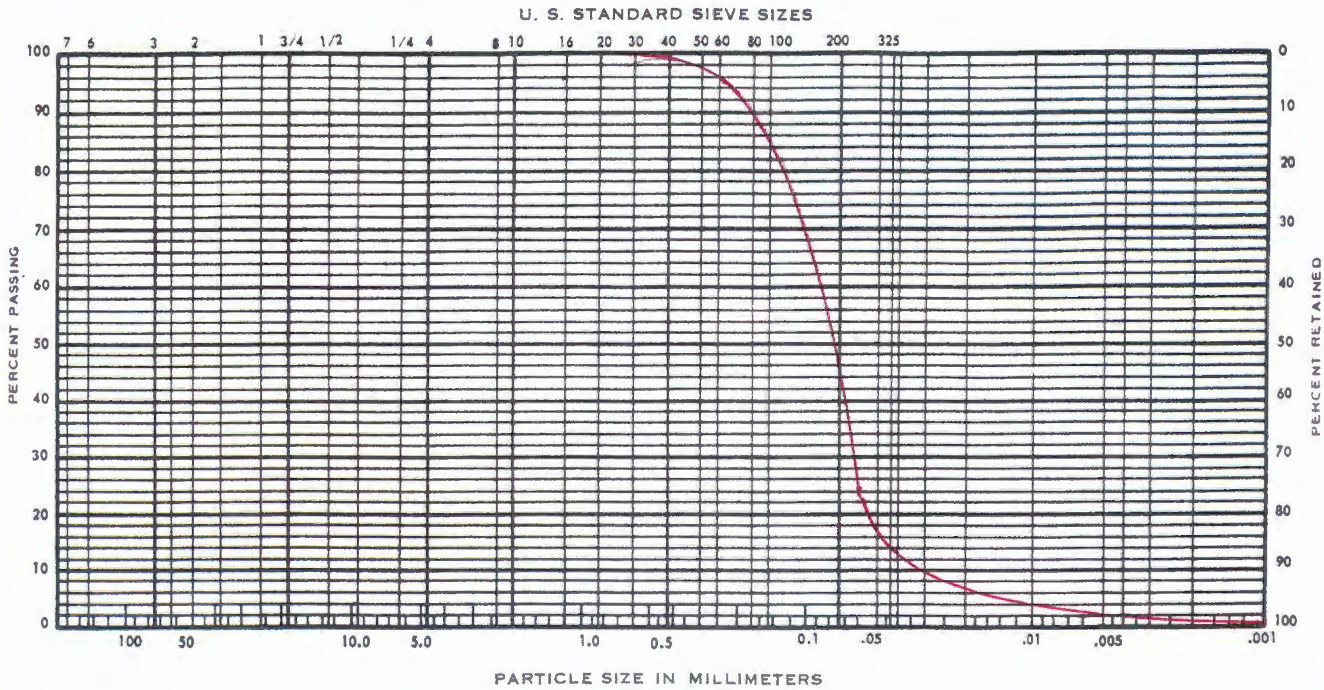
NORTHSTAR PHASE 8

TL 400, 4680 Hazelgreen Road NE

PROJECT NO.	DATE	
1017.029.G	6/07/21	Figure A-9

UNIFIED SOIL CLASSIFICATION SYSTEM

(ASTM D 422-72)



COBBLES	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

KEY SYMBOL	BORING NO.	SAMPLE DEPTH (feet)	ELEV. (feet)	UNIFIED SOIL CLASSIFICATION SYMBOL	SAMPLE DESCRIPTION
——	TH-#2	2.0		ML/SM	Medium to olive-brown, clayey, fine sandy SILT to silty fine SAND

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GRADATION TEST DATA		
NORTHSTAR PHASE 8 TL 400, 4680 Hazelgreen Road NE		
PROJECT NO.	DATE	FIGURE A-10
1017.029.G	6/07/21	

Appendix B: NRCS Soil Resource Web Survey Results

United States Department of Agriculture

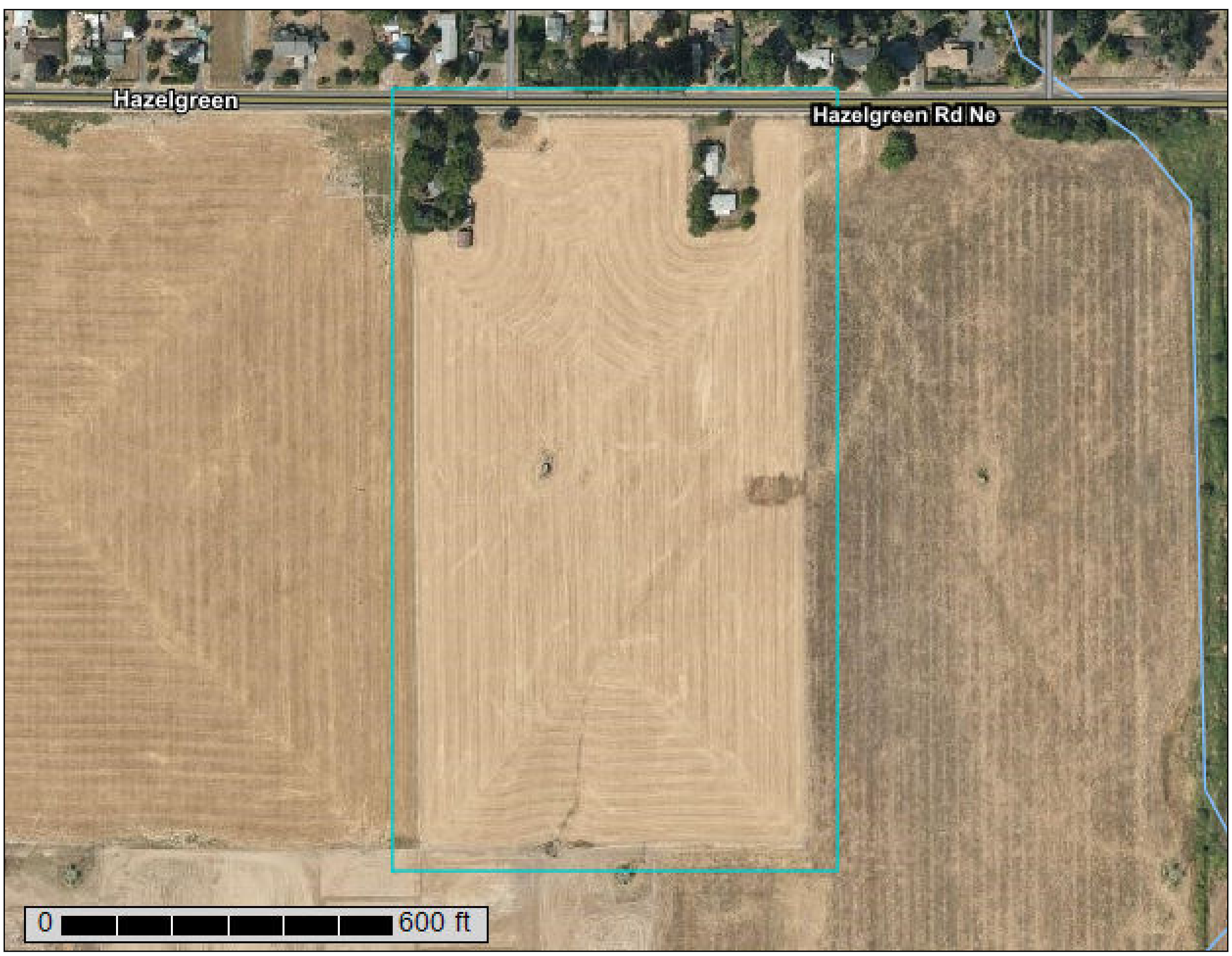
NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

Marion County Area, Oregon



May 22, 2023

Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

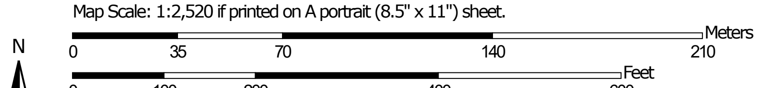
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Soil Map

Map Scale: 1:2,520 if printed on A portrait (8.5" x 11") sheet.



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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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: Marion County Area, Oregon
Survey Area Data: Version 20, Sep 14, 2022

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

Date(s) aerial images were photographed: Aug 1, 2018—Aug 31, 2018

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Co	Concord silt loam	2.1	7.9%
WuA	Woodburn silt loam, 0 to 3 percent slopes	20.0	76.2%
WuC	Woodburn silt loam, 3 to 12 percent slopes	4.2	15.8%
Totals for Area of Interest		**26.2**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Marion County Area, Oregon

Co—Concord silt loam

Map Unit Setting

National map unit symbol: 24p2
Elevation: 120 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 190 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Concord and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Concord

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Mixed mineralogy alluvium

Typical profile

H1 - 0 to 15 inches: silt loam
H2 - 15 to 29 inches: silty clay
H3 - 29 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: R002XC007OR - Valley Swale Group
Forage suitability group: Poorly Drained (G002XY006OR)
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

Minor Components

Dayton

Percent of map unit: 10 percent
Landform: Terraces

Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Other vegetative classification: Poorly Drained (G002XY006OR)
Hydric soil rating: Yes

WuA—Woodburn silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 24s3
Elevation: 150 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Woodburn and similar soils: 85 percent
Minor components: 1 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodburn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and mixed mineralogy loess

Typical profile

H1 - 0 to 17 inches: silt loam
H2 - 17 to 32 inches: silty clay loam
H3 - 32 to 68 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 25 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 2w
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C
Ecological site: R002XC008OR - Valley Terrace Group

Forage suitability group: Moderately Well Drained < 15% Slopes (G002XY004OR)
Other vegetative classification: Moderately Well Drained < 15% Slopes (G002XY004OR)
Hydric soil rating: No

Minor Components

Aquolls, somewhat poorly drained
Percent of map unit: 1 percent
Landform: Terraces
Hydric soil rating: Yes

WuC—Woodburn silt loam, 3 to 12 percent slopes

Map Unit Setting
National map unit symbol: 24s4
Elevation: 150 to 350 feet
Mean annual precipitation: 40 to 45 inches
Mean annual air temperature: 52 to 54 degrees F
Frost-free period: 200 to 210 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Woodburn and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodburn

Setting
Landform: Terraces
Landform position (three-dimensional): Riser, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Silty alluvium and mixed mineralogy loess

Typical profile
H1 - 0 to 17 inches: silt loam
H2 - 17 to 32 inches: silty clay loam
H3 - 32 to 68 inches: silt loam

Properties and qualities
Slope: 3 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 25 to 32 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R002XC008OR - Valley Terrace Group
Forage suitability group: Moderately Well Drained < 15% Slopes (G002XY004OR)
Other vegetative classification: Moderately Well Drained < 15% Slopes (G002XY004OR)
Hydric soil rating: No

Minor Components

Aquolls, poorly drained

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

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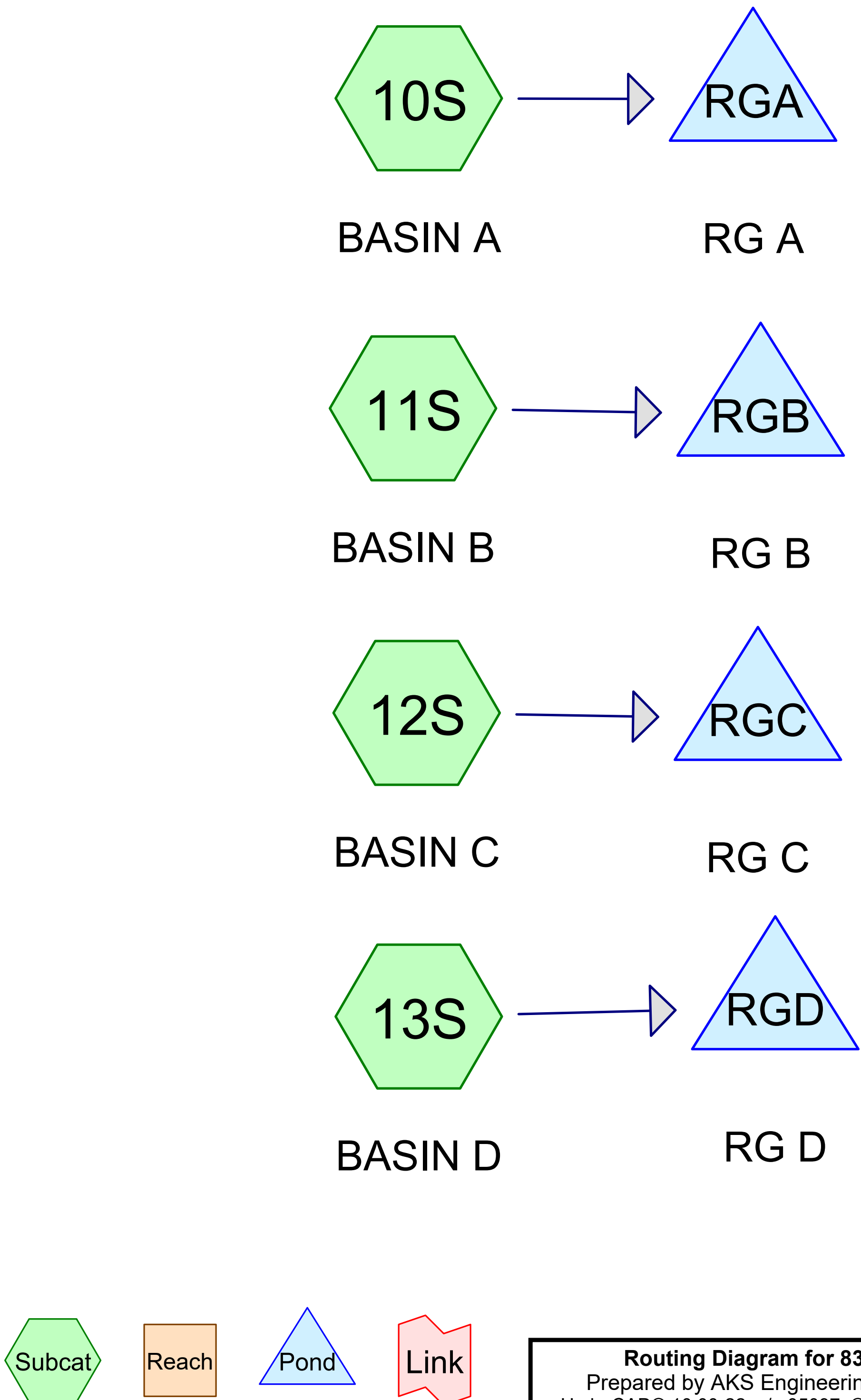
Appendix C: HydroCAD Analysis

Water Quality Model



Routing Diagram for 8321 20230801 Preliminary WQ
Prepared by AKS Engineering and Forestry, Printed 8/2/2023
HydroCAD® 10.00-22 s/n 05097 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment 10S: BASIN A

Runoff = 1.73 cfs @ 7.98 hrs, Volume= 0.621 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr Water Quality Rainfall=1.38"

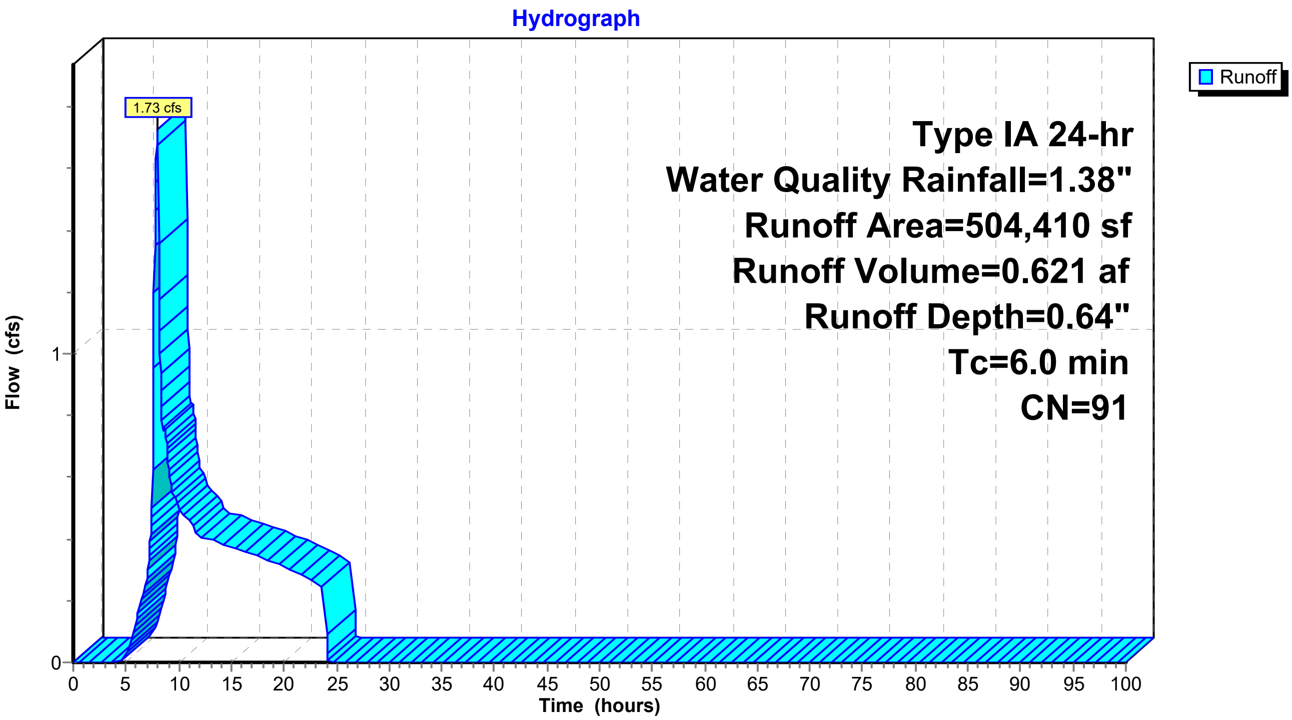
	Area (sf)	CN	Description	Land Use
*	358,264	98	Impervious	Pavement
*	146,146	74	Pervious	Open Space
	504,410	91	Weighted Average	
	146,146	74	28.97% Pervious Area	
	358,264	98	71.03% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Pollutant Loading for 0.80" Rainfall, Pj=1.000
Subcat 71.03% Impervious, Rv= 0.689, Runoff= 0.55"

Area (sq-ft)	Land Use
146,146	Open Space
358,264	Pavement
504,410	Total

Subcatchment 10S: BASIN A



Summary for Subcatchment 11S: BASIN B

Runoff = 0.07 cfs @ 8.00 hrs, Volume= 0.033 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr Water Quality Rainfall=1.38"

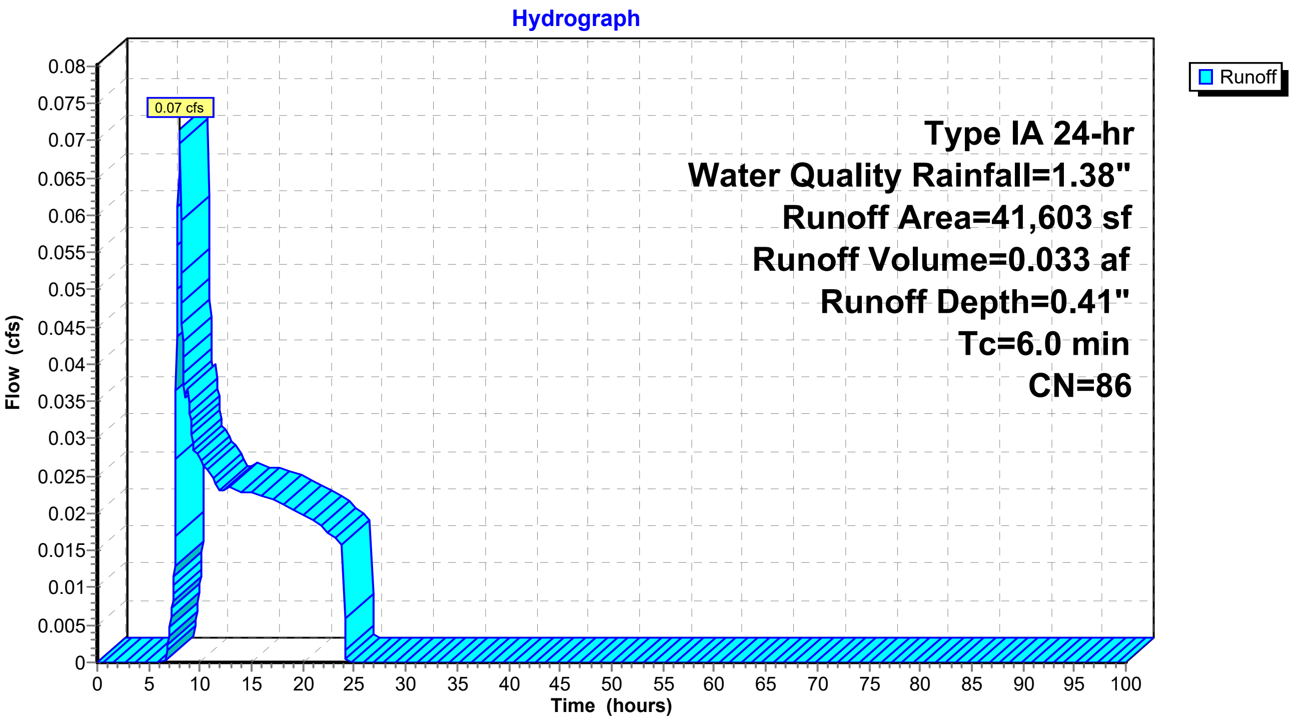
	Area (sf)	CN	Description	Land Use
*	20,296	98	Impervious	Pavement
*	21,307	74	Pervious	Open Space
	41,603	86	Weighted Average	
	21,307	74	51.22% Pervious Area	
	20,296	98	48.78% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Pollutant Loading for 0.80" Rainfall, Pj=1.000
Subcat 48.78% Impervious, Rv= 0.489, Runoff= 0.39"

Area (sq-ft)	Land Use
21,307	Open Space
20,296	Pavement
41,603	Total

Subcatchment 11S: BASIN B



Summary for Subcatchment 12S: BASIN C

Runoff = 0.12 cfs @ 8.00 hrs, Volume= 0.051 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr Water Quality Rainfall=1.38"

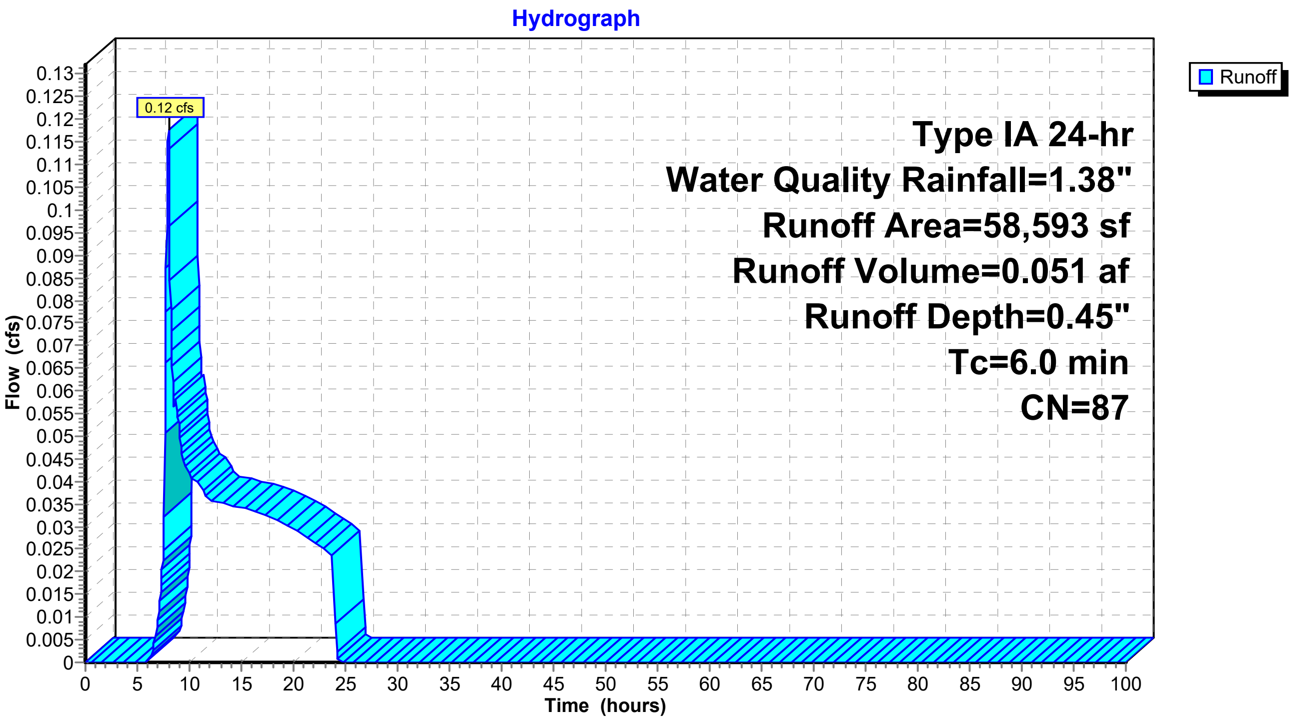
	Area (sf)	CN	Description	Land Use
*	30,724	98	Impervious	Pavement
*	27,869	74	Pervious	Open Space
	58,593	87	Weighted Average	
	27,869	74	47.56% Pervious Area	
	30,724	98	52.44% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Pollutant Loading for 0.80" Rainfall, Pj=1.000
Subcat 52.44% Impervious, Rv= 0.522, Runoff= 0.42"

Area (sq-ft)	Land Use
27,869	Open Space
30,724	Pavement
58,593	Total

Subcatchment 12S: BASIN C



Summary for Subcatchment 13S: BASIN D

Runoff = 0.04 cfs @ 7.99 hrs, Volume= 0.017 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Type IA 24-hr Water Quality Rainfall=1.38"

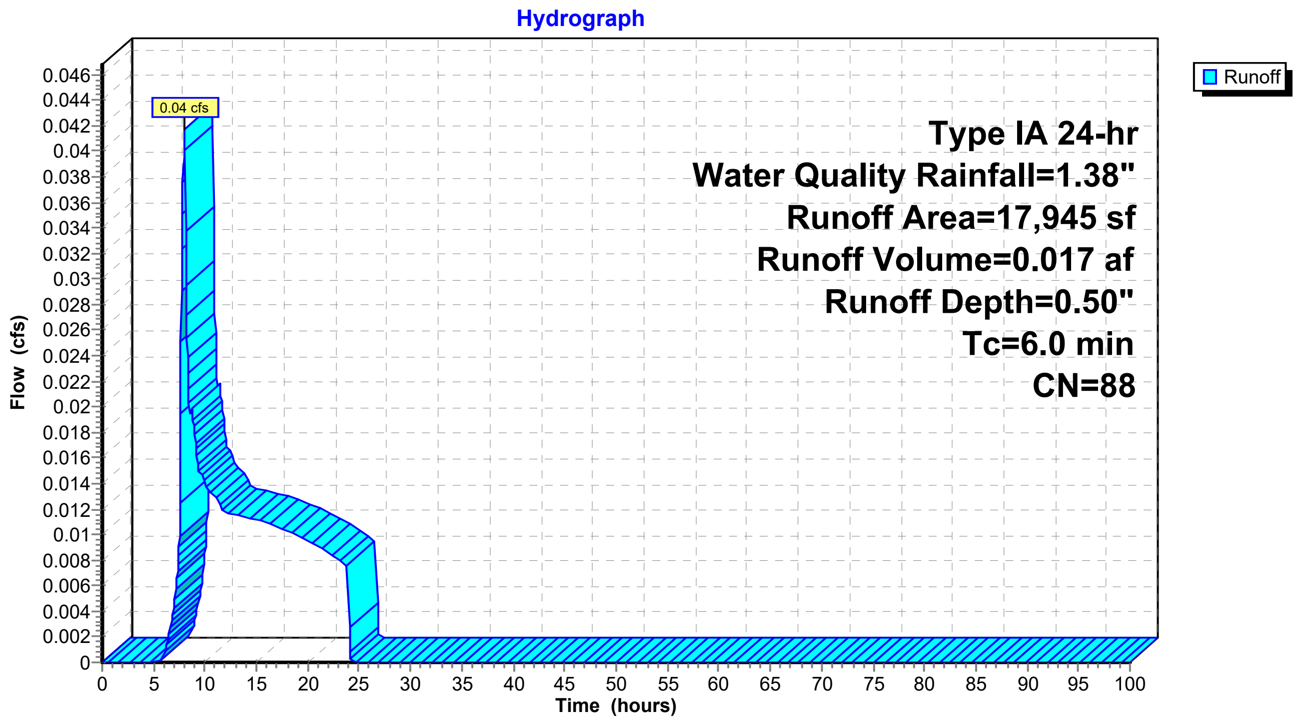
	Area (sf)	CN	Description	Land Use
*	10,115	98	Impervious	Pavement
*	7,830	74	Pervious	Open Space
	17,945	88	Weighted Average	
	7,830	74	43.63% Pervious Area	
	10,115	98	56.37% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Pollutant Loading for 0.80" Rainfall, Pj=1.000
Subcat 56.37% Impervious, Rv= 0.557, Runoff= 0.45"

Area (sq-ft)	Land Use
7,830	Open Space
10,115	Pavement
17,945	Total

Subcatchment 13S: BASIN D



Summary for Pond RGA: RG A

Inflow Area = 11.580 ac, 71.03% Impervious, Inflow Depth = 0.64" for Water Quality event
Inflow = 1.73 cfs @ 7.98 hrs, Volume= 0.621 af
Outflow = 0.36 cfs @ 16.37 hrs, Volume= 0.621 af, Atten= 79%, Lag= 503.3 min
Primary = 0.36 cfs @ 16.37 hrs, Volume= 0.621 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 174.93' @ 16.37 hrs Surf.Area= 7,775 sf Storage= 6,348 cf

Plug-Flow detention time= 231.0 min calculated for 0.621 af (100% of inflow)
Center-of-Mass det. time= 230.9 min (1,042.6 - 811.7)

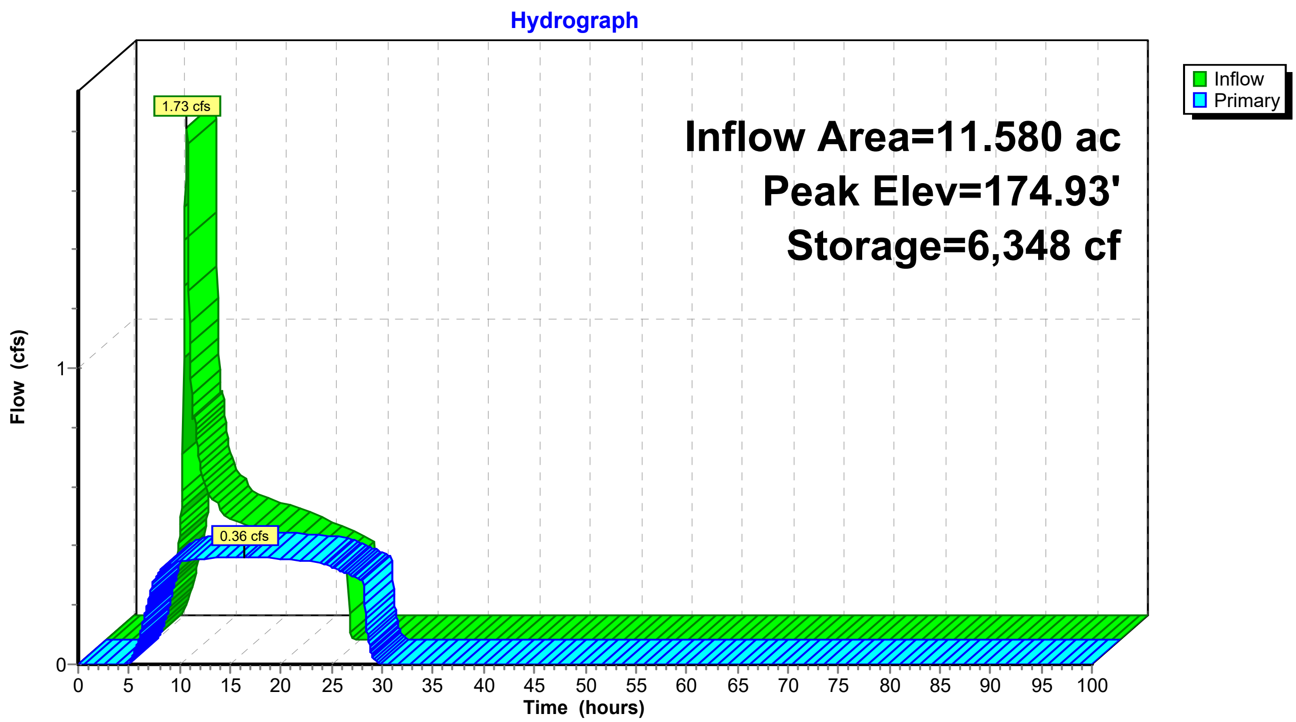
Volume	Invert	Avail.Storage	Storage Description
#1	174.00'	71,499 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
174.00	5,923	0	0
180.00	17,910	71,499	71,499

Device	Routing	Invert	Outlet Devices
#1	Primary	174.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.36 cfs @ 16.37 hrs HW=174.93' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.36 cfs)

Pond RGA: RG A



Summary for Pond RGB: RG B

Inflow Area = 0.955 ac, 48.78% Impervious, Inflow Depth = 0.41" for Water Quality event
Inflow = 0.07 cfs @ 8.00 hrs, Volume= 0.033 af
Outflow = 0.07 cfs @ 8.06 hrs, Volume= 0.033 af, Atten= 6%, Lag= 3.3 min
Primary = 0.07 cfs @ 8.06 hrs, Volume= 0.033 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 178.71' @ 8.06 hrs Surf.Area= 2,221 sf Storage= 22 cf

Plug-Flow detention time= 5.4 min calculated for 0.033 af (100% of inflow)
Center-of-Mass det. time= 5.4 min (879.1 - 873.7)

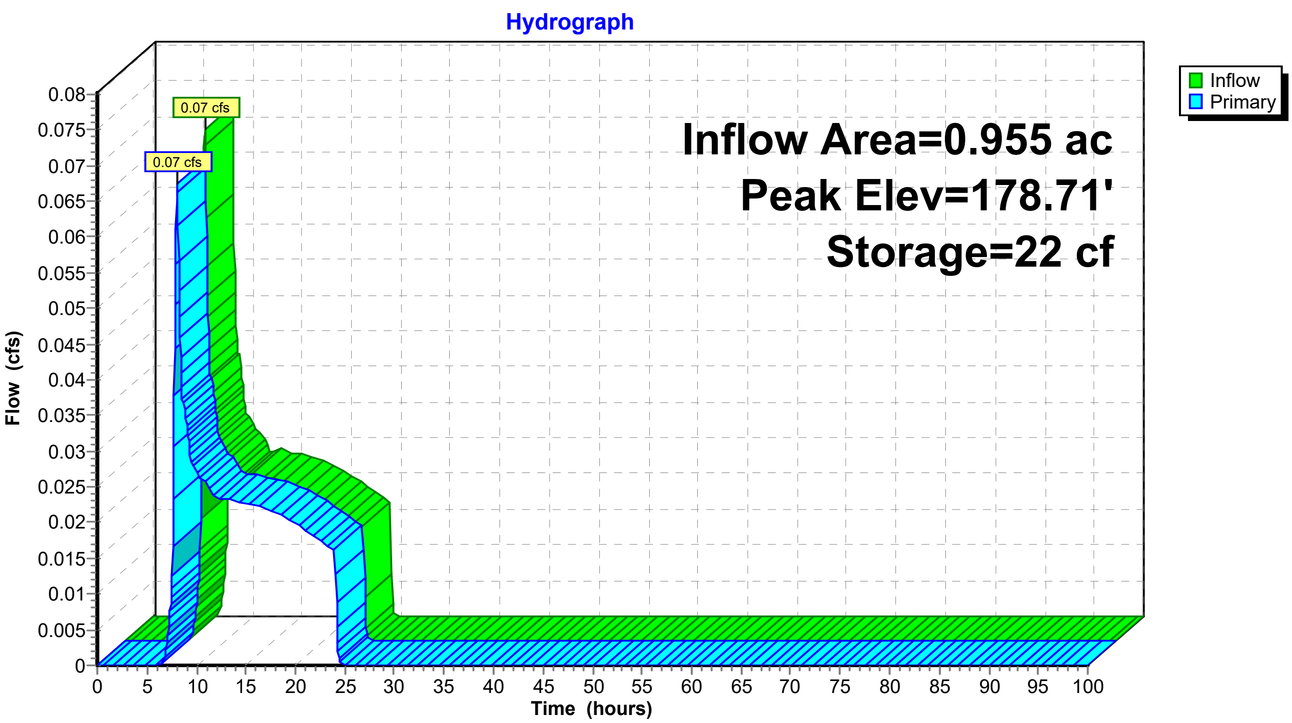
Volume	Invert	Avail.Storage	Storage Description
#1	178.70'	4,262 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.70	2,213	0	0
180.20	3,469	4,262	4,262

Device	Routing	Invert	Outlet Devices
#1	Primary	178.70'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.10 cfs @ 8.06 hrs HW=178.71' (Free Discharge)
└—**1=Exfiltration** (Exfiltration Controls 0.10 cfs)

Pond RGB: RG B



Summary for Pond RGC: RG C

Inflow Area = 1.345 ac, 52.44% Impervious, Inflow Depth = 0.45" for Water Quality event
Inflow = 0.12 cfs @ 8.00 hrs, Volume= 0.051 af
Outflow = 0.09 cfs @ 8.12 hrs, Volume= 0.051 af, Atten= 22%, Lag= 7.5 min
Primary = 0.09 cfs @ 8.12 hrs, Volume= 0.051 af

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 178.03' @ 8.12 hrs Surf.Area= 1,983 sf Storage= 54 cf

Plug-Flow detention time= 7.3 min calculated for 0.051 af (100% of inflow)
Center-of-Mass det. time= 7.3 min (868.8 - 861.5)

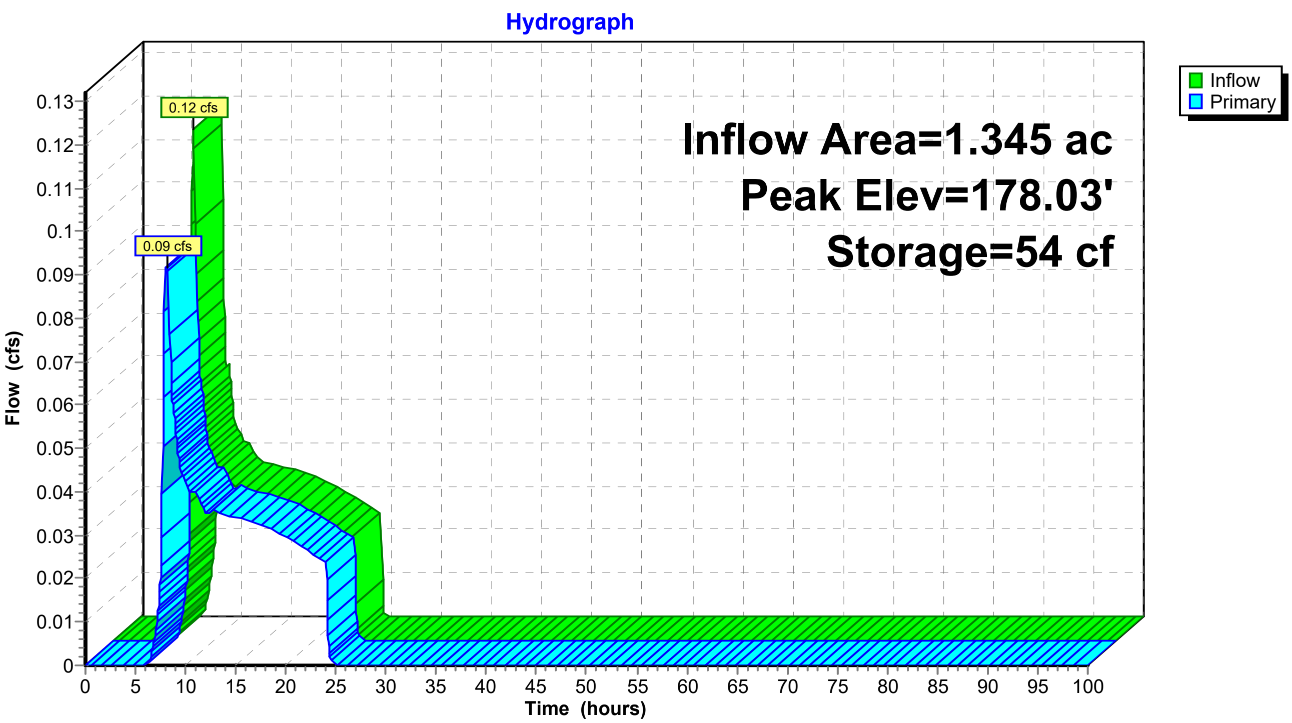
Volume	Invert	Avail.Storage	Storage Description
#1	178.00'	5,144 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.00	1,966	0	0
180.00	3,178	5,144	5,144

Device	Routing	Invert	Outlet Devices
#1	Primary	178.00'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.09 cfs @ 8.12 hrs HW=178.03' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.09 cfs)

Pond RGC: RG C



Summary for Pond RGD: RG D

Inflow Area =	0.412 ac, 56.37% Impervious, Inflow Depth = 0.50"	for Water Quality event	
Inflow =	0.04 cfs @ 7.99 hrs, Volume=	0.017 af	
Outflow =	0.01 cfs @ 10.96 hrs, Volume=	0.017 af, Atten= 69%, Lag= 178.0 min	
Primary =	0.01 cfs @ 10.96 hrs, Volume=	0.017 af	

Routing by Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.05 hrs
Peak Elev= 179.21' @ 10.96 hrs Surf.Area= 283 sf Storage= 97 cf

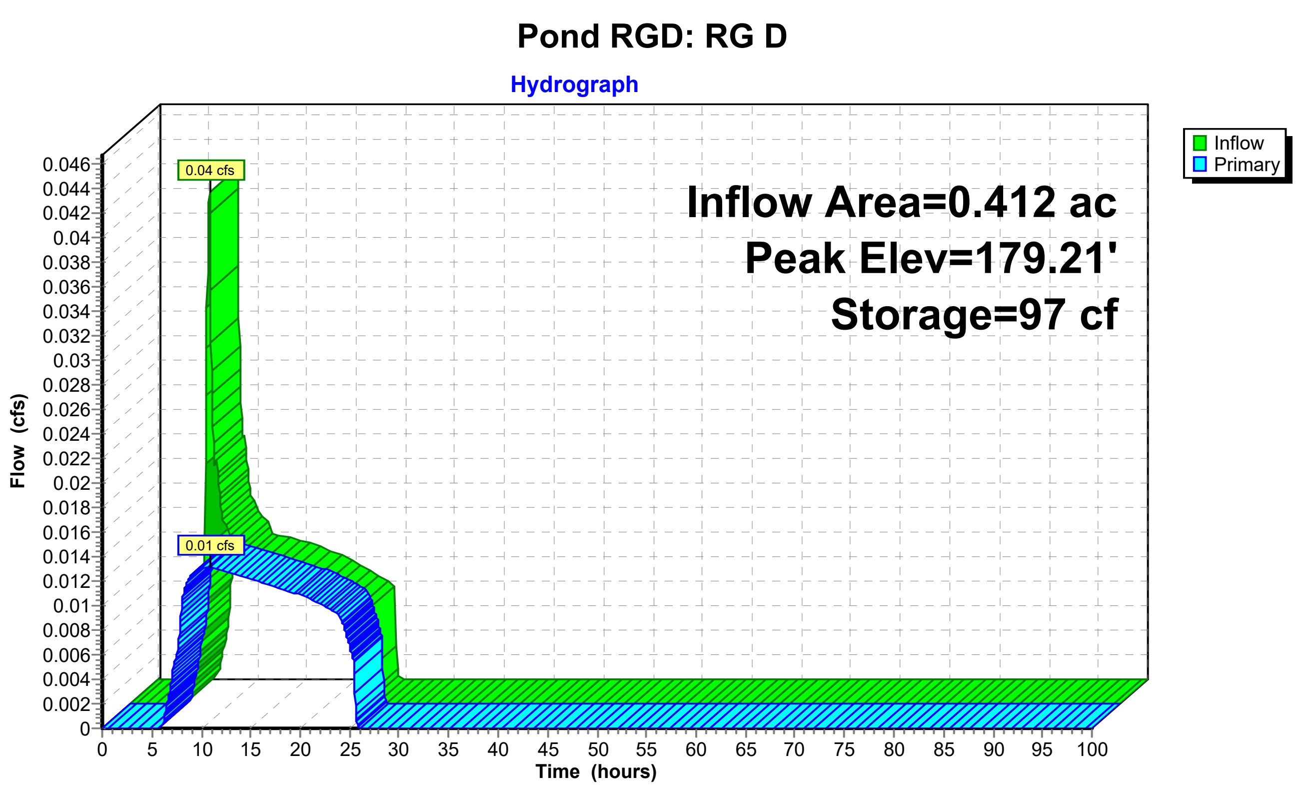
Plug-Flow detention time= 98.7 min calculated for 0.017 af (100% of inflow)
Center-of-Mass det. time= 98.7 min (948.0 - 849.3)

Volume	Invert	Avail.Storage	Storage Description
#1	178.72'	926 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
178.72	109	0	0
180.72	817	926	926

Device	Routing	Invert	Outlet Devices
#1	Primary	178.72'	**2.000 in/hr Exfiltration over Surface area**

Primary OutFlow Max=0.01 cfs @ 10.96 hrs HW=179.21' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.01 cfs)



Appendix D: Operations & Maintenance Form

Appendix B to 109-011 – Facility Maintenance Forms

2. Rain Garden

A rain garden is a **vegetated infiltration basin** or depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. The basin should infiltrate stormwater within 24 hours.

Inspections

All facility components and vegetation shall be inspected for proper operations and structural stability. *These inspections shall occur, at a minimum, quarterly for the first two years from the date of installation, and two times per year thereafter.* It is recommended that a visual inspection be made within 48 hours after each major storm event to ensure proper function. 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:

Date: ____/____/_________ Inspector's Name: ____

Basin inlet shall ensure unrestricted stormwater flow to the vegetated basin.

- □ Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
- □ Inlet shall be kept clear at all times.
- □ Rock splash pads shall be replenished to prevent erosion.

Inspection Comments: ____

____

Embankment, dikes, berms, and side slopes retain water in the infiltration basin.

- □ Structural deficiencies shall be corrected upon discovery.
- □ Slopes shall be stabilized using appropriate erosion control measures when soil is exposed/flow channels are forming.
- □ Sources of erosion damage shall be identified and controlled.

Inspection Comments: ____

____

Overflow or emergency spillway conveys flow exceeding reservoir capacity to an approved stormwater receiving system.

- □ Overflow shall be kept clear at all times.
- □ Sources of erosion damage shall be identified and controlled when soil is exposed.
- □ Rocks or other armament shall be replaced when only one layer of rock exists.

Inspection Comments: ____

____

Amended soils shall allow stormwater to percolate uniformly through the infiltration basin. If water remains 36 hours after a storm, sources of possible clogging shall be identified and corrected.

- □ Basin shall be raked and, if necessary, soil shall be excavated and cleaned or replaced.

Inspection Comments: ____

____

Appendix B to 109-011 – Facility Maintenance Forms

2. Rain Garden (continued)

Sediment/Basin debris management shall prevent loss of infiltration basin volume caused by sedimentation.

- □ Sediment exceeding 3 inches in depth, or so thick as to damage or kill vegetation, shall be removed.
- □ Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures.

Inspection Comments: ____

____

Debris and litter shall be removed to ensure stormwater infiltration and to prevent clogging of overflow drains and interference with plant growth.

- □ Restricted sources of sediment and debris, such as discarded lawn clippings, shall be identified and prevented.

Inspection Comments: ____

____

Vegetation shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Proper horticultural practices shall be employed to ensure that plants are vigorous and healthy.

- □ Mulch shall be replenished as needed, but not inhibiting water flow.
- □ Vegetation, large shrubs, or trees that interfere with rain garden operation shall be pruned.
- □ Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
- □ Nuisance or prohibited vegetation from the City of Salem Non-Native Invasive Plant list shall be removed when discovered. Invasive vegetation shall be removed immediately upon discovery.
- □ Dead vegetation shall be removed upon discovery.
- □ Vegetation shall be replaced as soon as possible to maintain cover density and control erosion where soils are exposed.

Inspection Comments: ____

____

Spill prevention measures shall be exercised when handling substances that contaminate stormwater.

- □ Releases of pollutants shall be corrected as soon as identified.

Inspection Comments: ____

Training and/or written guidance information for operating and maintaining vegetated infiltration basins shall be provided to all property owners and tenants. This Facility Maintenance Form can be used to meet this requirement.

Inspection Comments: ____

Access to the infiltration basin shall be safe and efficient. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.

- □ Obstacles preventing maintenance personnel and/or equipment access to the infiltration basin shall be removed.
- □ Gravel or ground cover shall be added if erosion has occurred.

Inspection Comments: ____

____

Appendix B to 109-011 – Facility Maintenance Forms

2. Rain Garden (continued)

Nuisance insects and rodents shall not be harbored in the infiltration basin. Pest control measures shall be taken when nuisance insects/rodents are found to be present.

- □ Holes in the ground located in and around the infiltration basin shall be filled.

Inspection Comments: ____

____

If used at this site, the following will be applicable:

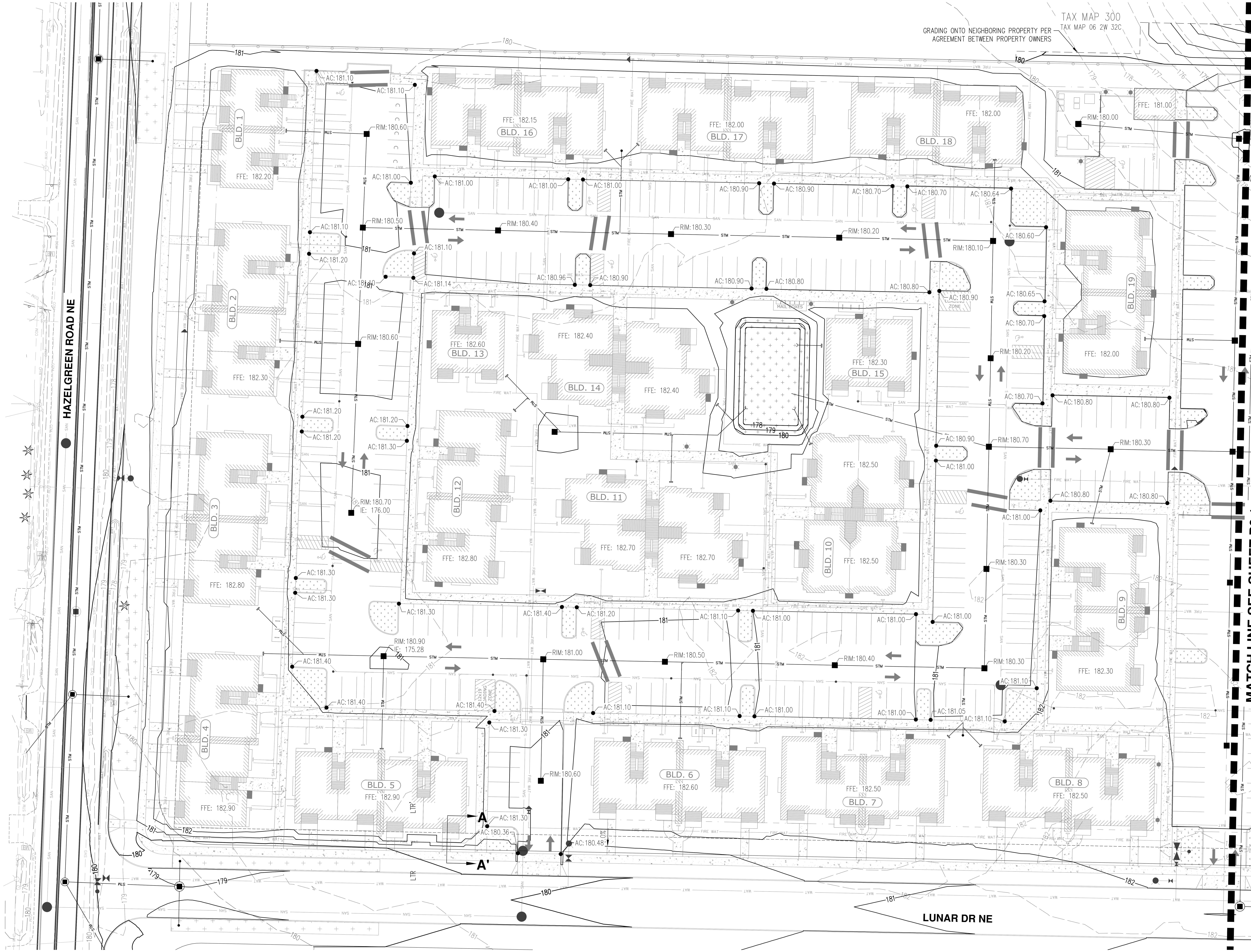
Fences shall be maintained to preserve their functionality and appearance.

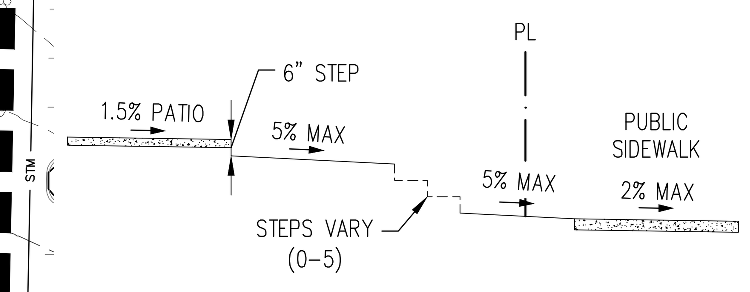
- □ Collapsed fences shall be restored to an upright position.
- □ Jagged edges and damaged fences shall be repaired or replaced.

Inspection Comments: ____

____

Appendix E: Reduced-Size Grading & Drainage Plan





TYPICAL BUILDING PATIO TO ROAD FRONTAGE SECTION A-A'

1" = 2.5'

LEGEND

EXISTING GROUND CONTOUR (1 FT)	181
EXISTING GROUND CONTOUR (5 FT)	180
FINISHED GRADE CONTOUR (1 FT)	181
FINISHED GRADE CONTOUR (5 FT)	180
PROPOSED MANHOLE (MH)	
PROPOSED CLEANOUT (CO)\DOWNSPOUT (DS)	
PROPOSED CATCH BASIN (CB)	
STORMWATER FACILITY	

SCALE: 1"=60 FEET

ORIGINAL PAGE SIZE: 11" x 17"

AKS DRAWING FILE: 8321 PRELIM GRADING AND DRAINAGE.DWG | LAYOUT: REDUCED - NORTH

PRELIMINARY GRADING AND DRAINAGE PLAN - NORTH
NORTHPLACE APARTMENTS PHASE 2
I&E CONSTRUCTION, INC.
SALEM, OREGON

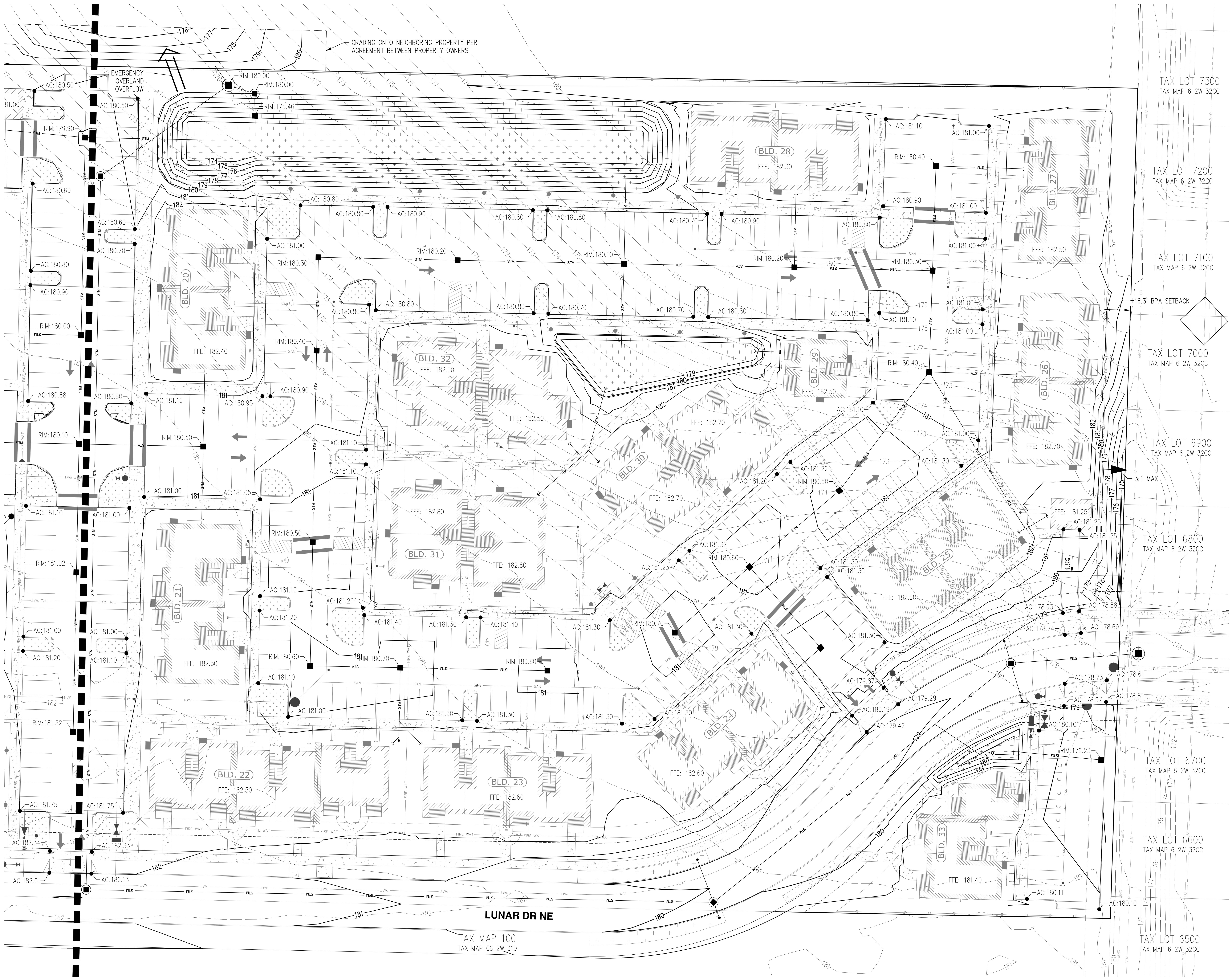
AKS
AKS ENGINEERING & FORESTRY, LLC
3700 RIVER RD N, STE 1
KEIZER, OR 97303
503.400.6028
WWW.AKS-ENG.COM
ENGINEERING · SURVEYING · NATURAL RESOURCES
FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

PRELIMINARY NOT FOR CONSTRUCTION

REGISTERED PROFESSIONAL ENGINEER, OREGON, ... R D. ROTH

RENEWS: DECEMBER 31, 2024

JOB NUMBER:	8321
DATE:	8/10/2023
DESIGNED BY:	TDR
DRAWN BY:	TBD
CHECKED BY:	TDR



SCALE: 1"=60 FEET

60 0 12 30 60

ORIGINAL PAGE SIZE: 11" x 17"

PRELIMINARY GRADING AND DRAINAGE PLAN - SOUTH

NORTHPLACE APARTMENTS PHASE 2

I&E CONSTRUCTION, INC.

SALEM, OREGON

AKS

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