Camas Meadows Subdivision (PA22-49)

Preliminary Stormwater Technical Information Report (TIR)

Date: March 2023

Submitted To:
City of Camas
Community Development Department
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References

Camas Stormwater Design Standards Manual, November 2016, Resolution #1193 – “CSDSM”

Certificate of the Engineer

Camas Meadows Subdivision
Camas, Washington
Preliminary Technical Information Report

This Preliminary Technical Information Report and the data contained herein were prepared by the undersigned, whose seal, as a Professional Engineer licensed to practice as such, is affixed below. All information required by Camas Municipal Code (CMC) Chapter 14.02 is included in the proposed stormwater plan, and the proposed facilities are feasible.

3-13-23

2019 Stormwater Management Manual for Western Washington, (Ecology Publication No. 19-10-021, July 2019), Errata released January 22, 2020 – “SWMMWW”

Preliminary Stormwater Technical Information Report (TIR)

CAMAS MEADOWS SUBDIVISION
CAMAS, WASHINGTON

Section A – Project Overview

This report analyzes the effects the proposed development will have on the existing stormwater conveyance system; documents the criteria, methodology, and informational sources used to design the proposed stormwater system; and presents the results from the preliminary hydraulic analysis.

Section A.1 – Site Location

The Camas Meadows Subdivision project site consists of seven parcels and is ±13.81 acres in size. The site is addressed 4525 NW Camas Meadows Drive, Camas, WA 98607. The property is identified as Clark County Parcel Numbers 175980000, 172973000, 172963000, 986035734, 986035733, 172970000, and 986026906 of the northwest and southwest ¼ of Section 28, Township 2 North, Range 3 East, and the northeast ¼ of Section 29, Township 2 North, Range 3 East, Willamette Meridian. The site is zoned Mixed Use (MX) and is currently vacant with no structures on-site. The site will be accessed from NW Camas Meadows Drive along the southern boundary.

Section A.2 – Site Topography and Critical Areas

The site slopes from NW Camas Meadows Drive to the north and northeast, with slopes ranging from 3 percent to 18 percent, with a general average of 10-percent slope across the site. The site is mostly covered in field grass and Himalayan blackberry, with trees dispersed across the site, including some Oregon white oak. According to the City of Camas CARA Map, the site is not within a City of Camas mapped Critical Aquifer Recharge Area (CARA).

Section A.3 – Existing On-site Stormwater System

Currently, stormwater infiltrates or sheet flows north to northeast. No stormwater systems exist on the subject site.

Section A.4 – Site Parameters That Influence Stormwater Design

The Camas Meadows project site generally sheet flow towards the northern boundary of the site with existing low points in the north and northeast corners of the site, which are the proposed outfalls for underground detention vaults. The selected placement of the underground detention vault outfalls follow existing natural drainage paths. Per the geotechnical report, infiltration rates are reported at 0.20 inches per hour. The geotechnical report also reported partially cemented conglomerate within test pits. The reported infiltration rates and the underlying soil conditions rule out the use of infiltration facilities as an option for stormwater design.

Section A.5 – Adjacent Property Drainage

No adjacent properties drain to the Camas Meadows site. NW Camas Meadows Drive includes stormwater infrastructure; therefore, stormwater does not drain on-site from street frontage.

Section A.6 – Adjacent Site Areas

The proposed development is surrounded by Camas Meadows Golf Course to the north and east, Camas Meadows Golf Course driving range to the southeast, a business park to the south, and vacant land to the west.

Section A.7 – General Project Stormwater Description

Proposed site improvements include sidewalks, public streets, 77 single-family residences, and a commercial lot. Stormwater runoff from pollution generating surfaces within the development will be collected on-site and conveyed to mechanical filter vaults and catch basins for treatment prior to flowing to underground detention vaults where it will be released at rates permitted by Camas Municipal Code (CMC). Non-pollution-generating stormwater runoff from landscaped areas on lots and commercial site adjacent to the northern boundary are lower than the detention facilities and will sheet flow through lawn and native vegetation prior to flowing offsite through the golf course adjacent to the site effectively following existing drainage patterns. It would not be feasible to convey stormwater runoff from these areas to the detention facilities. However, stormwater flows are accounted for with detention facilities designed to over detain to meet the flow control requirements. The stormwater system is designed per the Stormwater Management Manual for Western Washington. See the development plans, Appendix C, and the Stormwater Basin Plans, Appendix D, for location and size of each basin.

Section B – Minimum Requirements

Section B.1 – Determination of Applicable Minimum Requirements

Proposed land disturbances shall include grading and excavation of unsuitable soils for the construction of sidewalks, utilities, streets, residential homes, and a commercial site. Due to the amount of proposed hard surfaces (greater than 5,000 square feet), the project is required to meet Minimum Requirements 1 through 9 per Figures 1.1 and 1.2 of the Camas Stormwater Design Standards Manual (CSDSM) (see Appendix B).

The tables in this section provide information pertaining to each stormwater basin within the project area. See the Stormwater Basin Plans for basin locations (Appendix D).

Table B-1: Proposed Hard Surface and Landscaping

Basin	Existing Hard Surfaces (acres)	New Hard Surfaces (acres)	Replaced Hard Surfaces (acres)	Native Vegetation Replaced w/ Landscaping (acres)	Total Land Disturbed (acres)
1S	0.000	0.764	0.000	0.444	1.208
2S	0.000	8.072	0.000	4.674	12.747

Note: Areas listed are in acres. Basin 2 assumes 600-square-foot driveways and 2,400-square-foot roof area per lot.

Tables B-2 and B-3 show the mitigated site basins, differentiated between pollution- and non-pollution-generating surfaces. It is important to note that any non-pollution-generating areas directly mixing or having the opportunity to mix with stormwater runoff from pollution-generating surface areas are classified as pollution-generating.

Table B-2: Pollution-Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1S	0.572	0.175	0.747
2S	7.962	2.808	10.720

Note: Areas listed are in acres. Basin 2 assumes 600-square-foot driveways and 2,400-square-foot roof area per lot.

Table B-3: Non-Pollution-Generating Surfaces

Basin	Hard Surfaces (acres)	Pervious Surfaces (acres)	Total Surface Area (acres)
1S	0.000	0.269	0.269
2S	0.000	1.543	1.543

Note: Areas listed are in acres. Basin 2 assumes 600-square-foot driveways and 2,400-square-foot roof area per lot.

Each developed basin's effective hard surfaces and their applicability for meeting Minimum Requirements 6 through 8 are summarized in Table B-4 below.

Table B-4: Effective Hard Surfaces

Basin	Hard Surface Area (acres)	MR #6 Required (Y/N)	MR #7 Required (Y/N)	MR #8 Required (Y/N)
1S	0.764	Y	Y	N
2S	8.072	Y	Y	N

Note: Areas listed are in acres. Basin 2 assumes 600-square-foot driveways and 2,400-square-foot roof area per lot.

Section C – Soils Evaluation

Section C.1 – Soil Suitability for Low Impact Development BMPs

The Camas Meadows project is not suitable for stormwater infiltration for flow control, runoff treatment, or low-impact development (LID) measures. The project geotechnical report dated December 28th, 2021, reports infiltration rates of 0.20 inches per hour and partially cemented conglomerate within test pits. All disturbed areas will meet post-construction soil quality and quantity requirements per BMP T5.13.

Section C.2 – Water Table Information

Per the project geotechnical report, light seepage was encountered in four test pits during site exploration. Perched groundwater may be present on-site during the wetter months and periods of heavy rain. It is anticipated that no stormwater facilities will be affected by groundwater presence.

Section C.3 – Soil Parameters

Soil parameters were not used in the design of the site storm facilities due to the existence of partially cemented conglomerate within test pits and low infiltration rates. Stormwater will be routed through mechanical filter vaults and catch basins upstream of the detention vaults for treatment prior to being released to flow spreaders at low points in the north and northeast corners of the site.

Section C.4 – Infiltration Rate Testing

The project geotechnical report dated December 28th, 2021, reports infiltration rates of 0.20 inches per hour.

Section C.5 – Complex Soil Conditions

A preliminary geotechnical report has been prepared and is included with this report (see Appendix G). Existing soil conditions are summarized, and recommendations are presented in relation to site design considerations.

Section D – Source Control

Volume IV of the Stormwater Management Manual for Western Washington (SWMMWW) contains the following applicable source control best management practices (BMPs) for residential development. The source control BMPs and applicable notes to control stormwater runoff impacted by these activities will be included in the Erosion Control Plans and Details and in the Stormwater Pollution Prevention Plan (SWPPP).

- S407: Dust Control at Disturbed Land Areas and Unpaved Roadways and Parking Lots
- S411: BMPs for Landscaping and Lawn/Vegetation Management

Section E – On-site Stormwater Management BMPs

Figure I-3.3 of the SWMMWW was used for determining LID requirements along with the List Approach, Table 1-3.2 and List #2, for evaluating feasibility of listed BMPs. LID BMPs per List #2 are infeasible for hard surface areas of the project. Full Dispersion (BMP T5.30), Downspout Dispersion (BMP T5.10B), and Sheet Flow Dispersion (BMP T5.12) are not feasible as slopes on site are too steep (10-15%). Full Infiltration (BMP T5.10A), Bioretention (BMP T7.30), Perforated Stub-outs (BMP T5.10C), and Permeable Pavements (BMP T5.15) are infeasible as infiltration rates on site are less than 1 inch per hour (see the geotechnical report in Appendix G). Lawn and landscape areas will meet post-construction soil quality and quantity requirements per BMP T5.13.

Site runoff will be collected and conveyed through mechanical filter vaults and catch basins upstream of the detention vaults for treatment prior to being released to flow spreaders at low points in the north and northeast corners of the site. The mechanical filters are proposed to meet water quality requirements for all on-site pollution-generating surfaces. Underground storage is proposed to meet water quantity requirements for all on-site areas.

Section F – Runoff Treatment Analysis and Design

Surface water from pollution-generating surfaces will be conveyed to a mechanical filter vault and catch basins for treatment based on Volume III, Chapter 1.2 of the SWMMWW as well as Chapter 5 of the CSDSM. Any basin that mixes non-pollution-generating runoff with pollution-generating runoff, will be considered pollution-generating.

Due to the location of the Camas Meadows site, above the dam at the south end of Round Lake, mechanical filter treatment vaults and catch basins will be required to meet phosphorus treatment per Chapter 5 of the CSDSM.

“Oldcastle” Perk Filter vault and catch basins are proposed to serve as a runoff treatment BMP and will provide off-line water quality treatment as calculated by Western Washington Hydrology Model (WWHM 2012). See Table F.1 below.

Table F-1: Water Quality Flow Rate

Proposed Structure	Basin	New Pollutant-Generating Impervious Surface (acres) (WWHM)	New Pollutant-Generating Pervious Surface (acres) (WWHM)	Required Water Quality Flow Rate (cubic feet per second)	Provided Water Quality Flow Rate (cubic feet per second)	"Oldcastle" Perk Filter Cartridges
(2)-Perk Filter Catch Basins	1S	0.572	0.175	0.0783	0.090	(2)-18"
Perk Filter Vault	2S	7.962	2.808	1.1415	1.175	(31)-12"+18" (stacked)

The water quality flow rates used for the basins are included in Appendix F. All stormwater quality facilities for the site have been designed in compliance with the SWMMWW. The approximate location and size of the proposed runoff treatment facilities are shown on the preliminary development plans located in Appendix C.

Section G – Flow Control Analysis and Design

The Camas Meadows site is comprised of two main basins. See the Basin Plans in Appendix D for the locations of these basins.

Basins 1S and 2S will be required to meet flow control standards. The project proposes to use underground detention vaults for storage equipped with flow control structures to meet the site flow control requirements. Roof, parking, and incidental landscape runoff within Basin 1S is proposed to flow to underground storage located under the parking area within Commercial Lot 78. Roadways, roofs, driveways, and incidental landscape runoff within Basin 2S is proposed to flow to underground storage located within Stormwater Tract F. Non-pollution-generating stormwater runoff from landscaped areas on lots and commercial site adjacent to the northern boundary are lower than the detention facilities and will sheet flow through lawn and native vegetation prior to flowing offsite through the golf course adjacent to the site effectively following existing drainage patterns. It would not be feasible to convey stormwater runoff from these areas to the detention facilities. However, stormwater flows are accounted for with detention facilities designed to over detain to meet flow control requirements and is included in the stormwater analysis. Analysis for the underground storage vaults is summarized by the 2012 Western Washington Hydrology Model, Version 4.2.18 (WWHM) output within Appendix F.

Section H – Wetland Protection

No wetlands exist on-site, and there are no proposed discharges to wetlands.

Appendix A: Map Submittals

VICINITY MAP

N.T.S.

Soil Map—Clark County, Washington
(Soils Map)

Soil Map—Clark County, Washington
(Soils Map)

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: Clark County, Washington
Survey Area Data: Version 20, Aug 30, 2022

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

Date(s) aerial images were photographed: Oct 15, 2018—Oct 18, 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
HcB	Hesson clay loam, 0 to 8 percent slopes	0.5	3.5%
HcD	Hesson clay loam, 8 to 20 percent slopes	0.0	0.2%
PoB	Powell silt loam, 0 to 8 percent slopes	10.0	73.5%
PoD	Powell silt loam, 8 to 20 percent slopes	3.1	22.8%
Totals for Area of Interest		**13.6**	**100.0%**

Appendix B: New Development Flow Chart

Chapter 1: General Requirements
Continued

Figure 1.1: Flow Chart for Determining Stormwater Requirements

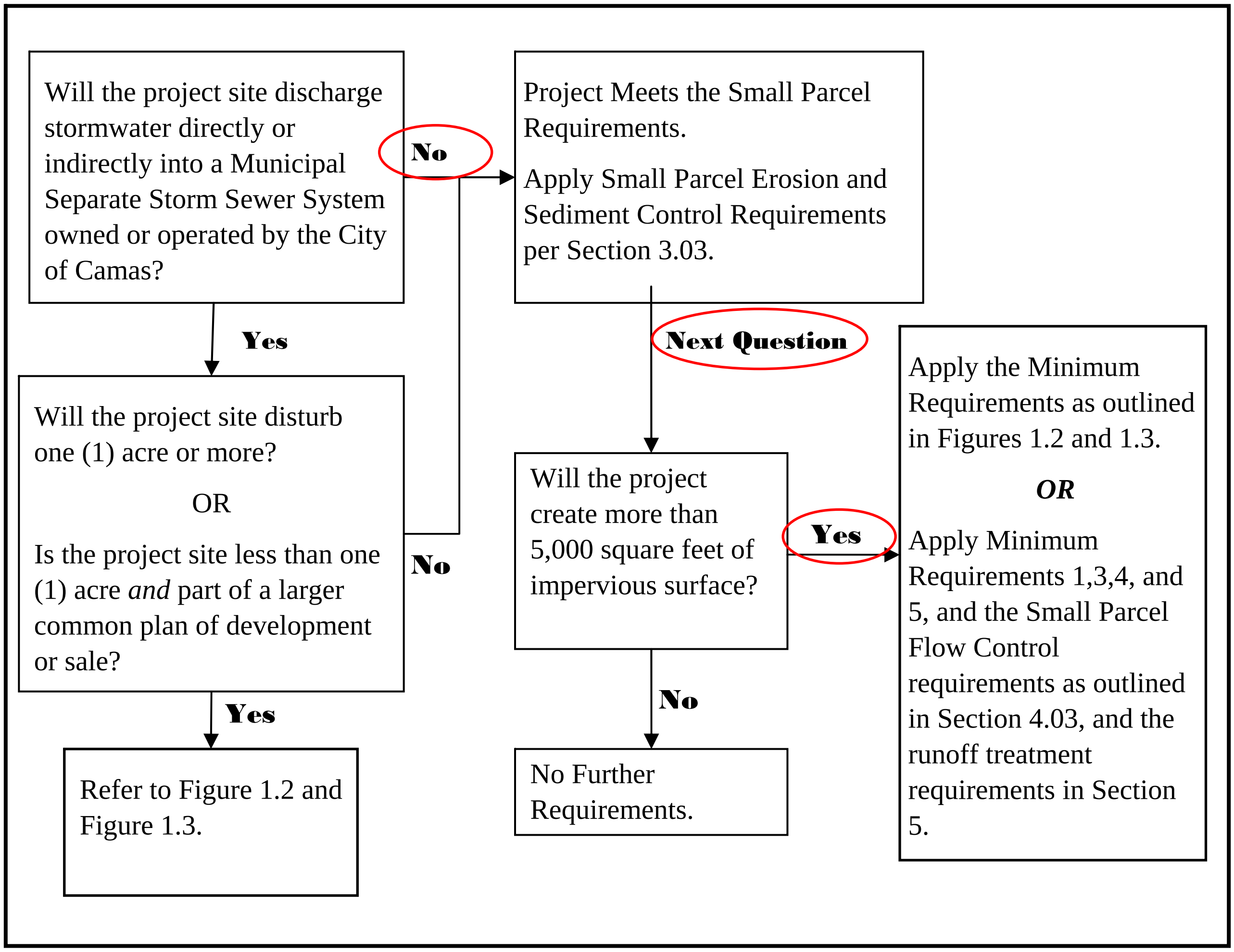


Figure 1.2: New Development Minimum Requirements Flow Chart

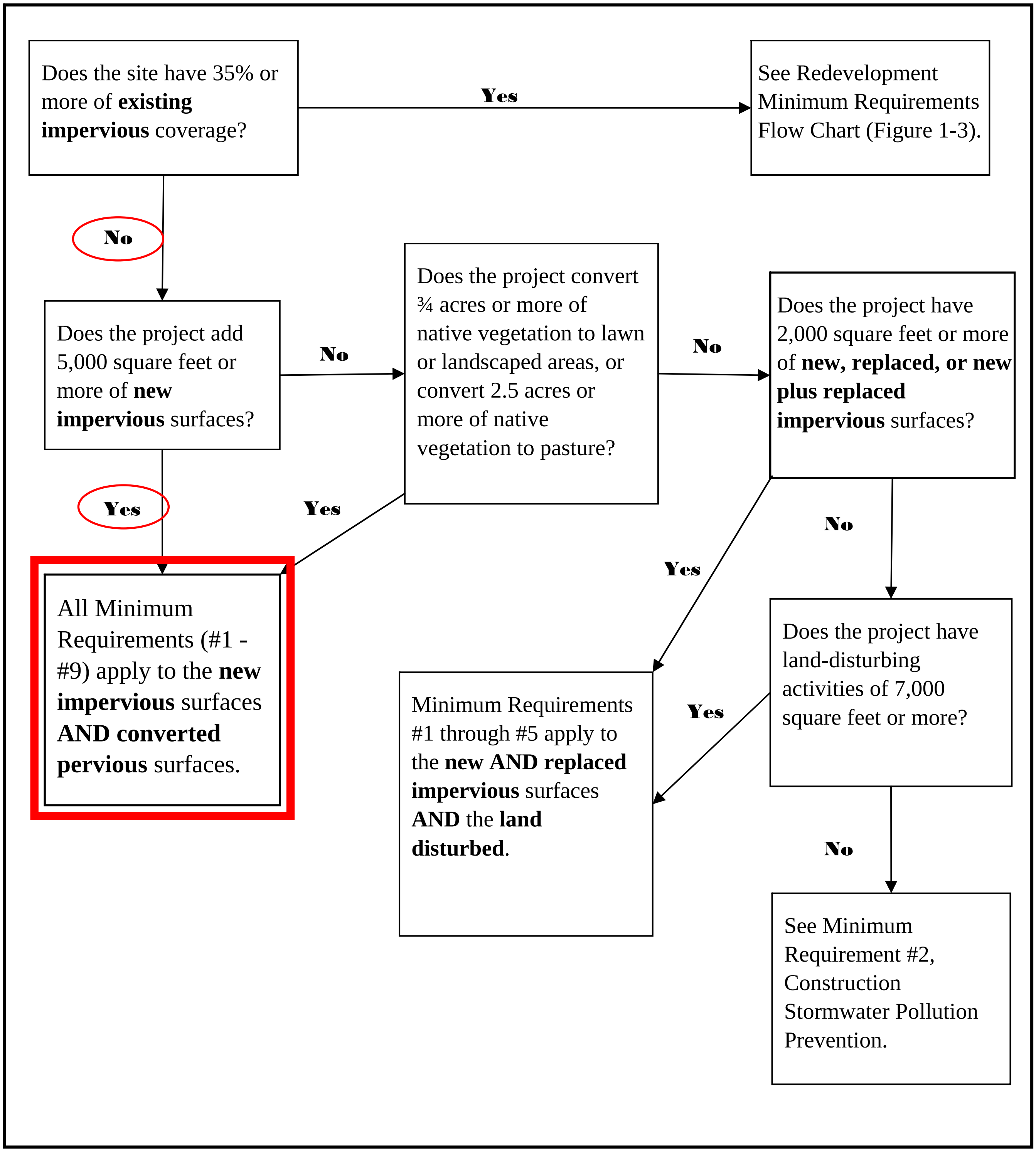


Figure I-3.3: Flow Chart for Determining MR #5 Requirements

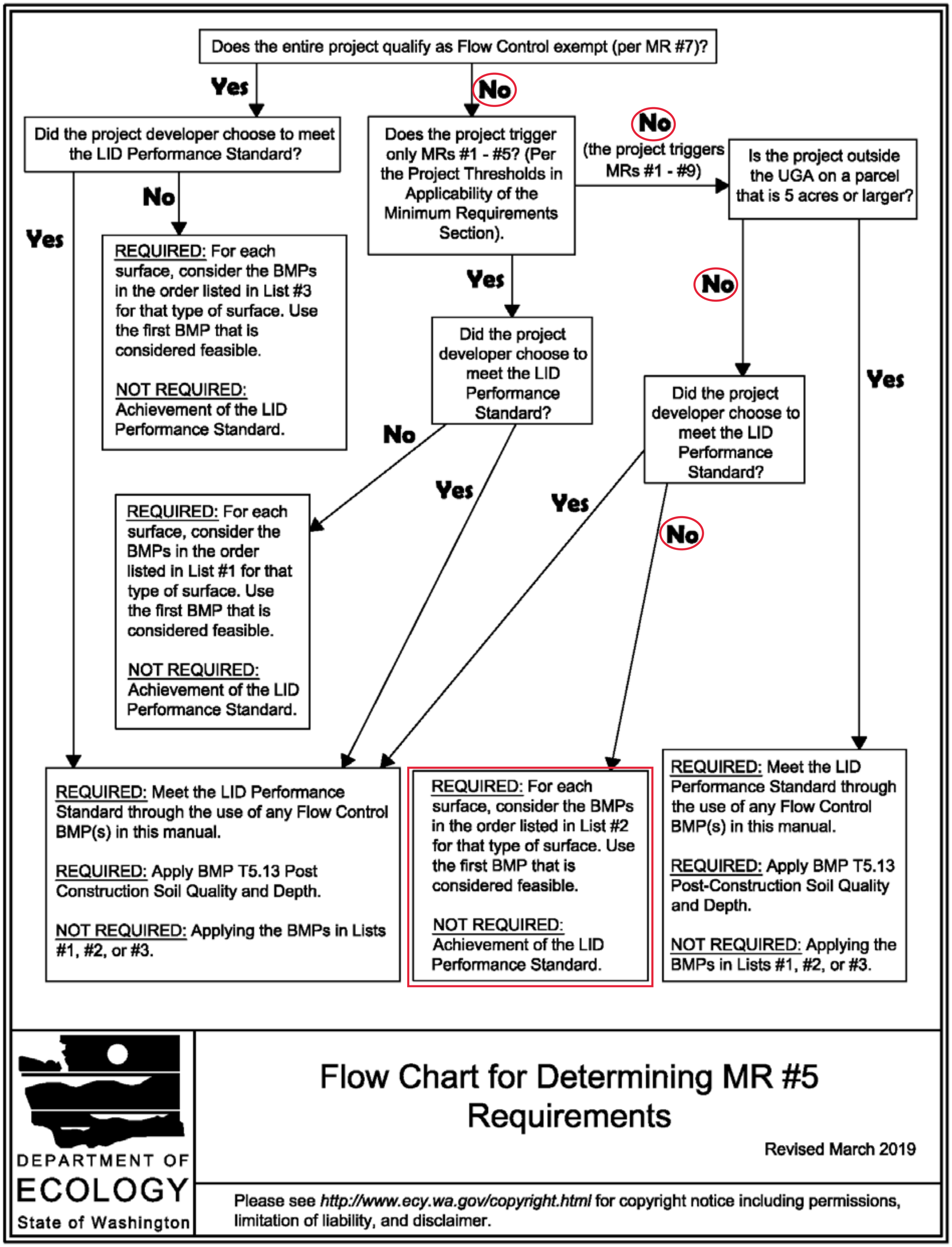


Table I-3.2: The List Approach for MR5 Compliance

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
Surface Type: Lawn and Landscaped Areas		
BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth	BMP T5.13: Post-Construction Soil Quality and Depth
Surface Type: Roofs		
1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.30: Full Dispersion or BMP T5.10A: Downspout Full Infiltration	1. BMP T5.10A: Downspout Full Infiltration
2. BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T7.30: Bioretention	2. BMP T5.10B: Downspout Dispersion Systems
3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10B: Downspout Dispersion Systems	3. BMP T5.10C: Perforated Stub-out Connections
4. BMP T5.10C: Perforated Stub-out Connections	4. BMP T5.10C: Perforated Stub-out Connections	
Surface Type: Other Hard Surfaces		
1. BMP T5.30: Full Dispersion	1. BMP T5.30: Full Dispersion	BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion
2. BMP T5.15: Permeable Pavements or BMP T5.14: Rain Gardens or BMP T7.30: Bioretention	2. BMP T5.15: Permeable Pavements	
3. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	3. BMP T7.30: Bioretention	
	4. BMP T5.12: Sheet Flow Dispersion or BMP T5.11: Concentrated Flow Dispersion	
Notes for using the List Approach: 1. Size BMP T5.14: Rain Gardens and BMP T7.30: Bioretention used in the List Approach to have a minimum horizontal projected surface area below the overflow which is at least 5% of the area drain-		

Table I-3.2: The List Approach for MR5 Compliance (continued)

List #1 (For MR #1 - #5 Projects That Are Not Flow Control Exempt)	List #2 (For MR #1 - #9 Projects That Are Not Flow Control Exempt)	List #3 (For Flow Control Exempt Projects)
ing to it. 2. When the designer encounters BMP T5.15: Permeable Pavements in the List Approach, it is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless BMP T5.30: Full Dispersion is employed.		

Objective

The objective of On-Site Stormwater Management is to use practices distributed across a development that reduce the amount of disruption of the natural hydrologic characteristics of the site.

Competing Needs Criteria

LID BMPs can be superseded or restricted where they are in conflict with:

- Requirements of the following federal or state laws, rules, and standards:
  - Historic Preservation Laws and Archaeology Laws as listed at https://dahp.wa.gov/project-review/preservation-laws,
  - Federal Superfund or Washington State Model Toxics Control Act,
  - Federal Aviation Administration requirements for airports,
  - Americans with Disabilities Act.
- When an LID requirement has been found to be in conflict with special zoning district design criteria adopted and being implemented pursuant to a community planning process. The existing local codes may supersede or reduce the LID requirement.
- Public health and safety standards (e.g. active zone of a skate park, bike park, or sport court where permeable pavement violates safety standards).
- Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way.
- A local Critical Area Ordinance that provides protection of tree species.
- A local code or rule adopted as part of a Wellhead Protection Program established under the Federal Safe Drinking Water Act; or adopted to protect a Critical Aquifer Recharge Area established under the State Growth Management Act.

Supplemental Guidelines

In order to meet the LID Performance Standard, designers may use any Flow Control BMP in the SWMMWW. There are no specific Flow Control BMPs that must be used to meet the LID Performance Standard.

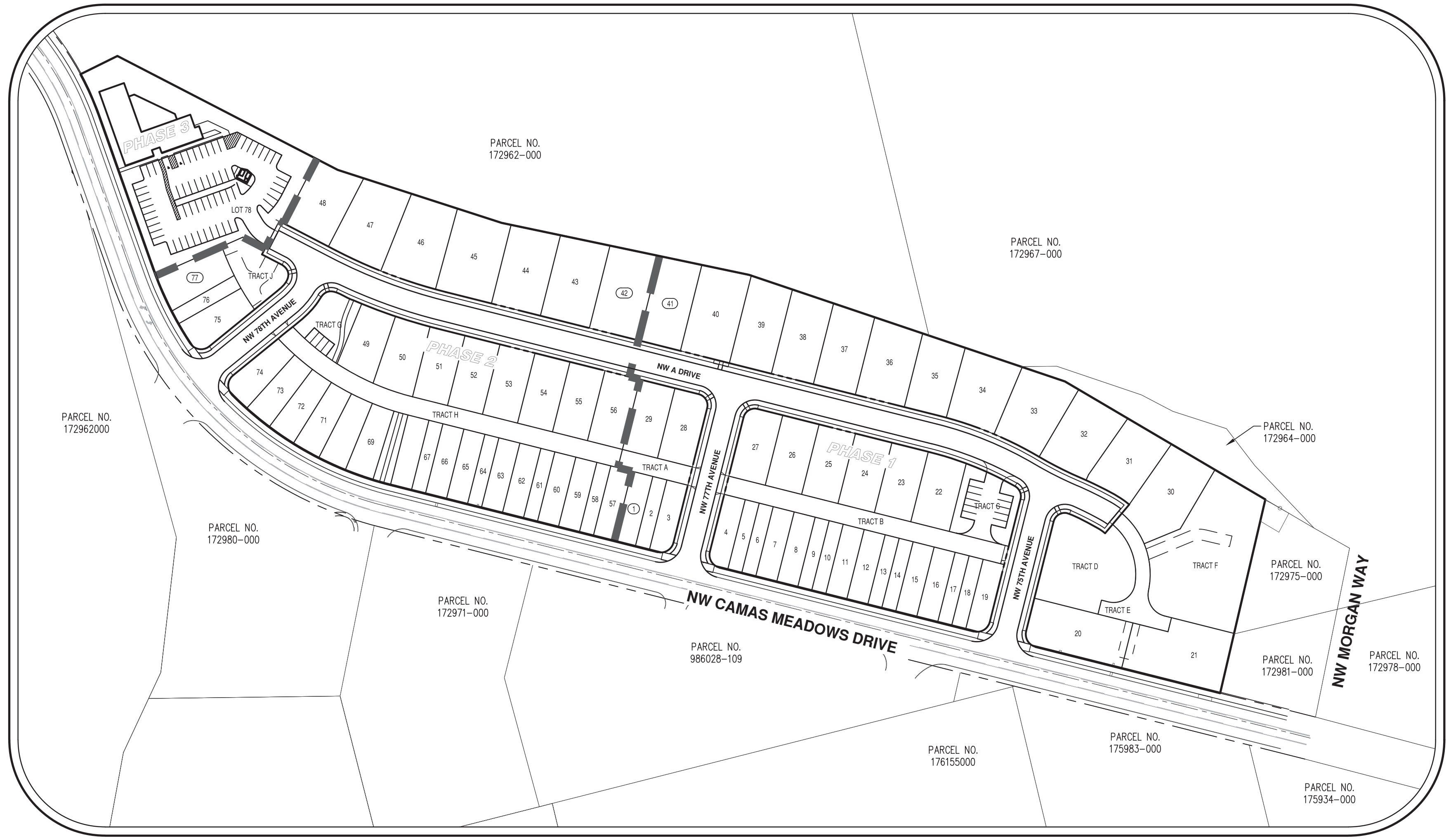
Appendix C: Development Plans

CAMAS MEADOWS SUBDIVISION

PRELIMINARY ENGINEERING/SITE/SUBDIVISION PLANS

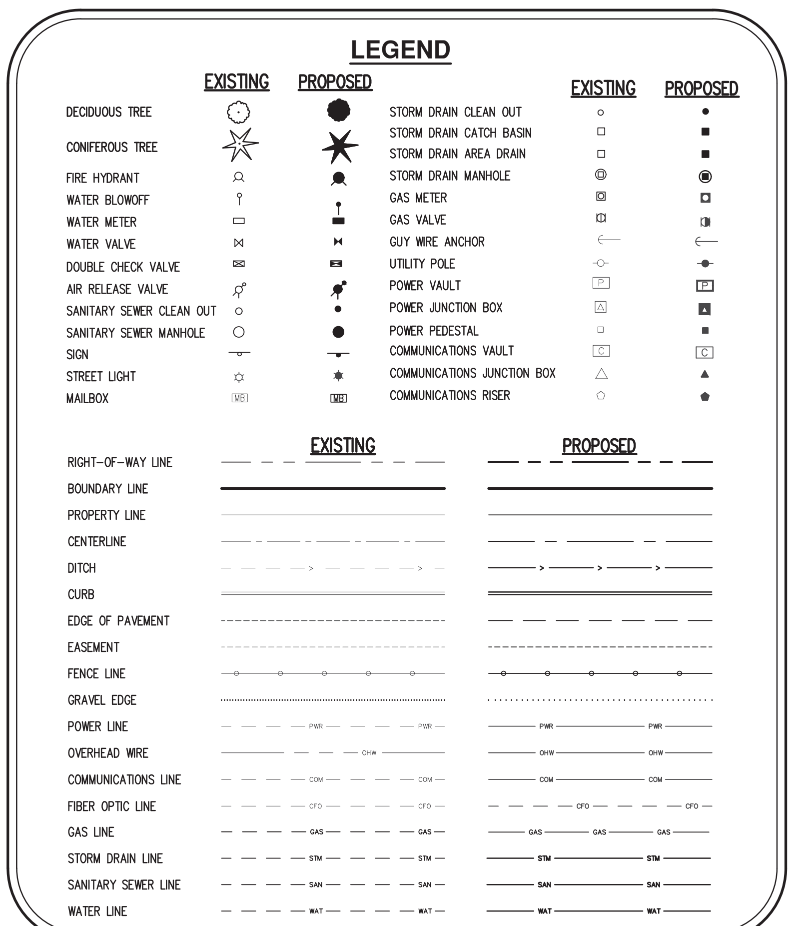
VICINITY MAP

N.T.S.



SITE MAP

N.T.S.



APPLICANT/CONTACT

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VANCOUVER, WA 98682
PH: (360) 904-4759
EMAIL: STACEY@ROMANOFINANCIAL.COM

OWNERS

LOFTS AT CAMAS MEADOWS PHASE I LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

LOFTS AT CAMAS MEADOWS PHASE II LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

VANPORT MANUFACTURING INC & HERTRICH ADOLF
PO BOX 97
BORING OR, 97009

PEDWAR DEVELOPMENT GROUP LLC
4711 NW CAMAS MEADOWS DRIVE
CAMAS, WA 98607

ENGINEER/PLANNER/ARBORIST/ SURVEYOR/LANDSCAPE ARCHITECT/BIOLOGIST

AKS ENGINEERING & FORESTRY, LLC.
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9600 NE 126TH AVENUE, SUITE 2520
VANCOUVER, WA 98682
PH: 360-882-0419
FAX: 360-882-0426
E-MAIL: ANDREOTTIM@AKS-ENG.COM

PROPERTY DESCRIPTION

LOCATED IN THE NORTHWEST AND SOUTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 NORTH, RANGE 3 EAST AND THE NORTHEAST 1/4 OF SECTION 29, TOWNSHIP 2 NORTH, RANGE 3 EAST, WILLAMETTE MERIDIAN, CLARK COUNTY, WASHINGTON. PROPERTY SERIAL NO.'S 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.

EXISTING LAND USE

UNDEVELOPED ZONED MIXED USE (MX)

PROJECT PURPOSE

PHASED MIXED USE SUBDIVISION WITH 77 SINGLE-FAMILY RESIDENTIAL LOTS AND ONE COMMERCIAL LOT WITH ASSOCIATED ROAD AND OTHER SITE IMPROVEMENTS.

SITE AREA

13.81 AC (601,725 SF)

SHEET INDEX

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FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

COVER SHEET
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

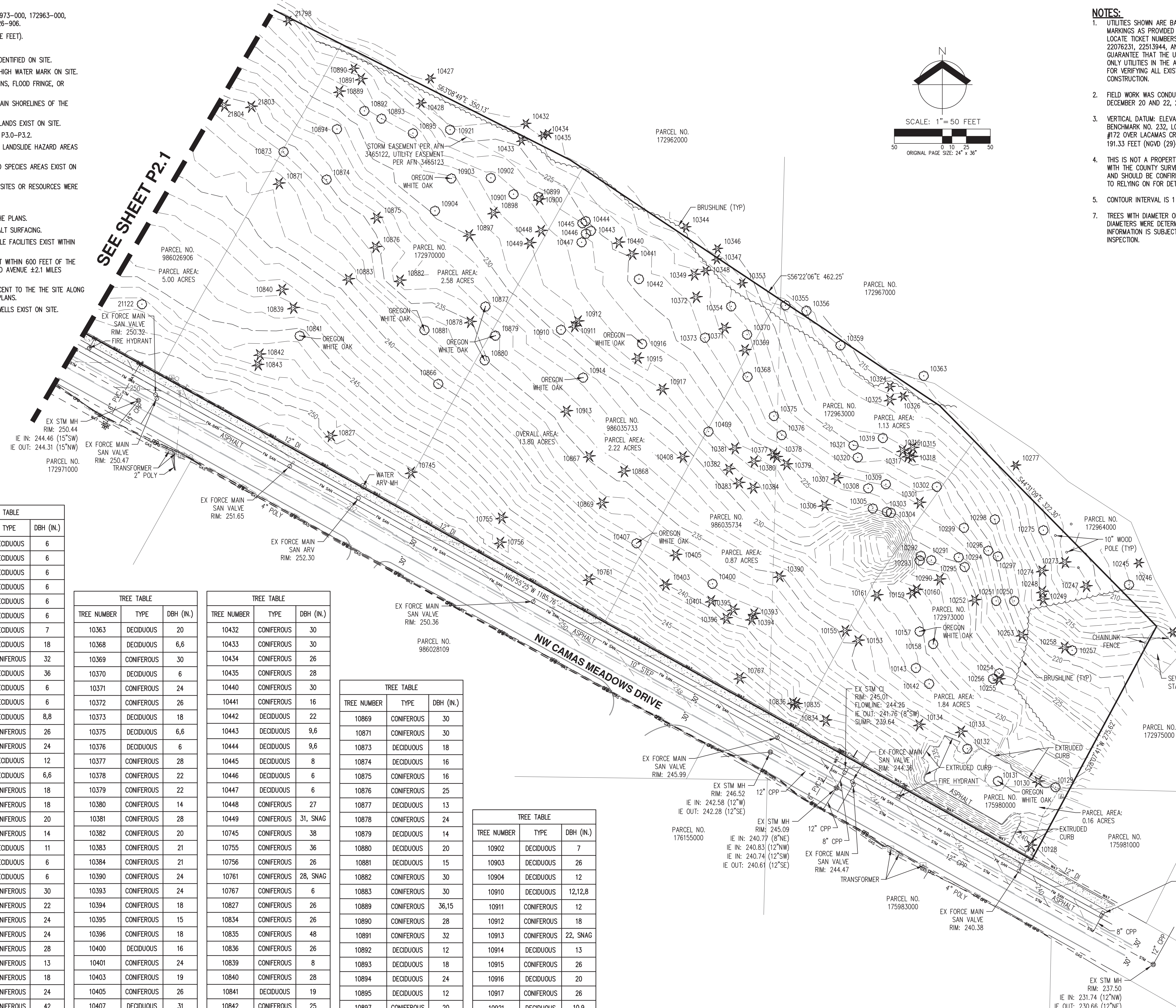
JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

P1.0

AKS DRAWING FILE: 9030 P1.0.DWG | LAYOUT: P1.0

EXISTING LAND USE NOTES:

1. THE SITE CONSISTS OF PARCELS 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.
1. TOTAL SITE AREA IS 13.81 ACRES (601,725 SQUARE FEET).
2. CONTOURS SHOWN ARE AT 1 FOOT INTERVALS.
3. PER CLARK COUNTY GIS NO WATERCOURSES ARE IDENTIFIED ON SITE.
4. PER CLARK COUNTY GIS THERE IS NOT ORDINARY HIGH WATER MARK ON SITE.
5. PER CLARK COUNTY GIS THERE ARE NO FLOODPLAINS, FLOOD FRINGE, OR FLOODWAY ON SITE.
6. PER CLARK COUNTY GIS THE SITE DOES NOT CONTAIN SHORELINES OF THE STATE.
7. PER CLARK COUNTY GIS NO WATERBODIES OR WETLANDS EXIST ON SITE.
8. DEVELOPMENT ENVELOPES ARE SHOWN ON SHEETS P3.0–P3.2.
9. PER CLARK COUNTY GIS NO UNSTABLE SLOPES OR LANDSLIDE HAZARD AREAS EXIST ON SITE.
10. PER CLARK COUNTY GIS NO PRIORITY HABITAT AND SPECIES AREAS EXIST ON SITE.
11. PER CLARK COUNTY GIS NO SIGNIFICANT HISTORIC SITES OR RESOURCES WERE IDENTIFIED ON SITE.
12. NO STRUCTURES EXIST ON SITE.
13. EASEMENTS EXIST ON SITE AND ARE SHOWN ON THE PLANS.
14. NW CAMAS MEADOWS DRIVE IS PUBLIC WITH ASPHALT SURFACING.
15. PER CLARK COUNTY GIS NO PEDESTRIAN OR BICYCLE FACILITIES EXIST WITHIN 100 FEET OF THE SITE.
16. PER CLARK COUNTY GIS NO TRANSIT ROUTES EXIST WITHIN 600 FEET OF THE SITE. THE NEAREST STOP IS LOCATED ON SE 1932D AVENUE ±2.1 MILES SOUTHWEST OF THE SITE.
17. THE NEAREST FIRE HYDRANTS ARE LOCATED ADJACENT TO THE THE SITE ALONG NW CAMAS MEADOWS DRIVE AND SHOWN ON THE PLANS.
18. PER CLARK COUNTY GIS NO SEPTIC SYSTEMS OR WELLS EXIST ON SITE.



NOTES:

1. UTILITIES SHOWN ARE BASED ON UNDERGROUND UTILITY LOCATE MARKINGS AS PROVIDED BY OTHERS, PROVIDED PER UTILITY LOCATE TICKET NUMBERS 22076170, 22076193, 22076209, 22076231, 22513944, AND 22513945. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND LOCATES REPRESENT THE ONLY UTILITIES IN THE AREA. CONTRACTORS ARE RESPONSIBLE FOR VERIFYING ALL EXISTING CONDITIONS PRIOR TO BEGINNING CONSTRUCTION.
2. FIELD WORK WAS CONDUCTED MARCH 4, 9–10, AND 14, AND DECEMBER 20 AND 22, 2022.
3. VERTICAL DATUM: ELEVATIONS ARE BASED ON CLARK COUNTY BENCHMARK NO. 232, LOCATED IN THE SE WINGWALL OF BRIDGE #172 OVER LACAMAS CREEK ON NE GOODWIN ROAD. ELEVATION = 191.33 FEET (NGVD (29)47)).
4. THIS IS NOT A PROPERTY BOUNDARY SURVEY TO BE RECORDED WITH THE COUNTY SURVEYOR. BOUNDARIES MAY BE PRELIMINARY AND SHOULD BE CONFIRMED WITH THE STAMPING SURVEYOR PRIOR TO RELYING ON FOR DETAILED DESIGN OR CONSTRUCTION.
5. CONTOUR INTERVAL IS 1 FOOT.
7. TREES WITH DIAMETER OF 6" AND GREATER ARE SHOWN. TREE DIAMETERS WERE DETERMINED BY VISUAL INSPECTION. TREE INFORMATION IS SUBJECT TO CHANGE UPON ARBORIST INSPECTION.

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10128	CONIFEROUS	7
10129	DECIDUOUS	7
10130	CONIFEROUS	6
10131	DECIDUOUS	24,18
10132	DECIDUOUS	15,11
10133	CONIFEROUS	40
10134	CONIFEROUS	44
10142	DECIDUOUS	12,8
10143	DECIDUOUS	10
10153	CONIFEROUS	36, SNAG
10155	CONIFEROUS	32, SNAG
10157	DECIDUOUS	30
10158	DECIDUOUS	24
10159	CONIFEROUS	18
10160	DECIDUOUS	32
10161	CONIFEROUS	30
10185	CONIFEROUS	40
10245	CONIFEROUS	40
10246	DECIDUOUS	14
10247	CONIFEROUS	40
10248	CONIFEROUS	16
10249	CONIFEROUS	19
10250	DECIDUOUS	6,6,6,6,6
10251	DECIDUOUS	9,9
10252	CONIFEROUS	36
10253	CONIFEROUS	30
10254	DECIDUOUS	12,11,8
10255	CONIFEROUS	10
10256	DECIDUOUS	12
10257	DECIDUOUS	13
10258	CONIFEROUS	26
10273	CONIFEROUS	28
10274	CONIFEROUS	18
10275	DECIDUOUS	27
10277	CONIFEROUS	48
10290	CONIFEROUS	30
10291	DECIDUOUS	6

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10292	DECIDUOUS	6
10293	DECIDUOUS	6
10294	DECIDUOUS	6
10295	DECIDUOUS	6
10296	DECIDUOUS	6
10297	DECIDUOUS	6
10298	DECIDUOUS	7
10299	DECIDUOUS	18
10301	CONIFEROUS	32
10302	DECIDUOUS	36
10303	DECIDUOUS	6
10304	DECIDUOUS	6
10305	DECIDUOUS	8,8
10306	CONIFEROUS	26
10307	CONIFEROUS	24
10308	DECIDUOUS	12
10309	DECIDUOUS	6,6
10315	CONIFEROUS	18
10316	CONIFEROUS	18
10317	CONIFEROUS	20
10318	CONIFEROUS	14
10319	DECIDUOUS	11
10320	DECIDUOUS	6
10321	DECIDUOUS	6
10324	CONIFEROUS	30
10325	CONIFEROUS	22
10326	CONIFEROUS	24
10344	CONIFEROUS	24
10346	CONIFEROUS	28
10347	CONIFEROUS	13
10348	CONIFEROUS	18
10349	CONIFEROUS	24
10353	CONIFEROUS	42
10354	DECIDUOUS	6
10355	DECIDUOUS	18
10356	DECIDUOUS	24
10359	DECIDUOUS	19

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10363	DECIDUOUS	20
10368	DECIDUOUS	6,6
10369	CONIFEROUS	30
10370	DECIDUOUS	6
10371	CONIFEROUS	24
10372	CONIFEROUS	26
10373	DECIDUOUS	18
10375	DECIDUOUS	6,6
10376	DECIDUOUS	6
10377	CONIFEROUS	28
10378	CONIFEROUS	22
10379	CONIFEROUS	22
10380	CONIFEROUS	14
10381	CONIFEROUS	28
10382	CONIFEROUS	20
10383	CONIFEROUS	21
10384	CONIFEROUS	21
10390	CONIFEROUS	24
10393	CONIFEROUS	24
10394	CONIFEROUS	18
10395	CONIFEROUS	15
10396	CONIFEROUS	18
10400	DECIDUOUS	16
10401	CONIFEROUS	24
10403	CONIFEROUS	19
10405	CONIFEROUS	26
10407	DECIDUOUS	31
10408	CONIFEROUS	28
10409	DECIDUOUS	6
10427	CONIFEROUS	40
10428	CONIFEROUS	30

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10432	CONIFEROUS	30
10433	CONIFEROUS	30
10434	CONIFEROUS	26
10435	CONIFEROUS	28
10440	CONIFEROUS	30
10441	CONIFEROUS	16
10442	DECIDUOUS	22
10443	DECIDUOUS	9,6
10444	DECIDUOUS	9,6
10445	DECIDUOUS	8
10446	DECIDUOUS	6
10447	DECIDUOUS	6
10448	CONIFEROUS	27
10449	CONIFEROUS	31, SNAG
10745	CONIFEROUS	38
10755	CONIFEROUS	36
10756	CONIFEROUS	26
10761	CONIFEROUS	28, SNAG
10767	CONIFEROUS	6
10827	CONIFEROUS	26
10834	CONIFEROUS	26
10835	CONIFEROUS	48
10836	CONIFEROUS	26
10839	CONIFEROUS	8
10840	CONIFEROUS	28
10841	DECIDUOUS	19
10842	CONIFEROUS	25
10843	CONIFEROUS	25
10866	DECIDUOUS	26
10867	CONIFEROUS	20
10868	CONIFEROUS	24

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10869	CONIFEROUS	30
10871	CONIFEROUS	30
10873	DECIDUOUS	18
10874	DECIDUOUS	16
10875	CONIFEROUS	16
10876	CONIFEROUS	25
10877	DECIDUOUS	13
10878	CONIFEROUS	24
10879	DECIDUOUS	14
10880	DECIDUOUS	20
10881	DECIDUOUS	15
10882	CONIFEROUS	30
10883	CONIFEROUS	30
10889	CONIFEROUS	36,15
10890	CONIFEROUS	28
10891	CONIFEROUS	32
10892	DECIDUOUS	12
10893	DECIDUOUS	18
10894	DECIDUOUS	24
10895	DECIDUOUS	12
10897	CONIFEROUS	20
10898	CONIFEROUS	24
10899	DECIDUOUS	8,8
10900	CONIFEROUS	22
10901	DECIDUOUS	6

TREE TABLE

TREE NUMBER	TYPE	DBH (IN.)
10902	DECIDUOUS	7
10903	DECIDUOUS	26
10904	DECIDUOUS	12
10910	DECIDUOUS	12,12,8
10911	CONIFEROUS	12
10912	CONIFEROUS	18
10913	CONIFEROUS	22, SNAG
10914	DECIDUOUS	13
10915	CONIFEROUS	26
10916	DECIDUOUS	20
10917	CONIFEROUS	26
10921	DECIDUOUS	10,9
21122	DECIDUOUS	7
21798	CONIFEROUS	32
21803	CONIFEROUS	36
21804	CONIFEROUS	37

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FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

EXISTING CONDITIONS PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

JAMES O. HANSON · STATE OF WASHINGTON · REGISTERED PROFESSIONAL LAND SURVEYOR
PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

EXISTING LAND USE NOTES:

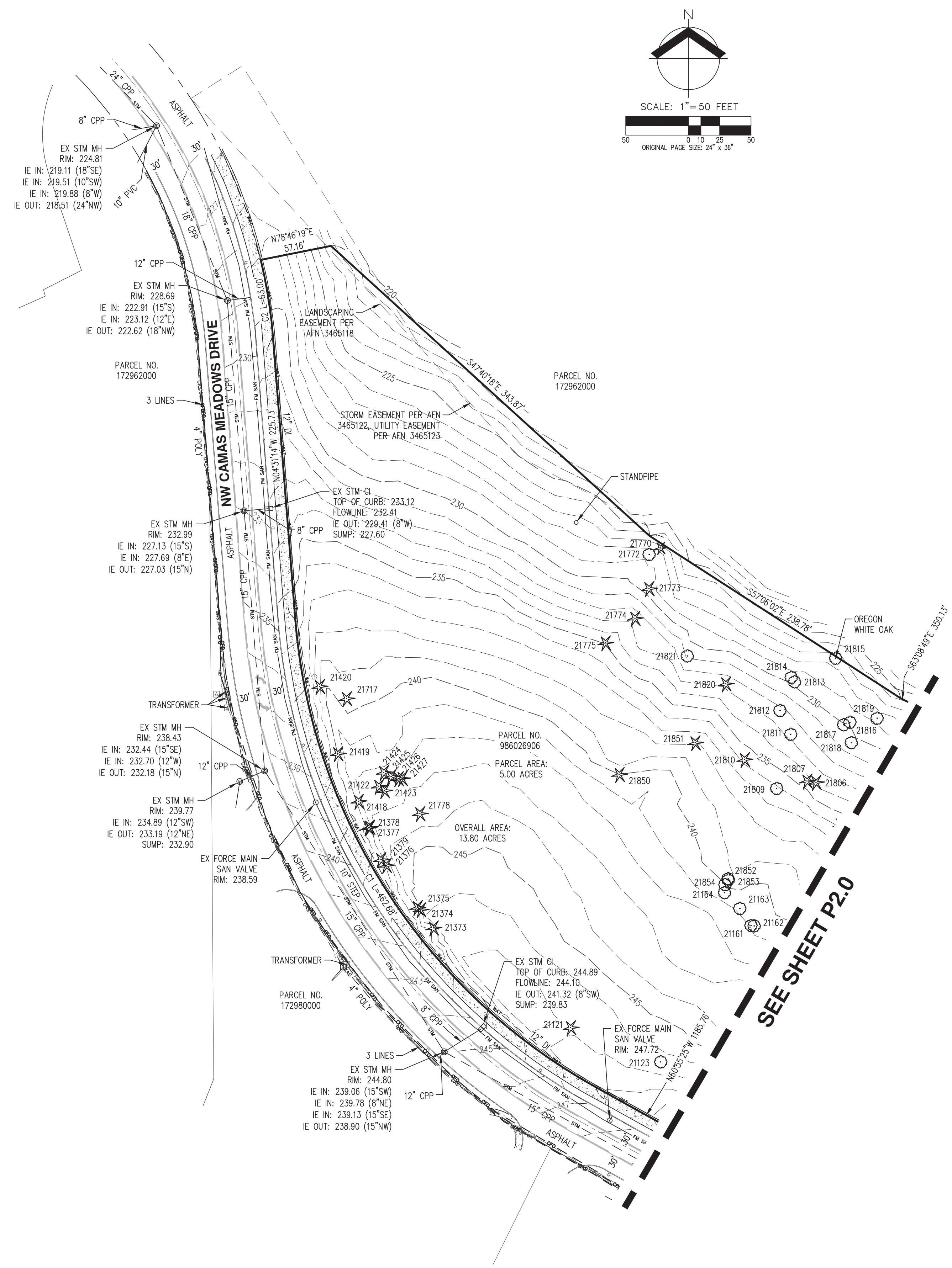
1. THE SITE CONSISTS OF PARCELS 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.
1. TOTAL SITE AREA IS 13.81 ACRES (601,725 SQUARE FEET).
2. CONTOURS SHOWN ARE AT 1 FOOT INTERVALS.
3. PER CLARK COUNTY GIS NO WATERCOURSES ARE IDENTIFIED ON SITE.
4. PER CLARK COUNTY GIS THERE IS NOT ORDINARY HIGH WATER MARK ON SITE.
5. PER CLARK COUNTY GIS THERE ARE NO FLOODPLAINS, FLOOD FRINGE, OR FLOODWAY ON SITE.
6. PER CLARK COUNTY GIS THE SITE DOES NOT CONTAIN SHORELINES OF THE STATE.
7. PER CLARK COUNTY GIS NO WATERBODIES OR WETLANDS EXIST ON SITE.
8. DEVELOPMENT ENVELOPES ARE SHOWN ON SHEETS P3.0–P3.2.
9. PER CLARK COUNTY GIS NO UNSTABLE SLOPES OR LANDSLIDE HAZARD AREAS EXIST ON SITE.
10. PER CLARK COUNTY GIS NO PRIORITY HABITAT AND SPECIES AREAS EXIST ON SITE.
11. PER CLARK COUNTY GIS NO SIGNIFICANT HISTORIC SITES OR RESOURCES WERE IDENTIFIED ON SITE.
12. NO STRUCTURES EXIST ON SITE.
13. EASEMENTS EXIST ON SITE AND ARE SHOWN ON THE PLANS.
14. NW CAMAS MEADOWS DRIVE IS PUBLIC WITH ASPHALT SURFACING.
15. PER CLARK COUNTY GIS NO PEDESTRIAN OR BICYCLE FACILITIES EXIST WITHIN 100 FEET OF THE SITE.
16. PER CLARK COUNTY GIS NO TRANSIT ROUTES EXIST WITHIN 600 FEET OF THE SITE. THE NEAREST STOP IS LOCATED ON SE 1932D AVENUE ±2.1 MILES SOUTHWEST OF THE SITE.
17. THE NEAREST FIRE HYDRANTS ARE LOCATED ADJACENT TO THE THE SITE ALONG NW CAMAS MEADOWS DRIVE AND SHOWN ON THE PLANS.
18. PER CLARK COUNTY GIS NO SEPTIC SYSTEMS OR WELLS EXIST ON SITE.

CURVE TABLE				
CURVE	RADIUS	DELTA	LENGTH	CHORD
C1	470.00'	56°24'11"	462.68'	N32°43'20"W 444.22'
C2	405.00'	8°54'45"	63.00'	N8°58'37"W 62.94'

TREE TABLE		
TREE NUMBER	TYPE	DBH (IN.)
21121	CONIFEROUS	6
21123	DECIDUOUS	7
21160	DECIDUOUS	6
21161	DECIDUOUS	6
21162	DECIDUOUS	6
21163	DECIDUOUS	6
21164	DECIDUOUS	8
21373	CONIFEROUS	8
21374	CONIFEROUS	6
21375	CONIFEROUS	6
21376	CONIFEROUS	6
21377	CONIFEROUS	7
21378	CONIFEROUS	6
21379	CONIFEROUS	6
21418	CONIFEROUS	6
21419	CONIFEROUS	6
21420	CONIFEROUS	7
21422	CONIFEROUS	6
21423	CONIFEROUS	6
21424	CONIFEROUS	6

TREE TABLE		
TREE NUMBER	TYPE	DBH (IN.)
21425	CONIFEROUS	7
21426	CONIFEROUS	7
21427	CONIFEROUS	6,6
21717	CONIFEROUS	8
21770	CONIFEROUS	44
21771	CONIFEROUS	30
21772	DECIDUOUS	6
21773	CONIFEROUS	28
21774	CONIFEROUS	54
21775	CONIFEROUS	77
21778	CONIFEROUS	8
21806	CONIFEROUS	30
21807	CONIFEROUS	23
21809	CONIFEROUS	14
21810	CONIFEROUS	27
21811	DECIDUOUS	24
21812	DECIDUOUS	9
21813	DECIDUOUS	8
21814	DECIDUOUS	17
21815	DECIDUOUS	17

TREE TABLE		
TREE NUMBER	TYPE	DBH (IN.)
21816	DECIDUOUS	16
21817	DECIDUOUS	12
21818	DECIDUOUS	15
21819	DECIDUOUS	8
21820	CONIFEROUS	36
21821	DECIDUOUS	6
21850	CONIFEROUS	7
21851	CONIFEROUS	7
21852	DECIDUOUS	6
21853	DECIDUOUS	6
21854	DECIDUOUS	6



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CAMAS MEADOWS SUBDIVISION
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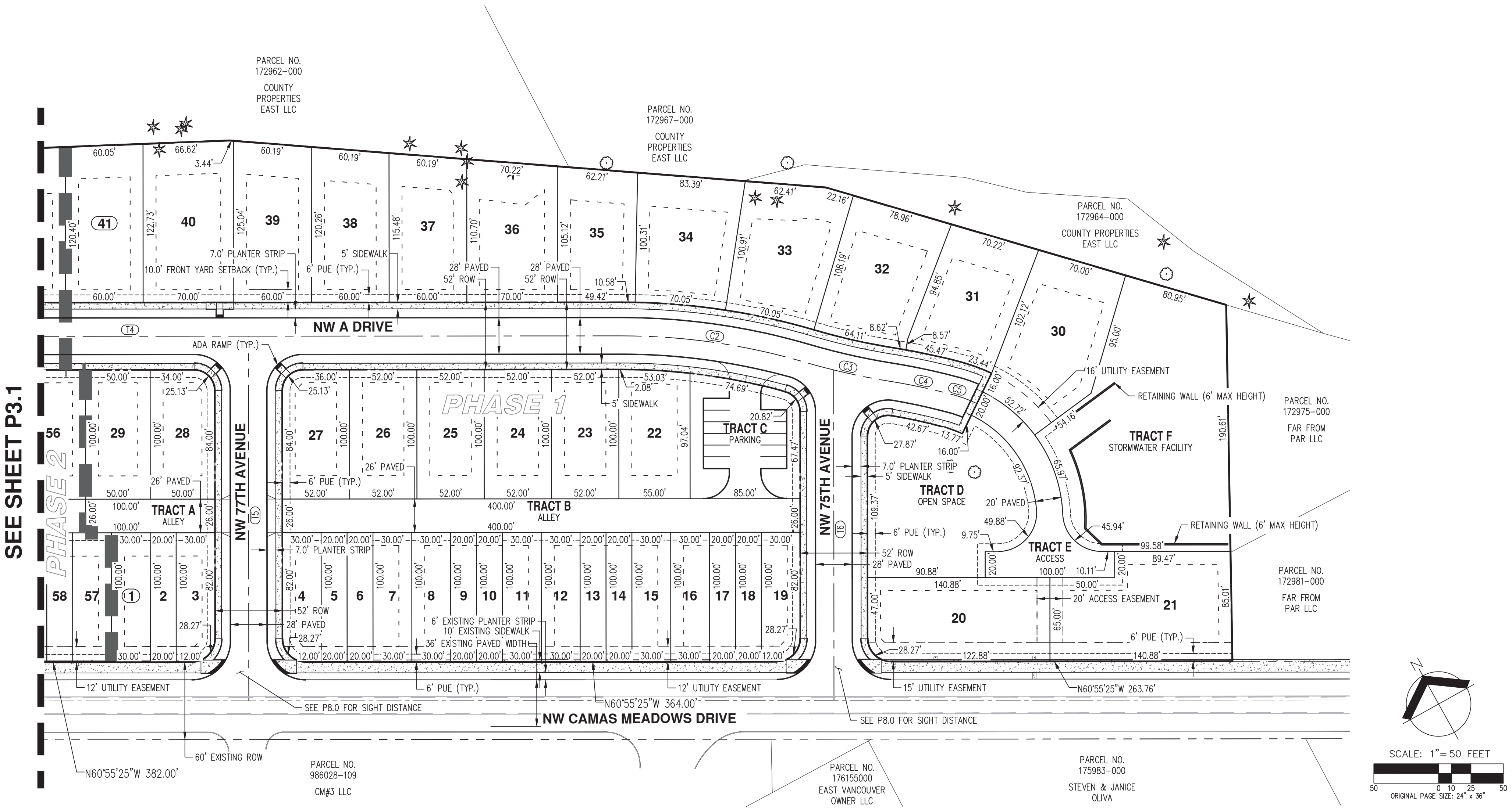

GENERAL NOTES

1. TOTAL SITE AREA IS 13.81 ACRES (600,725 SQUARE FEET).
2. NO WETLAND, STREAM, OR STEEP BANK BUFFER AREAS, OR PROTECTED AREAS EXIST ON SITE.
3. NO PLANNED ENHANCEMENT AREAS ARE PROPOSED. .
4. NO STRUCTURES EXIST ON SITE.
5. NO TRANSIT FACILITIES ARE PROPOSED.
6. NO BICYCLE FACILITIES BEYOND THOSE LOCATED IN THE RIGHT-OF-WAY ARE PROPOSED.
7. NW 75TH AVENUE, NW 77TH AVENUE, NW 78TH AVENUE, AND NW A DRIVE ARE PUBLIC WITH ASPHALT SURFACING.
8. NO ROADS ON OR WITHIN 500 FEET OF THE SITE PROPOSED TO PROVIDE SITE ACCESS ARE IN EXCESS OF 15% GRADE.
9. NW CAMAS MEADOWS DRIVE IS PUBLIC WITH ASPHALT SURFACING.
10. SIGHT DISTANCE TRIANGLES ARE SHOWN ON SHEET P8.0.
11. ALL PROPOSED EASEMENTS ARE SHOWN ON THE PLANS.
12. NO HARD LANDSCAPING FEATURES ARE PROPOSED.
13. SEE SHEETS P9.0 AND 9.1 FOR LANDSCAPE PLANS.
14. THE DEVELOPMENT PROPOSES TO SUBDIVIDE SEVEN PARCELS INTO 77 ATTACHED AND DETACHED SINGLE-FAMILY LOTS, AND ONE COMMERCIAL LOT.
15. THE DEVELOPMENT WILL CONSTRUCT FOUR INTERNAL STREETS. PROPOSED STREETS TO INCLUDE A 52-FOOT RIGHT-OF-WAY, 28-FOOT PAVED WIDTH, 7-FOOT PLANTER STRIP, AND 5-FOOT DETACHED SIDEWALK PER CITY OF CAMAS STANDARD DETAIL ST3.
16. SURFACE MATERIAL FOR ALL PROPOSED ROADWAYS IS ASPHALT.
17. ALL PROPOSED HOMES WILL BE CONSTRUCTED WITH FIRE SPRINKLERS.
18. ALL LOTS WILL BE SERVED WITH PUBLIC SANITARY SEWER AND WATER BY CITY OF CAMAS. WATER AND SEWER WILL BE EXTENDED FROM THE LINES IN NW CAMAS MEADOWS DRIVE INTO THE SITE.
19. STORMWATER FROM SUBDIVISION WILL BE COLLECTED ON SITE AND CONVEYED TO A MECHANICAL FILTER VAULT AND UNDERGROUND DETENTION IN TRACT TRACT F PRIOR TO DISCHARGING AT THE NORTHEAST CORNER OF THE SITE. STORMWATER FROM COMMERCIAL LOT WILL BE COLLECTED ON SITE AND CONVEYED TO MECHANICAL FILTER CATCH BASINS AND UNDERGROUND DETENTION PRIOR TO DISCHARGING AT THE NORTH CORNER OF THE SITE. STORMWATER TO BE DESIGNED PER CITY OF CAMAS STANDARDS.
20. OPEN SPACE/PARKING TRACTS C & G TO BE OWNED AND MAINTAINED BY THE HOME OWNERS ASSOCIATION (HOA).
21. ACCESS TRACTS A, B, E, & H TO BE OWNED AND MAINTAINED BY THE HOA.
22. STORMWATER FACILITIES IN TRACT F TO BE OWNED AND MAINTAINED BY THE HOA. STORMWATER FACILITIES IN COMMERCIAL LOT TO PRIVATELY OWNED AND MAINTAINED.
23. OPEN SPACE/ACCESS TRACT J TO BE OWNED AND MAINTAINED BY THE HOA.
24. OPEN SPACE TRACTS D & I TO BE OWNED AND MAINTAINED BY THE HOA.
25. BUILDING ENVELOPES SHALL BE PER DEVELOPMENT STANDARDS TABLE.
26. LOTS 1-19 AND 57-77 WILL BE REAR LOAD ATTACHED TOWNHOMES.
27. LOTS 20, 21, AND 30-48 WILL BE FRONT LOADED STANDARD DETACHED HOMES.
28. LOTS 22-29 AND 49-56 WILL EITHER BE REAR LOADED OR FRONT LOADED STANDARD DETACHED HOMES, LOT ACCESS WILL BE BASED ON FINAL GRADING.
29. NW CAMAS MEADOWS FRONTAGE IMPROVEMENTS WILL INCLUDE:
REPLACEMENT OF DAMAGED CURB AND SIDEWALK.
GRIND AND INLAY AT NW 75TH AVENUE AND NW 77TH AVENUE.

SITE STATISTICS

PARCEL ZONE:	MIXED USE (MX)
GROSS AREA:	13.81 AC (601,725 SF)
TOTAL ROW DEDICATION:	96,852 SF (2.22 AC)
MINIMUM LOT AREA:	2,000 SF
MAXIMUM LOT AREA:	9,915 SF
PROPOSED AVERAGE LOT AREA:	4,714 SF

LOT STATISTICS

ATTACHED REAR LOAD:	40
DETACHED FRONT LOAD:	37
COMMERCIAL	1
TOTAL LOTS:	78

DEVELOPMENT STANDARDS

MINIMUM FRONT YARD SETBACK:	10 FEET
GARAGE SETBACK:	5 FEET FROM FRONT OF DWELLING
MINIMUM SIDE YARD:	10 FEET
MINIMUM STREET SIDE YARD:	10 FEET
MINIMUM REAR YARD:	25 FEET

RESIDENTIAL PARKING STATISTICS

REQUIRED PARKING:	1 SPACE/5 LOTS
PROPOSED PARKING:	15 SPACES (77 LOTS/5 LOTS/SPACE)
TRACT C:	11 SPACES
TRACT G:	4 SPACES
TOTAL PROPOSED;	15 SPACES

TRACT	PURPOSE	AREA
TRACT A	ALLEY	2,600 SF
TRACT B	ALLEY	10,400 SF
TRACT C	OPEN SPACE/PARKING	7,590 SF
TRACT D	OPEN SPACE	13,804 SF
TRACT E	ACCESS	5,117 SF
TRACT F	STORMWATER FACILITY	23,425 SF
TRACT G	OPEN SPACE/PARKING	5,123 SF
TRACT H	ALLEY	13,083 SF
TRACT I	OPEN SPACE	2,270 SF
TRACT J	OPEN SPACE/ACCESS	4,981 SF
TOTAL		88,393 SF

APPLICANT/CONTACT

ROMANO DEVELOPMENT, LLC
CONTACT: STACEY SHIELDS
4610 NE 77TH AVENUE, SUITE 102
VANCOUVER, WA 98682
PH: (360) 904-4759
EMAIL: STACEY@ROMANOFINANCIAL.COM

OWNERS

LOFTS AT CAMAS MEADOWS PHASE I LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

LOFTS AT CAMAS MEADOWS PHASE II LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

VANPORT MANUFACTURING INC & HERTRICH ADOLF
PO BOX 97
BORING OR, 97009

PEDWAR DEVELOPMENT GROUP LLC
4711 NW CAMAS MEADOWS DRIVE
CAMAS, WA 98607

ENGINEER/PLANNER/ARBORIST/SURVEY/LANDSCAPE ARCHITECT/BIOLOGIST

AKS ENGINEERING & FORESTRY, LLC.
CONTACT: MICHAEL ANDREOTTI
9600 NE 126TH AVENUE, SUITE 2520
VANCOUVER, WA 98682
PH: 360-882-0419
FAX: 360-882-0426
E-MAIL: ANDREOTTIM@AKS-ENG.COM

PROPERTY DESCRIPTION

LOCATED IN THE NORTHWEST AND SOUTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 NORTH, RANGE 3 EAST AND THE NORTHEAST 1/4 OF SECTION 29, TOWNSHIP 2 NORTH, RANGE 3 EAST, WILLAMETTE MERIDIAN, CLARK COUNTY, WASHINGTON. PROPERTY SERIAL NO.'S 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.

EXISTING LAND USE

UNDEVELOPED ZONED MIXED USE (MX)

PROJECT PURPOSE

PHASED MIXED USE SUBDIVISION WITH 77 SINGLE-FAMILY RESIDENTIAL LOTS AND ONE COMMERCIAL LOT WITH ASSOCIATED ROAD AND OTHER SITE IMPROVEMENTS.

SITE AREA

13.81 AC (601,725 SF)

PARCEL AREA TABLE

PARCEL #	AREA (SF)
1	3,000
2	2,000
3	2,930
4	2,930
5	2,000
6	2,000
7	3,000
8	3,000
9	2,000
10	2,000
11	3,000
12	3,000
13	2,000
14	2,000

PARCEL AREA TABLE

PARCEL #	AREA (SF)
15	3,000
16	3,000
17	2,000
18	2,000
19	2,930
20	9,088
21	10,915
22	5,448
23	5,200
24	5,200
25	5,200
26	5,200
27	5,145
28	4,945

PARCEL AREA TABLE

PARCEL #	AREA (SF)
29	5,000
30	9,138
31	7,089
32	7,974
33	8,115
34	7,645
35	6,266
36	7,554
37	6,786
38	7,072
39	7,359
40	8,686
41	7,294

CENTERLINE TANGENT TABLE

LINE #	LENGTH	DIRECTION
T1	171.70	S65° 51' 46.18"W
T2	31.67	S42° 22' 23.73"W
T3	88.24	S47° 37' 36.27"E
T4	704.72	S60° 55' 25.29"E
T5	282.00	S29° 04' 34.71"W
T6	255.50	S29° 04' 34.71"W

CENTERLINE CURVE TABLE

CURVE #	ARC LENGTH	DELTA	RADIUS
C1	169.42	13°17'49"	730.00
C2	143.24	16°24'49"	500.00
C3	67.45	7°20'49"	526.00
C4	51.28	6°11'53"	474.00
C5	18.60	10°39'29"	100.00
C6	41.00	23°29'22"	100.00

THE PURPOSE OF THIS PRELIMINARY PLAT IS TO SHOW THE PROPOSED LOT DIMENSIONS AND AREAS FOR PLANNING PURPOSES. THIS IS NOT AN OFFICIAL PLAT AND IS NOT TO BE USED FOR SURVEY PURPOSES.

PRELIMINARY NOT FOR CONSTRUCTION

PRELIMINARY SUBDIVISION PLAT
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

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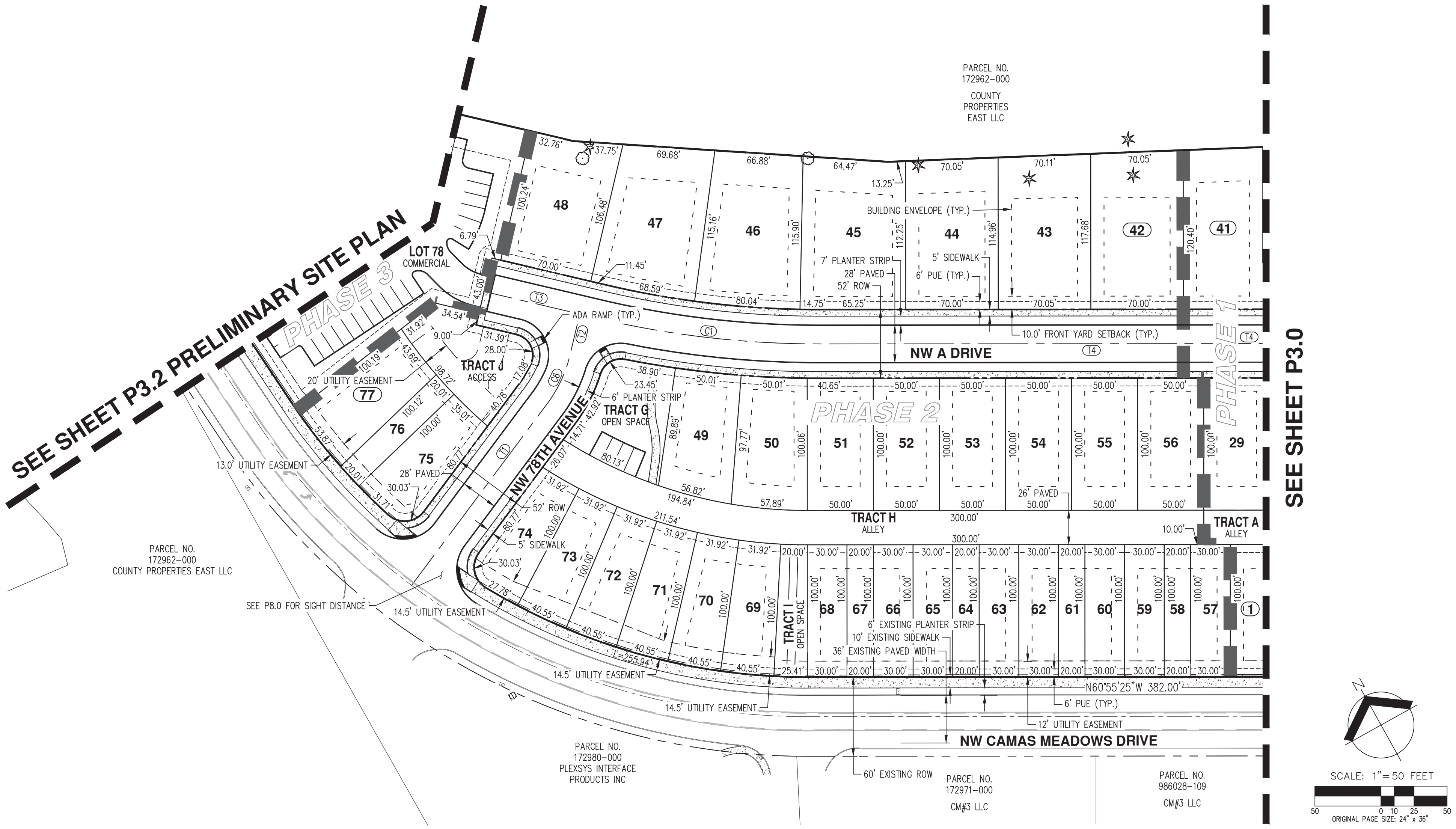

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4. NO STRUCTURES EXIST ON SITE.
5. NO TRANSIT FACILITIES ARE PROPOSED.
6. NO BICYCLE FACILITIES BEYOND THOSE LOCATED IN THE RIGHT-OF-WAY ARE PROPOSED.
7. NW 75TH AVENUE, NW 77TH AVENUE, NW 78TH AVENUE, AND NW A DRIVE ARE PUBLIC WITH ASPHALT SURFACING.
8. NO ROADS ON OR WITHIN 500 FEET OF THE SITE PROPOSED TO PROVIDE SITE ACCESS ARE IN EXCESS OF 15% GRADE.
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22. STORMWATER FACILITIES IN TRACT F TO BE OWNED AND MAINTAINED BY THE HOA. STORMWATER FACILITIES IN COMMERCIAL LOT TO PRIVATELY OWNED AND MAINTAINED.
23. OPEN SPACE/ACCESS TRACT J TO BE OWNED AND MAINTAINED BY THE HOA.
24. OPEN SPACE TRACTS D & I TO BE OWNED AND MAINTAINED BY THE HOA.
25. BUILDING ENVELOPES SHALL BE PER DEVELOPMENT STANDARDS TABLE.
26. LOTS 1-19 AND 57-77 WILL BE REAR LOAD ATTACHED TOWNHOMES.
27. LOTS 20, 21, AND 30-48 WILL BE FRONT LOADED STANDARD DETACHED HOMES.
28. LOTS 22-29 AND 49-56 WILL EITHER BE REAR LOADED OR FRONT LOADED STANDARD DETACHED HOMES, LOT ACCESS WILL BE BASED ON FINAL GRADING.
29. NW CAMAS MEADOWS FRONTAGE IMPROVEMENTS WILL INCLUDE:
REPLACEMENT OF DAMAGED CURB AND SIDEWALK.
GRIND AND INLAY AT NW 75TH AVENUE AND NW 77TH AVENUE.

PARCEL AREA TABLE	
PARCEL #	AREA (SF)
42	8,333
43	8,149
44	7,952
45	8,949
46	8,531
49	5,010
50	5,358
51	5,000
52	5,000
53	5,000
54	5,000
55	5,000
56	5,000
57	3,000
58	2,000
59	3,000
60	3,000

PARCEL AREA TABLE	
PARCEL #	AREA (SF)
61	2,000
62	3,000
63	3,000
64	2,000
65	3,000
66	3,000
67	2,000
68	3,000
69	3,624
70	3,624
71	3,624
72	3,624
73	3,624
74	3,892
75	4,242
76	2,001
77	4,878

SITE STATISTICS

PARCEL ZONE:	MIXED USE (MX)
GROSS AREA:	13.81 AC (601,725 SF)
TOTAL ROW DEDICATION:	96,852 SF (2.22 AC)
MINIMUM LOT AREA:	2,000 SF
MAXIMUM LOT AREA:	9,915 SF
PROPOSED AVERAGE LOT AREA:	4,714 SF

LOT STATISTICS

ATTACHED REAR LOAD:	40
DETACHED FRONT LOAD:	37
COMMERCIAL	1
TOTAL LOTS:	78

DEVELOPMENT STANDARDS

MINIMUM FRONT YARD SETBACK:	10 FEET
GARAGE SETBACK:	5 FEET FROM FRONT OF DWELLING
MINIMUM SIDE YARD:	10 FEET
MINIMUM STREET SIDE YARD:	10 FEET
MINIMUM REAR YARD:	25 FEET

RESIDENTIAL PARKING STATISTICS

REQUIRED PARKING:	1 SPACE/5 LOTS
PROPOSED PARKING:	15 SPACES (77 LOTS/5 LOTS/SPACE)
TRACT C:	11 SPACES
TRACT G:	4 SPACES
TOTAL PROPOSED;	15 SPACES

TRACT	PURPOSE	AREA
TRACT A	ALLEY	2,600 SF
TRACT B	ALLEY	10,400 SF
TRACT C	OPEN SPACE/PARKING	7,590 SF
TRACT D	OPEN SPACE	13,804 SF
TRACT E	ACCESS	5,117 SF
TRACT F	STORMWATER FACILITY	23,425 SF
TRACT G	OPEN SPACE/PARKING	5,123 SF
TRACT H	ALLEY	13,083 SF
TRACT I	OPEN SPACE	2,270 SF
TRACT J	OPEN SPACE/ACCESS	4,981 SF
TOTAL		88,393 SF

APPLICANT/CONTACT

ROMANO DEVELOPMENT, LLC
CONTACT: STACEY SHIELDS
4610 NE 77TH AVENUE, SUITE 102
VANCOUVER, WA 98682
PH: (360) 904-4759
EMAIL: STACEY@ROMANOFINANCIAL.COM

OWNERS

LOFTS AT CAMAS MEADOWS PHASE I LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

LOFTS AT CAMAS MEADOWS PHASE II LLC
2370 E 3RD LOOP SUITE 100
VANCOUVER, WA 98661

VANPORT MANUFACTURING INC & HERTRICH ADOLF
PO BOX 97
BORING OR, 97009

PEDWAR DEVELOPMENT GROUP LLC
4711 NW CAMAS MEADOWS DRIVE
CAMAS, WA 98607

ENGINEER/PLANNER/ARBORIST/ SURVEY/LANDSCAPE ARCHITECT/BIOLOGIST

AKS ENGINEERING & FORESTRY, LLC.
CONTACT: MICHAEL ANDREOTTI
9600 NE 126TH AVENUE, SUITE 2520
VANCOUVER, WA 98682
PH: 360-882-0419
FAX: 360-882-0426
E-MAIL: ANDREOTTIM@AKS-ENG.COM

PROPERTY DESCRIPTION

LOCATED IN THE NORTHWEST AND SOUTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 NORTH, RANGE 3 EAST AND THE NORTHEAST 1/4 OF SECTION 29, TOWNSHIP 2 NORTH, RANGE 3 EAST, WILLAMETTE MERIDIAN, CLARK COUNTY, WASHINGTON. PROPERTY SERIAL NO.'S 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.

EXISTING LAND USE

UNDEVELOPED ZONED MIXED USE (MX)

PROJECT PURPOSE

PHASED MIXED USE SUBDIVISION WITH 77 SINGLE-FAMILY RESIDENTIAL LOTS AND ONE COMMERCIAL LOT WITH ASSOCIATED ROAD AND OTHER SITE IMPROVEMENTS.

SITE AREA

13.81 AC (601,725 SF)

CENTERLINE TANGENT TABLE		
LINE #	LENGTH	DIRECTION
T1	171.70	S65° 51' 46.18"W
T2	31.67	S42° 22' 23.73"W
T3	88.24	S47° 37' 36.27"E
T4	704.72	S60° 55' 25.29"E
T5	282.00	S29° 04' 34.71"W
T6	255.50	S29° 04' 34.71"W

CENTERLINE CURVE TABLE			
CURVE #	ARC LENGTH	DELTA	RADIUS
C1	169.42	13°17'49"	730.00
C2	143.24	16°24'49"	500.00
C3	67.45	7°20'49"	526.00
C4	51.28	6°11'53"	474.00
C5	18.60	10°39'29"	100.00
C6	41.00	23°29'22"	100.00

THE PURPOSE OF THIS PRELIMINARY PLAT IS TO SHOW THE PROPOSED LOT DIMENSIONS AND AREAS FOR PLANNING PURPOSES. THIS IS NOT AN OFFICIAL PLAT AND IS NOT TO BE USED FOR SURVEY PURPOSES.

AKS DRAWING FILE: 9030 P3.0.DWG | LAYOUT: P3.1

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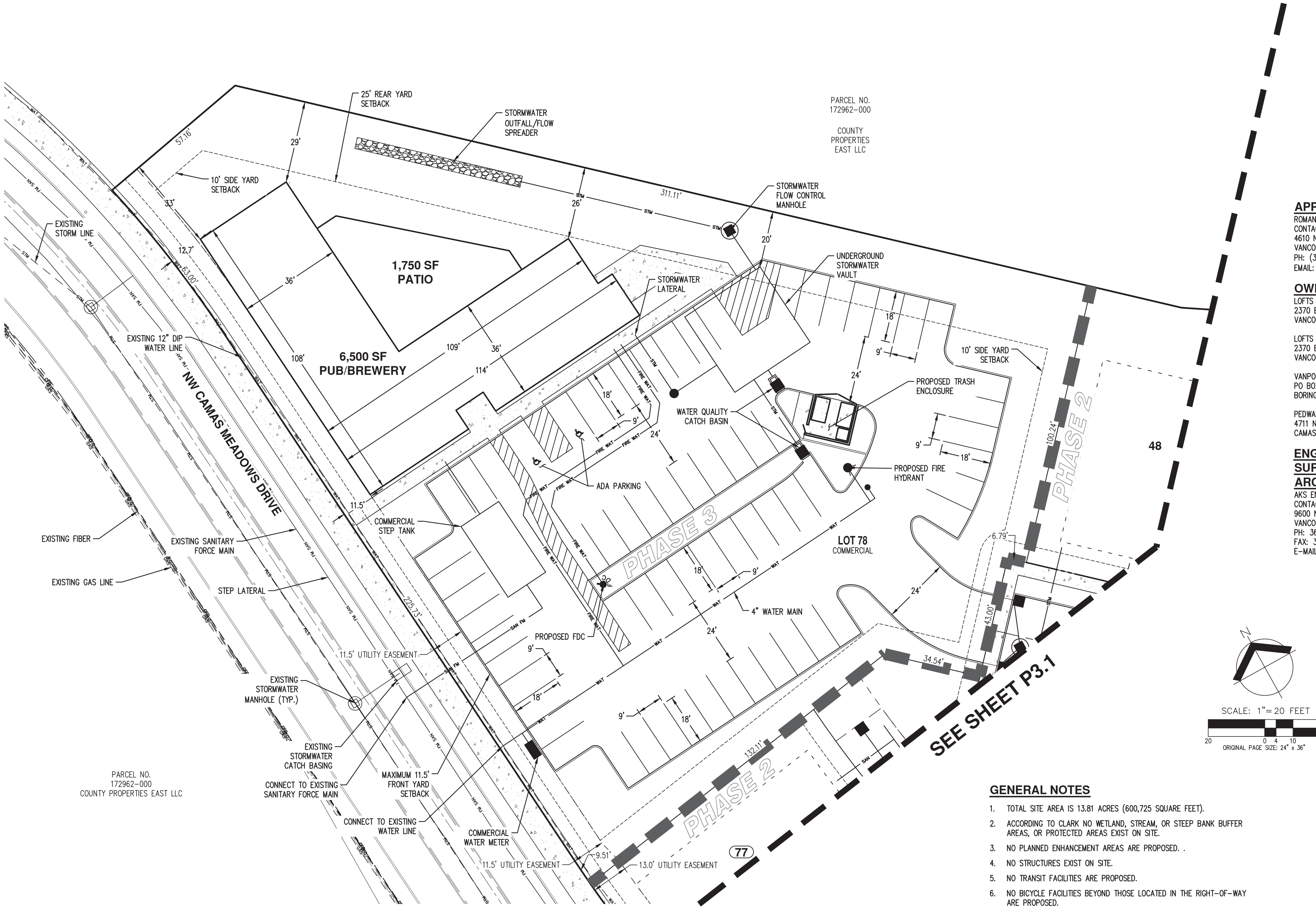
PRELIMINARY SUBDIVISION PLAT
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

JOHN M. MEIER · STATE OF WASHINGTON · 42614 · REGISTERED PROFESSIONAL ENGINEER
PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

P3.1



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LOCATED IN THE NORTHWEST AND SOUTHWEST 1/4 OF SECTION 28, TOWNSHIP 2 NORTH, RANGE 3 EAST AND THE NORTHEAST 1/4 OF SECTION 29, TOWNSHIP 2 NORTH, RANGE 3 EAST, WILLAMETTE MERIDIAN, CLARK COUNTY, WASHINGTON. PROPERTY SERIAL NO.'S 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986026-906.

EXISTING LAND USE

UNDEVELOPED ZONED MIXED USE (MX)

PROJECT PURPOSE

PHASED MIXED USE SUBDIVISION WITH 77 SINGLE-FAMILY RESIDENTIAL LOTS AND ONE COMMERCIAL LOT WITH ASSOCIATED ROAD AND OTHER SITE IMPROVEMENTS.

SITE AREA

13.81 AC (601,725 SF)

GENERAL NOTES

1. TOTAL SITE AREA IS 13.81 ACRES (600,725 SQUARE FEET).
2. ACCORDING TO CLARK NO WETLAND, STREAM, OR STEEP BANK BUFFER AREAS, OR PROTECTED AREAS EXIST ON SITE.
3. NO PLANNED ENHANCEMENT AREAS ARE PROPOSED. .
4. NO STRUCTURES EXIST ON SITE.
5. NO TRANSIT FACILITIES ARE PROPOSED.
6. NO BICYCLE FACILITIES BEYOND THOSE LOCATED IN THE RIGHT-OF-WAY ARE PROPOSED.
7. NW 75TH AVENUE, NW 77TH AVENUE, NW 78TH AVENUE, AND NW A DRIVE ARE PUBLIC WITH ASPHALT SURFACING.
8. NO ROADS ON OR WITHIN 500 FEET OF THE SITE PROPOSED TO PROVIDE SITE ACCESS ARE IN EXCESS OF 15% GRADE.
9. NW CAMAS MEADOWS DRIVE IS PUBLIC WITH ASPHALT SURFACING.
10. SIGHT DISTANCE TRIANGLES ARE SHOWN ON SHEET P8.0.
11. ALL PROPOSED EASEMENTS ARE SHOWN ON THE PLANS.
12. NO HARD LANDSCAPING FEATURES ARE PROPOSED.
13. SEE SHEETS P9.0 AND 9.1 FOR LANDSCAPE PLANS.
14. STRUCTURE SQUARE FEET IS NOTED/SHOWN ON THE PLAN.
15. SEE ARCHITECTURAL PLANS INCLUDED IN THE APPLICATION SUBMITTAL PACKAGE FOR BUILDING ELEVATIONS AND FLOOR PLANS.
16. RECYCLABLE AND SOLID WASTE STORAGE IS SHOWN ON THE PLANS.
17. SEE SHEETS 10.0 AND 10.1 FOR OUTDOOR LIGHTING PLANS.
18. LOT 78, COMMERCIAL LOT, WILL BE SERVED WITH PUBLIC SANITARY SEWER AND WATER BY CITY OF CAMAS. WATER AND SEWER WILL BE EXTENDED FROM THE LINES IN NW CAMAS MEADOWS DRIVE INTO THE SITE.
19. STORMWATER WILL BE COLLECTED ON SITE AND CONVEYED TO MECHANICAL FILTER CATCH BASINS AND UNDERGROUND DETENTION PRIOR TO DISCHARGING AT THE NORTH CORNER OF THE SITE. STORMWATER TO BE DESIGNED PER CITY OF CAMAS STANDARDS.
20. STORMWATER FACILITIES TO BE PRIVATELY OWNED AND MAINTAINED.
21. NW CAMAS MEADOWS FRONTAGE IMPROVEMENTS WILL INCLUDE: REPLACEMENT OF DAMAGED CURB AND SIDEWALK.

SITE STATISTICS

PARCEL ZONE:	MIXED USE (MX)
GROSS AREA:	13.81 AC (601,725 SF)
TOTAL ROW DEDICATION:	95,084 SF (2.18 AC)
MINIMUM LOT AREA:	2,000 SF
MAXIMUM LOT AREA:	9,157 SF
PROPOSED AVERAGE LOT AREA:	4,620 SF

DEVELOPMENT STANDARDS

MINIMUM SIDE YARD:	10 FEET
MINIMUM STREET SIDE YARD:	11.5 FEET
MINIMUM REAR YARD:	25 FEET
MAXIMUM FRONT YARD:	10 FEET

COMMERCIAL PARKING STATISTICS

REQUIRED PARKING STALLS (6,500/100):	65
PROPOSED STANDARD PARKING STALLS (9' X 18'):	64
PROPOSED ADA PARKING STALLS (9' X 18'):	2
TOTAL PROPOSED PARKING STALLS:	66

COMMERCIAL LOT STATISTICS

ZONE:	MIXED USE (MX)
GROSS SITE AREA:	52,616 SF (1.21 AC)
ROW DEDICATION:	N/A
NET PROJECT AREA:	52,616 SF (1.21 AC)
DISTURBED AREA:	52,616 SF (1.21 AC)
PROPOSED BUILDING AREA:	6,500 SF
LANDSCAPED AREA:	19,326 SF (36.7%)
IMPERVIOUS AREA	33,290 SF (63.3%)

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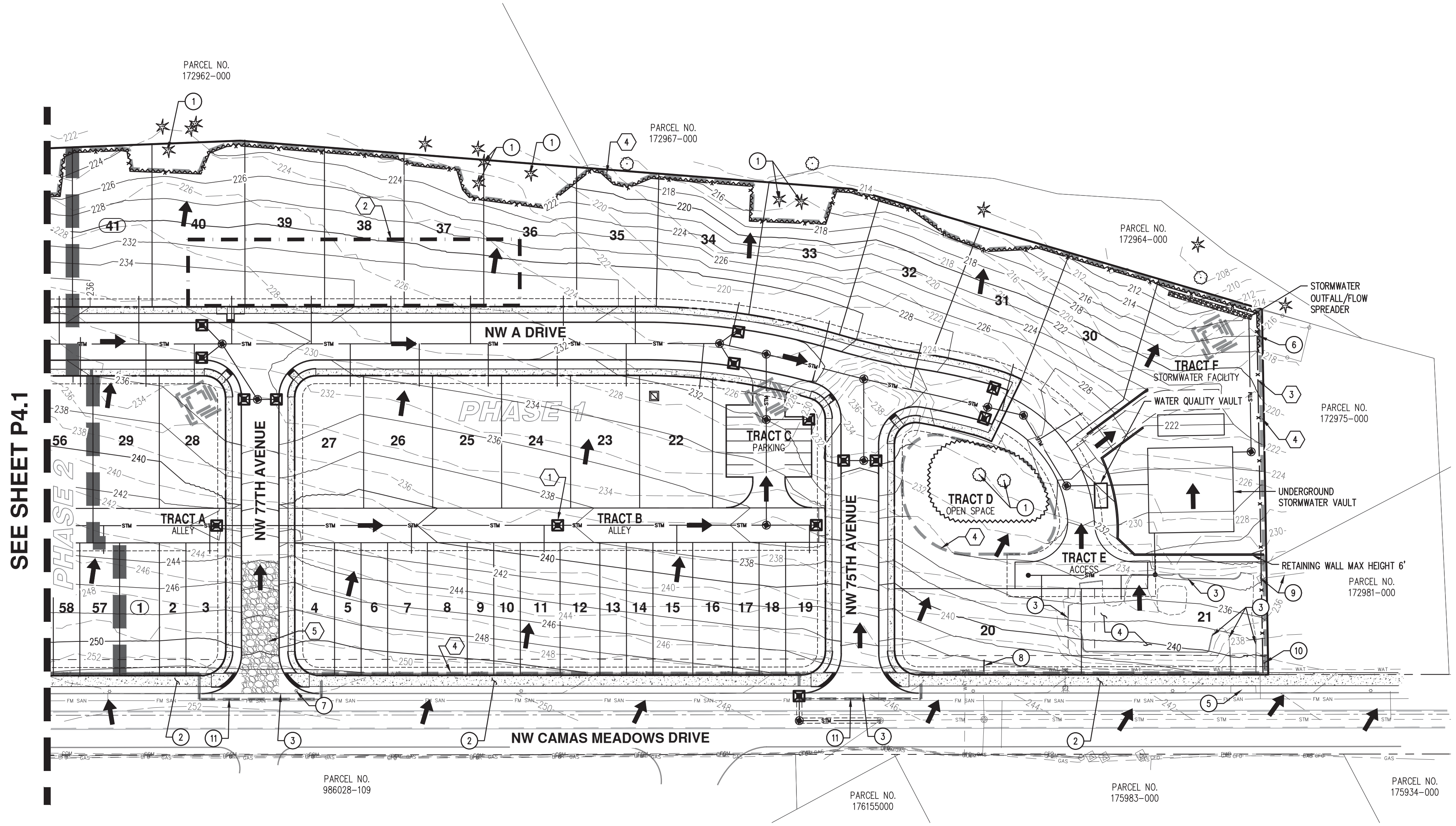
PRELIMINART SITE PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

P3.2

AKS DRAWING FILE: 9030 P3.2 SITE.DWG | LAYOUT: P3.2



LEGEND

EXISTING GROUND CONTOUR (2 FT)	342
EXISTING GROUND CONTOUR (10 FT)	350
FINISHED GRADE CONTOUR (2 FT)	342
FINISHED GRADE CONTOUR (10 FT)	350
SEDIMENT FENCE (TO BE INSTALLED PRIOR TO GRADING)	X
INLET PROTECTION (TYP) PER COMBINATION DETAIL	
PROPOSED DRAINAGE FLOW DIRECTION	
GRAVEL CONSTRUCTION ENTRANCE	
DISTURBED LIMITS	
TREE PROTECTION/CONSTRUCTION FENCE	
POTENTIAL STAGING/SOIL STOCKPILE AREA	
CONCRETE WASHOUT AREA	

GENERAL NOTES

1. SEE THE PRELIMINARY TREE PRESERVATION AND REMOVAL PLAN P5.0 FOR TREE PROTECTION AND CONSTRUCTION FENCE LOCATIONS AND TREE ROOT PROTECTION ZONE RADIUS ZONES.
2. ADDITIONAL EROSION CONTROL MEASURES WILL BE INCLUDED DURING FINAL ENGINEERING TO ACCOUNT FOR GRADING ON STEEP SLOPES AND CONSTRUCTION PHASING.
3. RETAINING WALLS MAY BE NECESSARY TO COMPLETE THIS PROJECT. WALL LOCATIONS WILL BE DETERMINED WITH FINAL ENGINEERING IF NECESSARY.

DEMOLITION KEYED NOTES (#)

1. EXISTING TREE TO REMAIN (TYP).
2. REPLACE ALL DAMAGED CURB AND SIDEWALK ALONG CAMAS MEADOWS FRONTAGE (TYP.).
3. REMOVE EXISTING CURB.
4. REMOVE EXISTING ASPHALT.
5. REMOVE EXISTING DRIVEWAY.
6. REMOVE EXISTING FENCE.
7. RELOCATE EXISTING STREET LIGHT.
8. REMOVE EXISTING SIGN.
9. REMOVE EXISTING TRANSFORMER AND ASSOCIATED WIRE.
10. REMOVE EXISTING WATER METER AND ASSOCIATED SERVICE LINE.
11. SAWCUT AND REMOVE EXISTING ASPHALT, AND GRIND AND INLAY NEW ASPHALT.

EROSION CONTROL KEYED NOTES ⟨#⟩

1. INSTALL INLET PROTECTION (TYP).
2. POTENTIAL STOCKPILE AREA.
3. INSTALL SEDIMENT FENCE (TYP).
4. DISTURBED LIMITS (TYP).
5. CONSTRUCTION ENTRANCE.
6. INSTALL TEMPORARY SEDIMENT TRAP (TYP).

PRELIMINARY GRADING QUANTITIES

CUT: 30,000 C.Y.
FILL: 30,000 C.Y.

SCALE: 1"= 50 FEET
50 0 10 25 50
ORIGINAL PAGE SIZE: 24" x 36"

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PRELIMINARY GRADING, DEMOLITION, AND ESC PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

P4.0

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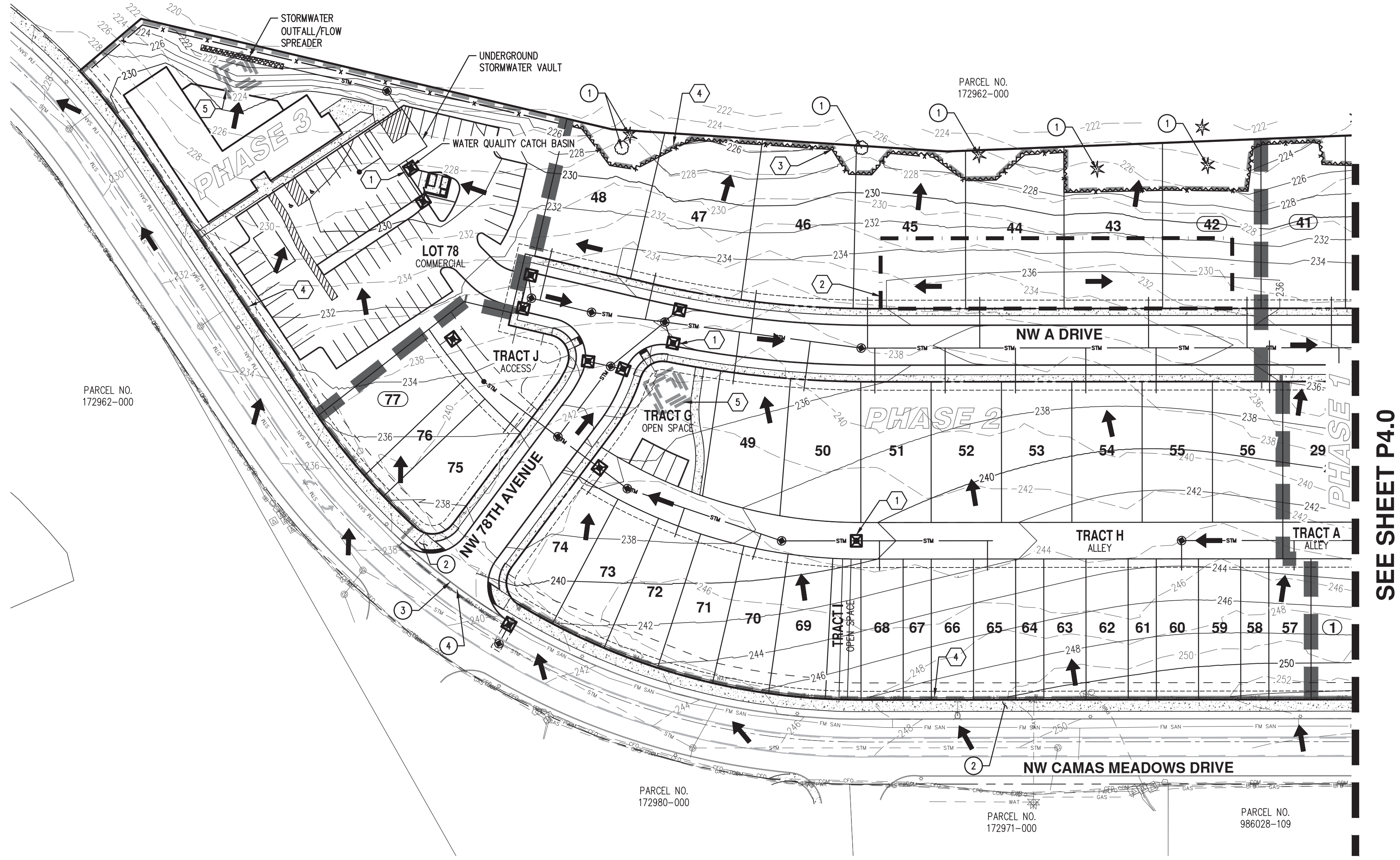

LEGEND

EXISTING GROUND CONTOUR (2 FT)	342
EXISTING GROUND CONTOUR (10 FT)	350
FINISHED GRADE CONTOUR (2 FT)	342
FINISHED GRADE CONTOUR (10 FT)	350
SEDIMENT FENCE (TO BE INSTALLED PRIOR TO GRADING)	X
INLET PROTECTION (TYP) PER COMBINATION DETAIL	
PROPOSED DRAINAGE FLOW DIRECTION	
GRAVEL CONSTRUCTION ENTRANCE	
DISTURBED LIMITS	
TREE PROTECTION/CONSTRUCTION FENCE	
POTENTIAL STAGING/SOIL STOCKPILE AREA	
CONCRETE WASHOUT AREA	

GENERAL NOTES

1. SEE THE PRELIMINARY TREE PRESERVATION AND REMOVAL PLAN P5.0 FOR TREE PROTECTION AND CONSTRUCTION FENCE LOCATIONS AND TREE ROOT PROTECTION ZONE RADIUS ZONES.
2. ADDITIONAL EROSION CONTROL MEASURES WILL BE INCLUDED DURING FINAL ENGINEERING TO ACCOUNT FOR GRADING ON STEEP SLOPES AND CONSTRUCTION PHASING.
3. RETAINING WALLS MAY BE NECESSARY TO COMPLETE THIS PROJECT. WALL LOCATIONS WILL BE DETERMINED WITH FINAL ENGINEERING IF NECESSARY.

DEMOLITION KEYED NOTES (#)

1. EXISTING TREE TO REMAIN (TYP).
2. REPLACE ALL DAMAGED CURB AND SIDEWALK ALONG CAMAS MEADOWS FRONTAGE (TYP.).
3. REMOVE EXISTING CURB.
4. SAWCUT AND REMOVE EXISTING ASPHALT, AND GRIND AND INLAY NEW ASPHALT.

EROSION CONTROL KEYED NOTES (#)

1. INSTALL INLET PROTECTION (TYP).
2. POTENTIAL STOCKPILE AREA.
3. INSTALL SEDIMENT FENCE (TYP).
4. DISTURBED LIMITS (TYP).
5. INSTALL TEMPORARY SEDIMENT TRAP (TYP).

PRELIMINARY GRADING QUANTITIES

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PRELIMINARY GRADING, DEMOLITION, AND ESC PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
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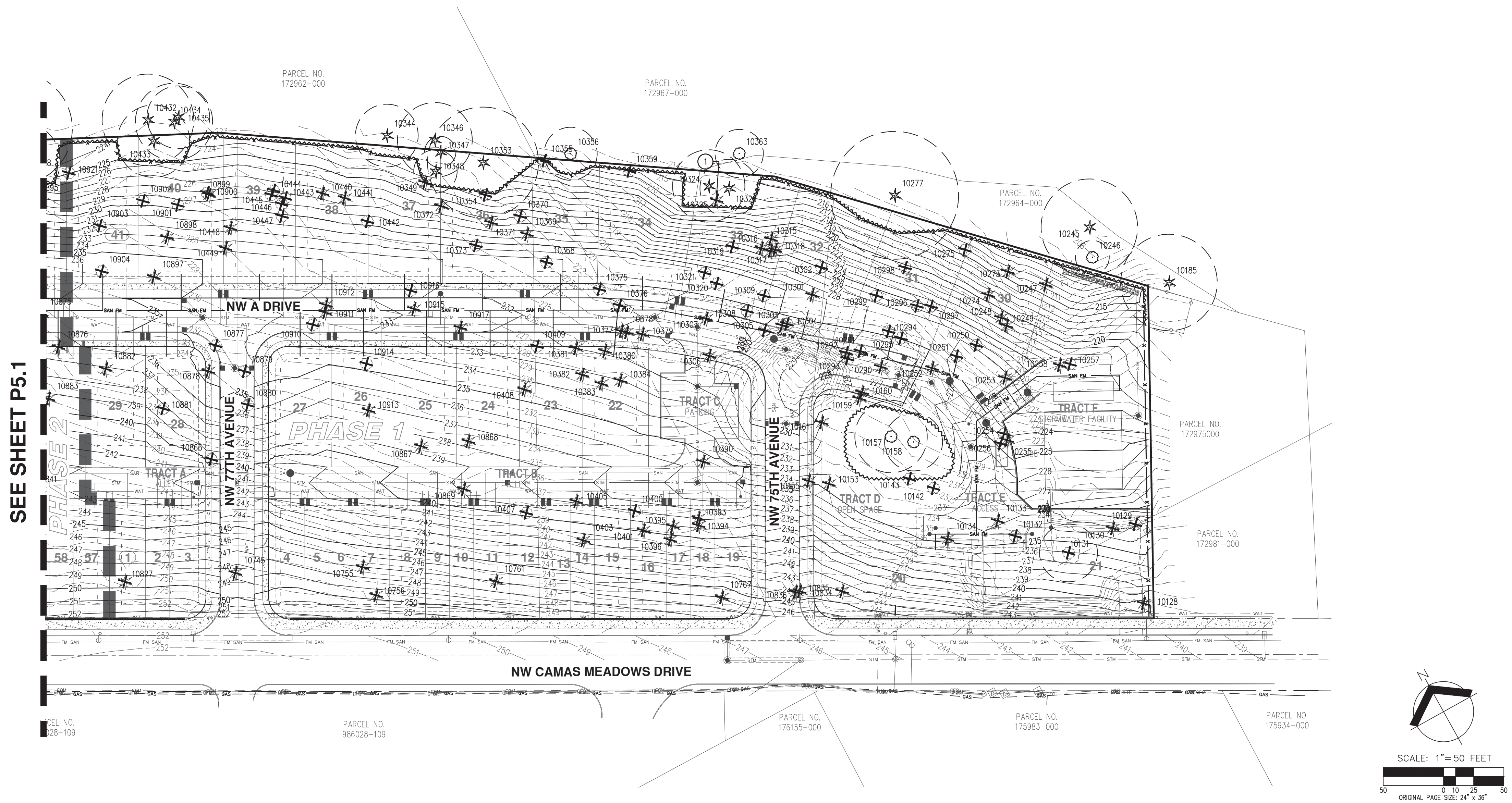
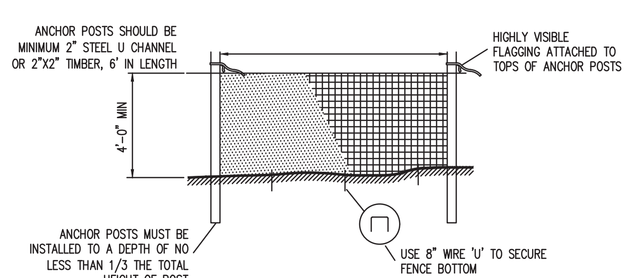


LEGEND

EXISTING GROUND CONTOUR (1 FT)	149
EXISTING GROUND CONTOUR (5 FT)	150
FINISHED GRADE CONTOUR (1 FT)	149
FINISHED GRADE CONTOUR (5 FT)	150
EXISTING CONIFEROUS TREE	
EXISTING DECIDUOUS TREE	
TREE REMOVAL	
TREE PROTECTION FENCE (TREE PROTECTION AREA)	
ORANGE SEDIMENT FENCE	
ASSUMED TREE ROOT ZONE (1-FT RADIUS PER 1-IN OF DBH)	



TREE PROTECTION NOTES:

1. BLAZE ORANGE OR BLUE PLASTIC MESH FENCE FOR TREE PROTECTION DEVICE, ONLY.
2. BOUNDARIES OF PROTECTION AREA WILL BE ESTABLISHED IN THE FIELD BY THE ARBORIST PRIOR TO CONSTRUCTION
3. BOUNDARIES OF PROTECTION AREA SHOULD BE STAKED AND FLAGGED BY THE ARBORIST, OR UNDER THE SUPERVISION OF THE ARBORIST, PRIOR TO INSTALLING DEVICES.
4. AVOID DAMAGE TO CRITICAL ROOT ZONE. DO NOT DAMAGE OR SEVER LARGE ROOTS WHEN INSTALLING POSTS.
5. TREE PROTECTION TO BE INSTALLED PRIOR TO CONSTRUCTION AND REMAIN IN PLACE UNTIL CONSTRUCTION IS COMPLETED.

PLASTIC MESH TREE PROTECTION FENCE

NOT TO SCALE

GENERAL NOTES:

1. A CERTIFIED ARBORIST SHALL BE PRESENT DURING EXCAVATION ACTIVITIES WITHIN TREE PROTECTION ZONE OF PRESERVED TREES. SEE TREE PROTECTION NOTES ON THIS SHEET FOR MORE INFORMATION.
2. A CERTIFIED ARBORIST SHALL BE PRESENT DURING ALL TREE REMOVAL ACTIVITIES BEHIND THE TREE PROTECTION FENCE.
3. SEE SHEET P5.3 FOR TREE PROTECTION NOTES.
4. SEE SHEET P5.2-P5.3 FOR DETAILED INVENTORY TABLE.
5. TREE PROTECTION MEASURES SHALL BE INSTITUTED PRIOR TO ANY DEVELOPMENT ACTIVITIES, INCLUDING, BUT NOT LIMITED TO, CLEARING, GRADING, EXCAVATION OR DEMOLITION WORK, AND SHALL BE REMOVED ONLY AFTER COMPLETION OF ALL CONSTRUCTION ACTIVITY, INCLUDING LANDSCAPING AND IRRIGATION INSTALLATION. SEE TREE PROTECTION DETAIL ON THIS SHEET.
6. TREE PROTECTION FENCING SHALL BE FLUSH WITH THE INITIAL UNDISTURBED GRADE.
7. NO CONSTRUCTION ACTIVITY SHALL OCCUR WITHIN THE TREE PROTECTION ZONE, INCLUDING, BUT NOT LIMITED TO, DUMPING OR STORAGE OF MATERIALS SUCH AS BUILDING SUPPLIES, SOIL, WASTE ITEMS OR PARKED VEHICLES OR EQUIPMENT.
8. NO EXCAVATION, TRENCHING, GRADING, ROOT PRUNING OR OTHER ACTIVITIES SHALL OCCUR WITHIN THE TREE PROTECTION ZONE UNLESS DIRECTED BY AN ARBORIST PRESENT ON-SITE AND APPROVED BY THE CITY.
9. FOLLOWING CLEARING AND GRADING ACTIVITIES, A CERTIFIED ARBORIST SHALL INSPECT RETAINED TREES FOR POTENTIALLY HAZARDOUS TREE CONDITIONS. COORDINATION WITH THE CITY SHALL OCCUR PRIOR TO ANY ADDITIONAL TREE REMOVALS FOR HAZARD ABATEMENT.

KEYED NOTE: (#)

1. ARBORIST OBSERVATION REQUIRED DURING TREE REMOVAL WITHIN THE TREE PROTECTION AREA.

TREE PLAN

SITE AREA:	13.81 AC
TOTAL TREE UNITS REQUIRED (13.81AC X 20):	276
EXISTING TREES RETAINED/(TREE UNITS):	15/(149.5)
PROPOSED SITE TREES/(TREE UNITS):	159/(159)
TOTAL TREE UNITS: (RETAINED AND PRESERVED)	308.5

NOTE: SEE LANDSCAPING PLAN (P9.0-P9.1) FOR PROPOSED TREE PLANTING PLAN

CERTIFIED ARBORIST ISA
BRYCE D. HANSON
CERTIFICATE NUMBER: PN 7554A
EXPIRATION DATE: 06/30/25

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PRELIMINARY TREE PRESERVATION AND REMOVAL PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
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DESIGNED BY:	DJL
DRAWN BY:	BRK
CHECKED BY:	BDH

P5.0

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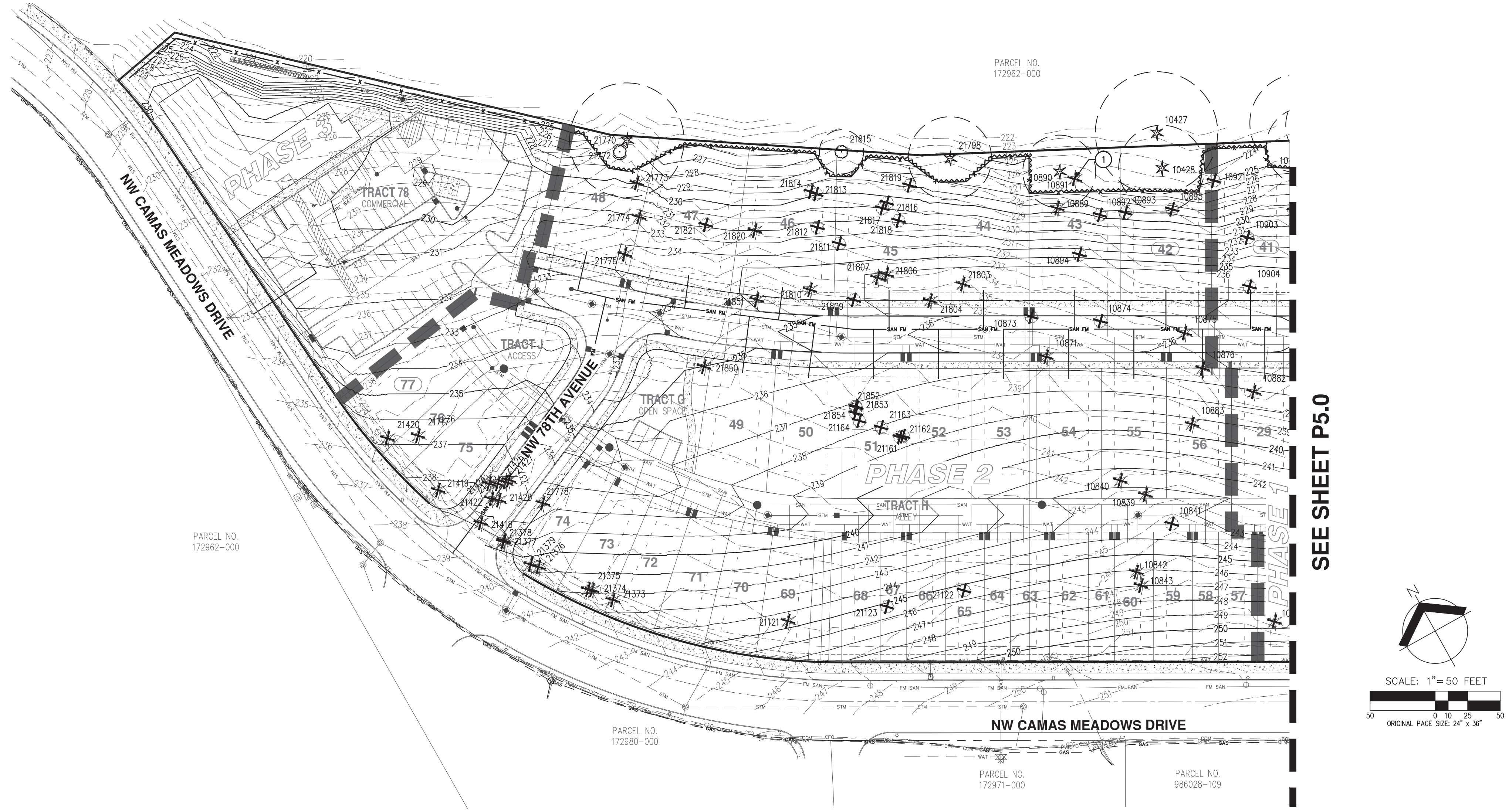
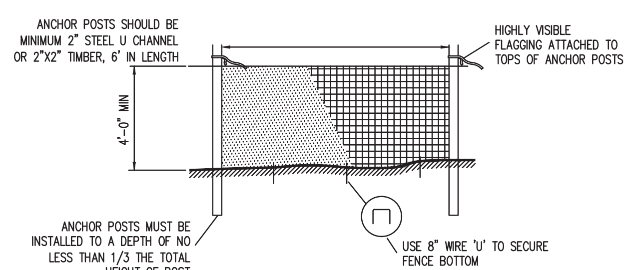


LEGEND

- EXISTING GROUND CONTOUR (1 FT) — 149
- EXISTING GROUND CONTOUR (5 FT) — 150
- FINISHED GRADE CONTOUR (1 FT) — 149
- FINISHED GRADE CONTOUR (5 FT) — 150
- EXISTING CONIFEROUS TREE
- EXISTING DECIDUOUS TREE
- TREE REMOVAL
- TREE PROTECTION FENCE (TREE PROTECTION AREA)
- ORANGE SEDIMENT FENCE
- ASSUMED TREE ROOT ZONE (1-FT RADIUS PER 1-IN OF DBH)



TREE PROTECTION NOTES:

1. BLAZE ORANGE OR BLUE PLASTIC MESH FENCE FOR TREE PROTECTION DEVICE, ONLY.
2. BOUNDARIES OF PROTECTION AREA WILL BE ESTABLISHED IN THE FIELD BY THE ARBORIST PRIOR TO CONSTRUCTION
3. BOUNDARIES OF PROTECTION AREA SHOULD BE STAKED AND FLAGGED BY THE ARBORIST, OR UNDER THE SUPERVISION OF THE ARBORIST, PRIOR TO INSTALLING DEVICES.
4. AVOID DAMAGE TO CRITICAL ROOT ZONE. DO NOT DAMAGE OR SEVER LARGE ROOTS WHEN INSTALLING POSTS.
5. TREE PROTECTION TO BE INSTALLED PRIOR TO CONSTRUCTION AND REMAIN IN PLACE UNTIL CONSTRUCTION IS COMPLETED.

PLASTIC MESH TREE PROTECTION FENCE

NOT TO SCALE

GENERAL NOTES:

1. A CERTIFIED ARBORIST SHALL BE PRESENT DURING EXCAVATION ACTIVITIES WITHIN TREE PROTECTION ZONE OF PRESERVED TREES. SEE TREE PROTECTION NOTES ON THIS SHEET FOR MORE INFORMATION.
2. A CERTIFIED ARBORIST SHALL BE PRESENT DURING ALL TREE REMOVAL ACTIVITIES BEHIND THE TREE PROTECTION FENCE.
3. SEE SHEET P5.3 FOR TREE PROTECTION NOTES.
4. SEE SHEET P5.2–P5.3 FOR DETAILED INVENTORY TABLE.
5. TREE PROTECTION MEASURES SHALL BE INSTITUTED PRIOR TO ANY DEVELOPMENT ACTIVITIES, INCLUDING, BUT NOT LIMITED TO, CLEARING, GRADING, EXCAVATION OR DEMOLITION WORK, AND SHALL BE REMOVED ONLY AFTER COMPLETION OF ALL CONSTRUCTION ACTIVITY, INCLUDING LANDSCAPING AND IRRIGATION INSTALLATION. SEE TREE PROTECTION DETAIL ON THIS SHEET.
6. TREE PROTECTION FENCING SHALL BE FLUSH WITH THE INITIAL UNDISTURBED GRADE.
7. NO CONSTRUCTION ACTIVITY SHALL OCCUR WITHIN THE TREE PROTECTION ZONE, INCLUDING, BUT NOT LIMITED TO, DUMPING OR STORAGE OF MATERIALS SUCH AS BUILDING SUPPLIES, SOIL, WASTE ITEMS OR PARKED VEHICLES OR EQUIPMENT.
8. NO EXCAVATION, TRENCHING, GRADING, ROOT PRUNING OR OTHER ACTIVITIES SHALL OCCUR WITHIN THE TREE PROTECTION ZONE UNLESS DIRECTED BY AN ARBORIST PRESENT ON-SITE AND APPROVED BY THE CITY.
9. FOLLOWING CLEARING AND GRADING ACTIVITIES, A CERTIFIED ARBORIST SHALL INSPECT RETAINED TREES FOR POTENTIALLY HAZARDOUS TREE CONDITIONS. COORDINATION WITH THE CITY SHALL OCCUR PRIOR TO ANY ADDITIONAL TREE REMOVALS FOR HAZARD ABATEMENT.

KEYED NOTE: (#)

1. ARBORIST OBSERVATION REQUIRED DURING TREE REMOVAL WITHIN THE TREE PROTECTION AREA.

TREE PLAN

SITE AREA:	13.81 AC
TOTAL TREE UNITS REQUIRED (13.81AC X 20):	276
EXISTING TREES RETAINED/(TREE UNITS):	15/(149.5)
PROPOSED SITE TREES/(TREE UNITS):	159/(159)
TOTAL TREE UNITS: (RETAINED AND PRESERVED)	308.5

NOTE: SEE LANDSCAPING PLAN (P9.0–P9.1) FOR PROPOSED TREE PLANTING PLAN

CERTIFIED ARBORIST ISA
BRYCE D. HANSON
CERTIFICATE NUMBER: PN 7554A
EXPIRATION DATE: 06/30/25

PRELIMINARY NOT FOR CONSTRUCTION

AKS ENGINEERING & FORESTRY, LLC
9600 NE 126TH AVE, STE 2520
VANCOUVER, WA 98682
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WWW.AKS-ENG.COM
ENGINEERING · SURVEYING · NATURAL RESOURCES
FORESTRY · PLANNING · LANDSCAPE ARCHITECTURE

PRELIMINARY TREE PRESERVATION AND REMOVAL PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	BRK
CHECKED BY:	BDH

P5.1

AKS DRAWING FILE: 9030 P5.0.DWG | LAYOUT: P5.1

Detailed Tree Inventory for Camas Meadows Subdivsion

AKS Job No. 9030 - Evaluation Date: 3/22/2022 & 1/11/2023 - Evaluated By: BRK

Tree #	DBH (in.)	Tree Species Common Name (*Scientific name*)	Tree Units Initial	Condition/Comments	Windthrow Rating	Reason for Removal	Tree Units Retained
10128	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
10129	7	Black Cottonwood (*Populus trichocarpa*)	2	Good Condition	C	Impacts from Lot Grading	0
10130	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
10131	24,18	Oregon White Oak (*Quercus garryana*)	11	Sparse canopy; Historic root removal; Large cavities with decay; Some large dead limbs	A	Preserve	11
10132	15,11	Red Alder (*Alnus rubra*)	6	15" stem dead; 11" Broken top; In decline	A	Impacts from Lot Grading	0
10133	40	Douglas-fir (*Pseudotsuga menziesii*)	16	Slightly crooked bole	C	Impacts from Alley Construction	0
10134	44	Douglas-fir (*Pseudotsuga menziesii*)	18	Slightly crooked bole	C	Impacts from Lot Grading	0
10142	12,8	Sweet Cherry (*Prunus avium*)	3	8" stem dead; 12" dead top; In decline	A	Impacts from Lot Grading	0
10143	10,6	Willow (*Salix sp.*)	2	Dead with some epicormic stems	A	Impacts from Lot Grading	0
10153	36	Western Hemlock (*Tsuga heterophylla*)	14	Dead (~30')	A	Impacts from Lot Grading	0
10155	32	Western Hemlock (*Tsuga heterophylla*)	12	Dead (~80')	A	Impacts from Public Road Construction	0
10157	30	Oregon White Oak (*Quercus garryana*)	11	1-sided canopy (SW)	C	Preserve	11
10158	24	Oregon White Oak (*Quercus garryana*)	8	1-sided canopy (SE)	C	Preserve	8
10159	18	Douglas-fir (*Pseudotsuga menziesii*)	5	1-sided canopy (S)	C	Impacts from Public Road Construction	0
10160	37	Douglas-fir (*Pseudotsuga menziesii*)	15	Good Condition	C	Impacts from Public Road Construction	0
10161	30	Western Hemlock (*Tsuga heterophylla*)	11	Dead (~80')	A	Impacts from Lot Grading	0
10185	40	Western Hemlock (*Tsuga heterophylla*)	0	OFFSITE; Evaluated from property line; Dead branches; Dead foliage; Sparse canopy	B	Preserve	0
10245	40	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10246	14	Red Alder (*Alnus rubra*)	0	OFFSITE; Evaluated from property line; Dead (~40'); Some remaining epicormic limbs	A	Preserve	0
10247	45	Douglas-fir (*Pseudotsuga menziesii*)	19	Good Condition	C	Impacts from Stormwater Facility Construction	0
10248	16	Douglas-fir (*Pseudotsuga menziesii*)	4	Good Condition	C	Impacts from Lot Grading	0
10249	20	Douglas-fir (*Pseudotsuga menziesii*)	6	Good Condition	C	Impacts from Stormwater Facility Construction	0
10250	6,6,6,6,6	Willow (*Salix sp.*)	3	Good Condition	C	Impacts from Public Road Construction	0
10251	9,9	Willow (*Salix sp.*)	3	Dead Codominant stem; Broken branches; Dead limbs; In decline	A	Impacts from Public Road Construction	0
10252	40	Douglas-fir (*Pseudotsuga menziesii*)	16	Good Condition	C	Impacts from Public Road Construction	0
10253	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Public Road Construction	0
10254	12,11,8	Sweet Cherry (*Prunus avium*)	5	Sparse canopy; Lean (SE)	B	Impacts from Public Road Construction	0
10255	10	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
10256	12	Sweet Cherry (*Prunus avium*)	2	Sparse canopy; Dead limbs; Lean (SE)	B	Impacts from Public Road Construction	0
10257	13	Sweet Cherry (*Prunus avium*)	3	Good Condition	C	Impacts from Stormwater Facility Construction	0
10258	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Stormwater Facility Construction	0
10273	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0
10274	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Lot Grading	0
10275	27	Bigleaf Maple (*Acer macrophyllum*)	10	Good Condition	C	Impacts from Lot Grading	0
10277	53	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10290	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Public Road Construction	0
10291	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10292	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10293	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10294	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10295	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10296	6,6,6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10297	6,5	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10298	7,6,6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10299	18	Sweet Cherry (*Prunus avium*)	5	Some broken limbs; Some dead limbs	B	Impacts from Lot Grading	0
10301	35	Western Hemlock (*Tsuga heterophylla*)	14	Good Condition	C	Impacts from Lot Grading	0
10302	39	Bigleaf Maple (*Acer macrophyllum*)	16	Some large broken limbs; Dead codominant stem in canopy	B	Impacts from Lot Grading	0
10303	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10304	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10305	8,8	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10306	26	Western Hemlock (*Tsuga heterophylla*)	9	Broken top @ 50'; Dead branches; Sparse canopy; Decay	A	Impacts from Public Road Construction	0
10307	27	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Public Road Construction	0
10308	12	Black Cottonwood (*Populus trichocarpa*)	2	Good Condition	C	Impacts from Public Road Construction	0
10309	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10315	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Lot Grading	0
10316	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Lot Grading	0
10317	20	Douglas-fir (*Pseudotsuga menziesii*)	6	Good Condition	C	Impacts from Lot Grading	0
10318	14	Douglas-fir (*Pseudotsuga menziesii*)	3	Lean (E)	B	Impacts from Lot Grading	0
10319	11	Black Cottonwood (*Populus trichocarpa*)	2	Good Condition	C	Impacts from Lot Grading	0
10320	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10321	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10324	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Preserve	11
10325	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Good Condition	C	Impacts from Lot Grading	0
10326	24	Douglas-fir (*Pseudotsuga menziesii*)	8	Good Condition	C	Preserve	8
10344	26	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line; Sparse canopy	B	Preserve	0
10346	31	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10347	13	Douglas-fir (*Pseudotsuga menziesii*)	3	Suppressed	B	Preserve	3
10348	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Preserve	5
10349	24	Douglas-fir (*Pseudotsuga menziesii*)	8	Good Condition	C	Impacts from Lot Grading	0
10353	46	Douglas-fir (*Pseudotsuga menziesii*)	19	Good Condition	C	Preserve	19
10354	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10355	19	Bigleaf Maple (*Acer macrophyllum*)	6	Dead and broken top; Epicormic stems; Broken limbs	A	Impacts from Lot Grading	0
10356	22	Red Alder (*Alnus rubra*)	0	OFFSITE; Evaluated from property line; Dead top; In decline	A	Preserve	0
10359	22	Red Alder (*Alnus rubra*)	7	Sluffing bark; Several cavities with decay; Dead top	A	Impacts from Lot Grading	0
10363	20	Oregon White Oak (*Quercus garryana*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10368	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10369	36	Western Hemlock (*Tsuga heterophylla*)	14	Dead; Broken @ 20'	A	Impacts from Lot Grading	0
10370	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10371	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10372	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10373	18	Willow (*Salix sp.*)	5	Broken limbs; Dead branches; Small cavity with decay	B	Impacts from Lot Grading	0
10375	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10376	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10377	28	Western Hemlock (*Tsuga heterophylla*)	10	Dead (~80')	A	Impacts from Public Road Construction	0
10378	22	Western Hemlock (*Tsuga heterophylla*)	7	Dead (~80')	A	Impacts from Public Road Construction	0
10379	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Good Condition	C	Impacts from Public Road Construction	0
10380	17	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Lot Grading	0
10381	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0
10382	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Good Condition	C	Impacts from Lot Grading	0
10383	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Good Condition	C	Impacts from Lot Grading	0
10384	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Good Condition	C	Impacts from Lot Grading	0
10390	24	Douglas-fir (*Pseudotsuga menziesii*)	8	Good Condition	C	Impacts from Parking Lot Construction	0
10393	25	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10394	20	Douglas-fir (*Pseudotsuga menziesii*)	6	Good Condition	C	Impacts from Lot Grading	0
10395	15	Douglas-fir (*Pseudotsuga menziesii*)	4	Good Condition	C	Impacts from Lot Grading	0
10396	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Lot Grading	0
10400	16	Red Alder (*Alnus rubra*)	4	Dead top half; In decline	A	Impacts from Lot Grading	0
10401	24	Douglas-fir (*Pseudotsuga menziesii*)	8	Some dead branches	C	Impacts from Lot Grading	0
10403	19	Douglas-fir (*Pseudotsuga menziesii*)	6	Good Condition	C	Impacts from Lot Grading	0
10405	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0

Detailed Tree Inventory for Camas Meadows Subdivsion

AKS Job No. 9030 - Evaluation Date: 3/22/2022 & 1/11/2023 - Evaluated By: BRK

Tree #	DBH (in.)	Tree Species Common Name (*Scientific name*)	Tree Units Initial	Condition/Comments	Windthrow Rating	Reason for Removal	Tree Units Retained
10407	31	Oregon White Oak (*Quercus garryana*)	12	Good Condition	C	Impacts from Lot Grading	0
10408	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0
10409	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Public Road Construction	0
10427	47	Western Hemlock (*Tsuga heterophylla*)	0	OFFSITE; Evaluated from property line; Large bore holes; Small cavities in base with decay; Many dead branches; In decline	A	Preserve	0
10428	33	Douglas-fir (*Pseudotsuga menziesii*)	13	Good Condition	C	Preserve	13
10432	38	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10433	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Codominant leader; 1-sided canopy (S)	B	Preserve	11
10434	26	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10435	32	Douglas-fir (*Pseudotsuga menziesii*)	0	OFFSITE; Evaluated from property line	C	Preserve	0
10440	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Lot Grading	0
10441	16	Douglas-fir (*Pseudotsuga menziesii*)	4	Good Condition	C	Impacts from Lot Grading	0
10442	22	Willow (*Salix sp.*)	7	Broken top; Significant decay; Conks	A	Impacts from Lot Grading	0
10443	9,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10444	9,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10445	8	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10446	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10447	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10448	35	Douglas-fir (*Pseudotsuga menziesii*)	14	Good Condition	C	Impacts from Lot Grading	0
10449	31	Western Hemlock (*Tsuga heterophylla*)	12	Dead (~60)	A	Impacts from Lot Grading	0
10745	38	Douglas-fir (*Pseudotsuga menziesii*)	15	Good Condition	C	Impacts from Public Road Construction	0
10755	36	Douglas-fir (*Pseudotsuga menziesii*)	14	Good Condition	C	Impacts from Lot Grading	0
10756	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Dead branches	B	Impacts from Lot Grading	0
10761	28	Western Hemlock (*Tsuga heterophylla*)	10	Dead (~100')	A	Impacts from Lot Grading	0
10767	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
10827	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10834	29	Douglas-fir (*Pseudotsuga menziesii*)	11	Slightly crooked bole	C	Impacts from Lot Grading	0
10835	50	Western Redcedar (*Thuja plicata*)	21	Dead top; Sparse canopy; In decline	A	Impacts from Public Road Construction	0
10836	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Sweep (S)	B	Impacts from Public Road Construction	0
10839	8	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Alley Construction	0
10840	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Dead (~120')	A	Impacts from Lot Grading	0
10841	19	Oregon White Oak (*Quercus garryana*)	6	Good Condition	C	Impacts from Alley Construction	0
10842	25	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10843	25	Douglas-fir (*Pseudotsuga menziesii*)	9	Dead at very top	B	Impacts from Lot Grading	0
10866	26	Willow (*Salix sp.*)	9	Broken top; Decay; Epicormic limbs; In decline	A	Impacts from Public Road Construction	0
10867	20	Douglas-fir (*Pseudotsuga menziesii*)	6	Good Condition	C	Impacts from Lot Grading	0
10868	27	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0
10869	35	Douglas-fir (*Pseudotsuga menziesii*)	14	Good Condition	C	Impacts from Alley Construction	0
10871	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Codominant; Crooked bole	B	Impacts from Public Road Construction	0
10873	18	Oregon White Oak (*Quercus garryana*)	5	Good Condition	C	Impacts from Public Road Construction	0
10874	16	Red Alder (*Alnus rubra*)	4	Dead with some epicormic stems remaining	A	Impacts from Public Road Construction	0
10875	16	Douglas-fir (*Pseudotsuga menziesii*)	4	Large cavity with decay up bole; Conks; Slight lean (N)	A	Impacts from Public Road Construction	0
10876	25	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Public Road Construction	0
10877	15	Oregon White Oak (*Quercus garryana*)	4	Good Condition	C	Impacts from Public Road Construction	0
10878	24	Douglas-fir (*Pseudotsuga menziesii*)	8	Good Condition	C	Impacts from Public Road Construction	0
10879	16	Oregon White Oak (*Quercus garryana*)	4	Good Condition	C	Impacts from Public Road Construction	0
10880	21	Oregon White Oak (*Quercus garryana*)	7	Good Condition	C	Impacts from Public Road Construction	0
10881	15	Oregon White Oak (*Quercus garryana*)	4	Good Condition	C	Impacts from Lot Grading	0
10882	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Some dead branches	C	Impacts from Lot Grading	0
10883	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Lot Grading	0
10889	36,15	Douglas-fir (*Pseudotsuga menziesii*)	16	Codominant base	C	Impacts from Lot Grading	0
10890	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Preserve	10
10891	32	Douglas-fir (*Pseudotsuga menziesii*)	12	Dead (~100')	A	Impacts from Lot Grading	0
10892	12	Sweet Cherry (*Prunus avium*)	2	Dead (~70'); Lean (W)	A	Impacts from Lot Grading	0
10893	20	Oregon Ash (*Fraxinus latifolia*)	6	Good Condition	C	Impacts from Lot Grading	0
10894	24	Bigleaf Maple (*Acer macrophyllum*)	8	Some large broken limbs; Decay	B	Impacts from Lot Grading	0
10895	14	Sweet Cherry (*Prunus avium*)	3	Dead top; In decline	A	Impacts from Lot Grading	0
10897	20	Western Hemlock (*Tsuga heterophylla*)	6	Some dead branches	C	Impacts from Lot Grading	0
10898	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10899	8,8	Bigleaf Maple (*Acer macrophyllum*)	2	Good Condition	C	Impacts from Lot Grading	0
10900	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Lot Grading	0
10901	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10902	7	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
10903	26	Oregon White Oak (*Quercus garryana*)	9	One broken limbs	C	Impacts from Lot Grading	0
10904	15	Sweet Cherry (*Prunus avium*)	4	Dead top with few epicormic limbs; In decline	A	Impacts from Lot Grading	0
10910	14,12,8	Oregon Ash (*Fraxinus latifolia*)	6	Codominant base	C	Impacts from Public Road Construction	0
10911	12	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
10912	18	Douglas-fir (*Pseudotsuga menziesii*)	5	Good Condition	C	Impacts from Public Road Construction	0
10913	22	Douglas-fir (*Pseudotsuga menziesii*)	7	Dead (~80')	A	Impacts from Lot Grading	0
10914	13	Oregon White Oak (*Quercus garryana*)	3	Good Condition	C	Impacts from Lot Grading	0
10915	26	Douglas-fir (*Pseudotsuga menziesii*)	9	Good Condition	C	Impacts from Public Road Construction	0
10916	20	Oregon White Oak (*Quercus garryana*)	6	Slight lean (N)	C	Impacts from Public Road Construction	0
10917	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Public Road Construction	0
10921	10,9	Sweet Cherry (*Prunus avium*)	3	Dead top on 10" stem; Broken limbs	B	Impacts from Lot Grading	0
21121	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21122	7	Sweet Cherry (*Prunus avium*)	2	Good Condition	C	Impacts from Lot Grading	0
21123	7	Bigleaf Maple (*Acer macrophyllum*)	2	Good Condition	C	Impacts from Lot Grading	0
21161	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21162	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21163	6,6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21164	8	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21373	8	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21374	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21375	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21376	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21378	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21379	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21418	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21419	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21420	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21422	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21423	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21424	6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21425	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21426	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21427	6,6	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21717	8	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21770	44,30	Douglas-fir (*Pseudotsuga menziesii*)	22.5	Good Condition	C	Preserve	22.5
21772	6	Willow (*Salix sp.*)	2	Lean (W)	B	Preserve	
21773	28	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0

CERTIFIED ARBORIST ISA®
BRYCE D. HANSON
CERTIFICATE NUMBER: PN 7554A
EXPIRATION DATE: 06/30/25

PRELIMINARY NOT FOR CONSTRUCTION

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CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

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JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	BRK
CHECKED BY:	BDH

P5.2

Detailed Tree Inventory for Camas Meadows Subdivsion

AKS Job No. 9030 - Evaluation Date: 3/22/2022 & 1/11/2023 - Evaluated By: BRK

Tree #	DBH (in.)	Tree Species Common Name (*Scientific name*)	Tree Units Initial	Condition/Comments	Windthrow Rating	Reason for Removal	Tree Units Retained
21774	54	Douglas-fir (*Pseudotsuga menziesii*)	23	Good Condition	C	Impacts from Lot Grading	0
21775	77	Douglas-fir (*Pseudotsuga menziesii*)	31	codominant Top; Dead at very top	B	Impacts from Lot Grading	0
21778	8	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21798	32	Douglas-fir (*Pseudotsuga menziesii*)	12	Good Condition	C	Preserve	12
21803	36	Douglas-fir (*Pseudotsuga menziesii*)	14	Some abnormal dead limbs at the top	B	Impacts from Lot Grading	0
21804	37	Douglas-fir (*Pseudotsuga menziesii*)	15	Good Condition	C	Impacts from Public Road Construction	0
21806	30	Douglas-fir (*Pseudotsuga menziesii*)	11	Good Condition	C	Impacts from Lot Grading	0
21807	23	Douglas-fir (*Pseudotsuga menziesii*)	8	Lean (W)	B	Impacts from Lot Grading	0
21809	14	Willow (*Salix sp.*)	3	Dead top; Broken limbs; In decline	A	Impacts from Public Road Construction	0
21810	27	Douglas-fir (*Pseudotsuga menziesii*)	10	Good Condition	C	Impacts from Lot Grading	0
21811	24	Willow (*Salix sp.*)	8	Failed leader with decay and bore holes; Large crack up bole	A	Impacts from Lot Grading	0
21812	9	Bigleaf Maple (*Acer macrophyllum*)	2	Good Condition	C	Impacts from Lot Grading	0
21813	8	Willow (*Salix sp.*)	2	Broken primary stem; Epicormic leaders; Significant decay	A	Impacts from Lot Grading	0
21814	17	Willow (*Salix sp.*)	5	Broken primary stem; Epicormic leaders; Significant decay	A	Impacts from Lot Grading	0
21815	17	Oregon White Oak (*Quercus garryana*)	5	Good Condition	C	Preserve	5
21816	16	Sweet Cherry (*Prunus avium*)	4	Broken top; Significant decay; In decline	A	Impacts from Lot Grading	0
21817	12	Sweet Cherry (*Prunus avium*)	2	Broken at 5' with epicormic leaders; Significant decay	A	Impacts from Lot Grading	0
21818	15	Sweet Cherry (*Prunus avium*)	4	Broken top; Dead codominant stem; In decline	A	Impacts from Lot Grading	0
21819	8	Willow (*Salix sp.*)	2	Dead primary stem with epicormic leaders; In decline	A	Impacts from Lot Grading	0
21820	36	Douglas-fir (*Pseudotsuga menziesii*)	14	Good Condition	C	Impacts from Lot Grading	0
21821	6	Bigleaf Maple (*Acer macrophyllum*)	2	Good Condition	C	Impacts from Lot Grading	0
21850	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Lot Grading	0
21851	7	Douglas-fir (*Pseudotsuga menziesii*)	2	Good Condition	C	Impacts from Public Road Construction	0
21852	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21853	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0
21854	6	Red Alder (*Alnus rubra*)	2	Good Condition	C	Impacts from Lot Grading	0

Total # of Existing Trees Inventoried = 225

Total # of Existing Onsite Trees = 213
Total Onsite Existing Tree Units = 1387.5
Total # of Onsite Trees Retained = 15
Total # of Tree Units Retained = 149.5
Minimum Tree Units Required per City Code = 276
*(13.81 acres * 20 trees/acre)*
Minimum # Trees to Replant = 126.5

Total # of Existing Trees Removed = 198
Total Existing Tree Units Removed = 1238

Site Area = 13.81 Acres

Windthrow Rating
A=Least windthrow resistant
B=Moderate windthrow resistant
C=Most windthrow resistant

Arborist Disclosure Statement:
Arborists are tree specialists who use their education, knowledge, training, and experience to examine trees, recommend measures to enhance the health of trees, and attempt to reduce the risk of living near trees. The Client and Jurisdiction may choose to accept or disregard the recommendations of the arborist, or seek additional advice. Arborists cannot detect every condition that could possibly lead to the structural failure of a tree. Trees are living organisms that fail in ways we do not fully understand. Conditions are often hidden within trees and below ground. Arborists cannot guarantee that a tree will be healthy or safe under all circumstances, or for a specified period of time. Likewise, remedial treatments, like medicine, cannot be guaranteed. Trees can be managed, but they cannot be controlled. To live near trees is to accept some degree of risk. The only way to eliminate all risk associated with trees is to eliminate all trees. Neither this author nor AKS Engineering & Forestry, LLC have assumed any responsibility for liability associated with the trees on or adjacent to this site.

At the completion of construction, all trees should once again be reviewed. Land clearing and removal of adjacent trees can expose previously unseen defects and otherwise healthy trees can be damaged during construction.

TREE PROTECTION NOTES

A. PLACING MATERIALS NEAR TREES – NO PERSON MAY CONDUCT ANY ACTIVITY WITHIN THE PROTECTED AREA OF ANY TREE DESIGNATED TO REMAIN, INCLUDING, BUT NOT LIMITED TO, PARKING EQUIPMENT, PLACING SOLVENTS, STORING BUILDING MATERIALS AND SOIL DEPOSITS, DUMPING CONCRETE WASHOUT, ETC.

B. ATTACHMENTS TO TREES – DURING CONSTRUCTION, NO PERSON SHALL ATTACH ANY OBJECT TO ANY TREE DESIGNATED FOR PROTECTION.

C. PROTECTIVE BARRIER – BEFORE DEVELOPMENT, LAND CLEARING, FILLING OR ANY LAND ALTERATION FOR WHICH A TREE REMOVAL PERMIT IS REQUIRED, THE CONTRACTOR:

- C.A. SHALL ERECT AND MAINTAIN READILY VISIBLE PROTECTIVE TREE FENCING ALONG THE OUTER EDGE AND COMPLETELY SURROUNDING THE PROTECTED AREA OF ALL PROTECTED TREES OR GROUP OF TREES. FENCES SHALL BE CONSTRUCTED PER THE DETAIL ON THIS SHEET.
- C.B. MAY BE REQUIRED TO COVER WITH MULCH TO A DEPTH OF AT LEAST SIX (6) INCHES OR WITH PLYWOOD OR SIMILAR MATERIAL IN THE AREAS ADJOINING THE CRITICAL ROOT ZONE OF A TREE IN ORDER TO PROTECT ROOTS FROM DAMAGE CAUSED BY HEAVY EQUIPMENT.
- C.C. SHALL PROHIBIT EXCAVATION OR COMPACTING OF EARTH OR OTHER POTENTIALLY DAMAGING ACTIVITIES WITHIN THE BARRIERS.
- C.D. MAY BE REQUIRED TO MINIMIZE ROOT DAMAGE BY EXCAVATING A TWO (2) FOOT DEEP TRENCH, AT EDGE OF CRITICAL ROOT ZONE, TO CLEANLY SEVER THE ROOTS OF TREES TO BE RETAINED. ROOTS ONE (1) INCH DIAMETER OR GREATER SHALL BE CLEANLY CUT WITH A SAW OR PRUNERS.
- C.E. MAY BE REQUIRED TO HAVE CORRECTIVE PRUNING PERFORMED ON PROTECTED TREES IN ORDER TO AVOID DAMAGE FROM MACHINERY OR BUILDING ACTIVITY. MAY BE REQUIRED TO MAINTAIN TREES THROUGHOUT THE CONSTRUCTION PERIOD BY WATERING AND FERTILIZING.
- C.F. SHALL MAINTAIN THE PROTECTIVE BARRIERS IN PLACE UNTIL THE PROJECT ARBORIST AUTHORIZES THEIR REMOVAL OR A FINAL CERTIFICATE OF OCCUPANCY IS ISSUED, WHICHEVER OCCURS FIRST.
- C.G. SHALL ENSURE THAT ANY LANDSCAPING DONE IN THE PROTECTED ZONE SUBSEQUENT TO THE REMOVAL OF THE BARRIERS SHALL BE ACCOMPLISHED WITH LIGHT MACHINERY OR HAND LABOR.

D. GRADE

- D.A. THE GRADE SHALL NOT BE ELEVATED OR REDUCED WITHIN THE CRITICAL ROOT ZONE OF TREES TO BE PRESERVED WITHOUT THE PROJECT ARBORISTS'S AUTHORIZATION. THE PROJECT ARBORIST MAY ALLOW COVERAGE OF UP TO ONE HALF OF THE AREA OF THE TREE'S CRITICAL ROOT ZONE WITH LIGHT SOILS (NO CLAY) TO THE MINIMUM DEPTH NECESSARY TO CARRY OUT GRADING OR LANDSCAPING PLANS, IF IT WILL NOT IMPERIL THE SURVIVAL OF THE TREE. AERATION DEVICES MAY BE REQUIRED TO ENSURE THE TREE'S SURVIVAL.
- D.B. IF THE GRADE ADJACENT TO A PRESERVED TREE IS RAISED SUCH THAT IT COULD SLOUGH OR ERODE INTO THE TREES CRITICAL ROOT ZONE, IT SHALL BE PERMANENTLY STABILIZED TO PREVENT SUFFOCATION OF THE ROOTS.
- D.C. THE APPLICANT SHALL NOT INSTALL AN IMPERVIOUS SURFACE WITHIN THE CRITICAL ROOT ZONE OF ANY TREE TO BE RETAINED WITHOUT THE AUTHORIZATION OF THE PROJECT ARBORIST. THE PROJECT ARBORIST MAY REQUIRE SPECIFIC CONSTRUCTION METHODS AND/OR USE OF AERATION DEVICES TO ENSURE THE TREE'S SURVIVAL AND TO MINIMIZE THE POTENTIAL FOR ROOT INDUCED DAMAGE TO THE IMPERVIOUS SURFACE.
- D.D. TO THE GREATEST EXTENT PRACTICAL, UTILITY TRENCHES SHALL BE LOCATED OUTSIDE OF THE CRITICAL ROOT ZONE OF TREES TO BE RETAINED. THE PROJECT ARBORIST MAY REQUIRE THAT UTILITIES BE TUNNELED UNDER THE ROOTS OF TREES TO BE RETAINED IF THE PROJECT ARBORIST DETERMINES THAT TRENCHING WOULD SIGNIFICANTLY REDUCE THE CHANCES OF THE TREE'S SURVIVAL.
- D.E. TREE AND OTHER VEGETATION TO BE RETAINED SHALL BE PROTECTED FROM EROSION AND SEDIMENTATION. CLEARING OPERATIONS SHALL BE CONDUCTED SO AS TO EXPOSE THE SMALLEST PRACTICAL AREA OF SOIL TO EROSION FOR THE LEAST POSSIBLE TIME. TO CONTROL EROSION, SHRUBS, GROUND COVER, AND STUMPS SHALL BE MAINTAINED ON THE INDIVIDUAL LOTS, WHERE FEASIBLE. WHERE NOT FEASIBLE, APPROPRIATE EROSION CONTROL PRACTICES SHALL BE IMPLEMENTED PURSUANT TO CAMAS MUNICIPAL CODE CHAPTER 14.06.

E. DIRECTIONAL FELLING OF TREES SHALL BE USED TO AVOID DAMAGE TO TREES DESIGNATED FOR RETENTION.

F. ADDITIONAL REQUIREMENTS – THE PROJECT ARBORIST MAY REQUIRE ADDITIONAL TREE PROTECTION MEASURES WHICH ARE CONSISTENT WITH ACCEPTED URBAN FORESTRY PRACTICES.

G. ENCROACHMENT INTO THE ROOT PROTECTION ZONE IS ALLOWED WITH PROJECT ARBORIST APPROVAL AS DESCRIBED IN THE FOLLOWING NOTES:

- G.A. EXCAVATION IN THE TOP 24 INCHES OF THE SOIL IN THE CRITICAL ROOT ZONE AREA SHOULD BEGIN AT THE EXCAVATION LINE THAT IS CLOSEST TO THE TREE.
- G.B. THE EXCAVATION SHOULD BE DONE BY HAND/SHOVEL OR WITH A BACKHOE AND A MAN WITH A SHOVEL, PRUNING SHEARS, AND A PRUNING SAW.
- G.C. IF DONE BY HAND, ALL ROOTS 1 INCH OR LARGER SHOULD BE PRUNED AT THE EXCAVATION LINE.
- G.D. IF DONE WITH BACKHOE (MOST LIKELY SCENARIO), THEN THE OPERATOR SHALL START THE CUT AT THE EXCAVATION LINE AND CAREFULLY "FEEL" FOR ROOT/RESISTANCE. WHEN THERE IS RESISTANCE, THE MAN WITH THE SHOVEL HAND DIGS AROUND THE ROOTS AND PRUNES THE ROOTS LARGER THAN 1 INCH DIAMETER.
- G.E. THE BACKHOE IS TO REMAIN OFF OF THE TREE ROOTS TO BE PRESERVED AT ALL TIMES.
- G.F. ALL ROOTS SHALL BE CUT CLEANLY WITH PRUNING SHEARS OR A PRUNING SAW.
- G.G. PROJECT ARBORIST MUST BE ONSITE DURING ANY WORK WITHIN THE TREE ROOT PROTECTION ZONE.
- G.H. THE CITY PLANNER MUST BE CONTACTED 24 HOURS PRIOR TO WORKING WITHIN THE TREE ROOT PROTECTION ZONE.

H. TREE PROTECTION ZONE IS DEFINED AS ALL AREAS BOUND AND PROTECTING THE OPTIMAL TREE PROTECTION ZONE.

I. TIMELINE FOR CLEARING, GRADING, AND INSTALLATION OF TREE PROTECTION MEASURES: WORK WILL BEGIN IMMEDIATELY FOLLOWING FINAL APPROVAL BY THE CITY. TREE PROTECTION MEASURES WILL BE DONE DURING CLEARING AND ANY GRADING WILL FOLLOW.

J. PRUNING/TREE REMOVAL NOTES: THE WORK TO BE COMPLETED UNDER THIS PROJECT SHALL CONSIST OF TREE REMOVAL AND TREE TRIMMING AS LISTED.

- J.A. THE CONTRACTOR SHALL PROVIDE ADEQUATE CREW OF MEN, EQUIPMENT AND MATERIALS TO SAFELY AND EFFICIENTLY COMPLETE THE ASSIGNED WORK. EACH SUCH CREW SHALL INCLUDE AN INDIVIDUAL WHO SHALL BE DESIGNATED AS THE CREW SUPERVISOR AND WHO SHALL BE RESPONSIBLE FOR THE CREW'S ACTIVITIES AND WHO SHALL RECEIVE INSTRUCTION FROM THE OWNER OR THE OWNER'S REPRESENTATIVE AND DIRECT THE CREW TO ACCOMPLISH SUCH WORK.
- J.B. WHENEVER A TREE, WHICH IS NOT SCHEDULED TO BE REMOVED, MUST BE TRIMMED OR PRUNED, THE CONTRACTOR SHALL INSURE THAT SUCH TRIMMING AND PRUNING IS CARRIED OUT UNDER THE DIRECT SUPERVISION OF A LICENSED ARBORIST. ALL PRUNING AND TRIMMING SHALL BE PERFORMED IN ACCORDANCE WITH THE PROVISIONS OF ANSI A 300 "STANDARD PRACTICES FOR TREE, SHRUB AND OTHER WOODY PLANT MAINTENANCE".
- J.C. THE CONTRACTOR SHALL BE REQUIRED TO CUT TREES TO A HEIGHT OF APPROXIMATELY 12". THE STUMPS AND ROOTS SHALL BE GROUND DOWN A MINIMUM OF TWELVE (12) INCHES BELOW NORMAL GROUND LEVEL.
- J.D. THE CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH THE LATEST GOVERNMENTAL SAFETY REGULATIONS. ALL WORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH ANSI Z133.1 "PRUNING, TRIMMING, REPAIRING, MAINTAINING AND REMOVING TREES AND CUTTING BRUSH–SAFETY REQUIREMENTS" WITH SPECIAL EMPHASIS GIVEN TO THE REQUIREMENT THAT ONLY QUALIFIED LINE–CLEARANCE TREE TRIMMERS BE ASSIGNED TO WORK WHERE A POTENTIAL ELECTRICAL HAZARD EXISTS.
- J.E. THE CONTRACTOR SHALL MAKE ALL THE NECESSARY ARRANGEMENTS WITH ANY UTILITY THAT MUST BE PROTECTED OR RELOCATED IN ORDER TO ACCOMPLISH THE WORK. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR THE PROTECTION OF THE OPERATING CONDITION OF ALL ACTIVE UTILITIES WITHIN THE AREA OF CONSTRUCTION AND THEY SHALL TAKE ALL NECESSARY PRECAUTIONS TO AVOID DAMAGE TO EXISTING UTILITIES.
- J.F. ANY MATERIAL RESULTING FROM THE TRIMMING OR REMOVAL OF ANY TREES SHALL BECOME THE RESPONSIBILITY OF THE CONTRACTOR.
- J.G. HAZARDOUS TREES–REPORTING – ANY PERSON ENGAGED IN TRIMMING OR PRUNING WHO BECOMES AWARE OF A TREE OF DOUBTFUL STRENGTH, THAT COULD BE DANGEROUS TO PERSONS AND PROPERTY, SHALL REPORT SUCH TREE(S) TO THE OWNER OR THE OWNERS REPRESENTATIVE. SUCH TREES SHALL INCLUDE THOSE THAT ARE OVER MATURE, DISEASED, OR SHOWING SIGNS OF DECAY OR OTHER STRUCTURAL WEAKNESS.
- J.H. DAMAGES–ANY DAMAGE CAUSED BY THE CONTRACTOR, INCLUDING, BUT NOT LIMITED TO, BROKEN SIDEWALK, CURB, RUTTED LAWN, BROKEN WATER SHUT–OFFS, WIRE DAMAGE, BUILDING DAMAGE, STREET DAMAGE, ETC., WILL BE REPAIRED OR REPLACED IN A TIMELY MANNER, TO THE OWNER'S SATISFACTION, AND ALL COSTS PAID BY THE CONTRACTOR.
- J.I. ANY BRUSH CLEARING REQUIRED WITHIN THE TREE PROTECTION ZONE SHALL BE ACCOMPLISHED WITH HAND OPERATED EQUIPMENT.
- J.J. TREES TO BE REMOVED SHALL BE FELLED SO AS TO FALL AWAY FROM TREE ROOT PROTECTION ZONES AND TO AVOID PULLING AND BREAKING OF ROOTS TO REMAIN.
- J.K. ALL DOWNED BRUSH AND TREES SHALL BE REMOVED FROM THE TREE PROTECTION ZONE EITHER BY HAND OR WITH EQUIPMENT SITTING OUTSIDE THE TREE ROOT PROTECTION ZONE. EXTRACTION SHALL OCCUR BY LIFTING THE MATERIAL OUT, NOT BY SKIDDING IT ACROSS THE GROUND.
- J.L. IF TEMPORARY HAUL OR ACCESS ROADS MUST PASS OVER THE ROOT AREA OF TREES TO BE RETAINED A ROADBED OF 6 INCHES OF MULCH OR GRAVEL SHALL BE CREATED TO PROTECT THE SOIL. THE ROADBED MATERIAL SHALL BE REPLENISHED AS NECESSARY TO MAINTAIN A 6–INCH DEPTH.
- J.M. PRUNING. TREES SHALL BE PRUNED PRIOR TO THE START OF CONSTRUCTION. TREES SHALL BE CROWN CLEANED TO REMOVE THE DEADWOOD 2 INCHES IN DIAMETER AND OVER. TREES SHALL BE CROWN THINNED BY 10–20%. CROWNS MAY BE RAISED BY REMOVING BOTTOM BRANCHES AS NECESSARY UP TO 14 FEET HIGH TO GIVE CLEARANCE FOR ANY CONSTRUCTION TRAFFIC, ACTIVITIES, ETC. ALL WORK TO BE DONE IN ACCORDANCE WITH ANSI A300 PRUNING STANDARDS. REMOVE ANY LIMBS OF DOUBTFUL STRENGTH THAT COULD BE DANGEROUS TO PERSONS AND PROPERTY.

CERTIFIED ARBORIST ISA
PRELIMINARY NOT FOR CONSTRUCTION
BRYCE D. HANSON
CERTIFICATE NUMBER: PN 7554A
EXPIRATION DATE: 06/30/25

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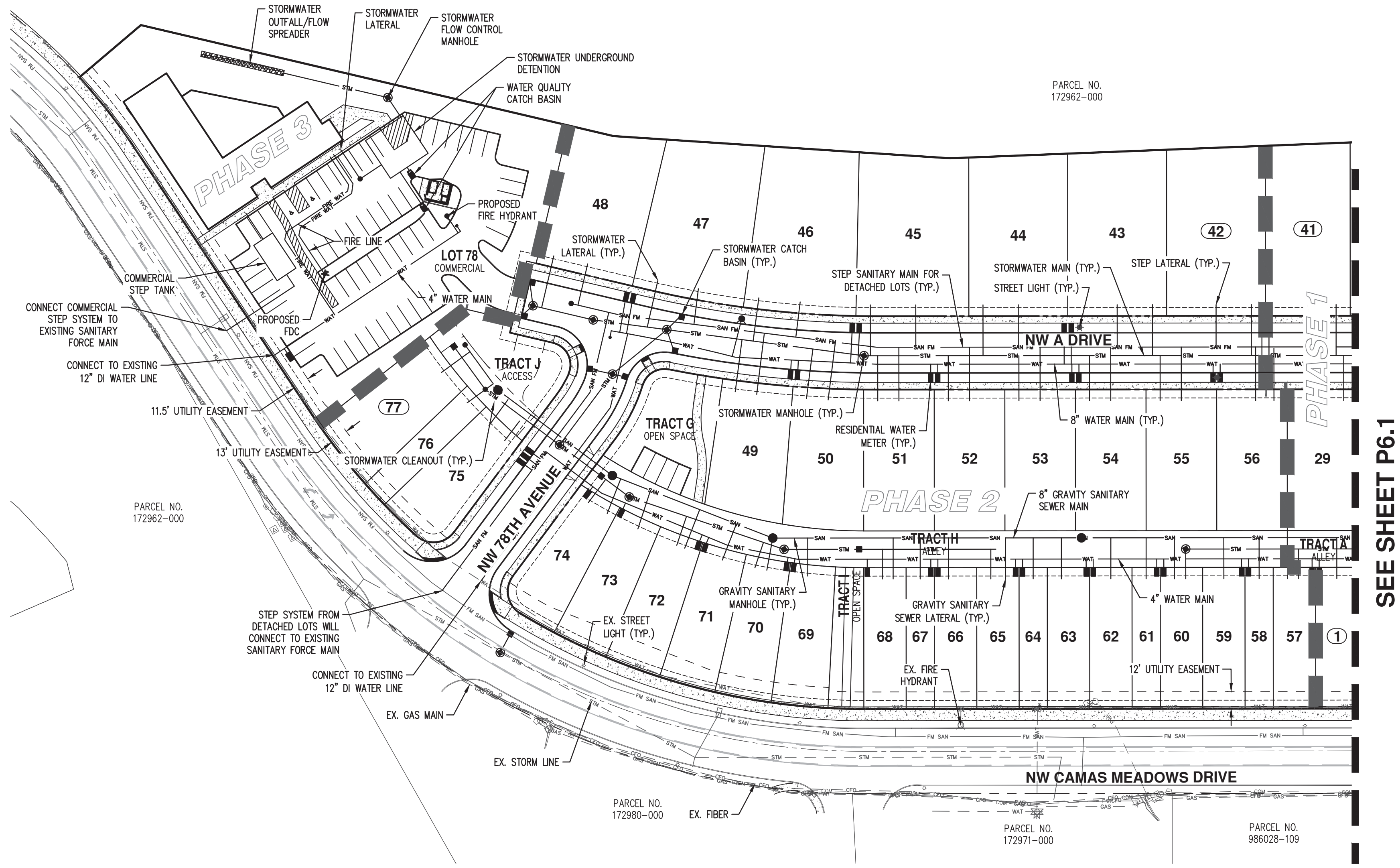
PRELIMINARY TREE PRSERVATION AND REMOVAL TABLE
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	BRK
CHECKED BY:	BDH



SCALE: 1"=50 FEET

ORIGINAL PAGE SIZE: 24" x 36"

GENERAL NOTES

1. RESIDENTIAL FIRE SPRINKLERS REQUIRED IN ALL NEW DWELLINGS.
2. LOTS 20-56 TO INCLUDE INDIVIDUAL STEP TANKS INSTALLED AT TIME OF HOME CONSTRUCTION.
3. LOTS 1-19 AND 57-77 TO BE CONNECTED TO A SANITARY SEWER LATERAL FROM GRAVITY SANITARY SEWER MAIN AND CONVEYED TO A COMMUNITY STEP TANK IN TRACT F.
4. COMMERCIAL LOT (TRACT K) TO INCLUDE A STEP TANK INSTALLED AT TIME OF CONSTRUCTION.

AKS DRAWING FILE: 9030 P6.0.DWG | LAYOUT: P6.0

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PRELIMINARY COMPOSITE UTILITY PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

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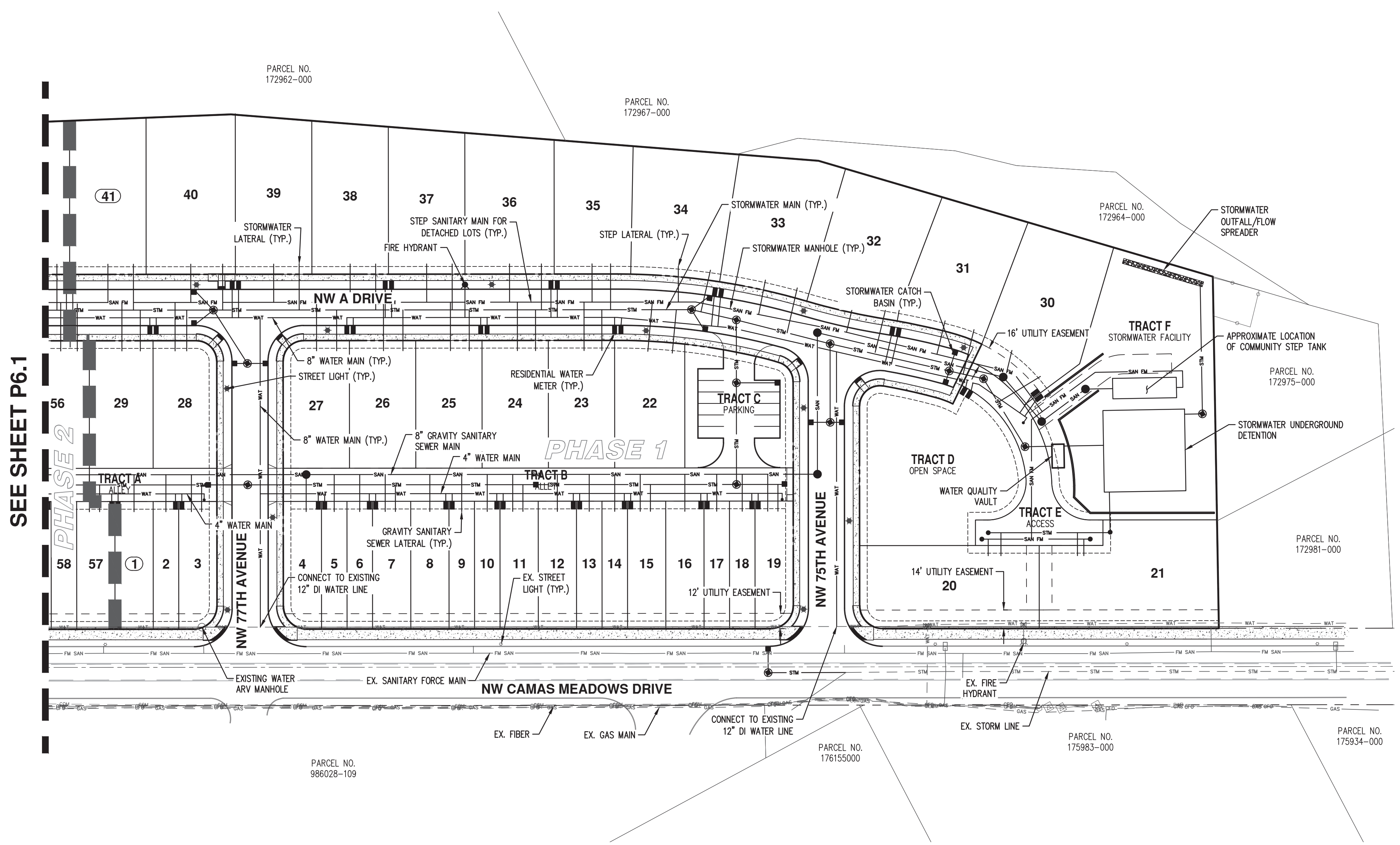
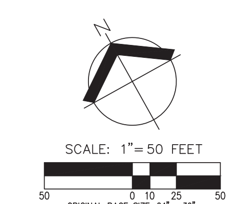
CHECKED BY:	JMM

P6.0





GENERAL NOTES

1. RESIDENTIAL FIRE SPRINKLERS REQUIRED IN ALL NEW DWELLINGS.
2. LOTS 20–56 TO INCLUDE INDIVIDUAL STEP TANKS INSTALLED AT TIME OF HOME CONSTRUCTION.
3. LOTS 1–19 AND 57–77 TO BE CONNECTED TO A SANITARY SEWER LATERAL FROM GRAVITY SANITARY SEWER MAIN AND CONVEYED TO A COMMUNITY STEP TANK IN TRACT F.

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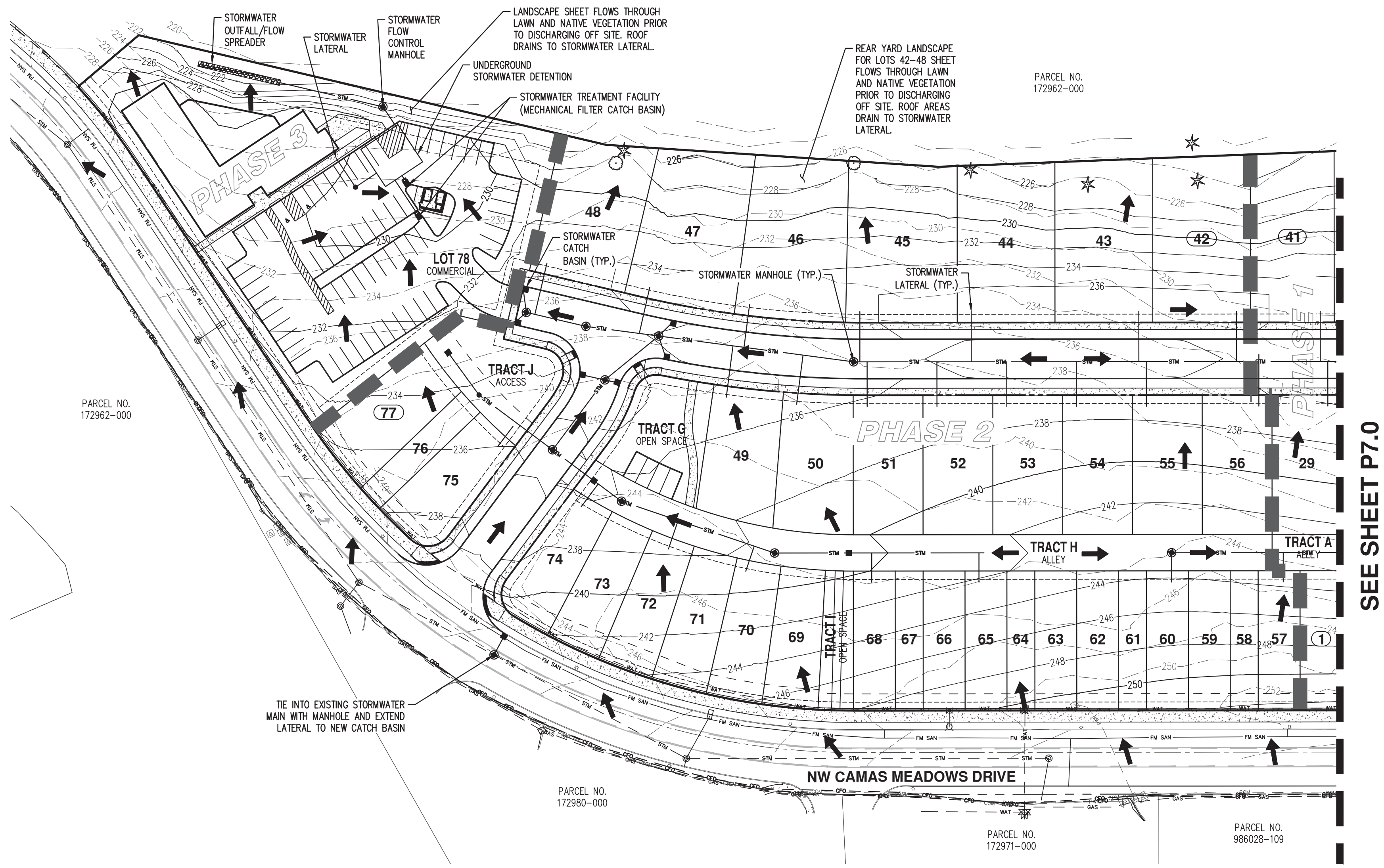

SCALE: 1"= 50 FEET

ORIGINAL PAGE SIZE: 24" x 36"

GENERAL NOTES

1. LOT 78, COMMERCIAL LOT, INCLUDES UNDERGROUND DETENTION UNDER PARKING AREA AND WATER QUALITY CATCH BASINS FOR STORMWATER FLOW AND TREATMENT OF RUNOFF FROM COMMERCIAL LOT.

   PRELIMINARY SIZE OF REQUIRED DETENTION FACILITY: 32'W X 32'L X 4'H

   PRELIMINARY WATER QUALITY FEATURES INCLUDE:
   2 MECHANICAL FILTER CATCH BASINS
   CARTRIDGE COUNT AND SIZE PER CATCH BASIN: 1 – 18"
   OFF–LINE FLOW RATE PROVIDED: 0.080 CFS (0.040 CFS PER CATCH BASIN)
   OFF–LINE FLOW RATE REQUIRED: 0.078 CFS

2. TRACT F INCLUDES UNDERGROUND DETENTION AND A WATER QUALITY VAULT FOR STORMWATER FLOW AND TREATMENT OF RUNOFF FROM SUBDIVISION.

   PRELIMINARY SIZE OF REQUIRED DETENTION FACILITY: 64'W X 64"L X 9'H

   PRELIMINARY WATER QUALITY FEATURES INCLUDE:
   9'X16' MECHANICAL FILTER VAULT
   CARTRIDGE COUNT AND SIZE: 31–12"+18" STACKED
   OFF–LINE FLOW RATE PROVIDED: 1.175 CFS
   OFF–LINE FLOW RATE REQUIRED: 1.142 CFS

3. ACCORDING TO CLARK COUNTY GIS, THE SITE IS NOT WITHIN OR ADJACENT TO A 100–YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
4. THERE ARE NO KNOWN ON–SITE STORMWATER FACILITIES.
5. STORMWATER INFRASTRUCTURE EXISTS IN NW CAMAS MEADOWS DRIVE. STORMWATER FROM CAMAS MEADOWS DRIVE DOES NOT CONTRIBUTE TO ON–SITE FLOWS.
6. ACCORDING TO CLARK GIS, NO WELLS, AGRICULTURAL DRAIN TILES, POTENTIAL SLOPE INSTABILITY, STRUCTURES, UTILITIES, SEPTIC TANKS, OR DRAIN FIELDS EXIST ONSITE.
7. ACCORDING TO CLARK GIS, NO FLOODPLAIN, FLOODWAYS, OR SHORELINE EXIST ONSITE.
8. ACCORDING TO CLARK GIS, NO WETLANDS EXIST ON THE SITE.
9. EXISTING DRAINAGE FLOW ROUTES ARE GENERALLY NORTH TO NORTHEAST FOR THE THRESHOLD DISCHARGE AREA (TDA). EXISTING STORMWATER FROM THE SITE DISCHARGES NORTH TO NORTHEAST THROUGH NEIGHBORING PROPERTY (GOLF COURSE).
10. PROPOSED DRAINAGE FLOW ROUTES TO FOLLOW EXISTING FLOW ROUTES WITH STORMWATER DISCHARGED FROM STORMWATER FACILITIES CONVEYED TO EXISTING LOW POINTS IN THE NORTH AND NORTHEAST CORNERS OF THE SITE.
11. RUNOFF FROM LANDSCAPE AREAS LOWER THAN STORMWATER FACILITIES, REAR YARDS FOR LOTS 30–48 AND COMMERCIAL LOT, DISPERSE THROUGH LAWN AND NATIVE VEGETATION PRIOR TO DISCHARGING TO NORTHERN BOUNDARY AND NEIGHBORING PROPERTY (GOLF COURSE) FOLLOWING EXISTING FLOW ROUTE.
12. ROOF AREAS FOR ALL LOTS, RESIDENTIAL AND COMMERCIAL, DRAIN TO A STORMWATER LATERAL.

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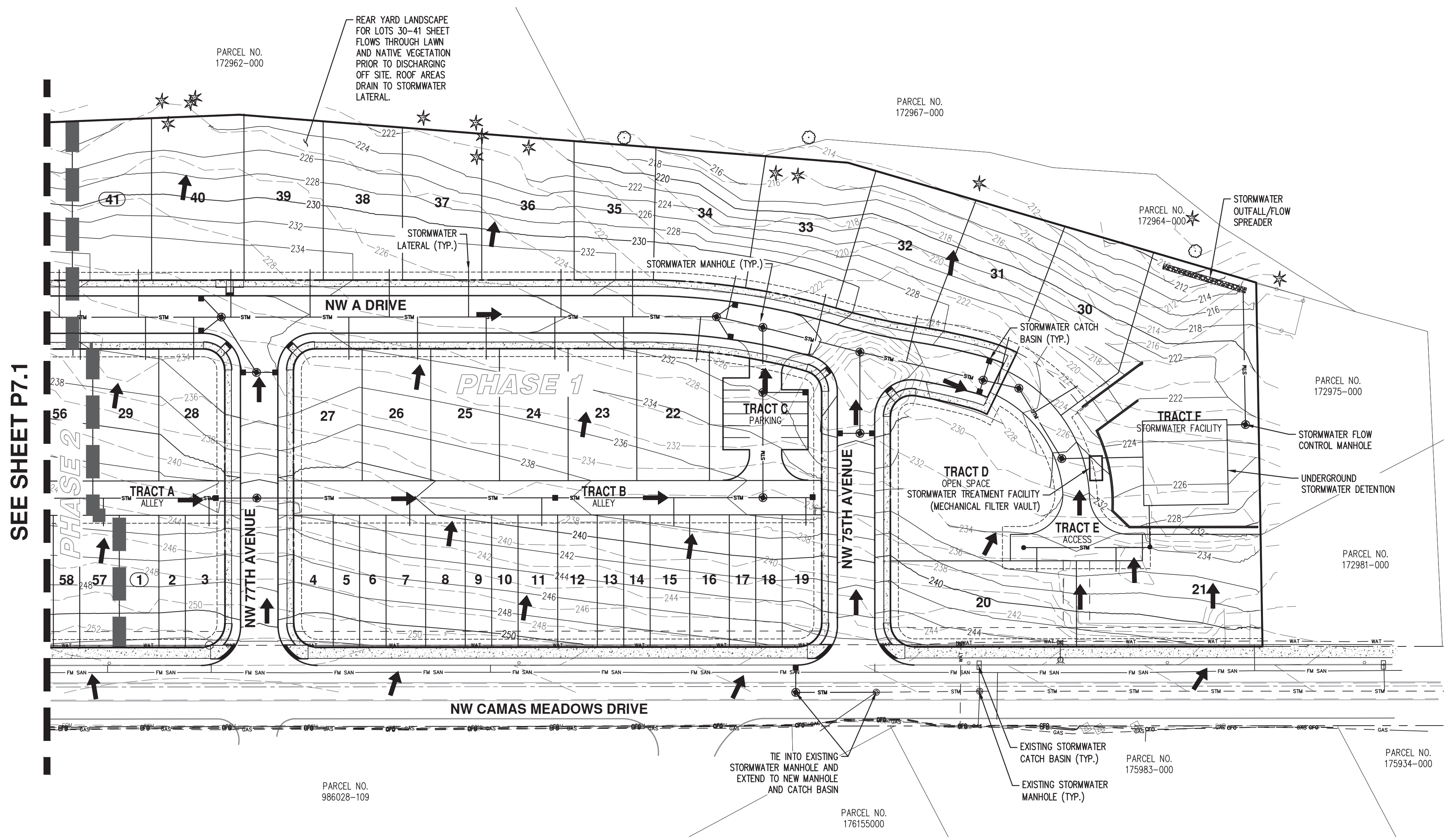
PRELIMINARY STORMWATER PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
DRAWN BY:	DJL
CHECKED BY:	JMM

P7.0

AKS DRAWING FILE: 9030 P7.0.DWG | LAYOUT: P7.0



GENERAL NOTES

1. LOT 78, COMMERCIAL LOT, INCLUDES UNDERGROUND DETENTION UNDER PARKING AREA AND WATER QUALITY CATCH BASINS FOR STORMWATER FLOW AND TREATMENT OF RUNOFF FROM COMMERCIAL LOT.

   PRELIMINARY SIZE OF REQUIRED DETENTION FACILITY: 32'W X 32'L X 4'H

   PRELIMINARY WATER QUALITY FEATURES INCLUDE:
   2 MECHANICAL FILTER CATCH BASINS
   CARTRIDGE COUNT AND SIZE PER CATCH BASIN: 1 – 18"
   OFF-LINE FLOW RATE PROVIDED: 0.080 CFS (0.040 CFS PER CATCH BASIN)
   OFF-LINE FLOW RATE REQUIRED: 0.078 CFS

2. TRACT F INCLUDES UNDERGROUND DETENTION AND A WATER QUALITY VAULT FOR STORMWATER FLOW AND TREATMENT OF RUNOFF FROM SUBDIVISION.
   PRELIMINARY SIZE OF REQUIRED DETENTION FACILITY: 64'W X 64"L X 9'H

   PRELIMINARY WATER QUALITY FEATURES INCLUDE:
   9'X16' MECHANICAL FILTER VAULT
   CARTRIDGE COUNT AND SIZE: 31-12"+18" STACKED
   OFF-LINE FLOW RATE PROVIDED: 1.175 CFS
   OFF-LINE FLOW RATE REQUIRED: 1.142 CFS

3. ACCORDING TO CLARK COUNTY GIS, THE SITE IS NOT WITHIN OR ADJACENT TO A 100-YEAR FLOODPLAIN OR SHORELINE MANAGEMENT AREA.
4. THERE ARE NO KNOWN ON-SITE STORMWATER FACILITIES.
5. STORMWATER INFRASTRUCTURE EXISTS IN NW CAMAS MEADOWS DRIVE. STORMWATER FROM CAMAS MEADOWS DRIVE DOES NOT CONTRIBUTE TO ON-SITE FLOWS.
6. ACCORDING TO CLARK GIS, NO WELLS, AGRICULTURAL DRAIN TILES, POTENTIAL SLOPE INSTABILITY, STRUCTURES, UTILITIES, SEPTIC TANKS, OR DRAIN FIELDS EXIST ONSITE.
7. ACCORDING TO CLARK GIS, NO FLOODPLAIN, FLOODWAYS, OR SHORELINE EXIST ONSITE.
8. ACCORDING TO CLARK GIS, NO WETLANDS EXIST ON THE SITE.
9. EXISTING DRAINAGE FLOW ROUTES ARE GENERALLY NORTH TO NORTHEAST FOR THE THRESHOLD DISCHARGE AREA (TDA). EXISTING STORMWATER FROM THE SITE DISCHARGES NORTH TO NORTHEAST THROUGH NEIGHBORING PROPERTY (GOLF COURSE).
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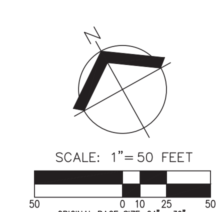

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PRELIMINARY STORMWATER PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
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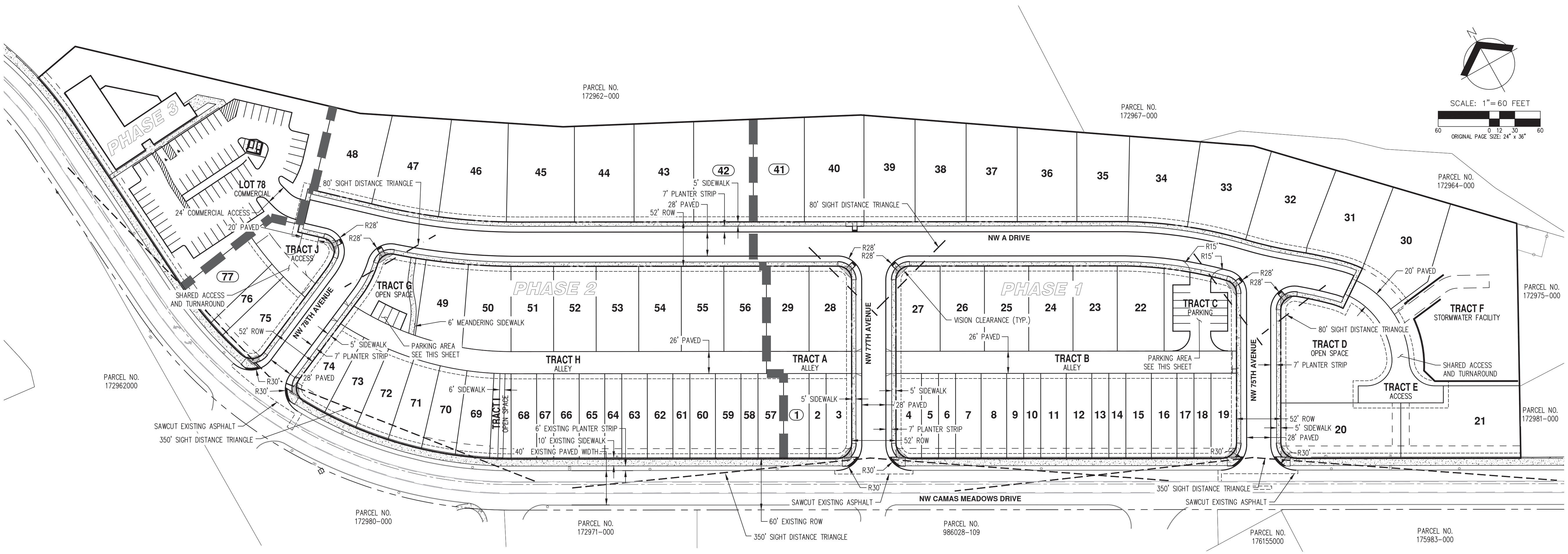
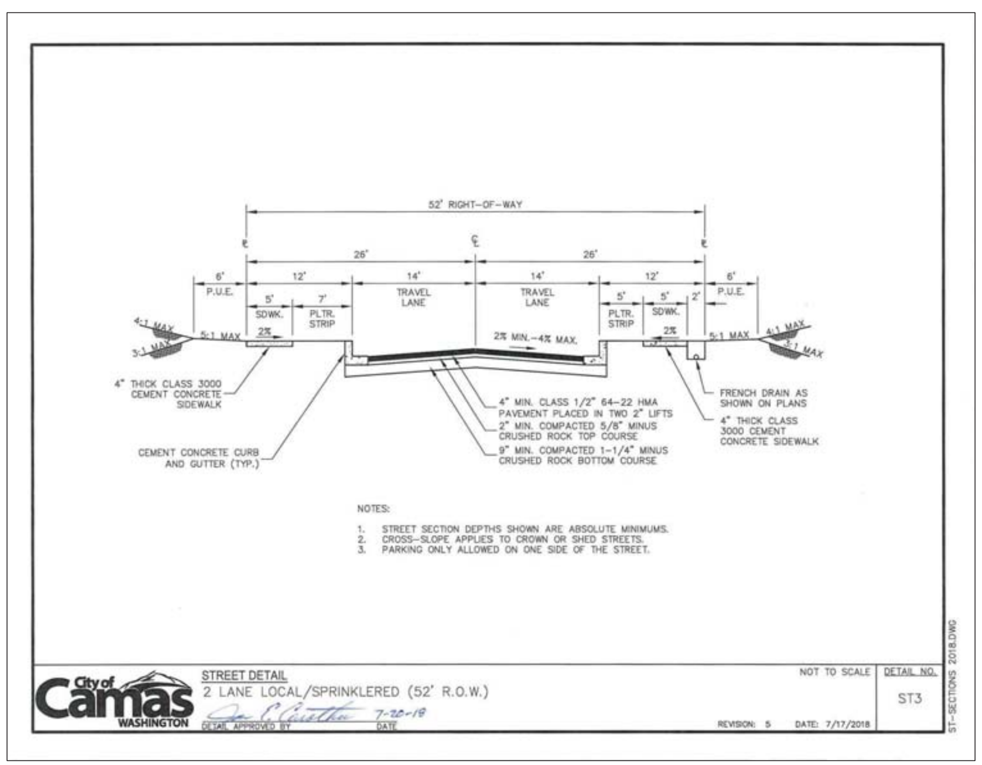
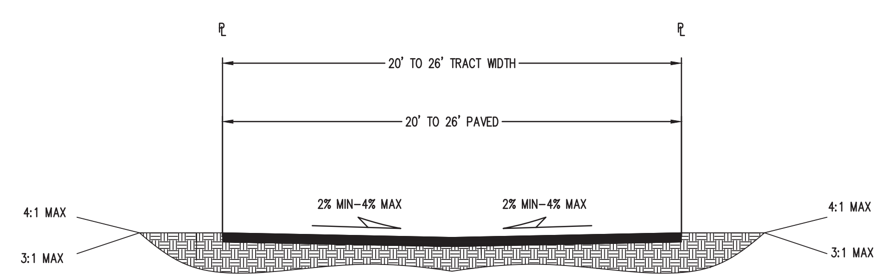




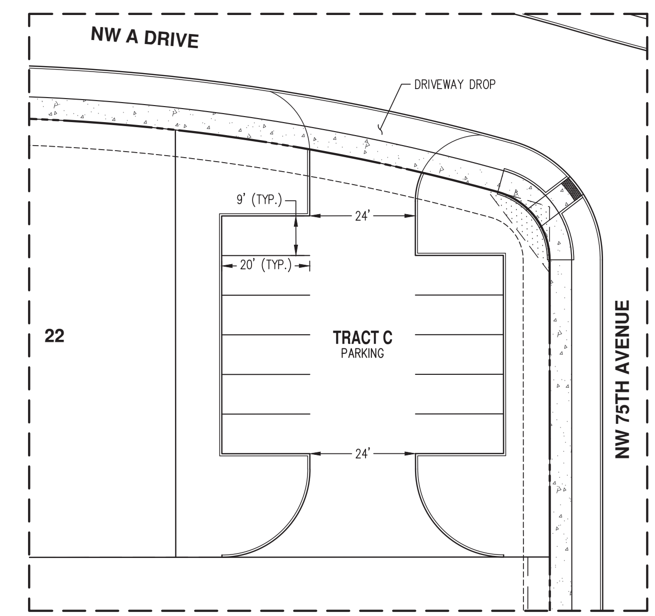
NW 75TH AVENUE - NW 77TH AVENUE - NW 78TH AVENUE - NW A DRIVE

GENERAL NOTES

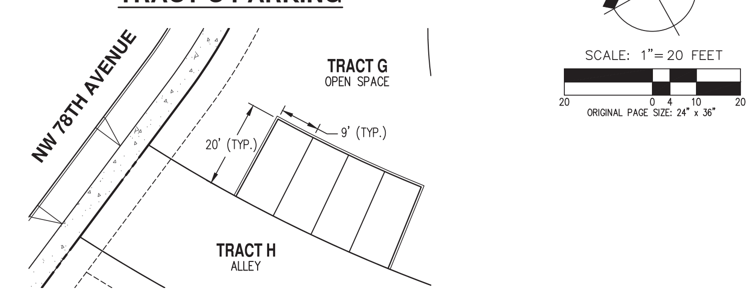
1. THE PROPOSED DEVELOPMENT WILL ACCESS OFF NE CAMAS MEADOWS DRIVE WHICH IS CLASSIFIED AS AN EXISTING 3-LANE ARTERIAL WITH CURB AND GUTTER, SIDEWALK, AND PLANTER STRIPS ON BOTH SIDES.
2. NW CAMAS MEADOWS FRONTAGE IMPROVEMENTS WILL INCLUDE:
   REPLACEMENT OF DAMAGED CURB AND SIDEWALK.
   GRIND AND INLAY AT NW 75TH AVENUE, NW 77TH AVENUE, AND NW 78TH AVENUE, IF NECESSARY.



PRIVATE ACCESS AND ALLEY
TRACT A, B, E, H, & J



TRACT C PARKING



TRACT G PARKING

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PRELIMINARY STREET PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
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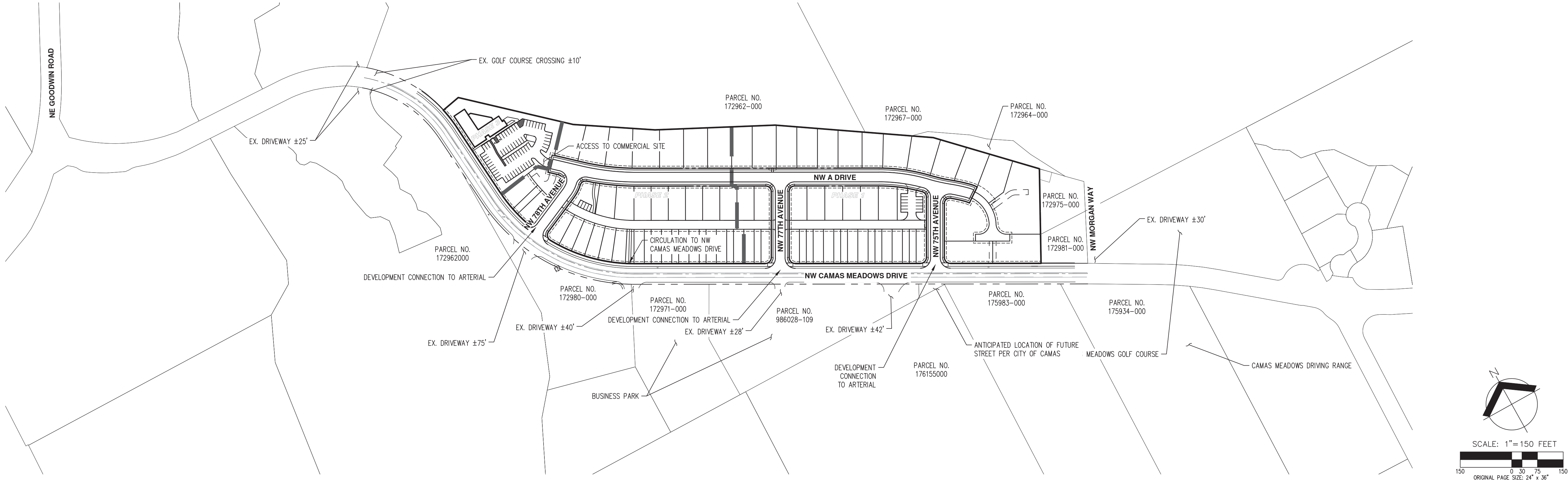
P8.0

AKS DRAWING FILE: 9030 P8.0.DWG | LAYOUT: P8.0



GENERAL NOTE

SEE SHEET P8.0 FOR PROPOSED ROADWAY WIDTHS, TURNING RADII, AND PARKING AREA LAYOUT.

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PRELIMINARY CIRCULATION PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	DJL
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CHECKED BY:	JMM

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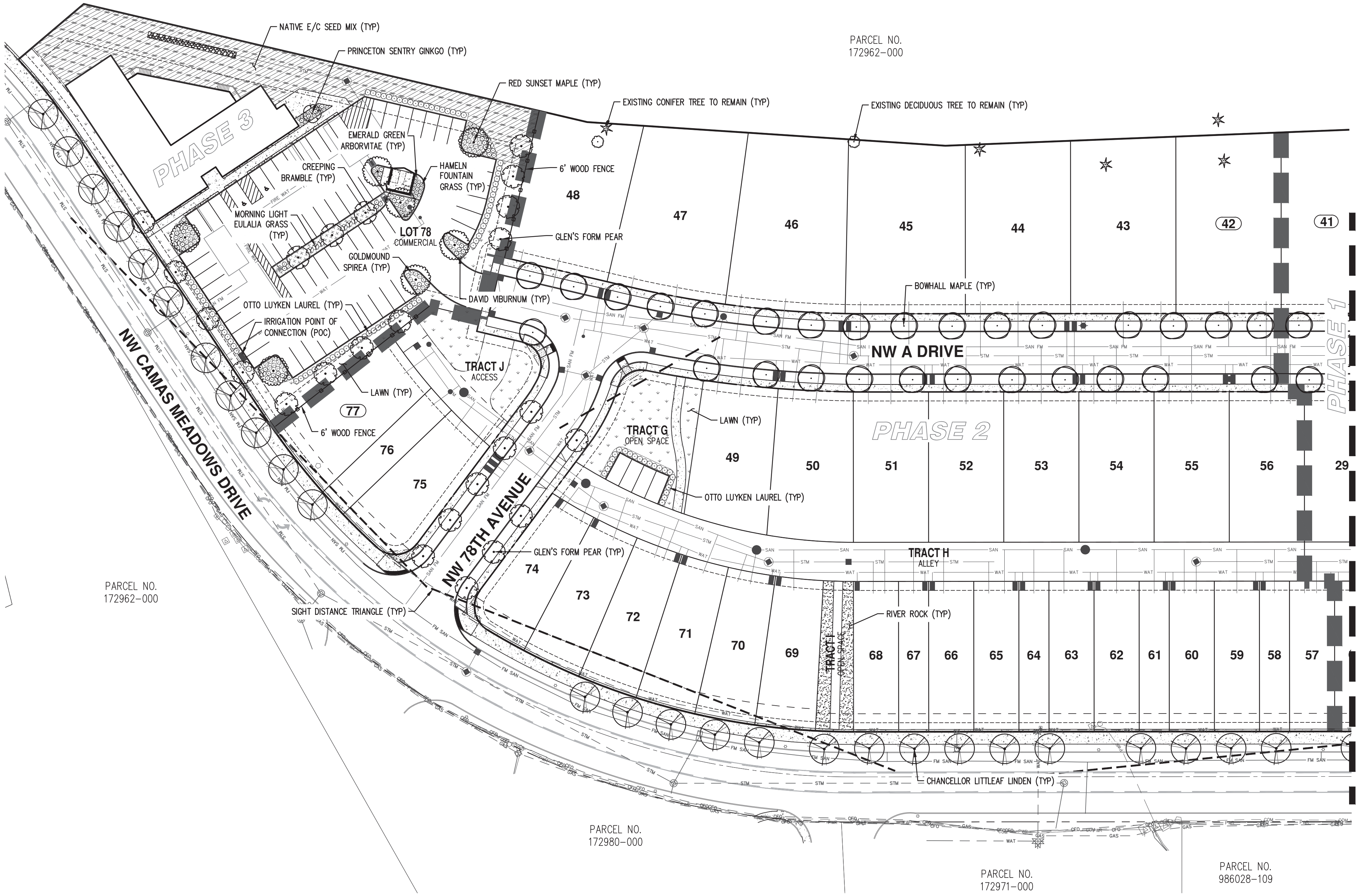

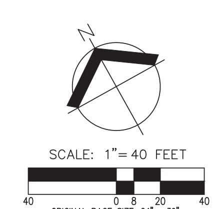

PRELIMINARY PLANT SCHEDULE

TREES	QTY	BOTANICAL NAME	COMMON NAME	SIZE/CONTAINER	SPACING
	11	ACER RUBRUM 'FRANKSRED' TM	RED SUNSET MAPLE	2" CAL. B&B	AS SHOWN
	1	GINKGO BILOBA 'PRINCETON SENTRY'	PRINCETON SENTRY GINKGO	2" CAL. B&B	AS SHOWN
STREET TREES	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE/CONTAINER**	**SPACING**
	61	ACER RUBRUM 'BOWHALL'	BOWHALL RED MAPLE	2" CAL. B&B	30' o.c.
	42	PYRUS CALLERYANA 'GLEN'S FORM' TM	GLEN'S FORM PEAR	2" CAL. B&B	30' o.c.
	44	TILIA CORDATA 'CHANCOLE' TM	CHANCELLOR LITTLELEAF LINDEN	2" CAL. B&B	30' o.c.
SHRUBS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE/CONTAINER**	**SPACING**
	12	MISCANTHUS SINENSIS 'MORNING LIGHT'	MORNING LIGHT EULALIA GRASS	1 GAL CONT.	48" o.c.
	42	PENNISETUM ALOPECUROIDES 'HAMELN'	HAMELN FOUNTAIN GRASS	1 GAL CONT.	30" o.c.
	145	PRUNUS LAUROCERASUS 'OTTO LUYKEN'	OTTO LUYKEN ENGLISH LAUREL	3 GAL CONT.	48" o.c.
	46	SPIRAEA X BUMALDA 'GOLDMOUND'	GOLD MOUND SPIREA	2 GAL CONT.	36" o.c.
	6	THUJA OCCIDENTALIS 'SMARAGD'	EMERALD GREEN ARBORVITAE	5'-6' HT. CONT.	30" o.c.
	73	VIBURNUM DAVIDII	DAVID VIBURNUM	2 GAL CONT.	36" o.c.
GROUND COVERS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE/CONTAINER**	**SPACING**
	147	RUBUS CALYCINOIDES	CREEPING BRAMBLE	1 GAL CONT.	24" o.c.
	±1,910 SF	RIVER ROCK			
	±13,889 SF	LAWN - NORTHWEST SUPREME LAWN SEED MIX - SUNMARK SEEDS (OR APPROVED EQUAL) - LOLIUM PERENNE VAR DASHER 3 (DASHER 3 PERENNIAL RYEGRASS) 35% - LOLIUM PERENNE VAR CUTTER II (CUTTER II PERENNIAL RYEGRASS) 35% - FESTUCA RUBRA VAR GARNET (GARNET CREEPING RED FESCUE) 15% - FESTUCA RUBRA SPP FALLAX VAR WINDWARD (WINDWARDS CHEWINGS FESCUE) 15% APPLY AT A ARTE OF 8 LBS. PER 1,000 SF OR AS RECOMMENDED BY SUPPLIER			
	±22,482 SF	NATIVE E/C SEED MIX - SUNMARK SEEDS (OR APPROVED EQUAL) - HORDEUM BRACHYANTHERUM (MEADOW BARLEY) 40% - BROMUS CARINATUS (CALIFORNIA BROME) 35% - FESTUCA RUBRA RUBRA (NATIVE RED FESCUE) 20% - DESCHAMPSIA CESPITOSA (TUFTED HAIRGRASS) 3% - AGROSTIS EXERATA (SPIKE BENTGRASS) 2% - APPLY AT A RATE OF 1 LB. PER 1,000 SF OR AS RECOMMENDED BY SUPPLIER ECOLIVE ORGANICS SHALL BE ADDED TO SEED MIX AT A RATE OF 1.5 LBS. PER 1,000 SF			

PRELIMINARY LANDSCAPE NOTES

1. LANDSCAPE PLAN IS PRELIMINARY AND INTENDED TO SHOW DESIGN INTENT ONLY. REVISIONS OR SUBSTITUTIONS, INCLUDING CHANGES TO PLANT LOCATION, QUANTITIES, TYPES, AND SIZES MAY BE NECESSARY PRIOR TO FINAL APPROVAL BASED ON PLANT AVAILABILITY, SITE CONDITIONS, UTILITY CONFLICTS, ETC. ALL SUBSTITUTIONS SHALL CONFORM TO CITY OF CAMAS LANDSCAPE DESIGN STANDARDS. STREET TREES WILL BE UPDATED TO AVOID FUTURE DRIVEWAY DROPS.
2. ALL PLANTS AND PLANTINGS SHALL CONFORM TO CITY OF CAMAS DESIGN STANDARDS AND TO AMERICAN NURSERY STANDARDS ANSI Z60.1. PLANT IN ACCORDANCE WITH ACCEPTED BEST-PRACTICE INDUSTRY STANDARDS SUCH AS THOSE ADOPTED BY THE WASHINGTON ASSOCIATION OF LANDSCAPE PROFESSIONALS (WALP).
3. CENTER TREES IN PLANTER STRIPS AND LANDSCAPE PLANTING BEDS WHERE POSSIBLE. KEEP OTHER TREE TRUNKS 3' O.C. MINIMUM FROM CURBS, SIDEWALKS, AND OTHER PAVING OR CENTERED IN PLANTING ISLAND. KEEP SHRUBS AND GROUNDCOVER A MINIMUM OF 24" O.C. FROM PAVING AND 3' O.C. FROM TREES. ADJUST PLANTINGS AS NECESSARY ON SITE TO AVOID CONFLICT WITH UTILITIES, HYDRANTS, LIGHT POLES, METERS, ETC..
4. HATCHED AREAS ARE MEANT TO CONVEY GENERAL PLANT LOCATION. PLANT COVERAGE, SPACING, AND LAYOUT SHALL BE CONSISTENT WITH THE SPACING LISTED IN THE PLANT LEGEND FOR FULL COVERAGE.
5. MULCH: APPLY 3" DEEP WELL-AGED MEDIUM GRIND OR SHREDDED DARK HEMLOCK BARK MULCH UNDER AND AROUND ALL TREES AND SHRUBS IN PLANTER STRIP AREAS NOT INCLUDED AS STORMWATER FACILITIES OR LAWN. WHERE TREES ARE IN LAWN AREAS, A MINIMUM 3' DIAMETER MULCH RING SHALL BE USED AROUND THE TREE TO PROTECT THE TRUNK FROM MOWER DAMAGE. CARE SHALL BE TAKEN TO AVOID COVERING FOLIAGE OR ROOT CROWNS OF PLANTS. PLANTS SHALL BE PLANTED AT A DEPTH TO ACCOMMODATE BARK MULCH APPLICATION.
6. IRRIGATION FOR HEALTHY PLANT ESTABLISHMENT AND SURVIVAL IS RECOMMENDED AND SHALL BE 'DESIGN-BUILD' BY LANDSCAPE CONTRACTOR.
7. REFER TO SHEET P5.0 FOR PRELIMINARY TREE PLAN.

TREE PLAN

SITE AREA:	13.81 AC
TOTAL TREE UNITS REQUIRED (13.81AC X 20):	276
EXISTING TREES RETAINED/(TREE UNITS):	15/(149.5)
PROPOSED SITE TREES/(TREE UNITS):	159
TOTAL TREE UNITS: (RETAINED AND PRESERVED)	308.5

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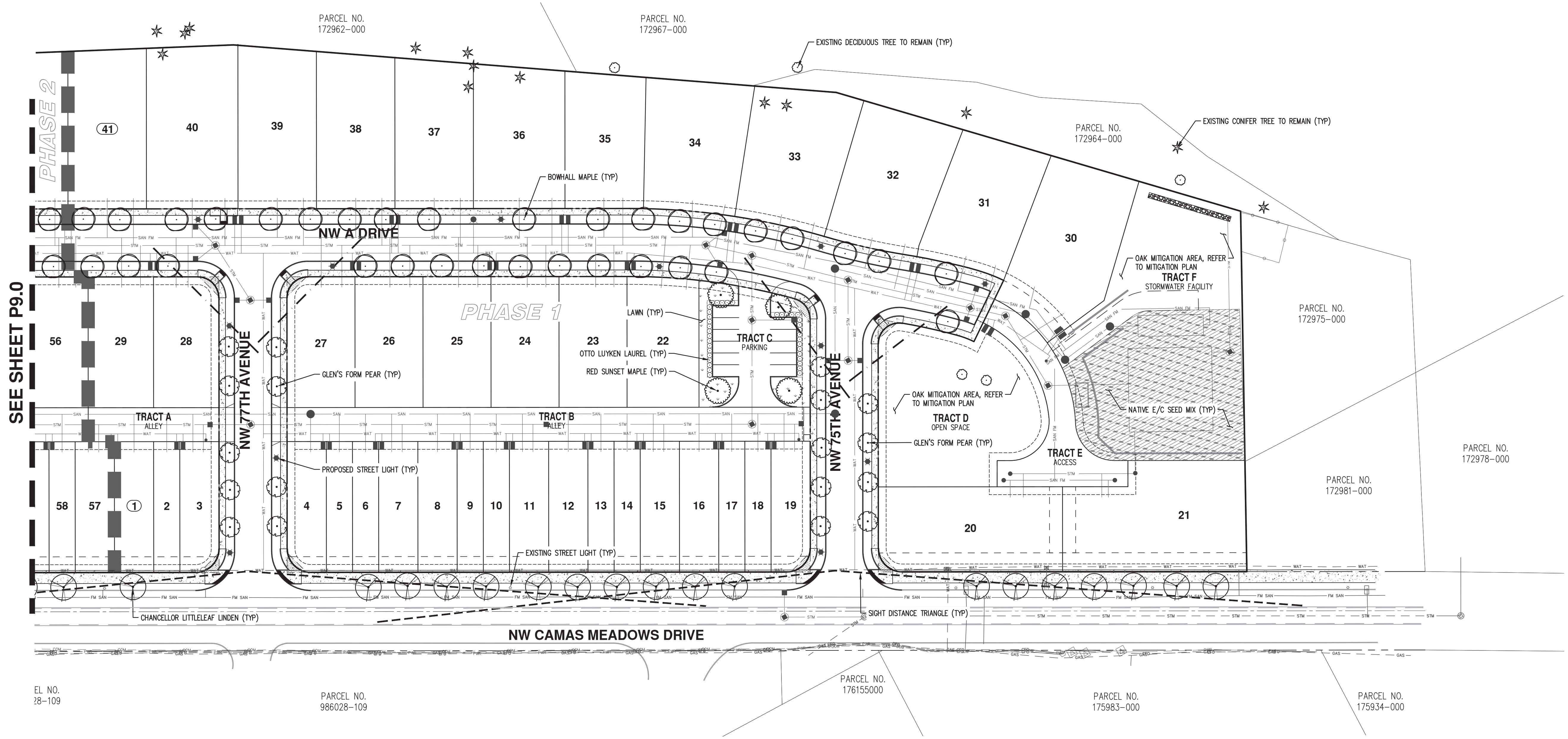
PRELIMINARY LANDSCAPE PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY NOT FOR CONSTRUCTION

JOB NUMBER:	9030
DATE:	3/13/2023
DESIGNED BY:	TEB
DRAWN BY:	TEB
CHECKED BY:	MPA

P9.0

AKS DRAWING FILE: 9030 P9.0.DWG | LAYOUT: P9.0



GENERAL NOTE

1. REFER TO SHEET P9.0 FOR PRELIMINARY PLANT SCHEDULE AND NOTES.

SCALE: 1"= 40 FEET

ORIGINAL PAGE SIZE: 24" x 36"

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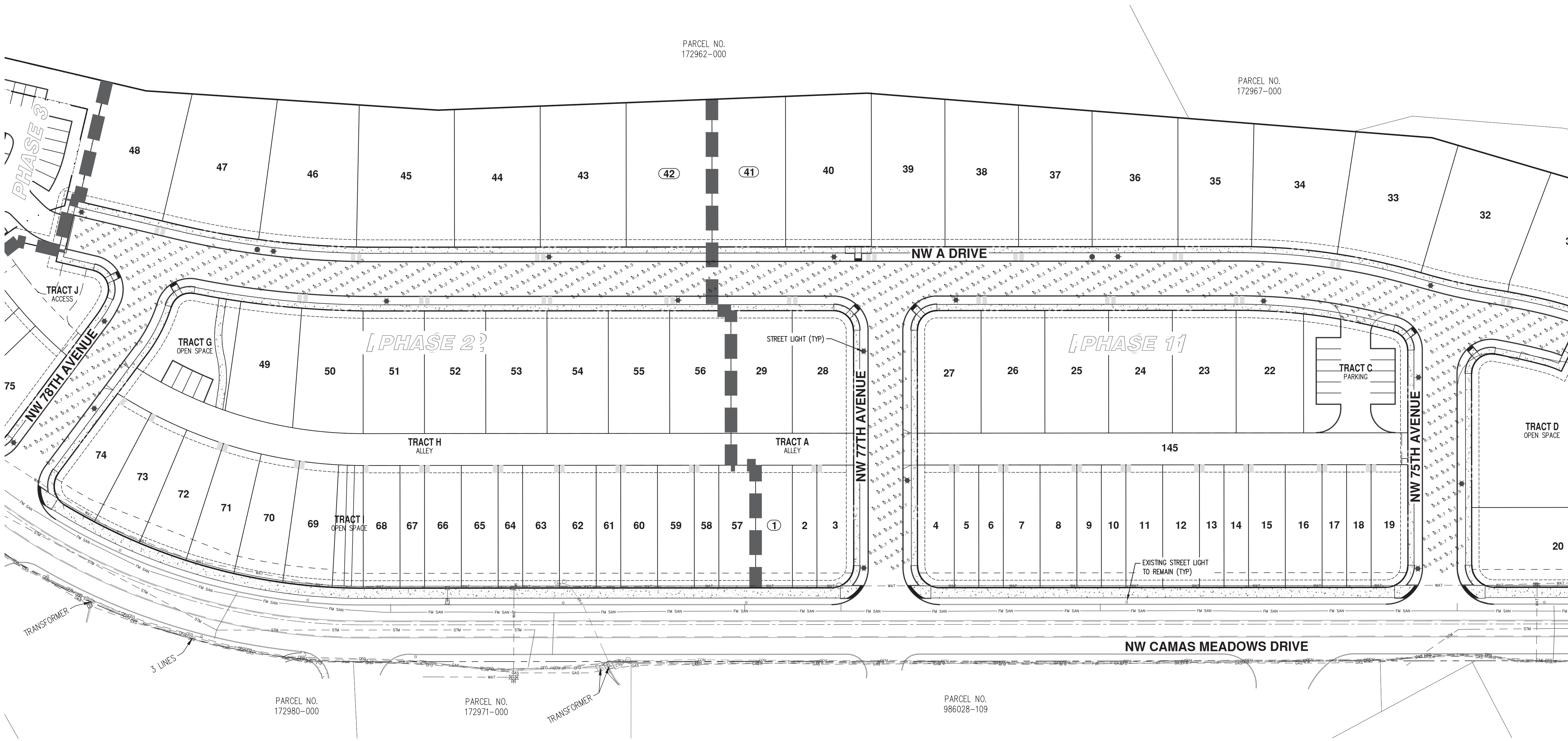
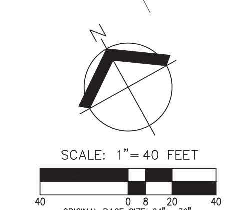
P9.1

AKS DRAWING FILE: 9030 P9.0.DWG | LAYOUT: P9.1





LUMINAIRE SCHEDULE					
SYMBOL	QUANTITY	STYLE	LUMINAIRE TYPE	POLE TYPE	HEIGHT
✹	20	PROPOSED	HOLOPHANE AWDE3-P20-30K-MVOLT-MS-AL3-BK-ST-TBK-AO-PR7-L1H-TB-NL1X1-UA-GVDHSS90	PLP DECORATIVE POLE SPECIFICATIONS PLP MODEL# DOM-DB-FL-14.5-BL-CI	14.5' HT.

ROADWAY LIGHT LEVEL SUMMARY - CITY OF CAMAS						
ROADWAY CLASSIFICATION	UNITS	AVERAGE	MAX	MIN	AVG / MIN	MAX / MIN
NEIGHBORHOOD (RESIDENTIAL)	Fc	0.43	0.8	0.1	4.30	8.00

GENERAL NOTE:

1. LIGHTING ANALYSIS PERFORMED WITH AGI SOFTWARE.

AKS DRAWING FILE: 9030 P10.0.DWG | LAYOUT: P10.0

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PRELIMINARY STREET LIGHTING PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

PRELIMINARY
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JOB NUMBER:	9030
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DESIGNED BY:	JTG
DRAWN BY:	JTG
CHECKED BY:	MPA

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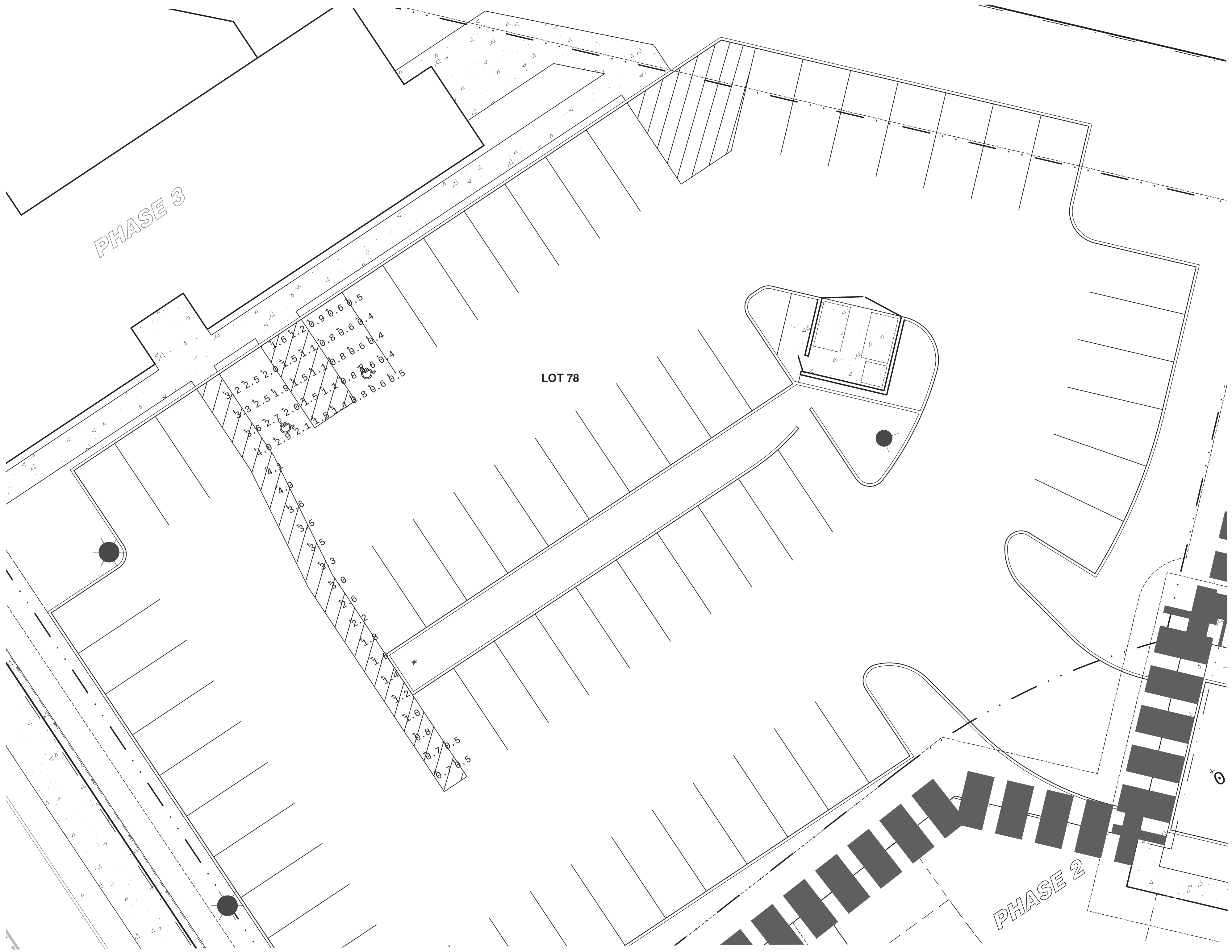

LUMINAIRE SCHEDULE					
SYMBOL	QUANTITY	STYLE	LUMINAIRE TYPE	POLE TYPE	HEIGHT
✷	2	PROPOSED	HUBBELL LIGHTING – AIRO SERIES – ASL-24L-N-T3	N/A	20.0' HT.

ADA/PEDESTRIAN LEVEL SUMMARY – CITY OF CAMAS

UNITS	AVERAGE	MAX	MIN	AVG / MIN	MAX / MIN
Fc	1.70	4.1	0.4	4.25	10.25

GENERAL NOTE:

1. LIGHTING ANALYSIS PERFORMED WITH AGI SOFTWARE.

N

SCALE: 1"=10 FEET

10 0 2 5 10

ORIGINAL PAGE SIZE: 24" x 36"

PRELIMINARY ADA AND PEDESTRIAN LIGHTING PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

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P10.1

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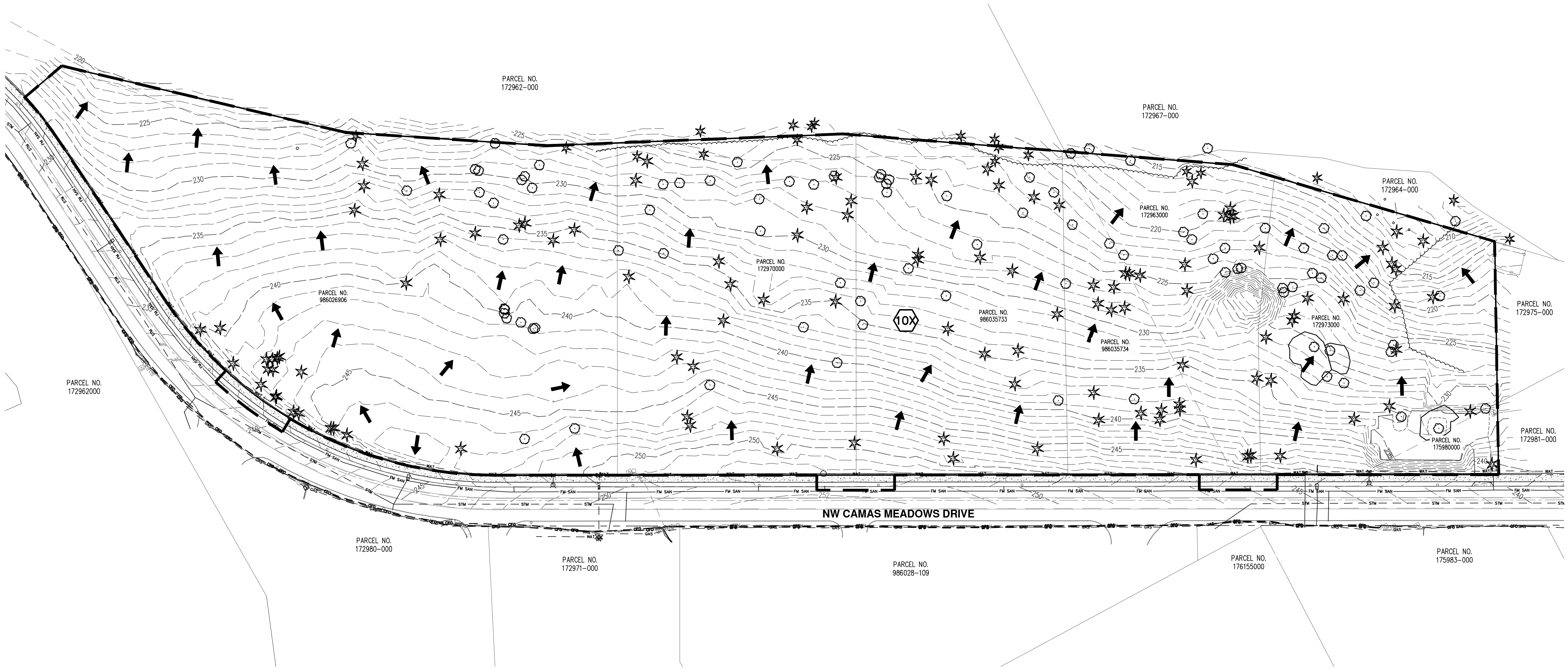
Appendix D: Stormwater Basin Plans



LEGEND

EXISTING GROUND CONTOUR (2 FT)	248
EXISTING GROUND CONTOUR (10 FT)	250
DRAINAGE FLOW DIRECTION	→
PRE-DEVELOPED BASIN	— —

BASIN NOTES:

1. PRE-DEVELOPED BASIN 10
   TOTAL AREA: 13.95 AC
   PERVIOUS AREA: 13.95 AC
   IMPERVIOUS AREA: 0.00 AC

SCALE: 1"=60 FEET
60 0 12 30 60
ORIGINAL PAGE SIZE: 24" x 36"

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PRE-DEVELOPED BASIN PLAN
CAMAS MEADOWS SUBDIVISION
ROMANO CAPITAL
CITY OF CAMAS, WASHINGTON

JOB NUMBER:	9030
DATE:	2/22/2023
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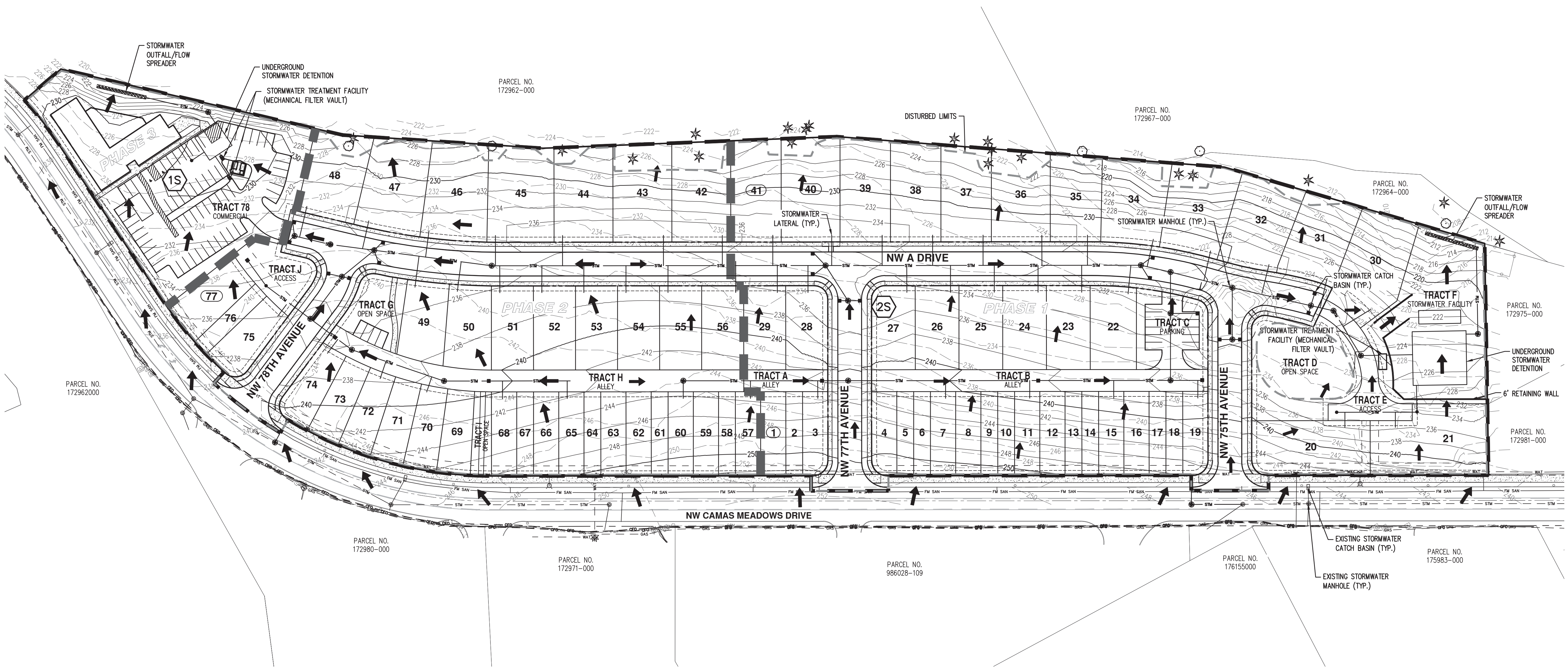
FIG. 1

AKS DRAWING FILE: 9030 PREDEVELOPED BASIN.DWG | LAYOUT: PREDEVELOPED



LEGEND

EXISTING GROUND CONTOUR (2 FT)	248
EXISTING GROUND CONTOUR (10 FT)	250
FINISHED GRADE CONTOUR (10 FT)	250
FINISHED GRADE CONTOUR (10 FT)	250
DRAINAGE FLOW DIRECTION	
POST-DEVELOPED BASIN	
DISTURBED LIMITS	

BASIN NOTES: #S

1. POST-DEVELOPED BASIN 1S
   TOTAL AREA: 1.208 AC
   PERVIOUS AREA: 0.444 AC
   IMPERVIOUS AREA: 0.764 AC

2. POST-DEVELOPED BASIN 2S
   TOTAL AREA: 12.747 AC
   PERVIOUS AREA: 4.674 AC
   IMPERVIOUS AREA: 8.072 AC

SCALE: 1"=60 FEET
60 0 12 30 60
ORIGINAL PAGE SIZE: 24" x 36"

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POST-DEVELOPED BASIN PLAN
CAMAS MEADOWS SUBDIVISION
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CITY OF CAMAS, WASHINGTON

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FIG. 2

AKS DRAWING FILE: 9030 POSTDEVELOPED BASIN.DWG | LAYOUT: POSTDEVELOPED

Appendix E: BMP Details

V-11 Miscellaneous LID BMPs

V-11.1 Introduction to Miscellaneous LID BMPs

BMPs in this chapter have been grouped because they have the following in common:

- They employ Low Impact Development (LID) Principles
- They cannot be used to meet I-3.4.6 MR6: Runoff Treatment
- They cannot, by themselves, be used to meet the Flow Control Performance Standard or the LID Performance Standard.
    - Some of the BMPs in this chapter do allow for some amount of Flow Control credit. See the guidance for each individual BMP for details.
- The design methods for each BMP in this chapter are unique. They do not have strong enough design similarities to other BMPs in this volume to place them in the other BMP categories identified in this volume.

BMP T5.13: Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Applications and Limitations

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to meet this BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

This BMP can be considered infeasible on till soil slopes greater than 33 percent.

Design Guidelines

Soil Retention

Retain, in an undisturbed state, the duff layer and native topsoil to the maximum extent practicable. In any areas requiring grading, remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.

Soil Quality

All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

1. A topsoil layer with a minimum organic matter content of 10% dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.
2. Mulch planting beds with 2 inches of organic material.
3. Use compost and other materials that meet the following organic content requirements:
    a. The organic content for “pre-approved” amendment rates can be met only using compost meeting the compost specification for BMP T7.30: Bioretention, with the exception that the compost may have up to 35% biosolids or manure.

       The compost must also have an organic matter content of 40% to 65%, and a carbon to nitrogen ratio below 25:1.

       The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

    b. Calculated amendment rates may be met through use of composted material meeting (a.) above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and not exceeding the contaminant limits identified in Table 220-B, Testing Parameters, in WAC 173-350-220.

The resulting soil should be conducive to the type of vegetation to be established.

Implementation Options

The soil quality design guidelines listed above can be met by using one of the methods listed below:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil either at default “pre-approved” rates, or at custom calculated rates based on tests of the soil and amendment.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default “pre-approved” rate or at a custom calculated rate.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

Local governments are encouraged to adopt guidelines and procedures similar to those recommended in *Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington* (Stenn et al., 2016).

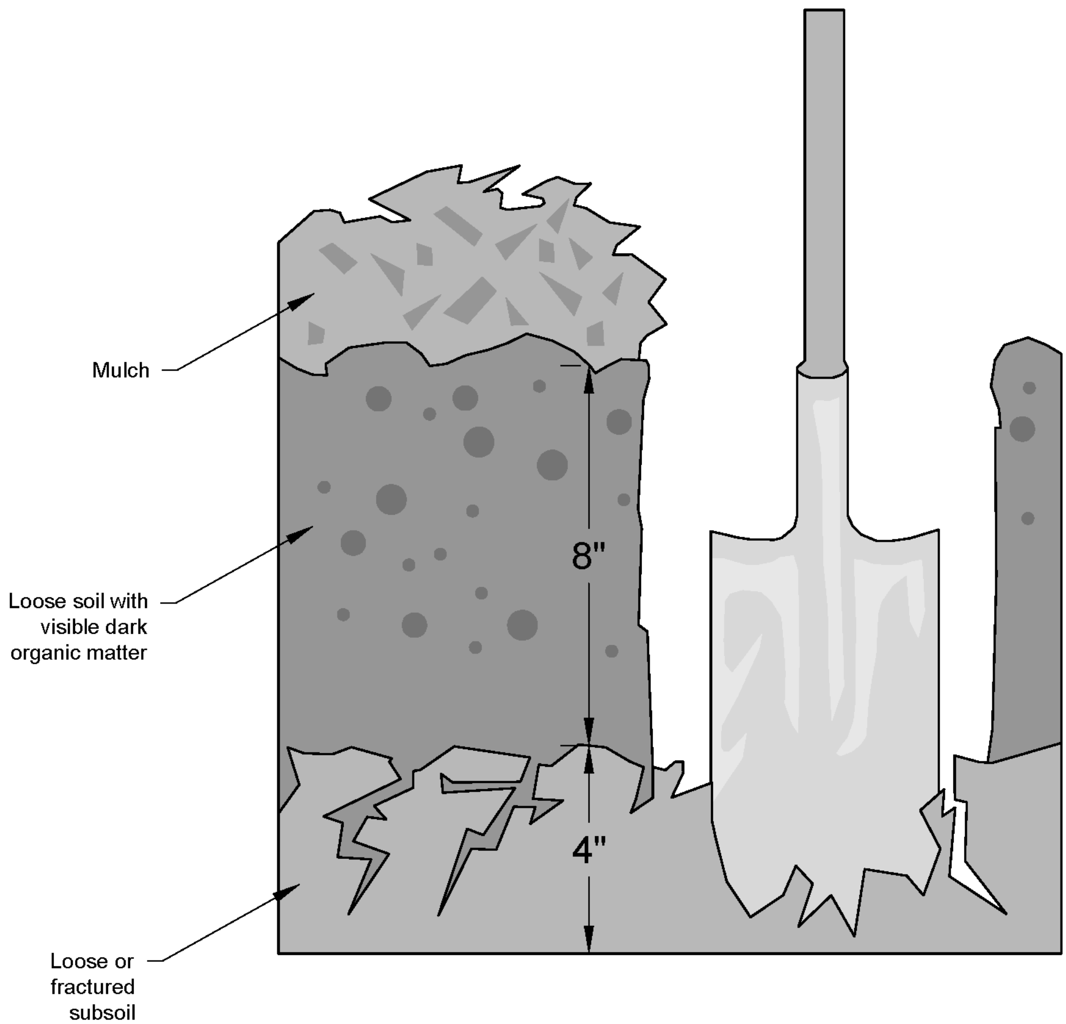
Maintenance

- Establish soil quality and depth toward the end of construction and once established, protect from compaction, such as from large machinery use, and from erosion.
- Plant vegetation and mulch the amended soil area after installation.
- Leave plant debris or its equivalent on the soil surface to replenish organic matter.
- Reduce and adjust, where possible, the use of irrigation, fertilizers, herbicides and pesticides, rather than continuing to implement formerly established practices.

Runoff Model Representation

All areas meeting the soil quality and depth design criteria may be entered into approved runoff models as “Pasture” rather than “Lawn/Landscaping”.

Figure V-11.1: Planting Bed Cross-Section



Reprinted from *Guidelines and Resources For Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington*, 2010, Washington Organic Recycling Council

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Planting Bed Cross-Section

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V-2 Site Design BMPs

V-2.1 Introduction to Site Design BMPs

Site Design BMPs are general practices for site design to minimize the impacts of development on stormwater runoff. They are provided here as an encouragement to project designers. The extent to which these BMPs must be followed depends upon the site development codes, rules, and standards adopted by the local government.

BMP T5.40: Preserving Native Vegetation

Purpose and Definition

Preserving native vegetation on-site to the maximum extent practicable will minimize the impacts of development on stormwater runoff. Preferably 65 percent or more of the development site should be protected for the purposes of retaining or enhancing existing forest cover and preserving wetlands and stream corridors. Maintain tree canopy on the project site to the greatest extent feasible and in accordance with the requirements of the local jurisdiction.

Applications and Limitations

New development often takes place on tracts of forested land. In fact, building sites are often selected because of the presence of mature trees. However, unless sufficient care is taken and planning done, in the interval between buying the property and completing construction much of this resource is likely to be destroyed. The property owner is ultimately responsible for protecting as many trees as possible, with their understory and groundcover. This responsibility is usually exercised by agents, the planners, designers and contractors. It takes 20 to 30 years for newly planted trees to provide the benefits for which trees are so highly valued.

Forest and native growth areas allow rainwater to naturally percolate into the soil, recharging ground water for summer stream flows and reducing surface water runoff that creates erosion and flooding. Conifers can hold up to about 50 percent of all rain that falls during a storm. Twenty to 30 percent of this rain may never reach the ground but evaporates or is taken up by the tree. Forested and native growth areas also may be effective as stormwater buffers around smaller developments.

Preservation of 65 percent or more of the site in native vegetation will allow the use of full dispersion techniques presented in BMP T5.30: Full Dispersion. Sites that can fully disperse per BMP T5.30: Full Dispersion have met the requirements of I-3.4.5 MR5: On-Site Stormwater Management, I-3.4.6 MR6: Runoff Treatment, and I-3.4.7 MR7: Flow Control.

Design Guidelines

- The preserved area should be situated to minimize the clearing of existing forest cover, to maximize the preservation of wetlands, and to buffer stream corridors.
- The preserved area should be placed in a separate tract or protected through recorded

easements for individual lots.

- If feasible, the preserved area should be located downslope from the building sites, since flow control and runoff treatment are enhanced by flow dispersion through duff, undisturbed soils, and native vegetation.
- The preserved area should be shown on all property maps and should be clearly marked during clearing and construction on the site.

Maintenance

Vegetation and trees should not be removed from the natural growth retention area, except for approved timber harvest activities and the removal of dangerous and diseased trees.

BMP T5.41: Better Site Design

Purpose and Definition

Fundamental hydrological and stormwater management concepts can be applied at the site design phase that are:

- more integrated with natural topography,
- reinforcing the hydrologic cycle,
- more aesthetically pleasing, and
- often less expensive to build.

A few site planning principles help to:

- locate development on the least sensitive areas of a site;
- accommodate residential land use; and
- mitigate the impact on stormwater quality.

Design Guidelines

- **Define Development Envelope and Protected Areas** - The first step in site planning is to define the development envelope. This is done by identifying protected areas, setbacks, easements and other site features, and by consulting applicable local standards and requirements. Site features to be protected may include important existing trees, steep slopes, erosive soils, riparian areas, or wetlands.

  By keeping the development envelope compact, environmental impacts can be minimized, construction costs can be reduced, and many of the site's most attractive landscape features can be retained. In some cases, economics or other factors may not allow avoidance of all sensitive areas. In these cases, care can be taken to mitigate the impacts of development through site work and other landscape treatments.

- **Minimize Directly Connected Impervious Areas** - Impervious areas directly connected to the drainage system are the greatest contributors to urban nonpoint source pollution. Any impervious surface that drains into a catch basin or other conveyance structure is a “directly connected impervious surface.” As stormwater runoff flows across parking lots, roadways, and other paved areas, the oil, sediment, metals, and other pollutants are collected and concentrated. If this runoff is collected by a drainage structure and carried directly along impervious gutters or in sealed underground pipes, it has no opportunity for filtering by plant material or infiltration into the soil. It also increases in velocity and amount, causing increased peak-flows in the winter and decreased base-flows in the summer.

A basic site design principle for stormwater management is to minimize these directly connected impervious areas. This can be done by limiting overall impervious land coverage or by infiltrating and/or dispersing runoff within these impervious areas.

- **Maximize Permeability** - Within the development envelope, many opportunities are available to maximize the permeability of new construction. These include minimizing impervious areas, paving with permeable materials, clustering buildings, and reducing the land coverage of buildings by smaller footprints. All of these strategies make more land available for infiltration and dispersion through natural vegetation.

  Clustered driveways, small visitor parking bays and other strategies can also minimize the impact of transportation-related surfaces while still providing adequate access.

  Once site coverage is minimized through clustering and careful planning, pavement surfaces can be selected for permeability. A patio of brick-on-sand, for example, is more permeable than a large concrete slab. Engineered soil/landscape systems are permeable ground covers suitable for a wide variety of uses. Permeable/porous pavements can be used in place of traditional concrete or asphalt pavements in many low traffic applications.

  Maximizing permeability at every possible opportunity requires the integration of many small strategies. These strategies will be reflected at all levels of a project, from site planning to materials selection. In addition to the environmental and aesthetic benefits, a high-permeability site plan may allow the reduction or elimination of expensive underground conveyance systems, Flow Control BMPs, and/or Runoff Treatment BMPs, yielding significant savings in development costs.

- **Build Narrower Streets** - More than any other single element, street design has a powerful impact on stormwater quantity and quality. In residential development, streets and other transportation-related structures typically can comprise between 60 and 70 percent of the total impervious area, and, unlike rooftops, streets are almost always directly connected to the drainage system.

  The combination of large, directly connected impervious areas, together with the pollutants generated by automobiles, makes the street network a principal contributor to stormwater pollution in residential areas.

  Street design is usually mandated by local municipal standards. These standards have been developed to facilitate efficient automobile traffic, maximize parking, and allow for emergency vehicle access. Most require large impervious land coverage. In recent years, new street standards have been gaining acceptance that meet the access requirements of local residential streets while reducing impervious land coverage. These standards generally create a new class of street that is narrower than the current local street standard, called an “access” street. An access street is intended only to provide access to a limited number of residences.

Because street design is the greatest factor in a residential development’s impact on stormwater quality, it is important that designers, municipalities and developers employ street standards that reduce impervious land coverage.

- **Maximize Choices for Mobility** - Given the costs of automobile use, both in land area consumed and pollutants generated, maximizing choices for mobility is a basic principle for environmentally responsible site design. By designing residential developments to promote alternatives to automobile use, a primary source of stormwater pollution can be mitigated.

  Bicycle lanes and paths, secure bicycle parking at community centers and shops, direct, safe pedestrian connections, and transit facilities are all site-planning elements that maximize choices for mobility.

- **Use Drainage as a Design Element** - Unlike conveyance drainage systems that hide water beneath the surface and work independently of surface topography, a drainage system for stormwater infiltration or dispersion can work with natural land forms and land uses to become a major design element of a site plan.

  By applying stormwater management techniques early in the site plan development, the drainage system can suggest pathway alignments, optimum locations for parks and play areas, and potential building sites. In this way, the drainage system helps to generate urban form, giving the development an integral, more aesthetically pleasing relationship to the natural features of the site. Not only does the integrated site plan complement the land, it can also save on development costs by minimizing earthwork and expensive drainage features.

V-12 Detention BMPs

V-12.1 Introduction to Detention BMPs

This section presents guidance for design and analysis of detention BMPs. These BMPs provide Flow Control by providing temporary storage of the increased surface water runoff that results from development. See I-3.4.7 MR7: Flow Control for details on the performance requirements for Flow Control.

The concept of detention is to collect runoff from a developed area and, using a control structure, release it at a slower rate than it enters the collection system (see V-12.2 Control Structure Design). The reduced release rate requires temporary storage of the excess runoff in a pond, tank, or vault, with release occurring over a few hours or days. The volume of temporary storage needed is dependent on:

1. The size of the drainage area.
2. The extent of disturbance of the natural vegetation, topography, and soils and creation of effective impervious surfaces (surfaces that drain to a stormwater collection system).
3. How rapidly the water is allowed to leave the detention pond; i.e., the target release rates.

If runoff from surfaces that require Flow Control is not separated from runoff from other existing surfaces (whether on-site or off-site), refer to the guidance in III-2.4 Flow Bypass and Additional Area Inflow for additional guidance when sizing the detention BMPs.

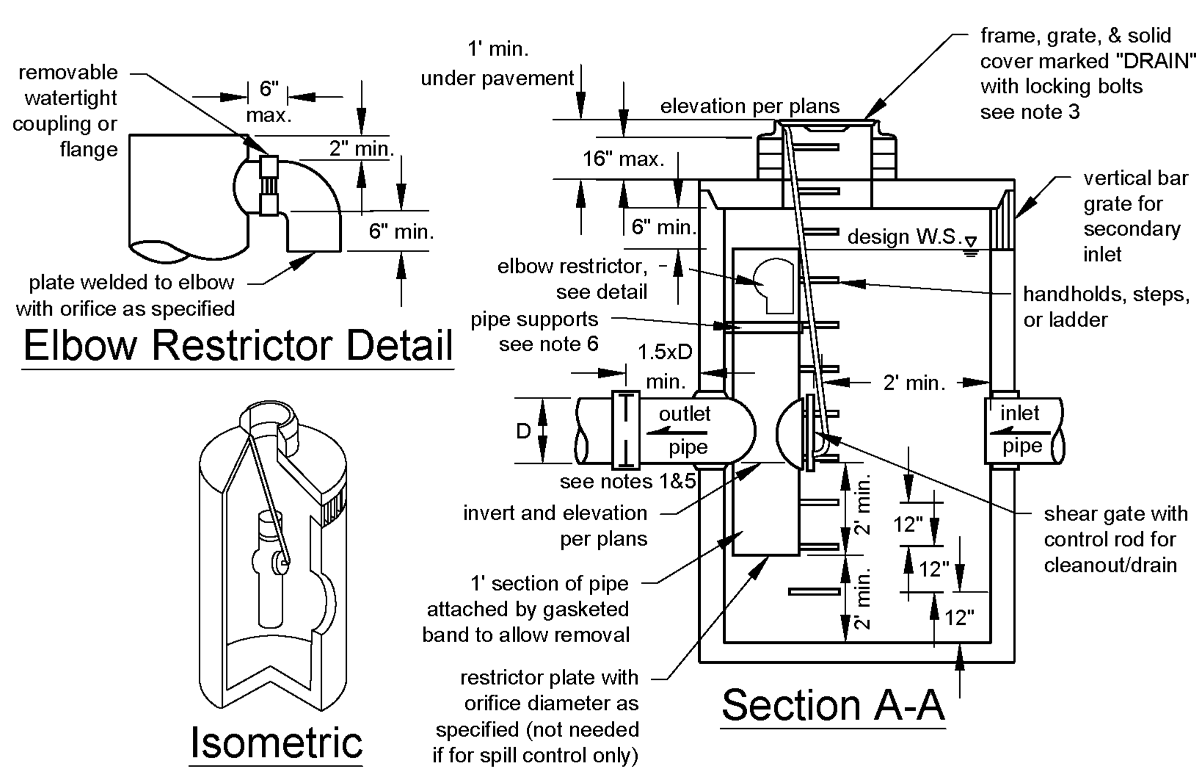
V-12.2 Control Structure Design

Control structures are catch basins or manholes with a restrictor device for controlling outflow from a detention BMP to meet the desired performance standard. Riser type restrictor devices (“tees” or “FROP Ts”) also provide some incidental oil and water separation to temporarily detain oil or other floatable pollutants in runoff due to accidental spill or illegal dumping.

The restrictor device usually consists of two or more orifices and/or a weir section sized to meet performance requirements.

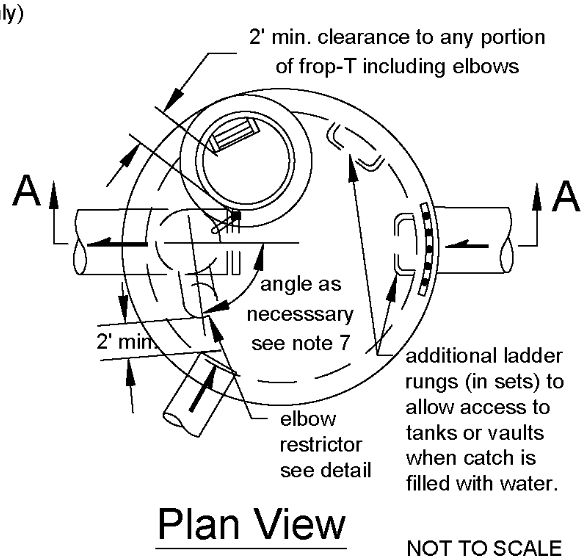
Standard control structure details are shown in Figure V-12.1: Flow Restrictor (TEE), Figure V-12.2: Flow Restrictor (Baffle), and Figure V-12.3: Flow Restrictor (Weir).

Figure V-12.1: Flow Restrictor (TEE)



Notes:

1. Use a minimum of a 54" diameter type 2 catch basin.
2. Outlet Capacity: 100-yr developed peak flow.
3. Metal Parts: Corrosion resistant. Non-Galvanized parts preferred. Galvanized pipe parts to have asphalt treatment 1.
4. Frame and ladder or steps offset so:
   A. Cleanout gate is visible from top.
   B. Climb-down space is clear of riser and cleanout gate.
   C. Frame is clear of curb.
5. If metal outlet pipe connects to cement concrete pipe: outlet pipe to have smooth O.D. equal to concrete pipe I.D. less ¼".
6. Provide at least one 3" x 0.90 inches support bracket anchored to concrete wall. (maximum 3'-0" vertical spacing)
7. Locate elbow restrictor(s) as necessary to provide minimum clearance as shown.
8. Locate additional ladder rungs in structures used as access to tanks or vaults to allow access when catch basin is filled with water.



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Flow Restrictor (TEE)

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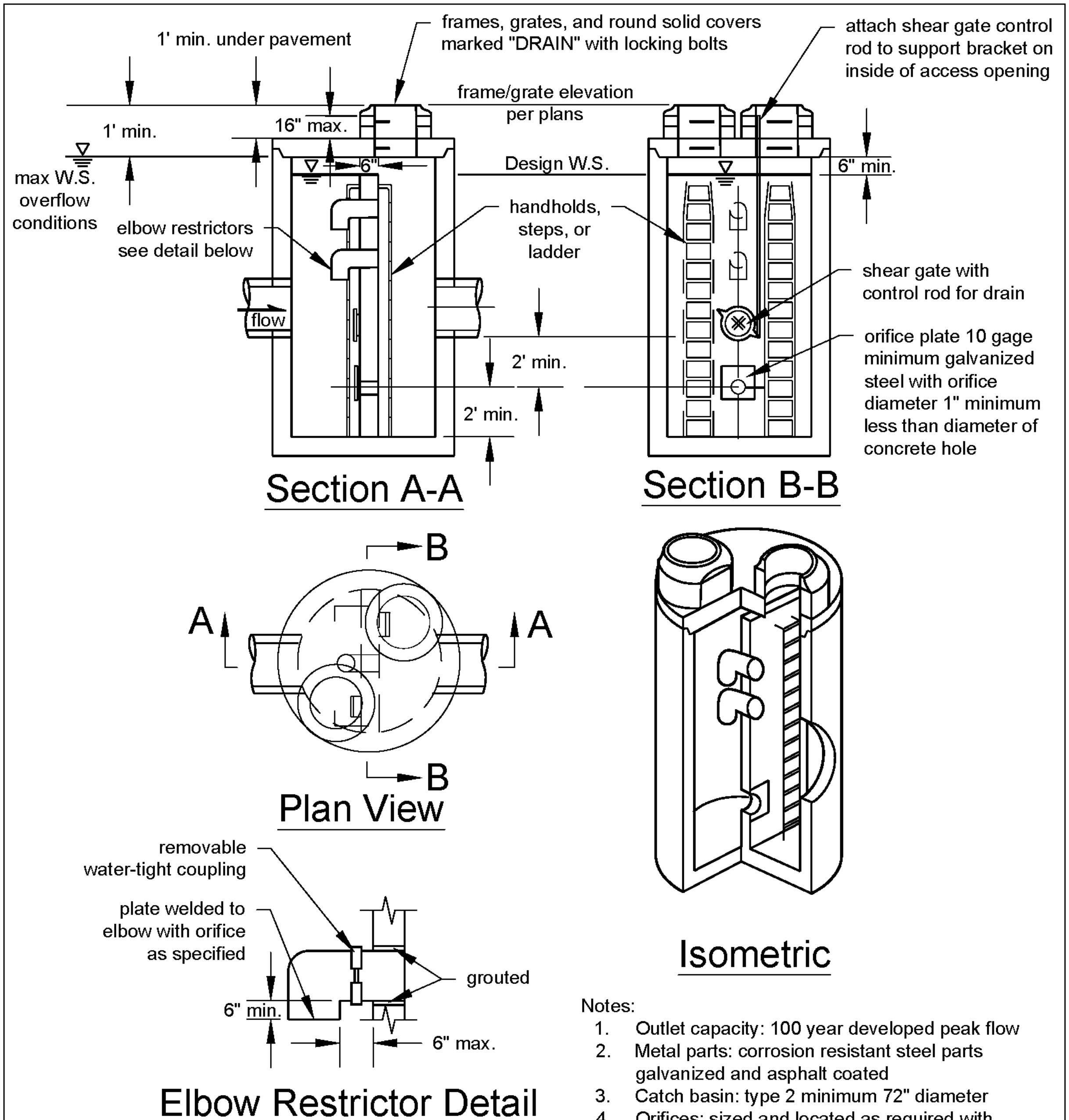
Figure V-12.2: Flow Restrictor (Baffle)



Notes:
1. Outlet capacity: 100 year developed peak flow
2. Metal parts: corrosion resistant steel parts galvanized and asphalt coated
3. Catch basin: type 2 minimum 72" diameter
4. Orifices: sized and located as required with lowest orifice a minimum of 2' from base

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Flow Restrictor (Baffle)

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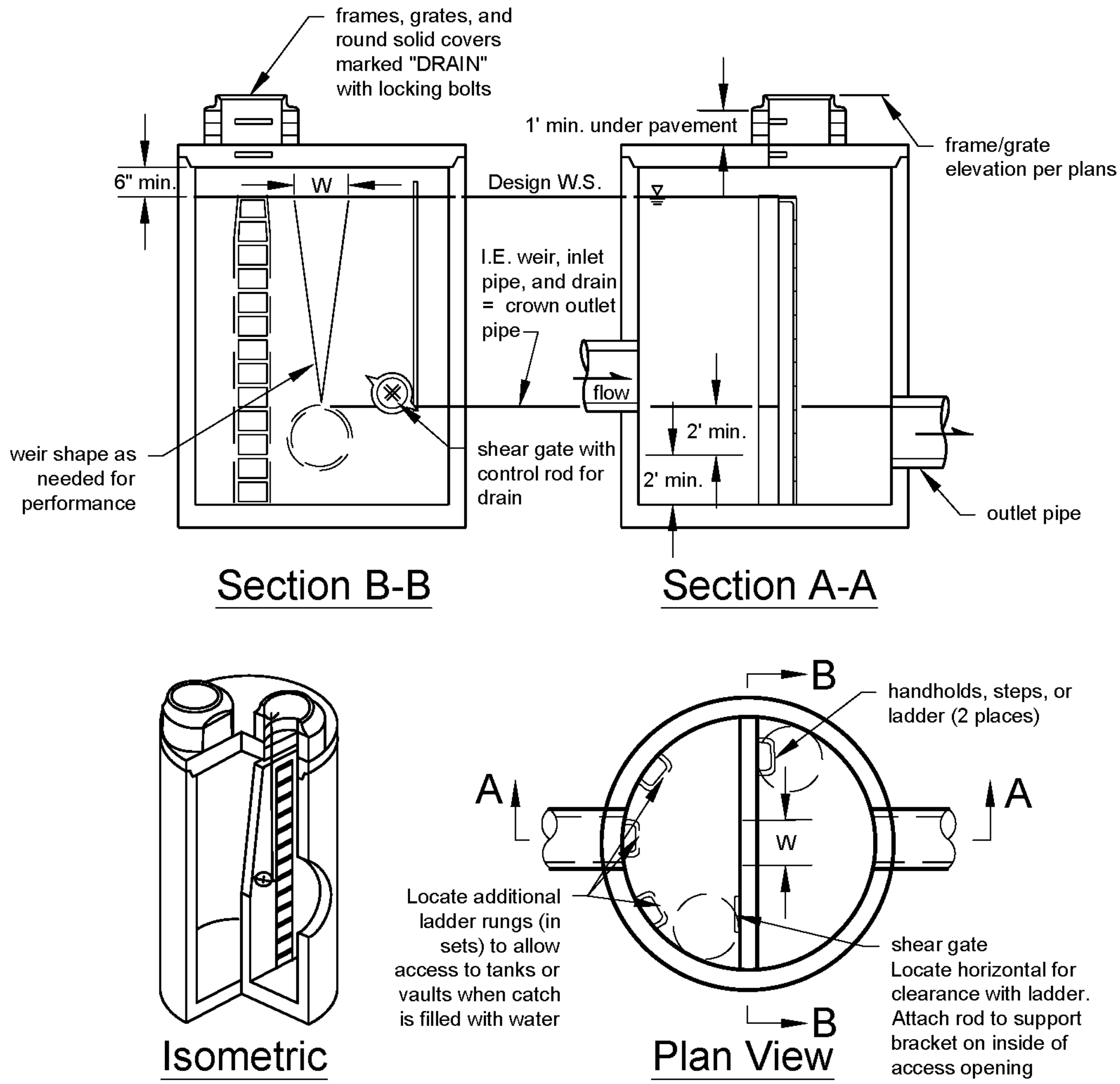
Figure V-12.3: Flow Restrictor (Weir)



Notes:

1. Outlet Capacity: 100-year developed peak flow.
2. Metal Parts: corrosion resistant steel parts galvanized and asphalt coated.
3. Catch Basin: type 2 min. 72" diameter.
4. Baffle Wall: to be designed with concrete reinforcing as required.
5. Spill containment must be provided to temporarily detain oil or floatable pollutants in runoff due to accidental spill or illegal dumping.

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Flow Restrictor (Weir)

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Design Criteria

Multiple Orifice Restrictor

In most cases, control structures need only two orifices: one at the bottom and one near the top of the riser, although additional orifices may best utilize the detention storage volume. Several orifices may be located at the same elevation if necessary to meet performance requirements.

1. The minimum orifice diameter is 0.5 inches.

   In some instances, a 0.5 inch bottom orifice will be too large to meet target release rates, even with minimal head. In these cases, the live storage depth need not be reduced to less than 3 feet in an attempt to meet the performance standards. Also, under such circumstances, flow-throttling devices may be a feasible option. These devices will throttle flows while maintaining a plug-resistant opening.

2. Orifices may be constructed on a tee section as shown in Figure V-12.1: Flow Restrictor (TEE) or on a baffle as shown in Figure V-12.2: Flow Restrictor (Baffle).

3. In some cases, performance requirements may require the top orifice/elbow to be located too high on the riser to be physically constructed (e.g., a 13-inch diameter orifice positioned 0.5 feet from the top of the riser). In these cases, a notch weir in the riser pipe may be used to meet performance requirements (see Figure V-12.5: Rectangular, Sharp Crested Weir).

4. Consider the backwater effect of water surface elevations in the downstream conveyance system. High tailwater elevations may affect performance of the restrictor system and reduce live storage volumes.

Riser and Weir Restrictor

1. Properly designed weirs may be used as flow restrictors (see Figure V-12.3: Flow Restrictor (Weir), Figure V-12.5: Rectangular, Sharp Crested Weir, Figure V-12.6: V-Notch, Sharp-Crested Weir, and Figure V-12.7: Sutro Weir). However, they must be designed to provide for primary overflow of the developed 100-year peak flow discharging to the detention BMP.

2. The combined orifice and riser (or weir) overflow may be used to meet performance requirements; however, the design must still provide for primary overflow of the developed 100 year peak flow assuming all orifices are plugged. Figure V-12.8: Riser Inflow Curves can be used to calculate the head in feet above a riser of given diameter and flow.

Access

1. Provide an access road to the control structure for inspection and maintenance. Design and construct the access road as specified in BMP D.1: Detention Ponds.

2. Manhole and catch basin lids for control structures must be locking, and rim elevations must match proposed finish grade.

3. Manholes and catch basins must meet the OSHA confined space requirements, which include

clearly marking entrances to confined space areas. This may be accomplished by hanging a removable sign in the access riser, just under the access lid.

Information Plate

It is recommended that a brass or stainless steel plate be permanently attached inside each control structure with the following information engraved on the plate:

- Name and file number of the project
- Name and organization of (1) project proponent, (2) engineer, and (3) contractor
- Date constructed
- Name and date of manual used for design
- Outflow performance criteria
- Release mechanism size, type, and invert elevation
- List of stage, discharge, and volume at one foot increments
- Elevation of overflow
- Recommended frequency of maintenance.

Maintenance

Control structures have a history of maintenance-related problems and it is imperative to establish a good maintenance program for them to function properly. Typically, sediment builds up inside the structure, which blocks or restricts flow to the inlet. To prevent this problem, routinely clean out control structures at least twice per year. Conduct regular inspections of control structures to detect the need for non-routine cleanout, especially if construction or land-disturbing activities occur in the contributing drainage area.

Appendix V-A: BMP Maintenance Tables provides maintenance recommendations for control structures.

Methods of Analysis

This section presents the methods and equations for design of control structure restrictor devices. Included are details for the design of orifices, rectangular sharp crested weirs, v notch weirs, sutro weirs, and overflow risers.

Orifices

Flow through orifice plates in the standard tee section or turned down elbow may be approximated by the general equation:

$$Q = CA\sqrt{2gh}$$

where

Q = flow (cfs)

C = coefficient of discharge (0.62 for plate orifice)

A = area of orifice (ft^2)

h = hydraulic head (ft)

g = gravity (32.2 ft/sec^2)

Figure V-12.4: Simple Orifice illustrates this simplified application of the orifice equation.

The diameter of the orifice is calculated from the flow. The orifice equation is often useful when expressed as the orifice diameter in inches:

$$d = \sqrt{\frac{36.88Q}{\sqrt{h}}}$$

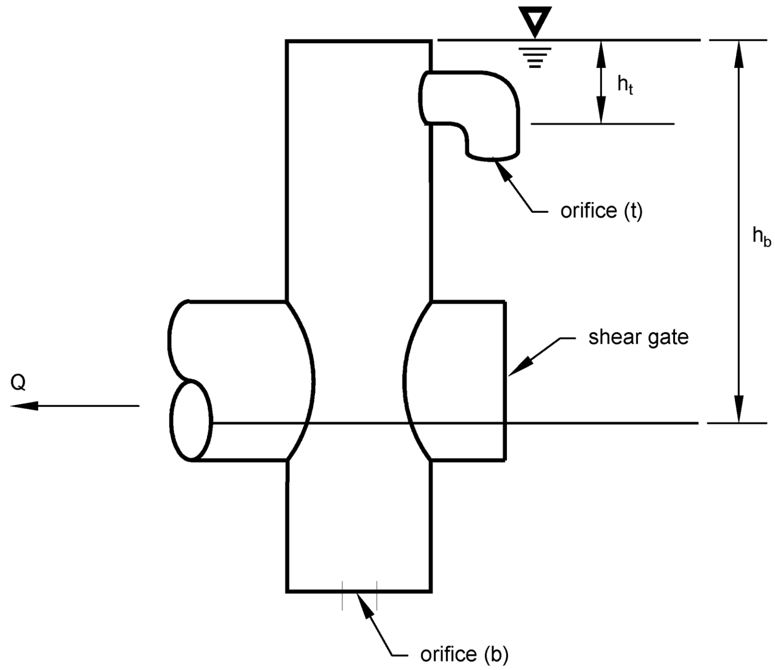
where

d = orifice diameter (inches)

Q = flow (cfs)

h = hydraulic head (ft)

Figure V-12.4: Simple Orifice



$$Q = CA_b\sqrt{2gh_b} + CA_t\sqrt{2gh_t}$$
$$= C\sqrt{2g}(A_b\sqrt{h_b} + A_t\sqrt{h_t})$$
h_b = distance from hydraulic grade line at the 2 – year flow of the outflow pipe to the overflow elevation

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Simple Orifice

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Rectangular Sharp Crested Weir

The rectangular sharp crested weir design shown in Figure V-12.5: Rectangular, Sharp Crested Weir may be analyzed using standard weir equations for the fully contracted condition.

$$Q=C(L-0.2H)H^{3/2}$$

where

Q = flow (cfs)

C = 3.27 + 0.40 H/P (ft)

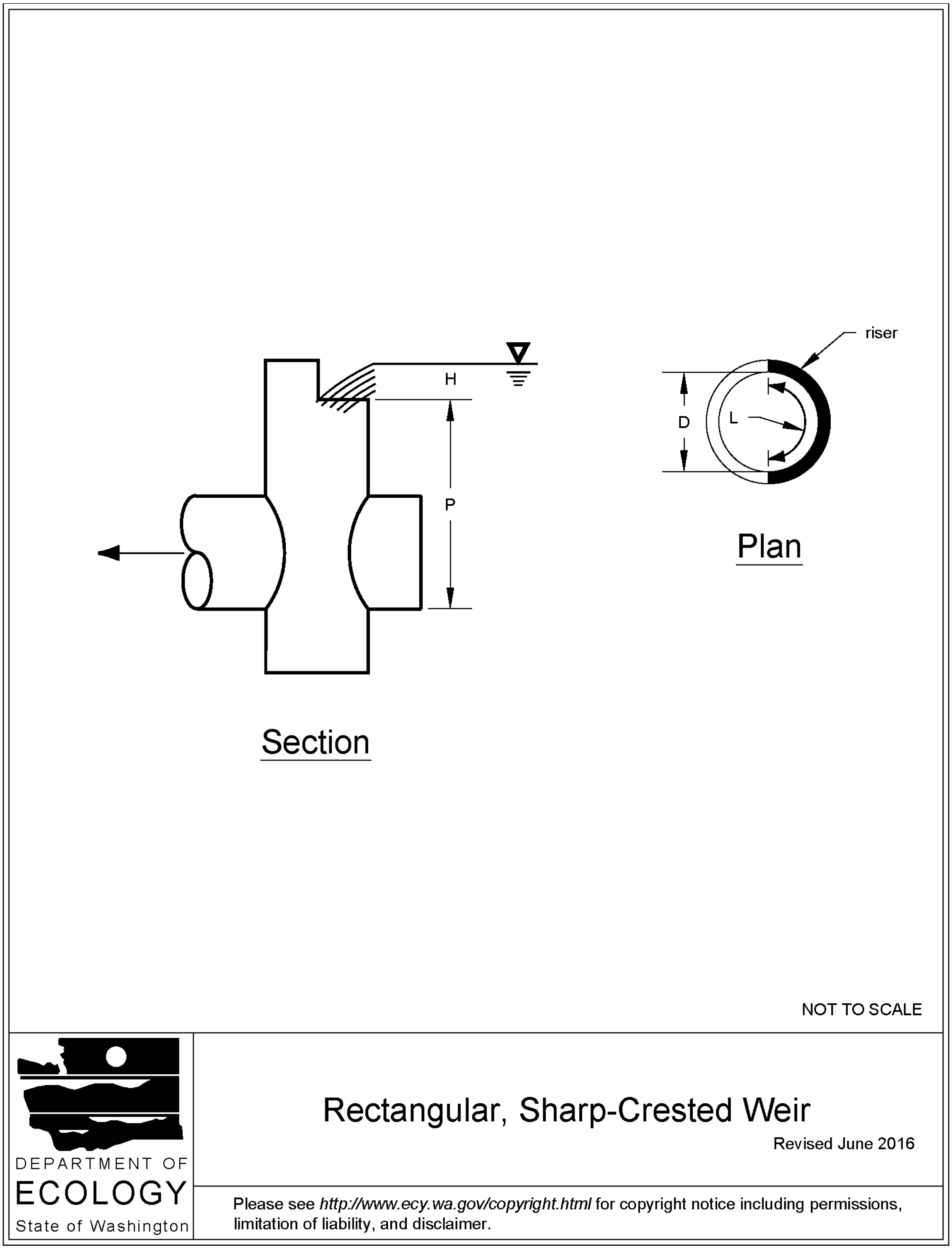
H, P are as shown in Figure V-12.5: Rectangular, Sharp Crested Weir

L = length (ft) of the portion of the riser circumference as necessary not to exceed 50 percent of the circumference

D = inside riser diameter (ft)

Note that this equation accounts for side contractions by subtracting 0.1H from L for each side of the notch weir.

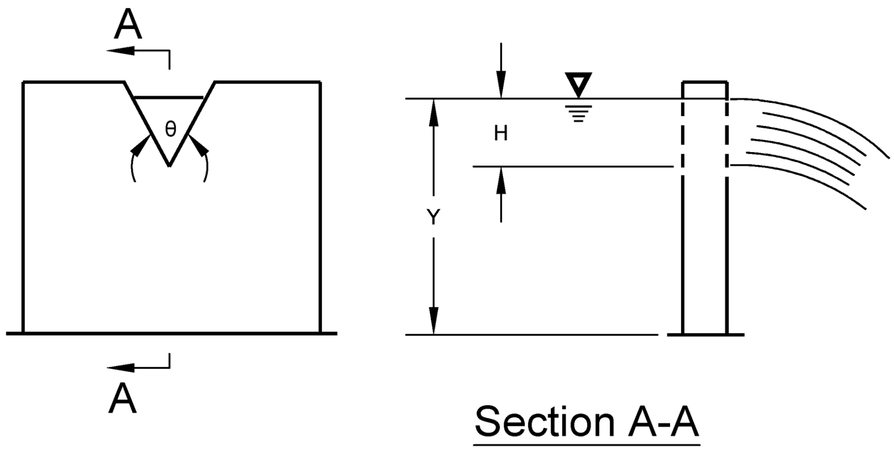
Figure V-12.5: Rectangular, Sharp Crested Weir



V-Notch Sharp - Crested Weir

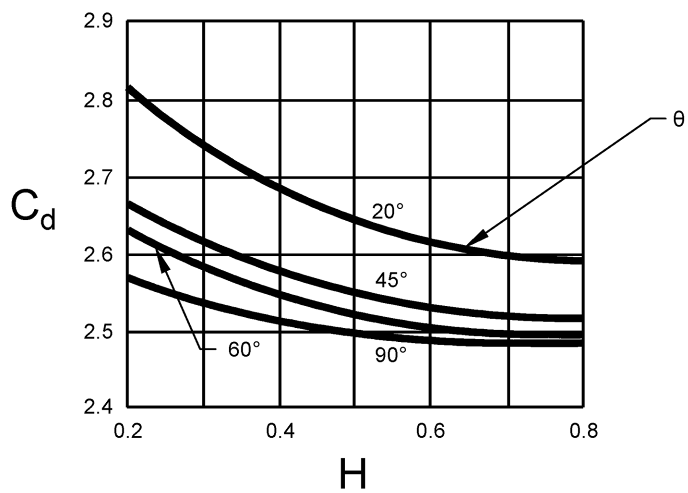
V-notch weirs as shown in Figure V-12.6: V-Notch, Sharp-Crested Weir may be analyzed using standard equations for the fully contracted condition.

Figure V-12.6: V-Notch, Sharp-Crested Weir



$$Q = C_d (\text{Tan}\frac{\theta}{2}) H^{\frac{5}{2}} \text{ in cfs}$$

Where values of C_d may be taken from the following chart :



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V-Notch, Sharp Crested Weir

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Proportional or Sutro Weir

Sutro weirs are designed so that the discharge is proportional to the total head. This design may be useful in some cases to meet performance requirements.

The sutro weir consists of a rectangular section joined to a curved portion that provides proportionality for all heads above the line A-B (see Figure V-12.7: Sutro Weir). The weir may be symmetrical or non-symmetrical.

For this type of weir, the curved portion is defined by the following equation (calculated in radians):

$$\frac{x}{b} = 1 - \frac{2}{\pi} Tan^{-1} \sqrt{\frac{Z}{a}}$$

where a, b, x and Z are as shown in Figure V-12.7: Sutro Weir.

The head discharge relationship is:

$$Q = (C_d)(b)(\sqrt{2ga})(h_1 - \frac{a}{3})$$

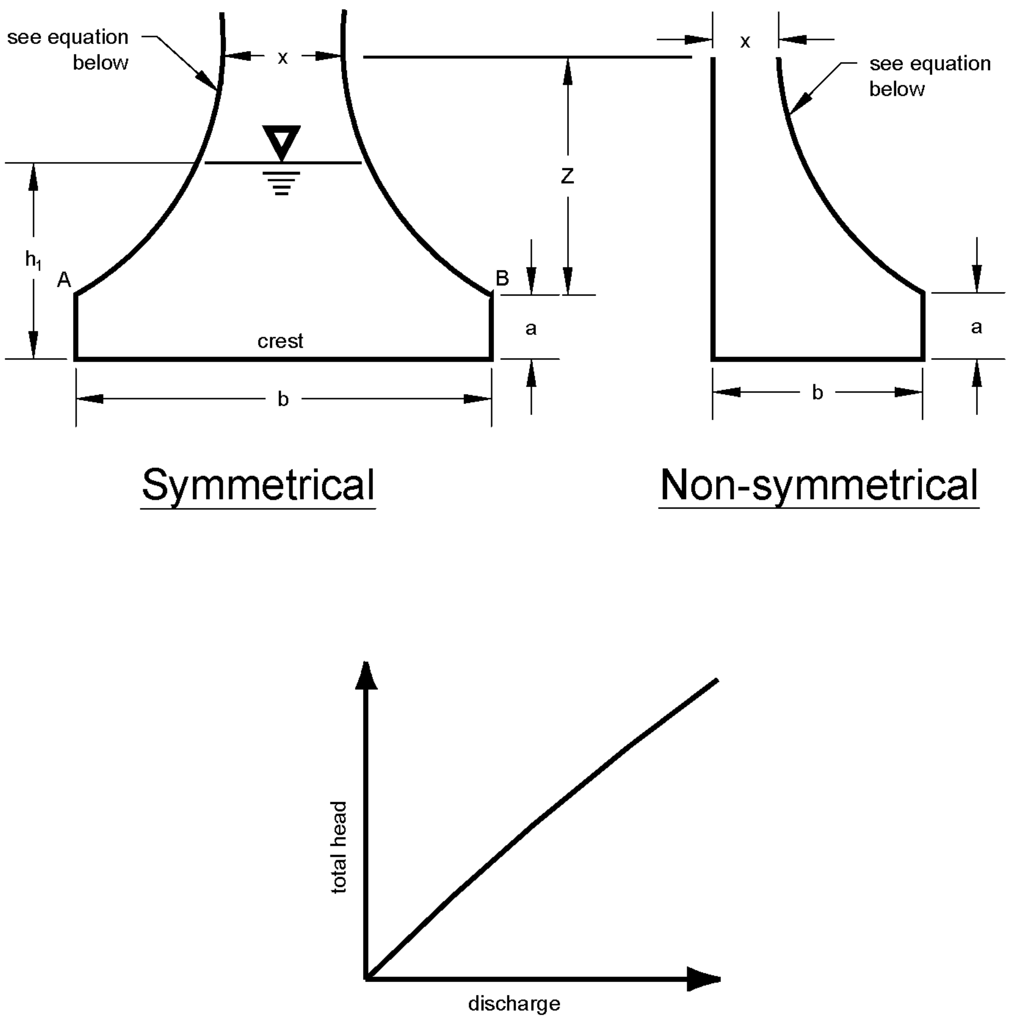
Values of C_d for both symmetrical and non symmetrical sutro weirs are summarized in Table V-12.1: Values of Cd for Sutro Weirs.

Note: When b > 1.50 or a > 0.30, use C_d=0.6.

Table V-12.1: Values of C_d for Sutro Weirs

C_d Values, Symmetrical							C_d Values, Non-Symmetrical					
b (ft)							b (ft)					
a (ft)	0.50	0.75	1.00	1.25	1.50		a (ft)	0.50	0.75	1.00	1.25	1.50
0.02	0.608	0.613	0.617	0.6185	0.619		0.02	0.614	0.619	0.623	0.6245	0.625
0.05	0.606	0.611	0.615	0.617	0.6175		0.05	0.612	0.617	0.621	0.623	0.6235
0.10	0.603	0.608	0.612	0.6135	0.614		0.10	0.609	0.614	0.618	0.6195	0.620
0.15	0.601	0.6055	0.610	0.6115	0.612		0.15	0.607	0.6115	0.616	0.6175	0.618
0.20	0.599	0.604	0.608	0.6095	0.610		0.20	0.605	0.610	0.614	0.6155	0.616
0.25	0.598	0.6025	0.6065	0.608	0.6085		0.25	0.604	0.6085	0.6125	0.614	0.6145
0.30	0.597	0.602	0.606	0.6075	0.608		0.30	0.603	0.608	0.612	0.6135	0.614

Figure V-12.7: Sutro Weir



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Sutro Weir

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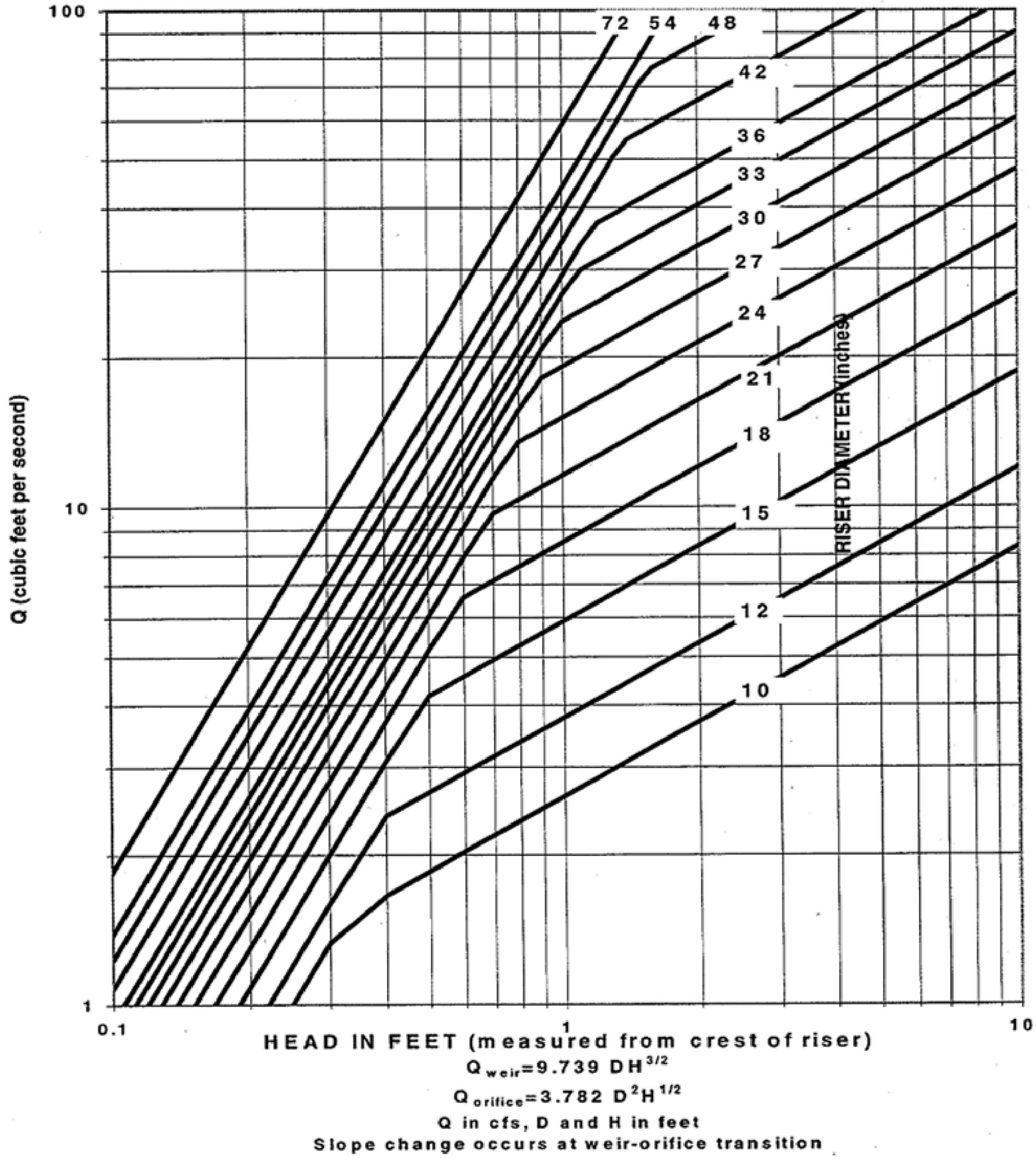
Riser Overflow

The nomograph in Figure V-12.8: Riser Inflow Curves can be used to determine the head (in feet) above a riser of given diameter and for a given flow (usually the 100 year peak flow for developed conditions).

Figure V-12.8: Riser Inflow Curves



DEPARTMENT OF ECOLOGY
State of Washington

Riser Inflow Curves

Revised June 2016

BMP D.3: Detention Vaults

Detention vaults are box shaped underground detention BMPs typically constructed with reinforced concrete. A standard detention vault detail is shown in Figure V-12.16: Typical Detention Vault. Control structure details are shown in V-12.2 Control Structure Design.

Design Criteria

General

Typical design guidelines for detention vaults are as follows:

1. Detention vaults may be designed as flow-through systems with bottoms level (longitudinally), or sloped toward the inlet to facilitate sediment removal. Maximize the distance between the inlet and outlet as feasible.
2. The detention vault bottom may slope at least 5 percent from each side towards the center, forming a broad “v” to facilitate sediment removal. More than one “v” may be used to minimize vault depth. However, the vault bottom may be flat with 0.5-1 foot of sediment storage if removable panels are provided over the entire vault. It is recommended that the removable panels be at grade, have stainless steel lifting eyes, and weigh no more than 5 tons per panel.
3. Elevate the invert elevation of the outlet above the bottom of the vault to provide an average 6 inches of sediment storage over the entire bottom. Also, elevate the outlet a minimum of 2 feet above the orifice to retain oil within the vault.
4. Details of outflow control structures are given in V-12.2 Control Structure Design.

Materials

Minimum 3,000 psi structural reinforced concrete may be used for detention vaults. Provide all construction joints with water stops.

Structural Stability

All vaults must meet structural requirements for overburden support and H20 traffic loading (See (AASHTO, 2002)). Vaults located under roadways must meet any live load requirements of the local government. Design cast-in place wall sections as retaining walls. Structural designs for cast in place vaults must be stamped by a licensed engineer in the state of Washington with structural expertise. Place vaults on stable, well consolidated native material with suitable bedding. Do not place vaults in fill slopes, unless analyzed in a geotechnical report for stability and constructability.

Access Openings

Provide access openings over the inlet pipe and control structure. Use the following guidelines for access.

1. Position access openings a maximum of 50 feet from any location within the vault. Additional access points may be needed on large vaults. Provide access to each “v” if more than one “v”

is provided in the vault floor.

2. For vaults with greater than 1,250 square feet of floor area, provide a 5' by 10' removable panel over the inlet pipe (instead of a standard frame, grate and solid cover). Or, provide a separate access vault as shown in Figure V-12.16: Typical Detention Vault.

3. For vaults under roadways, locate the removable panel outside the travel lanes. Or, provide multiple standard locking manhole covers. Ladders and hand holds need only be provided at the outlet pipe and inlet pipe, and as needed to meet OSHA confined space requirements.

4. All access openings, except those covered by removable panels, may have round, solid locking lids, or 3 foot square, locking diamond plate covers.

5. Vaults with widths 10 feet or less must have removable lids.

6. The maximum depth from finished grade to the vault invert should be 20 feet.

7. Provide internal structural walls of large vaults with openings sufficient for maintenance access between cells. Size and situate the openings to allow access to the maintenance “v” in the vault floor.

8. The minimum internal height should be 7 feet from the highest point of the vault floor (not sump), and the minimum width should be 4 feet. However, concrete vaults may be a minimum 3 feet in height and width if used as tanks with access manholes at each end, and if the width is no larger than the height. Also, the minimum internal height requirement may not be needed for any areas covered by removable panels.

9. Vaults must comply with the OSHA confined space requirements, which includes clearly marking entrances to confined space areas. This may be accomplished by hanging a removable sign in the access riser(s), just under the access lid.

10. Provide ventilation pipes (minimum 12 inch diameter or equivalent) in all four corners of vaults to allow for artificial ventilation prior to entry of maintenance personnel into the vault. Or, provide removable panels over the entire vault. Vaults providing manhole access at 12 foot spacing need not provide corner ventilation pipes.

Access Roads

Access roads are needed to the access panel (if applicable), the control structure, and at least one access point per cell, and they may be designed and constructed as specified for detention ponds in BMP D.1: Detention Ponds.

Right-of Way

Right-of-way is needed for detention vault maintenance. It is recommended that any tract not abutting public right of way should have a 15 to 20 foot wide extension of the tract to accommodate an access road to the detention vault.

Setbacks

It is recommended that detention vaults be a minimum of 20 feet from any structure, property line, and any vegetative buffer required by the local government and from any septic drainfield. However, the setback requirements are generally specified by the local government, uniform building code, or other statewide regulation and may be different from those mentioned above.

All detention vaults must be a minimum of 50 feet from the top of any steep (greater than 15%) slope. A geotechnical analysis and report must be prepared addressing the potential impact of the vault on a slope steeper than 15%.

Maintenance

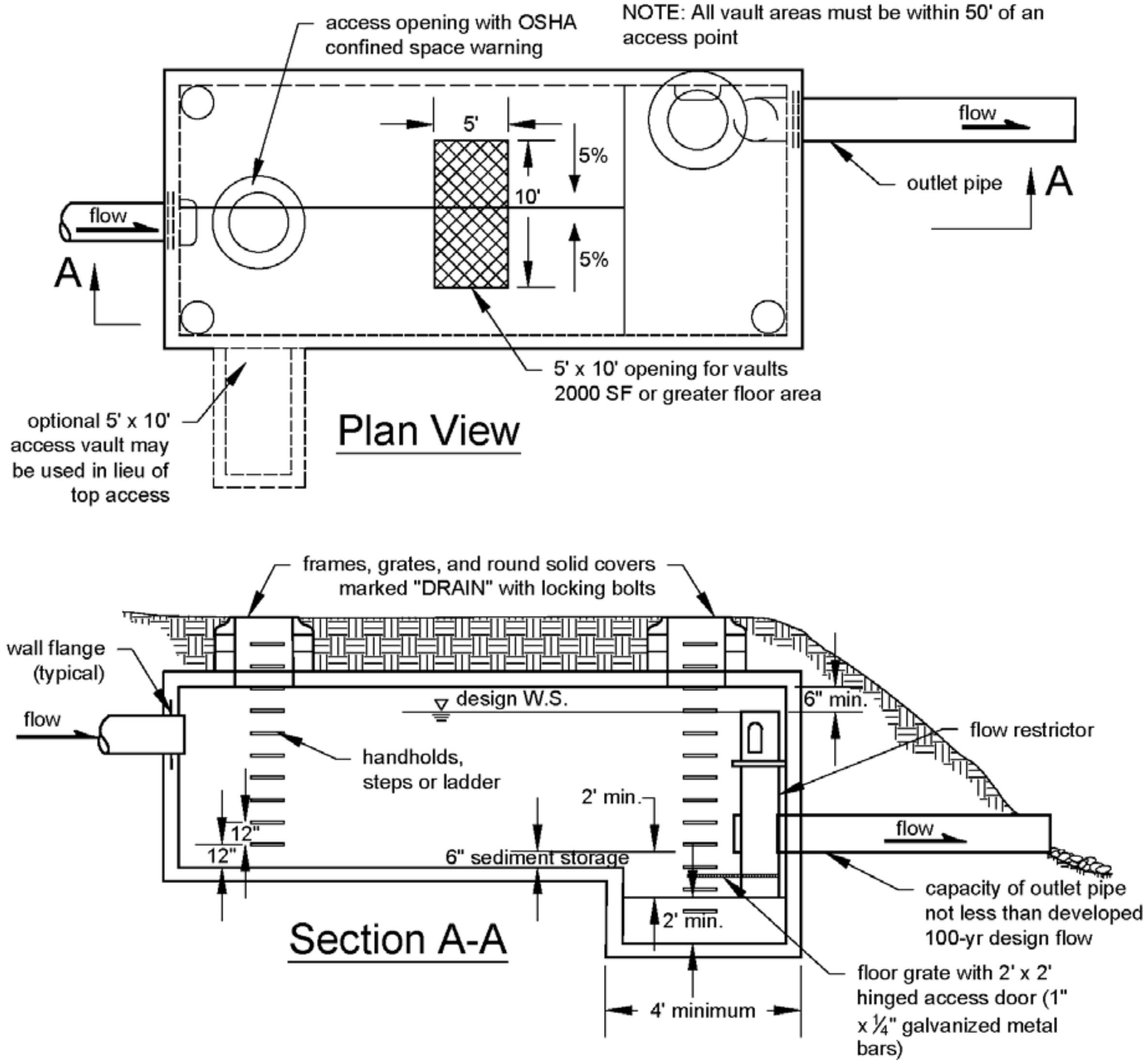
Build in provisions to facilitate maintenance operations into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost. See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults) for specific maintenance requirements.

Methods of Analysis

Detention Volume and Outflow

Design the volumes and outflows for detention vaults to meet the performance standards as required in I-3.4.5 MR5: On-Site Stormwater Management, I-3.4.7 MR7: Flow Control, and/or I-3.4.8 MR8: Wetlands Protection,and the hydrologic analysis and design methods in III-2 Modeling Your BMPs. Design guidelines for control structures are given in V-12.2 Control Structure Design.

Figure V-12.16: Typical Detention Vault



Notes:

1. All metal parts must be corrosion resistant. Steel parts must be galvanized and asphalt coated (Treatment 1 or better).
2. Provide water stop at all cast-in-place construction joints. Precast vaults shall have approved rubber gasket system.
3. Vaults ≤ 10' wide must use removable lids.
4. Prefabricated vault sections may require structural modifications to support 5' x 10' opening over main vault. Alternatively, access can be provided via a side vestibule as shown.

NOT TO SCALE

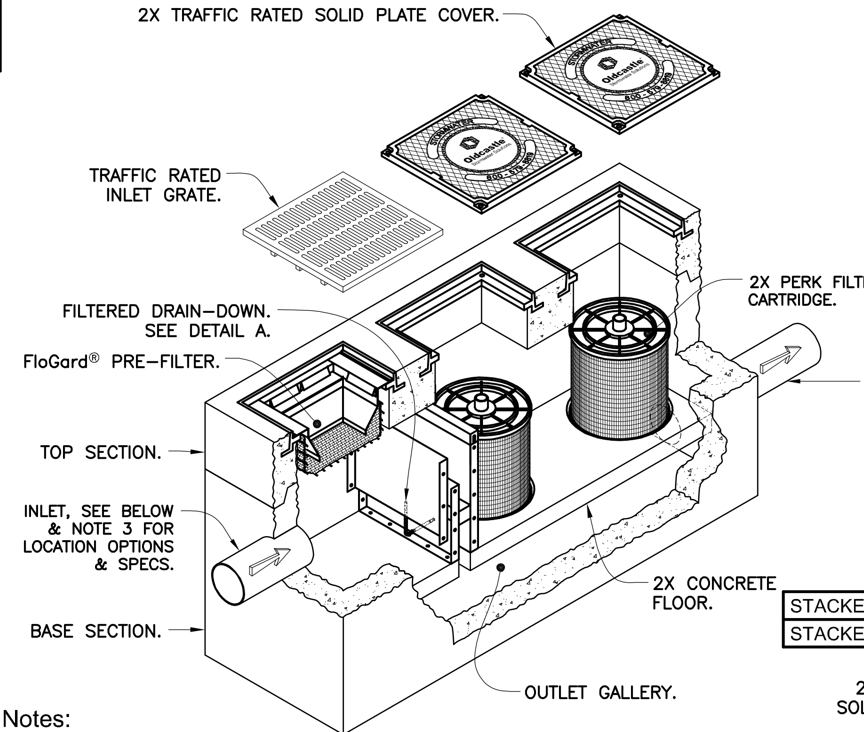
DEPARTMENT OF ECOLOGY State of Washington

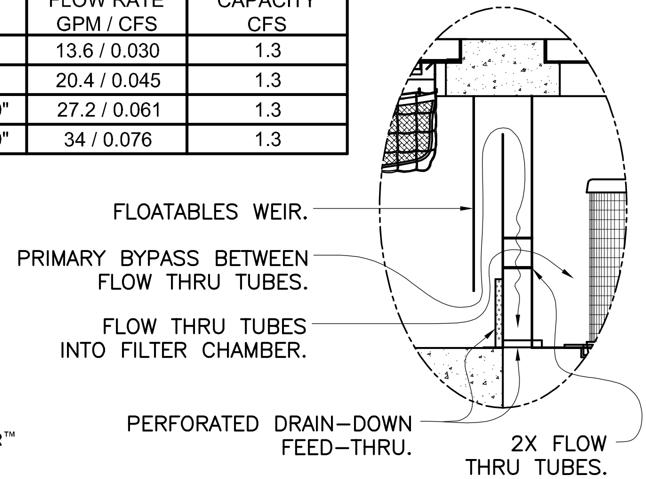
Typical Detention Vault

Revised June 2016

Washington GULD*

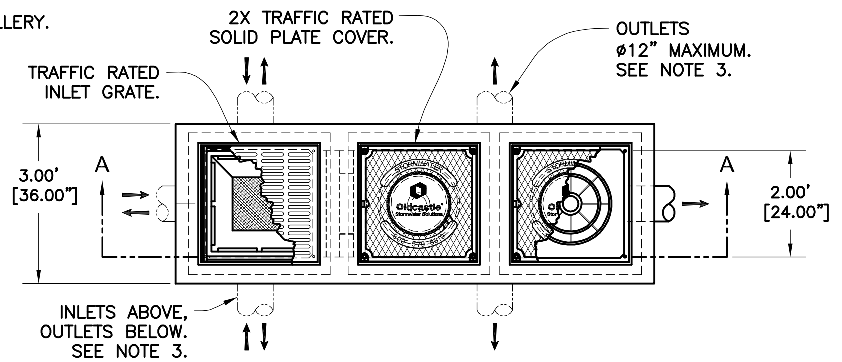
	CARTRIDGE SIZE	TREATMENT FLOW RATE GPM / CFS	TOTAL FLOW CAPACITY CFS
	12.00"	13.6 / 0.030	1.3
	18.00"	20.4 / 0.045	1.3
STACKED	12.00" + 12.00"	27.2 / 0.061	1.3
STACKED	18.00" + 12.00"	34 / 0.076	1.3





DETAIL A
INLET / BYPASS ASSEMBLY & DRAIN-DOWN SCALE: 2X

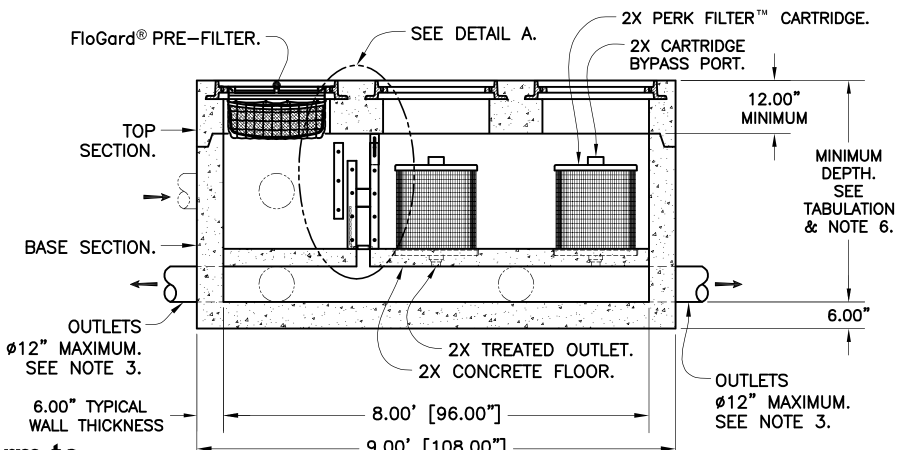
	MINIMUM DEPTHS (SEE NOTE 6)				
	CARTRIDGE SIZE	Ø 6.0" OUTLET PIPE (IN INCHES)	Ø 8.0" OUTLET PIPE (IN INCHES)	Ø 10.0" OUTLET PIPE (IN INCHES)	Ø 12.0" OUTLET PIPE (IN INCHES)
	12.00"	39	41	43	45
	18.00"	46	48	50	52
STACKED	12.00" + 12.00"	56	58	60	62
STACKED	18.00" + 12.00"	63	65	67	69



Notes:

1. Precast concrete structure shall be manufactured in accordance with ASTM Designation C857 and C858.
2. Perk Filter™ Catch basin shall be supplied with traffic rated (H20) bicycle-proof grates and solid plate cover.
3. Inlet pipe(s) may enter device on three sides of the inlet chamber. Outlet pipe(s) may exit on all four sides. All pipe is Ø 12" maximum.
4. Inlet chamber shall be supplied with a drain-down device designed to remove standing water between storm events.
5. Perk Filter™ catch basin shall be supplied with FloGard® pre-filter device. FloGard® pre-filter and Perk Filter™ cartridge shall be maintained in accordance with manufacturer recommendations.
6. For depths less than the specified minimum contact Oldcastle® Stormwater Solutions for engineering assistance.

*** Treatment Flow Rates shown conform to Washington State GULD Specifications.**



SECTION A-A
DOUBLE CARTRIDGE CONCRETE CATCH BASIN
(END GRATE CONFIGURATION)

Media Filtration

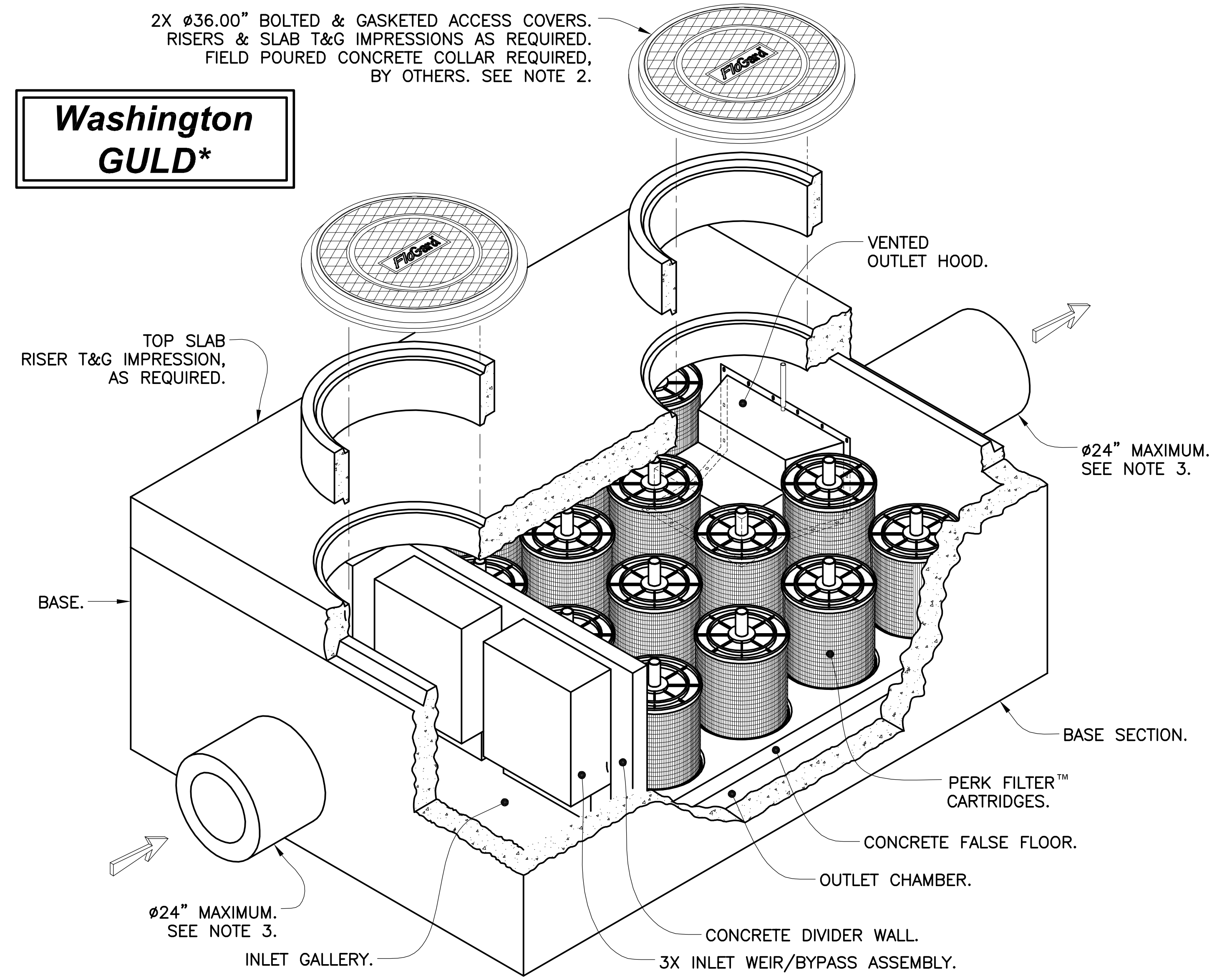
Perk Filter™
Concrete Catch Basin
Double Cartridge
Washington State GULD
(End Grate Configuration)

Oldcastle® Stormwater Solutions
7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

DRAWING NO.	REV	ECO	DATE	
PF-CCB-WA-0002	C	ECO-0128 JPR X/X/X	JPR 3/2/11	SHEET 1 OF 1

PF-V-8-WA-0001

Washington GULD*



Notes:

1. Precast concrete structure shall be manufactured in accordance with ASTM Designation C857 and C858.

2. Filter system shall be supplied with traffic rated (H20) bolted & gasketed Ø36" circular access covers with risers as required. Shallow applications may require configurations with (H20) bolted & gasketed square/rectangular access hatches. Field poured concrete collars required, by others.

3. Inlet & outlet pipe(s) (Ø 24" maximum) may enter device on all three sides of the inlet & outlet chambers respectively.

4. Inlet chamber shall be supplied with a drain-down device designed to remove standing water between storm events.

5. For depths less than specified minimums contact Oldcastle® Stormwater Solutions for engineering assistance.

*** Treatment Flow Rates shown conform to Washington State GULD Specifications**

Media Filtration

Perk Filter™

8' Wide Concrete Vault

Washington State GULD

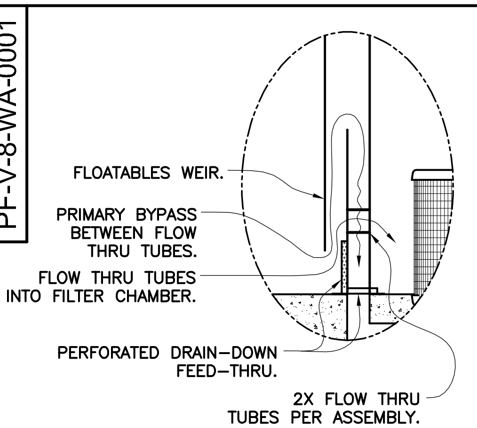
Six to Thirty One Cartridges / Stacks

Oldcastle® Stormwater Solutions

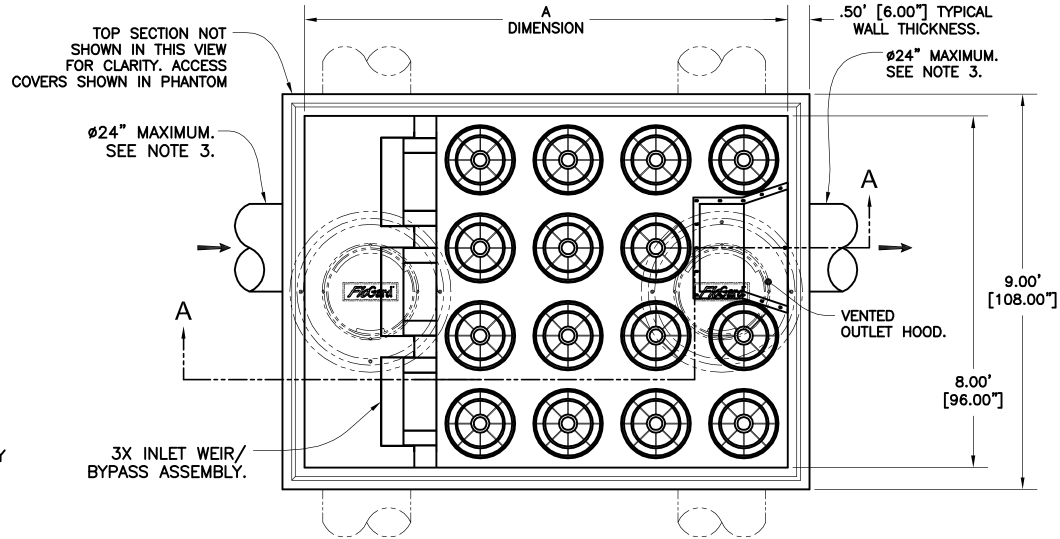
7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

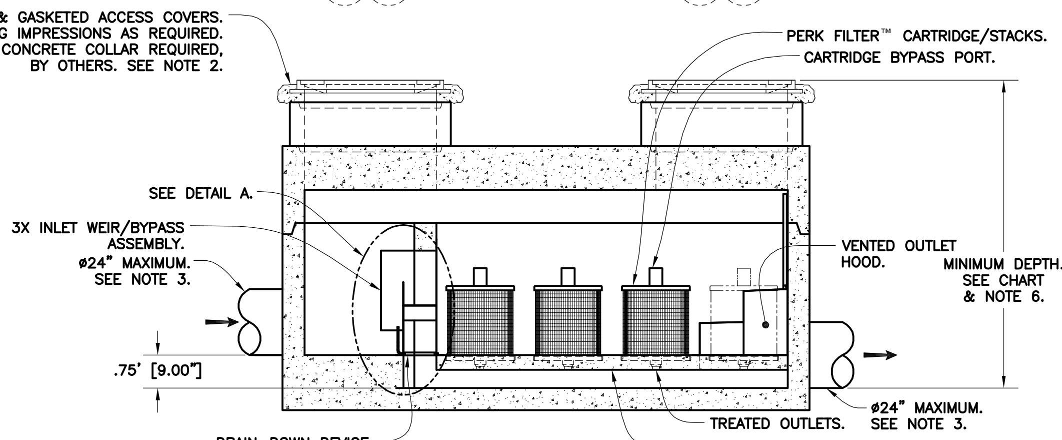
DRAWING NO.	REV	ECO	DATE	
PF-V-8-WA-0001	E	ECO-0122 JPR 10/3/14	JPR 3/2/11	SHEET 1 OF 2

PF-V-8-WA-0001



DETAIL A
INLET WEIR/BYPASS ASSEMBLY & DRAIN–DOWN.
SCALE: NONE





SECTION A-A

Washington GULD*

MINIMUM DEPTH - RIM TO OUTLET INVERT -			
CARTRIDGE STACK CONFIGURATION			
12"	18"	12" + 12"	12" + 18"
4.25' [51.00"]	5.00' [60.00"]	5.92' [71.00"]	6.67' [80.00"]

8' VAULT
TREATMENT FLOW RATES, TOTAL FLOW CAPACITIES & MAXIMUM HEAD LOSS

CARTRIDGE STACK QUANTITY	A DIMENSION - LENGTH - (ID-FEET)	CARTRIDGE STACK CONFIGURATION: 12" TREATMENT FLOW RATE (GPM / CFS)	12" TOTAL FLOW CAPACITY (CFS)	18" TREATMENT FLOW RATE (GPM / CFS)	18" TOTAL FLOW CAPACITY (CFS)	12" & 12" TREATMENT FLOW RATE (GPM / CFS)	12" & 12" TOTAL FLOW CAPACITY (CFS)	12" & 18" TREATMENT FLOW RATE (GPM / CFS)	12" & 18" TOTAL FLOW CAPACITY (CFS)
6	7	40.8 / 0.091	8.6	61.2 / 0.136	12.7	81.6 / 0.182	14.5	102.0 / 0.227	19.3
7	7	47.6 / 0.106	8.6	71.4 / 0.159	12.8	95.2 / 0.212	14.5	119.0 / 0.265	19.4
8	9	54.4 / 0.121	8.6	81.6 / 0.182	12.8	108.8 / 0.243	14.6	136.0 / 0.303	19.5
9	9	61.2 / 0.136	8.6	91.8 / 0.205	12.8	122.4 / 0.273	14.6	153.0 / 0.341	19.5
10	9	68.0 / 0.152	8.7	102.0 / 0.227	12.9	136.0 / 0.303	14.7	170.0 / 0.379	19.6
11	9	74.8 / 0.167	8.7	112.2 / 0.250	12.9	149.6 / 0.334	14.7	187.0 / 0.417	19.7
12	11	81.6 / 0.182	8.7	122.4 / 0.273	12.9	163.2 / 0.364	14.7	204.0 / 0.455	19.7
13	11	88.4 / 0.197	8.8	132.6 / 0.296	13.0	176.8 / 0.394	14.8	221.0 / 0.493	19.8
14	11	95.2 / 0.212	8.8	142.8 / 0.318	13.0	190.4 / 0.425	14.9	238.0 / 0.531	19.9
15	11	102.0 / 0.227	8.8	153.0 / 0.341	13.1	204.0 / 0.455	15.0	255.0 / 0.569	19.9
16	13	108.8 / 0.243	8.8	163.2 / 0.364	13.1	217.6 / 0.485	15.0	272.0 / 0.607	20.0
17	13	115.6 / 0.258	8.9	173.4 / 0.387	13.2	231.2 / 0.516	15.1	289.0 / 0.644	20.1
18	13	122.4 / 0.273	8.9	183.6 / 0.409	13.2	244.8 / 0.546	15.1	306.0 / 0.682	20.1
19	13	129.2 / 0.288	8.9	193.8 / 0.432	13.2	258.4 / 0.576	15.2	323.0 / 0.720	20.2
20	15	136.0 / 0.303	8.9	204.0 / 0.455	13.3	272.0 / 0.607	15.2	340.0 / 0.758	20.3
21	15	142.8 / 0.318	9.0	214.2 / 0.478	13.3	285.6 / 0.637	15.3	357.0 / 0.796	20.3
22	15	149.6 / 0.334	9.0	224.4 / 0.500	13.4	299.2 / 0.667	15.3	374.0 / 0.834	20.4
23	15	156.4 / 0.349	9.0	234.6 / 0.523	13.4	312.8 / 0.698	15.4	391.0 / 0.872	20.5
24	18	163.2 / 0.364	9.0	244.8 / 0.546	13.4	326.4 / 0.728	15.4	408.0 / 0.910	20.5
25	18	170.0 / 0.379	9.1	255.0 / 0.569	13.5	340.0 / 0.758	15.5	425.0 / 0.948	20.6
26	18	176.8 / 0.394	9.1	265.2 / 0.591	13.5	353.6 / 0.789	15.5	422.0 / 0.986	20.7
27	18	183.6 / 0.409	9.1	275.4 / 0.614	13.6	367.2 / 0.819	15.6	459.0 / 1.024	20.7
28	18	190.4 / 0.425	9.2	285.6 / 0.637	13.6	380.8 / 0.849	15.6	476.0 / 1.061	20.8
29	18	197.2 / 0.440	9.2	295.8 / 0.660	13.6	394.4 / 0.880	15.7	493.0 / 1.099	20.9
30	18	204.0 / 0.455	9.2	306.0 / 0.682	13.7	408.0 / 0.910	15.8	510.0 / 1.137	20.9
31	18	210.8 / 0.470	9.2	316.2 / 0.705	13.7	421.6 / 0.940	15.8	527.0 / 1.175	21.0
MAXIMUM HEAD LOSS		1.7 FEET		2.3 FEET		2.9 FEET		3.5 FEET	

*** Treatment Flow Rates shown conform to Washington State GULD Specifications.**

Media Filtration

Perk Filter™
8' Wide Concrete Vault
Washington State GULD
Six to Thirty One Cartridges / Stacks

Oldcastle® Stormwater Solutions

7921 Southpark Plaza, Suite 200 | Littleton, CO | 80120 | Ph: 800.579.8819 | oldcastlestormwater.com

DRAWING NO.	REV	ECO	DATE	
PF-V-8-WA-0001	E	ECO–0122 JPR 10/3/14	JPR 3/2/11	SHEET 2 OF 2

Appendix F: WWHM Analysis

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	9030 WWHM
Site Name:	Camas Meadows Subdivision
Site Address:	
City:	Camas
Report Date:	2/22/2023
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	0.000 (adjusted)
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data
Predeveloped Land Use

Basin 10X

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Mod	13.955
Pervious Total	13.955
Impervious Land Use	acre
Impervious Total	0
Basin Total	13.955

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Lawn, Mod	0.444
Pervious Total	0.444
Impervious Land Use	acre
ROOF TOPS FLAT	0.152
SIDEWALKS MOD	0.074
PARKING FLAT	0.538
Impervious Total	0.764
Basin Total	1.208

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Basin 2S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Lawn, Mod	4.675
Pervious Total	4.675
Impervious Land Use	acre
ROADS MOD	2.356
ROOF TOPS FLAT	4.242
DRIVEWAYS FLAT	1.061
SIDEWALKS MOD	0.413
Impervious Total	8.072
Basin Total	12.747

Element Flows To:

Surface	Interflow	Groundwater
Vault 2	Vault 2	

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

Width: 32 ft.
Length: 32 ft.
Depth: 4 ft.
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.092 ft.
Notch Height: 0.862 ft.
Orifice 1 Diameter: 2.069 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.023	0.000	0.000	0.000
0.0444	0.023	0.001	0.024	0.000
0.0889	0.023	0.002	0.034	0.000
0.1333	0.023	0.003	0.042	0.000
0.1778	0.023	0.004	0.049	0.000
0.2222	0.023	0.005	0.054	0.000
0.2667	0.023	0.006	0.060	0.000
0.3111	0.023	0.007	0.064	0.000
0.3556	0.023	0.008	0.069	0.000
0.4000	0.023	0.009	0.073	0.000
0.4444	0.023	0.010	0.077	0.000
0.4889	0.023	0.011	0.081	0.000
0.5333	0.023	0.012	0.084	0.000
0.5778	0.023	0.013	0.088	0.000
0.6222	0.023	0.014	0.091	0.000
0.6667	0.023	0.015	0.094	0.000
0.7111	0.023	0.016	0.098	0.000
0.7556	0.023	0.017	0.101	0.000
0.8000	0.023	0.018	0.103	0.000
0.8444	0.023	0.019	0.106	0.000
0.8889	0.023	0.020	0.109	0.000
0.9333	0.023	0.021	0.112	0.000
0.9778	0.023	0.023	0.114	0.000
1.0222	0.023	0.024	0.117	0.000
1.0667	0.023	0.025	0.120	0.000
1.1111	0.023	0.026	0.122	0.000
1.1556	0.023	0.027	0.124	0.000
1.2000	0.023	0.028	0.127	0.000
1.2444	0.023	0.029	0.129	0.000
1.2889	0.023	0.030	0.131	0.000
1.3333	0.023	0.031	0.134	0.000
1.3778	0.023	0.032	0.136	0.000
1.4222	0.023	0.033	0.138	0.000
1.4667	0.023	0.034	0.140	0.000
1.5111	0.023	0.035	0.142	0.000
1.5556	0.023	0.036	0.144	0.000
1.6000	0.023	0.037	0.146	0.000

1.6444	0.023	0.038	0.149	0.000
1.6889	0.023	0.039	0.151	0.000
1.7333	0.023	0.040	0.152	0.000
1.7778	0.023	0.041	0.154	0.000
1.8222	0.023	0.042	0.156	0.000
1.8667	0.023	0.043	0.158	0.000
1.9111	0.023	0.044	0.160	0.000
1.9556	0.023	0.046	0.162	0.000
2.0000	0.023	0.047	0.164	0.000
2.0444	0.023	0.048	0.166	0.000
2.0889	0.023	0.049	0.167	0.000
2.1333	0.023	0.050	0.169	0.000
2.1778	0.023	0.051	0.173	0.000
2.2222	0.023	0.052	0.180	0.000
2.2667	0.023	0.053	0.188	0.000
2.3111	0.023	0.054	0.197	0.000
2.3556	0.023	0.055	0.208	0.000
2.4000	0.023	0.056	0.218	0.000
2.4444	0.023	0.057	0.230	0.000
2.4889	0.023	0.058	0.242	0.000
2.5333	0.023	0.059	0.255	0.000
2.5778	0.023	0.060	0.268	0.000
2.6222	0.023	0.061	0.281	0.000
2.6667	0.023	0.062	0.295	0.000
2.7111	0.023	0.063	0.309	0.000
2.7556	0.023	0.064	0.323	0.000
2.8000	0.023	0.065	0.337	0.000
2.8444	0.023	0.066	0.352	0.000
2.8889	0.023	0.067	0.366	0.000
2.9333	0.023	0.069	0.381	0.000
2.9778	0.023	0.070	0.396	0.000
3.0222	0.023	0.071	0.457	0.000
3.0667	0.023	0.072	0.680	0.000
3.1111	0.023	0.073	0.995	0.000
3.1556	0.023	0.074	1.379	0.000
3.2000	0.023	0.075	1.815	0.000
3.2444	0.023	0.076	2.289	0.000
3.2889	0.023	0.077	2.788	0.000
3.3333	0.023	0.078	3.297	0.000
3.3778	0.023	0.079	3.802	0.000
3.4222	0.023	0.080	4.289	0.000
3.4667	0.023	0.081	4.745	0.000
3.5111	0.023	0.082	5.158	0.000
3.5556	0.023	0.083	5.519	0.000
3.6000	0.023	0.084	5.824	0.000
3.6444	0.023	0.085	6.074	0.000
3.6889	0.023	0.086	6.274	0.000
3.7333	0.023	0.087	6.441	0.000
3.7778	0.023	0.088	6.678	0.000
3.8222	0.023	0.089	6.856	0.000
3.8667	0.023	0.090	7.028	0.000
3.9111	0.023	0.091	7.197	0.000
3.9556	0.023	0.093	7.361	0.000
4.0000	0.023	0.094	7.521	0.000
4.0444	0.023	0.095	7.679	0.000
4.0889	0.000	0.000	7.832	0.000

Vault 2

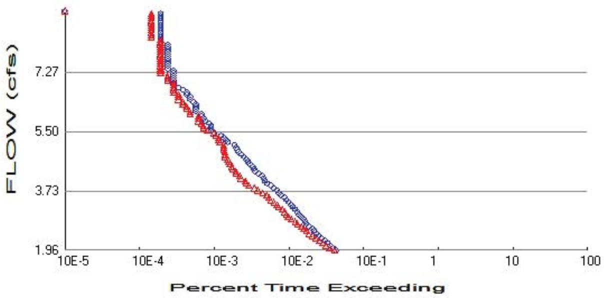
Width: 64 ft.
Length: 64 ft.
Depth: 9 ft.
Discharge Structure
Riser Height: 8 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.180 ft.
Notch Height: 2.100 ft.
Orifice 1 Diameter: 5.22 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

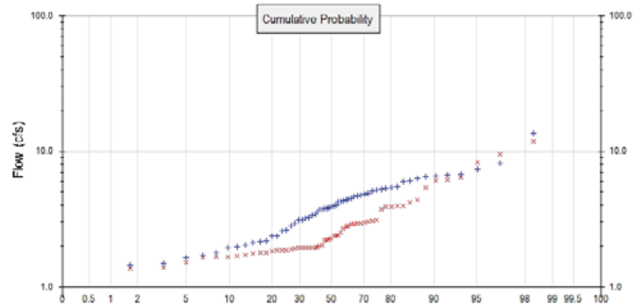
Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.094	0.000	0.000	0.000
0.1000	0.094	0.009	0.233	0.000
0.2000	0.094	0.018	0.330	0.000
0.3000	0.094	0.028	0.405	0.000
0.4000	0.094	0.037	0.467	0.000
0.5000	0.094	0.047	0.522	0.000
0.6000	0.094	0.056	0.572	0.000
0.7000	0.094	0.065	0.618	0.000
0.8000	0.094	0.075	0.661	0.000
0.9000	0.094	0.084	0.701	0.000
1.0000	0.094	0.094	0.739	0.000
1.1000	0.094	0.103	0.775	0.000
1.2000	0.094	0.112	0.810	0.000
1.3000	0.094	0.122	0.843	0.000
1.4000	0.094	0.131	0.874	0.000
1.5000	0.094	0.141	0.905	0.000
1.6000	0.094	0.150	0.935	0.000
1.7000	0.094	0.159	0.964	0.000
1.8000	0.094	0.169	0.992	0.000
1.9000	0.094	0.178	1.019	0.000
2.0000	0.094	0.188	1.045	0.000
2.1000	0.094	0.197	1.071	0.000
2.2000	0.094	0.206	1.096	0.000
2.3000	0.094	0.216	1.121	0.000
2.4000	0.094	0.225	1.145	0.000
2.5000	0.094	0.235	1.169	0.000
2.6000	0.094	0.244	1.192	0.000
2.7000	0.094	0.253	1.215	0.000
2.8000	0.094	0.263	1.237	0.000
2.9000	0.094	0.272	1.259	0.000
3.0000	0.094	0.282	1.280	0.000
3.1000	0.094	0.291	1.301	0.000
3.2000	0.094	0.300	1.322	0.000
3.3000	0.094	0.310	1.343	0.000
3.4000	0.094	0.319	1.363	0.000
3.5000	0.094	0.329	1.383	0.000
3.6000	0.094	0.338	1.403	0.000
3.7000	0.094	0.347	1.422	0.000
3.8000	0.094	0.357	1.441	0.000

3.9000	0.094	0.366	1.460	0.000
4.0000	0.094	0.376	1.478	0.000
4.1000	0.094	0.385	1.497	0.000
4.2000	0.094	0.394	1.515	0.000
4.3000	0.094	0.404	1.533	0.000
4.4000	0.094	0.413	1.551	0.000
4.5000	0.094	0.423	1.568	0.000
4.6000	0.094	0.432	1.585	0.000
4.7000	0.094	0.441	1.603	0.000
4.8000	0.094	0.451	1.620	0.000
4.9000	0.094	0.460	1.636	0.000
5.0000	0.094	0.470	1.653	0.000
5.1000	0.094	0.479	1.669	0.000
5.2000	0.094	0.489	1.686	0.000
5.3000	0.094	0.498	1.702	0.000
5.4000	0.094	0.507	1.718	0.000
5.5000	0.094	0.517	1.734	0.000
5.6000	0.094	0.526	1.749	0.000
5.7000	0.094	0.536	1.765	0.000
5.8000	0.094	0.545	1.780	0.000
5.9000	0.094	0.554	1.796	0.000
6.0000	0.094	0.564	1.829	0.000
6.1000	0.094	0.573	1.877	0.000
6.2000	0.094	0.583	1.933	0.000
6.3000	0.094	0.592	1.995	0.000
6.4000	0.094	0.601	2.061	0.000
6.5000	0.094	0.611	2.130	0.000
6.6000	0.094	0.620	2.201	0.000
6.7000	0.094	0.630	2.274	0.000
6.8000	0.094	0.639	2.347	0.000
6.9000	0.094	0.648	2.421	0.000
7.0000	0.094	0.658	2.509	0.000
7.1000	0.094	0.667	2.600	0.000
7.2000	0.094	0.677	2.694	0.000
7.3000	0.094	0.686	2.792	0.000
7.4000	0.094	0.695	3.174	0.000
7.5000	0.094	0.705	3.306	0.000
7.6000	0.094	0.714	3.441	0.000
7.7000	0.094	0.724	3.580	0.000
7.8000	0.094	0.733	3.723	0.000
7.9000	0.094	0.742	3.868	0.000
8.0000	0.094	0.752	4.018	0.000
8.1000	0.094	0.761	4.533	0.000
8.2000	0.094	0.771	5.448	0.000
8.3000	0.094	0.780	6.558	0.000
8.4000	0.094	0.789	7.701	0.000
8.5000	0.094	0.799	8.721	0.000
8.6000	0.094	0.808	9.496	0.000
8.7000	0.094	0.818	10.00	0.000
8.8000	0.094	0.827	10.45	0.000
8.9000	0.094	0.836	10.85	0.000
9.0000	0.094	0.846	11.23	0.000
9.1000	0.094	0.855	11.59	0.000
9.2000	0.000	0.000	11.93	0.000

Analysis Results
POC 1





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 13.955
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 5.119
Total Impervious Area: 8.836

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	3.925469
5 year	6.045385
10 year	7.189474
25 year	8.349572
50 year	9.037279
100 year	9.601854

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	2.46798
5 year	3.835317
10 year	4.995266
25 year	6.799794
50 year	8.424032
100 year	10.319018

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	2.951	2.407
1950	3.806	2.219
1951	5.159	1.933
1952	3.097	3.062
1953	4.220	1.861
1954	6.456	1.983
1955	3.243	1.796
1956	5.951	6.154
1957	5.261	2.357
1958	3.905	5.372

1959	2.361	1.501
1960	2.169	1.986
1961	5.428	2.761
1962	3.795	2.029
1963	4.247	1.949
1964	3.941	1.933
1965	3.379	2.873
1966	4.727	2.374
1967	4.272	1.948
1968	5.111	2.827
1969	4.893	8.267
1970	13.536	11.727
1971	2.161	1.631
1972	3.451	1.897
1973	3.590	2.879
1974	5.435	6.401
1975	3.091	1.858
1976	4.666	2.675
1977	0.139	1.385
1978	6.796	3.900
1979	4.433	3.871
1980	2.567	1.721
1981	6.087	4.200
1982	4.026	3.957
1983	7.362	3.029
1984	2.376	1.686
1985	1.712	2.247
1986	2.120	1.949
1987	3.743	2.273
1988	1.788	1.656
1989	1.933	1.829
1990	1.646	1.652
1991	4.347	1.925
1992	4.496	1.764
1993	5.337	4.348
1994	3.852	2.984
1995	3.180	3.929
1996	6.691	9.461
1997	8.155	6.021
1998	6.590	2.503
1999	4.596	3.086
2000	2.630	1.357
2001	1.451	1.332
2002	6.340	2.224
2003	4.828	2.937
2004	1.475	1.775
2005	1.963	1.859
2006	3.720	1.958
2007	2.027	3.714
2008	2.801	2.935

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	13.5355	11.7273
2	8.1550	9.4611
3	7.3616	8.2669
4	6.7959	6.4015

5	6.6908	6.1542
6	6.5898	6.0209
7	6.4560	5.3718
8	6.3403	4.3484
9	6.0866	4.1997
10	5.9505	3.9571
11	5.4350	3.9289
12	5.4278	3.8996
13	5.3368	3.8710
14	5.2610	3.7139
15	5.1588	3.0855
16	5.1112	3.0616
17	4.8926	3.0292
18	4.8277	2.9840
19	4.7274	2.9373
20	4.6663	2.9350
21	4.5961	2.8792
22	4.4958	2.8728
23	4.4328	2.8273
24	4.3468	2.7613
25	4.2719	2.6747
26	4.2474	2.5031
27	4.2198	2.4065
28	4.0261	2.3736
29	3.9411	2.3565
30	3.9045	2.2726
31	3.8519	2.2471
32	3.8061	2.2241
33	3.7954	2.2188
34	3.7434	2.0293
35	3.7203	1.9862
36	3.5901	1.9827
37	3.4512	1.9576
38	3.3794	1.9493
39	3.2427	1.9490
40	3.1804	1.9478
41	3.0975	1.9332
42	3.0908	1.9327
43	2.9511	1.9252
44	2.8011	1.8973
45	2.6295	1.8608
46	2.5670	1.8585
47	2.3757	1.8584
48	2.3612	1.8293
49	2.1690	1.7964
50	2.1605	1.7749
51	2.1204	1.7644
52	2.0269	1.7213
53	1.9627	1.6857
54	1.9333	1.6564
55	1.7880	1.6522
56	1.7117	1.6307
57	1.6461	1.5006
58	1.4746	1.3847
59	1.4511	1.3568
60	0.1392	1.3324

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.9627	895	860	96	Pass
2.0342	823	734	89	Pass
2.1057	755	658	87	Pass
2.1771	687	594	86	Pass
2.2486	626	532	84	Pass
2.3200	576	478	82	Pass
2.3915	535	434	81	Pass
2.4630	493	387	78	Pass
2.5344	456	362	79	Pass
2.6059	431	330	76	Pass
2.6773	392	306	78	Pass
2.7488	364	273	75	Pass
2.8203	346	255	73	Pass
2.8917	324	225	69	Pass
2.9632	305	206	67	Pass
3.0346	287	195	67	Pass
3.1061	271	183	67	Pass
3.1776	253	171	67	Pass
3.2490	237	153	64	Pass
3.3205	226	145	64	Pass
3.3919	211	133	63	Pass
3.4634	193	119	61	Pass
3.5349	182	113	62	Pass
3.6063	165	105	63	Pass
3.6778	152	94	61	Pass
3.7492	145	81	55	Pass
3.8207	131	73	55	Pass
3.8922	120	61	50	Pass
3.9636	107	56	52	Pass
4.0351	100	55	55	Pass
4.1065	96	48	50	Pass
4.1780	91	46	50	Pass
4.2495	83	41	49	Pass
4.3209	75	41	54	Pass
4.3924	71	37	52	Pass
4.4638	69	36	52	Pass
4.5353	62	34	54	Pass
4.6068	59	33	55	Pass
4.6782	56	32	57	Pass
4.7497	52	29	55	Pass
4.8211	49	29	59	Pass
4.8926	44	29	65	Pass
4.9641	43	28	65	Pass
5.0355	41	28	68	Pass
5.1070	39	28	71	Pass
5.1784	32	25	78	Pass
5.2499	30	24	80	Pass
5.3214	28	24	85	Pass
5.3928	26	22	84	Pass
5.4643	21	21	100	Pass
5.5357	19	17	89	Pass
5.6072	19	15	78	Pass
5.6787	19	15	78	Pass

5.7501	18	14	77	Pass
5.8216	16	13	81	Pass
5.8930	15	13	86	Pass
5.9645	14	13	92	Pass
6.0360	14	10	71	Pass
6.1074	12	10	83	Pass
6.1789	12	9	75	Pass
6.2503	12	9	75	Pass
6.3218	12	8	66	Pass
6.3933	11	8	72	Pass
6.4647	10	7	70	Pass
6.5362	10	7	70	Pass
6.6076	9	7	77	Pass
6.6791	9	6	66	Pass
6.7506	8	6	75	Pass
6.8220	7	6	85	Pass
6.8935	6	6	100	Pass
6.9649	6	6	100	Pass
7.0364	6	5	83	Pass
7.1079	6	5	83	Pass
7.1793	6	5	83	Pass
7.2508	6	4	66	Pass
7.3222	6	4	66	Pass
7.3937	5	4	80	Pass
7.4652	5	4	80	Pass
7.5366	5	4	80	Pass
7.6081	5	4	80	Pass
7.6795	5	4	80	Pass
7.7510	5	4	80	Pass
7.8225	5	4	80	Pass
7.8939	5	4	80	Pass
7.9654	5	4	80	Pass
8.0368	5	4	80	Pass
8.1083	5	4	80	Pass
8.1798	4	4	100	Pass
8.2512	4	4	100	Pass
8.3227	4	3	75	Pass
8.3941	4	3	75	Pass
8.4656	4	3	75	Pass
8.5371	4	3	75	Pass
8.6085	4	3	75	Pass
8.6800	4	3	75	Pass
8.7514	4	3	75	Pass
8.8229	4	3	75	Pass
8.8944	4	3	75	Pass
8.9658	4	3	75	Pass
9.0373	4	3	75	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Vault 1 POC	☐	183.35			☐	0.00			
Vault 2 POC	☐	1940.23			☐	0.00			
Total Volume Infiltrated		2123.57	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

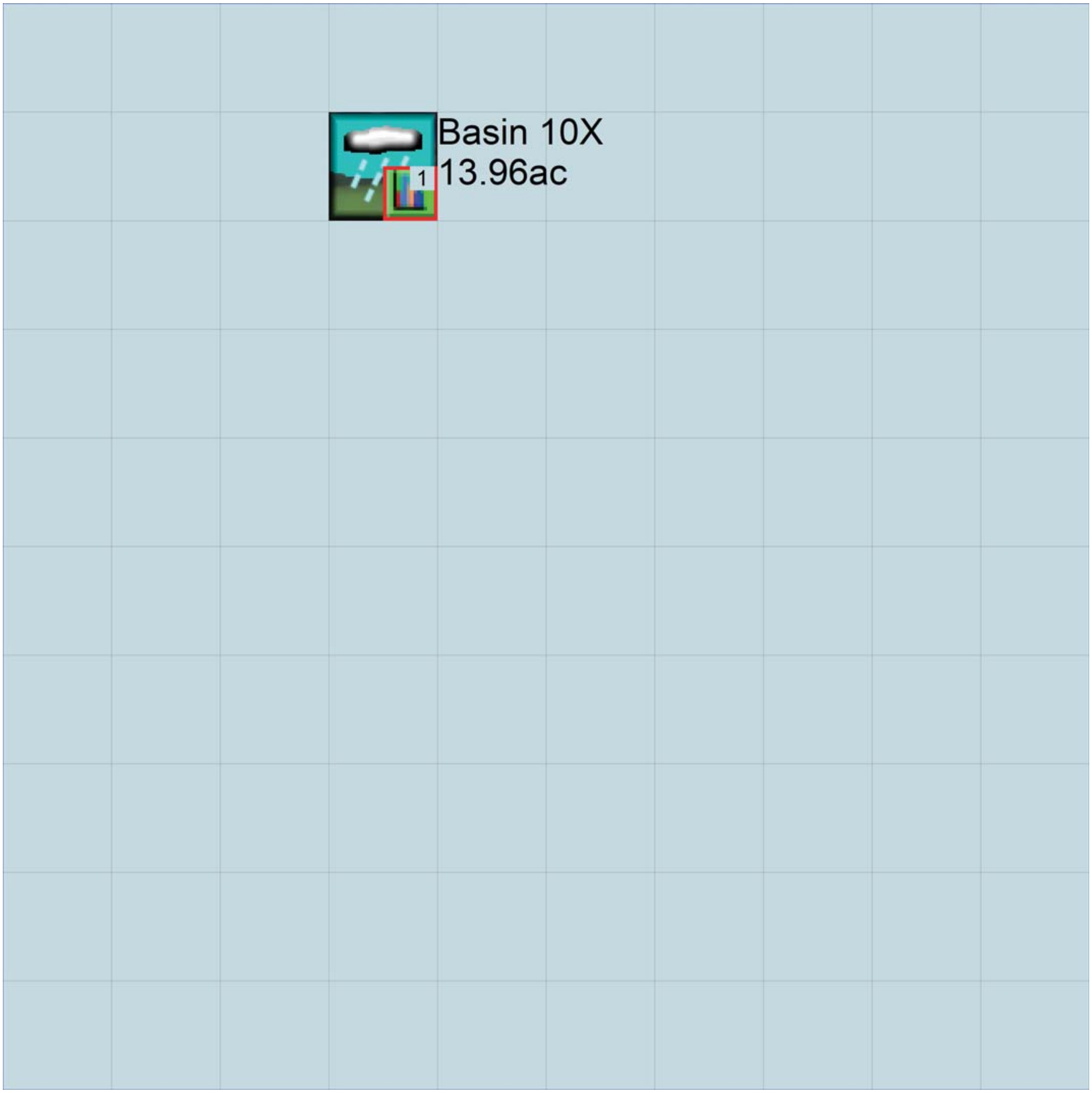
PERLND Changes

No PERLND changes have been made.

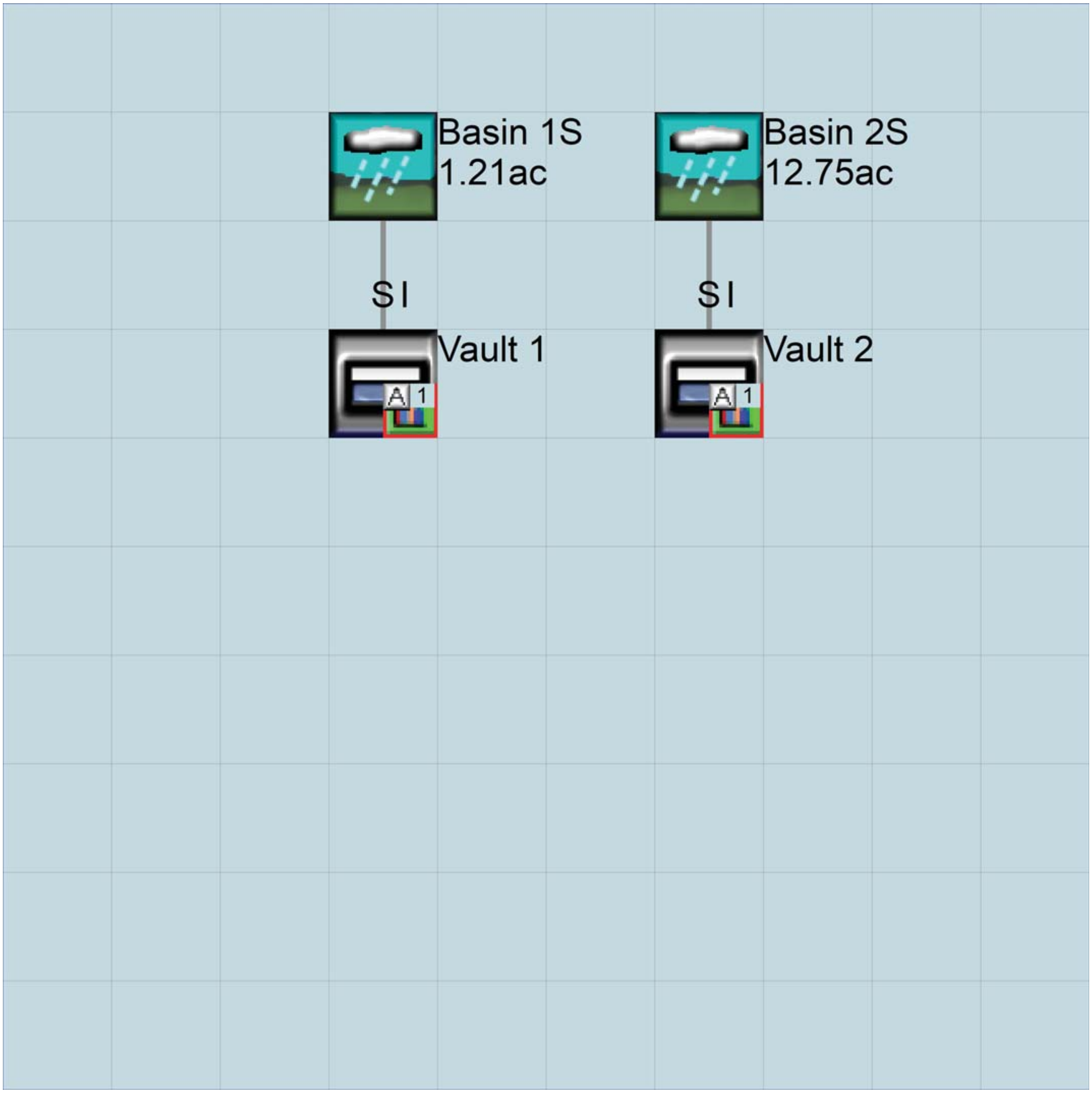
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   9030 WWHM.wdm
MESSU      25   Pre9030 WWHM.MES
           27   Pre9030 WWHM.L61
           28   Pre9030 WWHM.L62
           30   POC9030 WWHM1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin 10X                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                            User  t-series Engl Metr ***
                                            in  out           ***
   29      SG4, Forest, Mod        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   29         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   29         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   29         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   29              0         6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                     ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29            0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   29              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 10X***
PERLND  29                      13.955     COPY   501     12
PERLND  29                      13.955     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   9030 WWHM.wdm
MESSU      25   Mit9030 WWHM.MES
           27   Mit9030 WWHM.L61
           28   Mit9030 WWHM.L62
           30   POC9030 WWHM1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      35
      IMPLND       4
      IMPLND       9
      IMPLND      11
      IMPLND       2
      IMPLND       5
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault 1                   MAX                      1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   35      SG4, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   35         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   35         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   35         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   35              0         6      0.02       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   35              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   35            0.1       0.2      0.25         2       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   35              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name-------->   Unit-systems   Printer ***
    # -  #                      User  t-series Engl Metr ***
                                        in  out           ***
     4      ROOF TOPS/FLAT         1    1    1   27    0
     9      SIDEWALKS/MOD          1    1    1   27    0
    11      PARKING/FLAT           1    1    1   27    0
     2      ROADS/MOD              1    1    1   27    0
     5      DRIVEWAYS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
     4         0    0    1    0    0    0
     9         0    0    1    0    0    0
    11         0    0    1    0    0    0
     2         0    0    1    0    0    0
     5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
     4         0    0    4    0    0    0    1    9
     9         0    0    4    0    0    0    1    9
    11         0    0    4    0    0    0    1    9
     2         0    0    4    0    0    0    1    9
```

```
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
    9         0    0    0    0    0
   11         0    0    0    0    0
    2         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
    9            400      0.05       0.1      0.08
   11            400      0.01       0.1       0.1
    2            400      0.05       0.1      0.08
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
    9              0         0
   11              0         0
    2              0         0
    5              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
    9              0         0
   11              0         0
    2              0         0
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 1S***
PERLND  35                       0.444     RCHRES   1      2
PERLND  35                       0.444     RCHRES   1      3
IMPLND   4                       0.152     RCHRES   1      5
IMPLND   9                       0.074     RCHRES   1      5
IMPLND  11                       0.538     RCHRES   1      5
Basin 2S***
PERLND  35                       4.675     RCHRES   2      2
PERLND  35                       4.675     RCHRES   2      3
IMPLND   2                       2.356     RCHRES   2      5
IMPLND   4                       4.242     RCHRES   2      5
IMPLND   5                       1.061     RCHRES   2      5
IMPLND   9                       0.413     RCHRES   2      5

******Routing******
PERLND  35                       0.444     COPY     1     12
IMPLND   4                       0.152     COPY     1     15
IMPLND   9                       0.074     COPY     1     15
IMPLND  11                       0.538     COPY     1     15
PERLND  35                       0.444     COPY     1     13
PERLND  35                       4.675     COPY     1     12
IMPLND   2                       2.356     COPY     1     15
```

```
IMPLND   4                        4.242     COPY     1     15
IMPLND   5                        1.061     COPY     1     15
IMPLND   9                        0.413     COPY     1     15
PERLND  35                        4.675     COPY     1     13
RCHRES   1                            1     COPY   501     16
RCHRES   2                            1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
    1     Vault 1                 1    1    1    1   28    0    1
    2     Vault 2                 1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
    2        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
    1             1      0.01       0.0       0.0       0.5       0.0
    2             2      0.01       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2           0          4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
```

FTABLES
FTABLE 1
92 4

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.023508	0.000000	0.000000		
0.044444	0.023508	0.001045	0.024490		
0.088889	0.023508	0.002090	0.034634		
0.133333	0.023508	0.003134	0.042418		
0.177778	0.023508	0.004179	0.048980		
0.222222	0.023508	0.005224	0.054761		
0.266667	0.023508	0.006269	0.059988		
0.311111	0.023508	0.007314	0.064794		
0.355556	0.023508	0.008358	0.069268		
0.400000	0.023508	0.009403	0.073470		
0.444444	0.023508	0.010448	0.077444		
0.488889	0.023508	0.011493	0.081224		
0.533333	0.023508	0.012537	0.084836		
0.577778	0.023508	0.013582	0.088300		
0.622222	0.023508	0.014627	0.091633		
0.666667	0.023508	0.015672	0.094849		
0.711111	0.023508	0.016717	0.097960		
0.755556	0.023508	0.017761	0.100975		
0.800000	0.023508	0.018806	0.103902		
0.844444	0.023508	0.019851	0.106749		
0.888889	0.023508	0.020896	0.109523		
0.933333	0.023508	0.021941	0.112227		
0.977778	0.023508	0.022985	0.114868		
1.022222	0.023508	0.024030	0.117450		
1.066667	0.023508	0.025075	0.119976		
1.111111	0.023508	0.026120	0.122450		
1.155556	0.023508	0.027165	0.124875		
1.200000	0.023508	0.028209	0.127254		
1.244444	0.023508	0.029254	0.129589		
1.288889	0.023508	0.030299	0.131883		
1.333333	0.023508	0.031344	0.134137		
1.377778	0.023508	0.032389	0.136354		
1.422222	0.023508	0.033433	0.138536		
1.466667	0.023508	0.034478	0.140684		
1.511111	0.023508	0.035523	0.142800		
1.555556	0.023508	0.036568	0.144885		
1.600000	0.023508	0.037612	0.146940		
1.644444	0.023508	0.038657	0.148967		
1.688889	0.023508	0.039702	0.150966		
1.733333	0.023508	0.040747	0.152940		
1.777778	0.023508	0.041792	0.154888		
1.822222	0.023508	0.042836	0.156812		
1.866667	0.023508	0.043881	0.158713		
1.911111	0.023508	0.044926	0.160592		
1.955556	0.023508	0.045971	0.162448		
2.000000	0.023508	0.047016	0.164284		
2.044444	0.023508	0.048060	0.166099		
2.088889	0.023508	0.049105	0.167895		
2.133333	0.023508	0.050150	0.169672		
2.177778	0.023508	0.051195	0.173841		
2.222222	0.023508	0.052240	0.180532		
2.266667	0.023508	0.053284	0.188669		
2.311111	0.023508	0.054329	0.197902		
2.355556	0.023508	0.055374	0.208025		
2.400000	0.023508	0.056419	0.218896		
2.444444	0.023508	0.057464	0.230408		
2.488889	0.023508	0.058508	0.242475		
2.533333	0.023508	0.059553	0.255026		
2.577778	0.023508	0.060598	0.267999		
2.622222	0.023508	0.061643	0.281342		
2.666667	0.023508	0.062687	0.295009		
2.711111	0.023508	0.063732	0.308957		
2.755556	0.023508	0.064777	0.323149		
2.800000	0.023508	0.065822	0.337549		
2.844444	0.023508	0.066867	0.352125		

```
 2.888889  0.023508  0.067911  0.366849
 2.933333  0.023508  0.068956  0.381691
 2.977778  0.023508  0.070001  0.396626
 3.022222  0.023508  0.071046  0.457601
 3.066667  0.023508  0.072091  0.680039
 3.111111  0.023508  0.073135  0.995618
 3.155556  0.023508  0.074180  1.379271
 3.200000  0.023508  0.075225  1.815183
 3.244444  0.023508  0.076270  2.289467
 3.288889  0.023508  0.077315  2.788309
 3.333333  0.023508  0.078359  3.297523
 3.377778  0.023508  0.079404  3.802697
 3.422222  0.023508  0.080449  4.289670
 3.466667  0.023508  0.081494  4.745231
 3.511111  0.023508  0.082539  5.157979
 3.555556  0.023508  0.083583  5.519313
 3.600000  0.023508  0.084628  5.824545
 3.644444  0.023508  0.085673  6.074100
 3.688889  0.023508  0.086718  6.274824
 3.733333  0.023508  0.087762  6.441358
 3.777778  0.023508  0.088807  6.678554
 3.822222  0.023508  0.089852  6.855965
 3.866667  0.023508  0.090897  7.028670
 3.911111  0.023508  0.091942  7.197027
 3.955556  0.023508  0.092986  7.361349
 4.000000  0.023508  0.094031  7.521915
 4.044444  0.023508  0.095076  7.678971
 END FTABLE  1
 FTABLE      2
  92    4
    Depth      Area    Volume  Outflow1 Velocity  Travel Time***
     (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)     (Minutes)***
 0.000000  0.094031  0.000000  0.000000
 0.100000  0.094031  0.009403  0.233830
 0.200000  0.094031  0.018806  0.330685
 0.300000  0.094031  0.028209  0.405005
 0.400000  0.094031  0.037612  0.467659
 0.500000  0.094031  0.047016  0.522859
 0.600000  0.094031  0.056419  0.572764
 0.700000  0.094031  0.065822  0.618655
 0.800000  0.094031  0.075225  0.661370
 0.900000  0.094031  0.084628  0.701489
 1.000000  0.094031  0.094031  0.739435
 1.100000  0.094031  0.103434  0.775525
 1.200000  0.094031  0.112837  0.810010
 1.300000  0.094031  0.122241  0.843085
 1.400000  0.094031  0.131644  0.874911
 1.500000  0.094031  0.141047  0.905619
 1.600000  0.094031  0.150450  0.935319
 1.700000  0.094031  0.159853  0.964105
 1.800000  0.094031  0.169256  0.992056
 1.900000  0.094031  0.178659  1.019240
 2.000000  0.094031  0.188062  1.045718
 2.100000  0.094031  0.197466  1.071542
 2.200000  0.094031  0.206869  1.096759
 2.300000  0.094031  0.216272  1.121408
 2.400000  0.094031  0.225675  1.145527
 2.500000  0.094031  0.235078  1.169149
 2.600000  0.094031  0.244481  1.192302
 2.700000  0.094031  0.253884  1.215015
 2.800000  0.094031  0.263287  1.237311
 2.900000  0.094031  0.272691  1.259212
 3.000000  0.094031  0.282094  1.280738
 3.100000  0.094031  0.291497  1.301909
 3.200000  0.094031  0.300900  1.322741
 3.300000  0.094031  0.310303  1.343250
 3.400000  0.094031  0.319706  1.363450
 3.500000  0.094031  0.329109  1.383355
 3.600000  0.094031  0.338512  1.402978
 3.700000  0.094031  0.347916  1.422331
```

```
  3.800000  0.094031  0.357319  1.441423
  3.900000  0.094031  0.366722  1.460266
  4.000000  0.094031  0.376125  1.478869
  4.100000  0.094031  0.385528  1.497241
  4.200000  0.094031  0.394931  1.515390
  4.300000  0.094031  0.404334  1.533324
  4.400000  0.094031  0.413737  1.551051
  4.500000  0.094031  0.423140  1.568578
  4.600000  0.094031  0.432544  1.585910
  4.700000  0.094031  0.441947  1.603056
  4.800000  0.094031  0.451350  1.620020
  4.900000  0.094031  0.460753  1.636808
  5.000000  0.094031  0.470156  1.653426
  5.100000  0.094031  0.479559  1.669878
  5.200000  0.094031  0.488962  1.686170
  5.300000  0.094031  0.498365  1.702306
  5.400000  0.094031  0.507769  1.718291
  5.500000  0.094031  0.517172  1.734128
  5.600000  0.094031  0.526575  1.749821
  5.700000  0.094031  0.535978  1.765376
  5.800000  0.094031  0.545381  1.780794
  5.900000  0.094031  0.554784  1.796080
  6.000000  0.094031  0.564187  1.829813
  6.100000  0.094031  0.573590  1.877736
  6.200000  0.094031  0.582994  1.933759
  6.300000  0.094031  0.592397  1.995472
  6.400000  0.094031  0.601800  2.061366
  6.500000  0.094031  0.611203  2.130342
  6.600000  0.094031  0.620606  2.201541
  6.700000  0.094031  0.630009  2.274251
  6.800000  0.094031  0.639412  2.347866
  6.900000  0.094031  0.648815  2.421856
  7.000000  0.094031  0.658219  2.509577
  7.100000  0.094031  0.667622  2.600630
  7.200000  0.094031  0.677025  2.694869
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  7.900000  0.094031  0.742847  3.868939
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  8.700000  0.094031  0.818072  10.00013
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  8.900000  0.094031  0.836878  10.85552
  9.000000  0.094031  0.846281  11.23155
  9.100000  0.094031  0.855684  11.58973
  END FTABLE  2
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
```

```
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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WWHM2012

PROJECT REPORT

Water Quality

General Model Information

Project Name:	9030 WWHM WQ
Site Name:	Camas Meadows Subdivision
Site Address:	
City:	Camas
Report Date:	2/22/2023
Gage:	Lacamas
Data Start:	1948/10/01
Data End:	2008/09/30
Timestep:	15 Minute
Precip Scale:	1.300
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Mod	0.175
Pervious Total	0.175
Impervious Land Use	acre
SIDEWALKS MOD	0.034
PARKING FLAT	0.538
Impervious Total	0.572
Basin Total	0.747

Element Flows To:

Surface	Interflow	Groundwater

Basin 2S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Forest, Mod	10.77
Pervious Total	10.77
Impervious Land Use	acre
Impervious Total	0
Basin Total	10.77

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Lawn, Mod	0.175
Pervious Total	0.175
Impervious Land Use	acre
SIDEWALKS MOD	0.034
PARKING FLAT	0.538
Impervious Total	0.572
Basin Total	0.747

Element Flows To:

Surface	Interflow	Groundwater

Basin 2S

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SG4, Lawn, Mod	2.808
Pervious Total	2.808
Impervious Land Use	acre
ROADS MOD	2.356
ROOF TOPS FLAT	4.132
DRIVEWAYS FLAT	1.061
SIDEWALKS MOD	0.413
Impervious Total	7.962
Basin Total	10.77

Element Flows To:

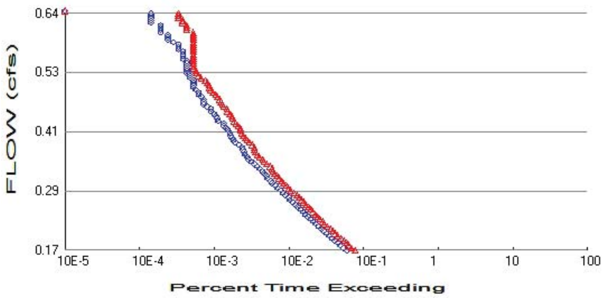
Surface	Interflow	Groundwater

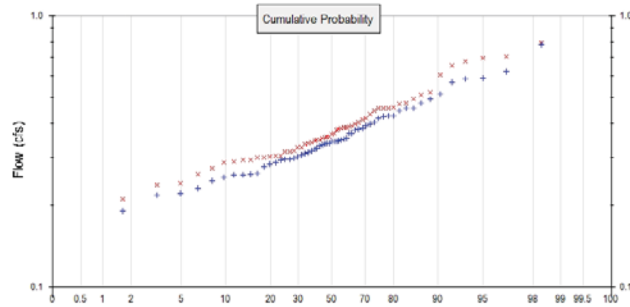
Routing Elements
Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 0.175
Total Impervious Area: 0.572

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.175
Total Impervious Area: 0.572

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.34323
5 year	0.439698
10 year	0.50323
25 year	0.583574
50 year	0.643672
100 year	0.704103

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.370379
5 year	0.477847
10 year	0.550532
25 year	0.644441
50 year	0.716044
100 year	0.789152

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.494	0.494
1950	0.298	0.326
1951	0.336	0.353
1952	0.324	0.365
1953	0.313	0.336
1954	0.447	0.475
1955	0.287	0.290
1956	0.367	0.379
1957	0.378	0.403
1958	0.403	0.455

1959	0.259	0.302
1960	0.258	0.294
1961	0.346	0.357
1962	0.296	0.317
1963	0.351	0.384
1964	0.259	0.293
1965	0.277	0.301
1966	0.330	0.348
1967	0.333	0.358
1968	0.569	0.698
1969	0.513	0.606
1970	0.780	0.793
1971	0.302	0.315
1972	0.418	0.434
1973	0.344	0.346
1974	0.339	0.348
1975	0.230	0.260
1976	0.293	0.304
1977	0.186	0.186
1978	0.427	0.445
1979	0.457	0.510
1980	0.247	0.274
1981	0.398	0.414
1982	0.344	0.417
1983	0.455	0.473
1984	0.218	0.241
1985	0.253	0.301
1986	0.382	0.456
1987	0.261	0.287
1988	0.306	0.359
1989	0.394	0.397
1990	0.353	0.383
1991	0.368	0.393
1992	0.344	0.368
1993	0.425	0.458
1994	0.310	0.315
1995	0.318	0.390
1996	0.475	0.521
1997	0.623	0.656
1998	0.586	0.707
1999	0.295	0.305
2000	0.221	0.237
2001	0.190	0.210
2002	0.428	0.456
2003	0.323	0.342
2004	0.338	0.338
2005	0.385	0.388
2006	0.349	0.387
2007	0.284	0.327
2008	0.590	0.677

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.7799	0.7930
2	0.6233	0.7072
3	0.5898	0.6981
4	0.5859	0.6775

5	0.5687	0.6561
6	0.5126	0.6064
7	0.4940	0.5211
8	0.4752	0.5101
9	0.4574	0.4941
10	0.4550	0.4746
11	0.4471	0.4729
12	0.4277	0.4581
13	0.4274	0.4562
14	0.4246	0.4556
15	0.4177	0.4549
16	0.4032	0.4454
17	0.3982	0.4337
18	0.3939	0.4175
19	0.3848	0.4141
20	0.3816	0.4034
21	0.3779	0.3974
22	0.3684	0.3930
23	0.3674	0.3898
24	0.3527	0.3885
25	0.3511	0.3869
26	0.3493	0.3839
27	0.3462	0.3829
28	0.3444	0.3794
29	0.3444	0.3677
30	0.3439	0.3653
31	0.3392	0.3591
32	0.3380	0.3581
33	0.3357	0.3567
34	0.3329	0.3527
35	0.3304	0.3478
36	0.3238	0.3476
37	0.3231	0.3459
38	0.3185	0.3415
39	0.3135	0.3384
40	0.3099	0.3357
41	0.3060	0.3269
42	0.3019	0.3260
43	0.2977	0.3167
44	0.2960	0.3150
45	0.2951	0.3148
46	0.2930	0.3046
47	0.2875	0.3039
48	0.2838	0.3018
49	0.2771	0.3006
50	0.2614	0.3006
51	0.2594	0.2942
52	0.2586	0.2930
53	0.2575	0.2899
54	0.2526	0.2869
55	0.2466	0.2741
56	0.2302	0.2597
57	0.2214	0.2411
58	0.2179	0.2371
59	0.1902	0.2103
60	0.1857	0.1860

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1716	1249	1621	129	Fail
0.1764	1129	1443	127	Fail
0.1812	1027	1321	128	Fail
0.1859	947	1243	131	Fail
0.1907	862	1141	132	Fail
0.1955	795	1055	132	Fail
0.2002	723	953	131	Fail
0.2050	672	877	130	Fail
0.2098	616	812	131	Fail
0.2145	574	752	131	Fail
0.2193	525	684	130	Fail
0.2241	480	627	130	Fail
0.2288	450	593	131	Fail
0.2336	411	546	132	Fail
0.2384	377	509	135	Fail
0.2431	346	474	136	Fail
0.2479	326	442	135	Fail
0.2527	300	410	136	Fail
0.2574	274	381	139	Fail
0.2622	256	353	137	Fail
0.2670	237	333	140	Fail
0.2717	219	311	142	Fail
0.2765	208	288	138	Fail
0.2813	189	267	141	Fail
0.2861	173	243	140	Fail
0.2908	163	224	137	Fail
0.2956	149	208	139	Fail
0.3004	137	192	140	Fail
0.3051	126	178	141	Fail
0.3099	119	167	140	Fail
0.3147	109	156	143	Fail
0.3194	104	145	139	Fail
0.3242	97	134	138	Fail
0.3290	93	128	137	Fail
0.3337	86	125	145	Fail
0.3385	80	118	147	Fail
0.3433	72	106	147	Fail
0.3480	66	97	146	Fail
0.3528	61	94	154	Fail
0.3576	58	85	146	Fail
0.3623	54	79	146	Fail
0.3671	53	75	141	Fail
0.3719	51	72	141	Fail
0.3766	50	72	144	Fail
0.3814	45	68	151	Fail
0.3862	40	62	155	Fail
0.3910	38	58	152	Fail
0.3957	36	55	152	Fail
0.4005	35	51	145	Fail
0.4053	34	49	144	Fail
0.4100	32	47	146	Fail
0.4148	30	47	156	Fail
0.4196	28	44	157	Fail
0.4243	28	41	146	Fail

0.4291	24	39	162	Fail
0.4339	23	37	160	Fail
0.4386	22	36	163	Fail
0.4434	21	34	161	Fail
0.4482	19	32	168	Fail
0.4529	19	31	163	Fail
0.4577	17	28	164	Fail
0.4625	15	27	180	Fail
0.4672	15	26	173	Fail
0.4720	15	25	166	Fail
0.4768	14	23	164	Fail
0.4816	13	22	169	Fail
0.4863	13	20	153	Fail
0.4911	12	19	158	Fail
0.4959	11	18	163	Fail
0.5006	11	18	163	Fail
0.5054	11	17	154	Fail
0.5102	11	16	145	Fail
0.5149	10	14	140	Fail
0.5197	10	13	130	Fail
0.5245	9	12	133	Fail
0.5292	9	12	133	Fail
0.5340	9	11	122	Fail
0.5388	9	11	122	Fail
0.5435	9	11	122	Fail
0.5483	9	11	122	Fail
0.5531	8	11	137	Fail
0.5578	8	11	137	Fail
0.5626	8	11	137	Fail
0.5674	8	11	137	Fail
0.5721	7	11	157	Fail
0.5769	7	11	157	Fail
0.5817	7	11	157	Fail
0.5865	6	11	183	Fail
0.5912	5	11	220	Fail
0.5960	5	11	220	Fail
0.6008	5	11	220	Fail
0.6055	4	11	275	Fail
0.6103	4	9	225	Fail
0.6151	4	9	225	Fail
0.6198	4	9	225	Fail
0.6246	3	8	266	Fail
0.6294	3	8	266	Fail
0.6341	3	7	233	Fail
0.6389	3	7	233	Fail
0.6437	3	7	233	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

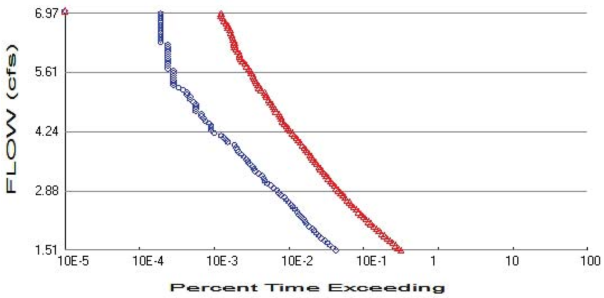
Water Quality BMP Flow and Volume for POC #1

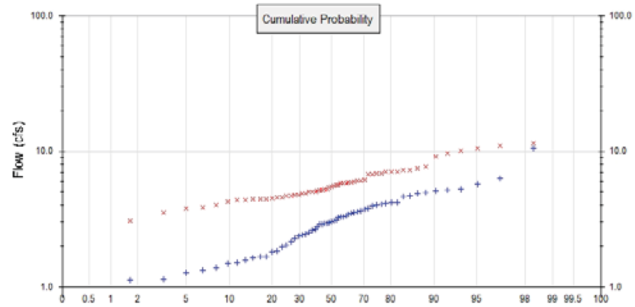
On-line facility volume:	0.0986 acre-feet
On-line facility target flow:	0.1417 cfs.
Adjusted for 15 min:	0.1417 cfs.
Off-line facility target flow:	0.0783 cfs.
Adjusted for 15 min:	0.0783 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 10.77
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 2.808
Total Impervious Area: 7.962

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	Flow(cfs)
2 year	3.029545
5 year	4.665625
10 year	5.548595
25 year	6.44392
50 year	6.97467
100 year	7.410389

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	Flow(cfs)
2 year	5.517921
5 year	7.144077
10 year	8.246867
25 year	9.674622
50 year	10.765206
100 year	11.880266

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	Predeveloped	Mitigated
1949	2.278	7.245
1950	2.937	4.781
1951	3.981	5.270
1952	2.391	5.456
1953	3.257	4.893
1954	4.983	7.237
1955	2.503	4.667
1956	4.592	5.608
1957	4.060	6.115
1958	3.013	7.041
1959	1.822	4.382

1960	1.674	4.409
1961	4.189	5.187
1962	2.929	4.682
1963	3.278	5.603
1964	3.042	4.243
1965	2.608	4.395
1966	3.648	5.079
1967	3.297	5.255
1968	3.945	10.146
1969	3.776	9.068
1970	10.446	11.515
1971	1.667	4.571
1972	2.664	6.784
1973	2.771	5.038
1974	4.195	5.017
1975	2.385	3.771
1976	3.601	4.571
1977	0.107	2.733
1978	5.245	6.732
1979	3.421	7.492
1980	1.981	3.986
1981	4.697	6.061
1982	3.107	6.040
1983	5.681	7.097
1984	1.833	3.524
1985	1.321	4.355
1986	1.636	6.912
1987	2.889	4.462
1988	1.380	5.415
1989	1.492	5.857
1990	1.270	5.779
1991	3.355	5.784
1992	3.470	5.546
1993	4.119	7.017
1994	2.973	4.868
1995	2.455	5.875
1996	5.164	7.730
1997	6.294	9.616
1998	5.086	10.560
1999	3.547	4.413
2000	2.029	3.835
2001	1.120	3.049
2002	4.893	6.839
2003	3.726	5.206
2004	1.138	5.028
2005	1.515	5.788
2006	2.871	5.978
2007	1.564	4.772
2008	2.162	10.950

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	10.4462	11.5145
2	6.2937	10.9499
3	5.6815	10.5601
4	5.2448	10.1462
5	5.1638	9.6157

6	5.0858	9.0678
7	4.9825	7.7300
8	4.8932	7.4920
9	4.6974	7.2454
10	4.5924	7.2372
11	4.1945	7.0972
12	4.1890	7.0406
13	4.1188	7.0174
14	4.0603	6.9122
15	3.9814	6.8394
16	3.9446	6.7843
17	3.7759	6.7317
18	3.7259	6.1147
19	3.6485	6.0612
20	3.6013	6.0404
21	3.5471	5.9779
22	3.4697	5.8752
23	3.4211	5.8573
24	3.3547	5.7880
25	3.2969	5.7837
26	3.2780	5.7790
27	3.2567	5.6076
28	3.1072	5.6033
29	3.0416	5.5455
30	3.0134	5.4560
31	2.9728	5.4145
32	2.9374	5.2702
33	2.9291	5.2548
34	2.8890	5.2060
35	2.8712	5.1871
36	2.7707	5.0786
37	2.6636	5.0379
38	2.6081	5.0285
39	2.5026	5.0173
40	2.4546	4.8928
41	2.3905	4.8685
42	2.3854	4.7810
43	2.2776	4.7724
44	2.1618	4.6822
45	2.0294	4.6674
46	1.9812	4.5714
47	1.8335	4.5710
48	1.8223	4.4622
49	1.6739	4.4130
50	1.6674	4.4092
51	1.6364	4.3955
52	1.5643	4.3824
53	1.5148	4.3546
54	1.4920	4.2428
55	1.3799	3.9864
56	1.3211	3.8353
57	1.2704	3.7715
58	1.1380	3.5237
59	1.1199	3.0487
60	0.1074	2.7327

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
1.5148	896	6623	739	Fail
1.5699	823	6091	740	Fail
1.6251	755	5607	742	Fail
1.6802	687	5167	752	Fail
1.7354	626	4702	751	Fail
1.7905	576	4344	754	Fail
1.8457	536	3993	744	Fail
1.9008	493	3656	741	Fail
1.9560	457	3377	738	Fail
2.0111	430	3101	721	Fail
2.0663	392	2861	729	Fail
2.1214	364	2632	723	Fail
2.1766	346	2436	704	Fail
2.2317	324	2255	695	Fail
2.2869	305	2099	688	Fail
2.3420	287	1945	677	Fail
2.3972	271	1803	665	Fail
2.4523	253	1669	659	Fail
2.5075	237	1544	651	Fail
2.5626	226	1447	640	Fail
2.6178	211	1351	640	Fail
2.6729	193	1260	652	Fail
2.7281	182	1186	651	Fail
2.7832	165	1120	678	Fail
2.8384	152	1044	686	Fail
2.8935	145	959	661	Fail
2.9487	131	908	693	Fail
3.0038	120	853	710	Fail
3.0590	107	804	751	Fail
3.1141	100	759	759	Fail
3.1693	96	707	736	Fail
3.2244	91	667	732	Fail
3.2796	83	628	756	Fail
3.3347	75	594	792	Fail
3.3899	71	558	785	Fail
3.4450	69	526	762	Fail
3.5002	62	493	795	Fail
3.5553	59	469	794	Fail
3.6105	56	442	789	Fail
3.6656	52	425	817	Fail
3.7208	49	399	814	Fail
3.7759	44	376	854	Fail
3.8311	43	354	823	Fail
3.8862	41	338	824	Fail
3.9414	39	315	807	Fail
3.9965	32	298	931	Fail
4.0517	30	278	926	Fail
4.1068	28	265	946	Fail
4.1620	26	246	946	Fail
4.2171	21	234	1114	Fail
4.2723	19	215	1131	Fail
4.3274	19	205	1078	Fail
4.3826	19	195	1026	Fail
4.4377	18	182	1011	Fail

4.4929	16	169	1056	Fail
4.5480	15	165	1100	Fail
4.6032	14	161	1150	Fail
4.6583	14	155	1107	Fail
4.7135	12	140	1166	Fail
4.7687	12	136	1133	Fail
4.8238	12	129	1075	Fail
4.8790	12	126	1050	Fail
4.9341	11	117	1063	Fail
4.9893	10	112	1120	Fail
5.0444	10	104	1040	Fail
5.0996	9	103	1144	Fail
5.1547	9	100	1111	Fail
5.2099	8	89	1112	Fail
5.2650	7	84	1200	Fail
5.3202	6	81	1350	Fail
5.3753	6	76	1266	Fail
5.4305	6	74	1233	Fail
5.4856	6	72	1200	Fail
5.5408	6	69	1150	Fail
5.5959	6	66	1100	Fail
5.6511	6	64	1066	Fail
5.7062	5	61	1220	Fail
5.7614	5	57	1140	Fail
5.8165	5	54	1080	Fail
5.8717	5	50	1000	Fail
5.9268	5	47	939	Fail
5.9820	5	46	920	Fail
6.0371	5	46	920	Fail
6.0923	5	43	860	Fail
6.1474	5	41	820	Fail
6.2026	5	39	780	Fail
6.2577	5	39	780	Fail
6.3129	4	39	975	Fail
6.3680	4	38	950	Fail
6.4232	4	37	925	Fail
6.4783	4	36	900	Fail
6.5335	4	35	875	Fail
6.5886	4	34	850	Fail
6.6438	4	32	800	Fail
6.6989	4	32	800	Fail
6.7541	4	30	750	Fail
6.8092	4	28	700	Fail
6.8644	4	27	675	Fail
6.9195	4	26	650	Fail
6.9747	4	26	650	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	1.4116 acre-feet
On-line facility target flow:	2.0656 cfs.
Adjusted for 15 min:	2.0656 cfs.
Off-line facility target flow:	1.1415 cfs.
Adjusted for 15 min:	1.1415 cfs.

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

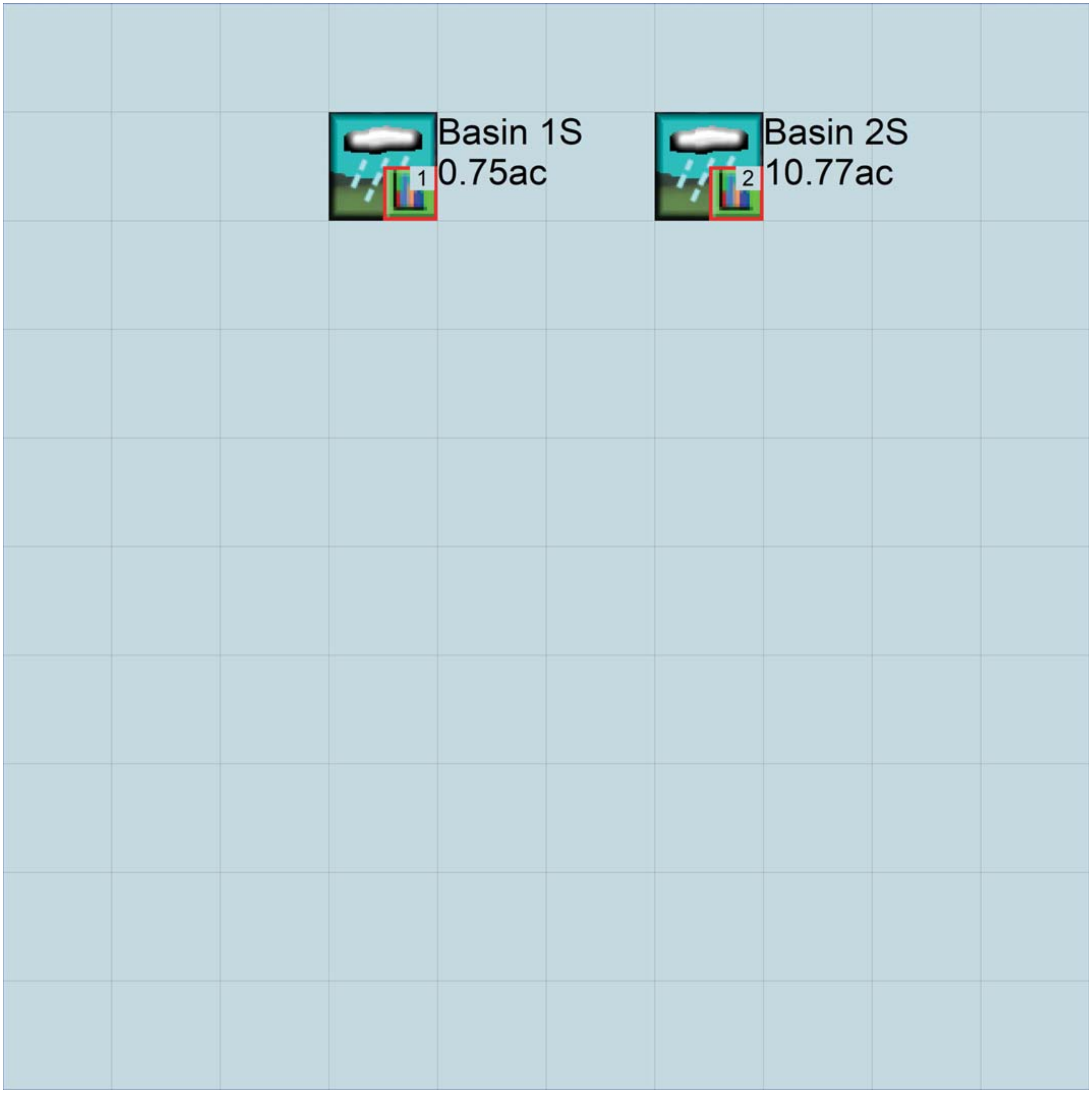
PERLND Changes

No PERLND changes have been made.

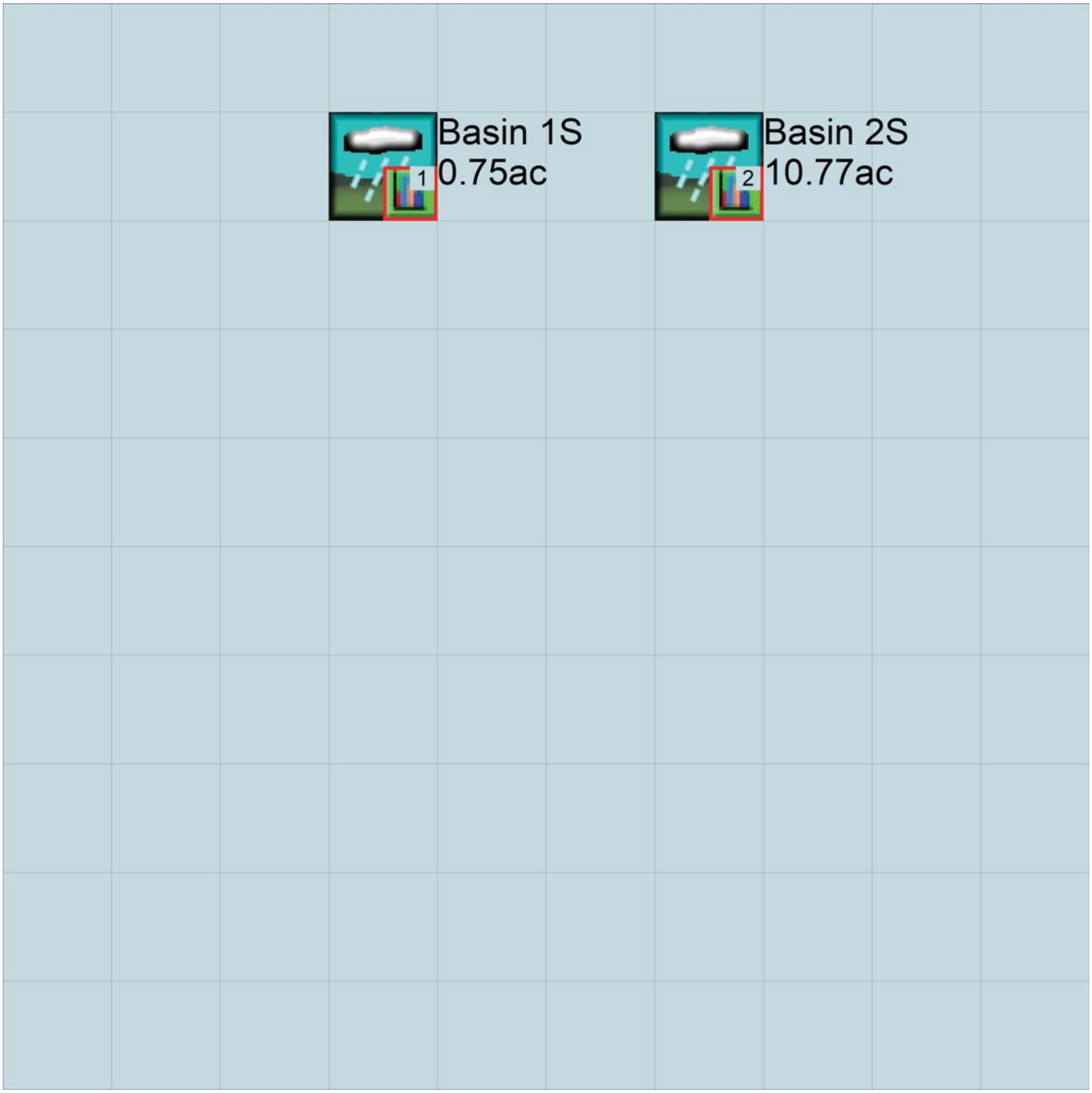
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   9030 WWHM WQ.wdm
MESSU      25   Pre9030 WWHM WQ.MES
           27   Pre9030 WWHM WQ.L61
           28   Pre9030 WWHM WQ.L62
           30   POC9030 WWHM WQ1.dat
           31   POC9030 WWHM WQ2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      29
      IMPLND       9
      IMPLND      11
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin 1S                   MAX                     1    2   30    9
    2        Basin 2S                   MAX                     1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   29      SG4, Forest, Mod        1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   29         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY
```

```
  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   29         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   29         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   29             0          6      0.04       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   29             0          0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   29              0.2       0.4      0.35         2       0.4       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   29             0          0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                       in  out          ***
    9      SIDEWALKS/MOD          1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    9         0    0    1    0    0    0
   11         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    9         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    9         0    0    0    0    0
   11         0    0    0    0    0
  END IWAT-PARM1
```

```
  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    9            400      0.05       0.1      0.08
   11            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    9              0         0
   11              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    9              0         0
   11              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                    <--Area-->     <-Target->   MBLK   ***
<Name>   #                    <-factor->     <Name>   #   Tbl#   ***
Basin 1S***
PERLND  29                         0.175     COPY   501     12
PERLND  29                         0.175     COPY   501     13
IMPLND   9                         0.034     COPY   501     15
IMPLND  11                         0.538     COPY   501     15
Basin 2S***
PERLND  29                         10.77     COPY   502     12
PERLND  29                         10.77     COPY   502     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
```

```
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01        END    2008 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   9030 WWHM WQ.wdm
MESSU      25   Mit9030 WWHM WQ.MES
           27   Mit9030 WWHM WQ.L61
           28   Mit9030 WWHM WQ.L62
           30   POC9030 WWHM WQ1.dat
           31   POC9030 WWHM WQ2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      35
      IMPLND       9
      IMPLND      11
      IMPLND       2
      IMPLND       4
      IMPLND       5
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin 1S                   MAX                     1    2   30    9
    2        Basin 2S                   MAX                     1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                           User  t-series Engl Metr ***
                                           in  out           ***
   35     SG4, Lawn, Mod          1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
```

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   35         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   35         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   35         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   35              0         6      0.02       400       0.1         0      0.96
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   35              0         0         3         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                 ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   35            0.1       0.2      0.25         2       0.4      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   35              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                      in  out           ***
    9      SIDEWALKS/MOD          1    1    1   27    0
   11      PARKING/FLAT           1    1    1   27    0
    2      ROADS/MOD              1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    5      DRIVEWAYS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    9         0    0    1    0    0    0
   11         0    0    1    0    0    0
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    9         0    0    4    0    0    0    1    9
   11         0    0    4    0    0    0    1    9
```

```
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    9         0    0    0    0    0
   11         0    0    0    0    0
    2         0    0    0    0    0
    4         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    9            400      0.05       0.1      0.08
   11            400      0.01       0.1       0.1
    2            400      0.05       0.1      0.08
    4            400      0.01       0.1       0.1
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    9              0         0
   11              0         0
    2              0         0
    4              0         0
    5              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    9              0         0
   11              0         0
    2              0         0
    4              0         0
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin 1S***
PERLND  35                       0.175     COPY   501     12
PERLND  35                       0.175     COPY   501     13
IMPLND   9                       0.034     COPY   501     15
IMPLND  11                       0.538     COPY   501     15
Basin 2S***
PERLND  35                       2.808     COPY   502     12
PERLND  35                       2.808     COPY   502     13
IMPLND   2                       2.356     COPY   502     15
IMPLND   4                       4.132     COPY   502     15
IMPLND   5                       1.061     COPY   502     15
IMPLND   9                       0.413     COPY   502     15

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
```

```
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                          in  out                            ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.3            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.3            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.8            PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.8            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
```

```
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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Appendix G: Geotechnical Reports

GEOPACIFIC

Real-World Geotechnical Solutions
Investigation • Design • Construction Support

Geotechnical Engineering Report

Project Information:	Camas Meadows Subdivision, Phase 1 & 2 GeoPacific Project No. 21-5938 & 21-5939 December 28, 2021
Site Location:	4525, 4555 & 4615 NW Camas Meadows Dr. Camas, Washington 97217 Property IDs. 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986036-906
Client:	Kess Romano Romano Development 4660 NE 77th Avenue, Suite 200 Vancouver, WA 98662

14835 SW 72nd Avenue
Portland, Oregon 97224
Tel (503) 598-8445
Fax (503) 941-9281

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1.0 PROJECT INFORMATION

This report presents the results of a geotechnical engineering study conducted by GeoPacific Engineering, Inc. (GeoPacific) for the above-referenced project. The purpose of our investigation was to evaluate subsurface conditions at the site, assess potential geologic hazards at the property, and to provide geotechnical recommendations for site development. This geotechnical study was performed in accordance with GeoPacific Proposal No. P-7920B, dated November 8, 2021, and your subsequent authorization of our proposal and *General Conditions for Geotechnical Services*.

2.0 SITE AND PROJECT DESCRIPTION

As indicated on Figures 1 through 3, the subject site is located at 4525-4615 NW Camas Meadows Drive in the City of Camas, Washington. The site is approximately 8.88 acres in size and consists of Clark County Properties 175980-000, 172973-000, 172963-000, 986035-734, 986035-733, 172970-000, & 986036-906. The properties are currently undeveloped with exception to an existing parking lot on the southeastern portion of the site. The site is primarily forested with medium to large size conifer, deciduous trees, grasses, and undergrowth. Topography onsite gently to moderately slopes down to the northwest with short slopes as steep as 30 percent near the northern property boundary.

Based on a preliminary site plan provided by AKS Engineering and Forestry, the proposed development will consist of approximately 60 lots with associated streets, stormwater management facilities and underground utilities, and the construction of associated underground utilities. A grading plan has not yet been provided for our review. However, we anticipate cuts and fills to be less than 10 feet.

3.0 REGIONAL GEOLOGIC SETTING

The *Geologic Map of the Lacamas Creek Quadrangle, Clark County, Washington, (*U.S. Department of the Interior, U.S. Geological Survey, 1998, Russell C. Evarts, 2006*)*, indicates that the site is underlain by late Pliocene to early Pleistocene-aged unconsolidated to semi-consolidated, thick-bedded, pebble to boulder conglomerate with matrix of volcanic lithic to micaceous, quartzo-feldspathic sand (QTc). Clasts are largely comprised of volcanic rocks eroded from the western Cascade Range and the Columbia River Basalt group (Qbgm).

According to the geologic mapping, the site lies near the contact of three other geologic units. To the north of the site, to the northwest of Lacamas Lake is comprised of Pliocene to Miocene-aged massive to crudely stratified, pebbly and cobble conglomerate, commonly referred to as the Troutdale Formation (Ttfc). The conglomerates are largely comprised of arkosic to basaltic sandstone, containing clasts of basalt, granit, and quartzo-feldspathic metamorphic rocks. To the east of the site, the Pliocene to Miocene-aged Hyaoclastic Sandstone Formation is present (Ttfh). The sandstone formation is commonly correlated with the upper portion of the Troutdale Formation, and is composed of indurated, coarse-grained sandstone and conglomerate composed largely of glassy to lithic basaltic debris. The area to the northeast of the site is comprised of a Quaternary-aged Gravel Facies (Qfg). The facies consists of unconsolidated peddle- to cobble-sized gravel which underlies Lacamas Creek Valley to the northwest of Lacamas Lake. Based on the geologic mapping, and our subsurface investigation at the site, it appears that the Pleistocene-aged conglomerates identified near ground surface (QTc) are likely underlain by the Troutdale Formation.

4.0 REGIONAL SEISMIC SETTING

At least three major fault zones capable of generating damaging earthquakes are thought to exist in the vicinity of the subject site. These include the Lacamas Creek/Sandy River Fault Zone, The Grant Butte and Damascus-Trickle Creek Fault Zone, and the Cascadia Subduction Zone.

4.1 Lacamas Creek / Sandy River Fault Zone

The northwest trending Lacamas Creek Fault intersects the northeast trending Sandy River Fault north of Camas, Washington at Lacamas Lake, approximately 0.5 miles northeast of the subject site. According to the USGS Earthquake Hazards Program the fault has been mapped as a normal fault with down-to-the-southwest displacement, and has also been described as a steeply northeast or southwest-dipping, oblique, right-lateral, slip-fault. The trace of the Lacamas Lake fault is marked by the very linear lower reach of Lacamas Creek. No fault scarps on Quaternary surficial deposits have been described. The Lacamas Lake fault offsets Pliocene-aged sedimentary conglomerates generally identified as the Troutdale formation, and Pliocene to Pleistocene aged basalts generally identified as the Boring Lava formation. Recent seismic reflection data across the probable trace of the fault under the Columbia River yielded no unequivocal evidence of displacement underlying the Missoula flood deposits, however, recorded mild seismic activity during the recent past indicates this area may be potentially seismogenic.

4.2 Grant Butte and Damascus-Trickle Creek Fault Zone

The Grant Butte fault zone was mapped along the north side of Mt. Scott and Powell Butte by Madin (1990). The fault is approximately 5.4 miles south of the subject site and extends eastward to Grant Butte on the basis of mapping by CH2M Hill and others (1991) and informally named the Grant Butte fault (Cornforth and Geomatrix, 1992). The Damascus-Trickle Creek fault zone displaces Pliocene and possibly Pleistocene sediments in the vicinity of Boring, Oregon (Madin,1992; Lite, 1992). Relatively short faults define a 17-km-long fault zone that is apparently linked to the Grant Butte fault on the basis of stratigraphic relationships showing middle and late Pleistocene activity. Geomatrix (1995) assigns a probability of 0.5 for activity on structures within these fault zones.

4.3 Cascadia Subduction Zone

The Cascadia Subduction Zone is a 680-mile-long zone of active tectonic convergence where oceanic crust of the Juan de Fuca Plate is subducting beneath the North American continent at a rate of 4 cm per year (Goldfinger et al., 1996). A growing body of geologic evidence suggests that prehistoric subduction zone earthquakes have occurred (Atwater, 1992; Carver, 1992; Peterson et al., 1993; Geomatrix Consultants, 1995). This evidence includes: (1) buried tidal marshes recording episodic, sudden subsidence along the coast of northern California, Oregon, and Washington, (2) burial of subsided tidal marshes by tsunami wave deposits, (3) paleoliquefaction features, and (4) geodetic uplift patterns on the Oregon coast. Radiocarbon dates on buried tidal marshes indicate a recurrence interval for major subduction zone earthquakes of 250 to 650 years with the last event occurring 300 years ago (Atwater, 1992; Carver, 1992; Peterson et al., 1993; Geomatrix Consultants, 1995). The inferred seismogenic portion of the plate interface lies approximately along the Oregon Coast at depths of between 20 and 40 kilometers below the surface.

5.0 FIELD EXPLORATION AND SUBSURFACE CONDITIONS

Our subsurface explorations for this report were conducted on December 1, 2021. A total of ten test pits (TP-1 through TP-10) were excavated at the site using a track-mounted excavator to a maximum depth of 11 feet bgs. Explorations were conducted under the full-time observation of a GeoPacific engineering staff member. During the explorations pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence was recorded. Soils were classified in accordance with the Unified Soil Classification System (USCS). Soil samples obtained from the explorations were placed in relatively air-tight plastic bags. At the completion of each test, the test pits were loosely backfilled with onsite soils. The approximate locations of the explorations are indicated on Figures 2 and 3.

It should be noted that exploration locations were located in the field by pacing or taping distances from apparent property corners and other site features shown on the plans provided. As such, the locations of the explorations should be considered approximate. Summary exploration logs are attached. The stratigraphic contacts shown on the individual test pit logs represent the approximate boundaries between soil types. The actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times. Soil and groundwater conditions encountered in the explorations are summarized below.

5.1 Soil Descriptions

Topsoil Horizon: Underlying the ground surface at the location of test pits TP-1 through TP-10, we encountered a topsoil horizon that consisted of dark brown, very moist, soft, moderately organic SILT (ML-OL). The topsoil horizon ranged from approximately 6 to 12 inches deep, and contained fine to medium-sized roots. The depth of organic soils will increase where trees are present.

Catastrophic Flood Deposits: Underlying the topsoil horizon at the location of our explorations, we encountered fine-grained catastrophic flood deposits. These soils generally consisted of medium stiff to very stiff, brown, Clayey SILT and SILTY CLAY (CL-ML) with Sand. The flood deposits generally extended to a depth of 2 to 6 feet below the ground surface.

Conglomerate: Underlying the flood deposits at the location of our explorations, we encountered conglomerate. These soils generally consisted of medium dense to very dense subrounded gravel (GC) with clayey silt to silty clay matrix or stiff to very stiff. In test pits TP-1 through TP-3, TP-5, and TP-6, a 1-3-foot-thick layer of medium dense Silty Sand (SM) with trace subrounded gravel was encountered below the flood deposits. The conglomerate was partially cemented and extended beyond the maximum depth of exploration within our test pits (6 to 11 feet). Practical refusal with a medium sized excavator was not encountered. However, very slow digging was encountered at depths ranging from 4.5 to 8.5 feet below the ground surface.

5.2 Shrink-Swell Potential

Low plasticity fine-grained soils were encountered near the ground surface within subsurface explorations conducted at the site. Based upon the results of our observations, laboratory testing, and our local experience with the soil layers in the vicinity of the subject site, the shrink-swell potential of the soil types is considered to be low. Special design measures are not considered necessary to minimize the risk of uncontrolled damage of foundations as a result of potential soil expansion at this site.

5.3 Groundwater and Soil Moisture

On December 1, 2021 observed soil moisture conditions were generally very moist to wet. Static groundwater was not observed within our test pit explorations, and light groundwater seepage was observed in thin layers within test pit TP-3, TP-5 through TP-7, and TP-9 at the approximate contact with very dense conglomerate. According to *Clark County Maps Online*, the static groundwater table in the vicinity of the subject site is expected to be present at depths ranging from 10 to 40 feet bgs. It is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, changes in site utilization, and other factors. Perched groundwater may be encountered in localized areas. Seeps and springs may exist in areas not explored and may become evident during site grading.

5.4 Infiltration Testing

GeoPacific conducted soil infiltration testing within test pit TP-3 using the single-ring, encased falling head permeability test method in general accordance with the Clark County Stormwater Manual. Where encased falling-head testing was conducted, the infiltration tests were prepared by carefully inserting rigid standpipe into undisturbed soil or hollow stem augers at the target depths. Prior to conducting the infiltration test, a pre-saturation period of two hours was conducted before recorded measurements and allowing the soil at the bottom of the tests to become fully saturated. In-situ soil moisture contents were generally observed to be near full saturation at the time of testing. Following the saturation period, the infiltration tests were conducted. During testing the water level was measured to the nearest tenth of an inch with reference to the ground surface. Tests were continued until three successive measurements did not vary by more than $1/10^{th}$ of an inch. Using Equation 1 of the Clark County Stormwater Manual, Appendix 1-C, Page C-2, Infiltration Test Methods (Darcy's Law), the hydraulic conductivity of the soils was calculated at each test location:

$$k = \frac{L}{t} \ln \frac{\mathrm{h1}}{\mathrm{h2}}$$

k = coefficient of permeability (inches per hour)
L = length of flow (inches)
t = time (hours)
h_1 = initial head (inches)
h_2 = final head (inches)

Infiltration rates are presented in Table 1 as a hydraulic conductivity (k) in inches per hour, and have been reported without applying a factor of safety. Soils at the test locations were observed and sampled in order to characterize the subsurface profile. Soil type descriptions are based upon laboratory analysis and visual assessment of collected samples, and are presented in the attached exploration logs. Exploration locations are indicated on Figures 2 & 3.

Table 1. Summary of Infiltration Test Results

Infiltration Test	Test Location	Depth (feet bgs)	Soil Type	Infiltration Rate (*k*) (in/hr)
IT-1	TP-3	4	SM	0.2

6.0 CONCLUSIONS AND RECOMMENDATIONS

Our site investigation indicates that the proposed construction appears to be geotechnically feasible, provided that the recommendations of this report are incorporated into the design and construction phases of the project. The primary geotechnical constraints to development as proposed include the presence of dense to very dense conglomerate which may present difficult or slow excavating conditions for deep cuts and excavation of utility trenches. The depth and location where dense to very dense conglomerate was observed during our site investigation is presented on Figures 2 and 3.

The following report sections provide recommendations for site development and construction in accordance with the current applicable codes and local standards of practice.

6.1 Site Preparation Recommendations

Areas of proposed construction and areas to receive fill should be cleared of any organic and inorganic debris, and loose stockpiled soils. Inorganic debris and organic materials from clearing should be removed from the site. Organic-rich soils and root zones should then be stripped from construction areas of the site or where engineered fill is to be placed. Depth of stripping of existing organic topsoil is estimated to be approximately 6 to 18 inches at the site and will be deepest where trees are present. Following removal of topsoil, the existing ground surface should be aerated, scarified and recompacted.

The final depth of soil removal should be determined by the geotechnical engineer or designated representative during site inspection while stripping/excavation is being performed. Stripped topsoil should be removed from areas proposed for placement of engineered fill and structures. Any remaining topsoil should be stockpiled only in designated areas and stripping operations should be observed and documented by the geotechnical engineer or his representative.

Where/if encountered, undocumented fills and any subsurface structures (dry wells, basements, driveway and landscaping fill, old utility lines, septic leach fields, etc.) should be completely removed and the excavations backfilled with engineered fill. Although we did not observe any undocumented fill within our test pit explorations, several feet of undocumented fill should be anticipated in the vicinity of the existing parking lot.

Site earthwork may be impacted by wet weather conditions. Stabilization of subgrade soils may require aeration and re-compaction. If subgrade soils are found to be difficult to stabilize, over-excavation, placement of granular soils, or cement treatment of subgrade soils may be feasible options. GeoPacific should be onsite to observe preparation of subgrade soil conditions prior to placement of engineered fill.

6.2 Engineered Fill

All grading for the proposed development should be performed as engineered grading in accordance with the applicable building code at time of construction with the exceptions and additions noted herein. Proper test frequency and earthwork documentation usually requires daily observation and testing during stripping, rough grading, and placement of engineered fill. Imported fill material must be approved by the geotechnical engineer before being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Engineered fill should be compacted in horizontal lifts not exceeding 8 inches using standard compaction equipment. We recommend that engineered fill be compacted to at least 95% of the maximum dry density determined by ASTM D698 (Standard Proctor) or equivalent. Field density testing should conform to ASTM D2922 and D3017, or D1556. All engineered fill should be observed and tested by the project geotechnical engineer or their representative. Typically, one density test is performed for at least every 2 vertical feet of fill placed or every 500 yd^3, whichever requires more testing. Because testing is performed on an on-call basis, we recommend that the earthwork contractor be held contractually responsible for test scheduling and frequency.

Onsite native soils appear to be suitable for use as engineered fill. Soils containing greater than 5 percent organic content should not be used as structural fill. Imported fill material must be approved by the geotechnical engineer prior to being imported to the site. Oversize material greater than 6 inches in size should not be used within 3 feet of foundation footings, and material greater than 12 inches in diameter should not be used in engineered fill.

Site earthwork may be impacted by shallow groundwater, soil moisture and wet weather conditions. Earthwork in wet weather would likely require extensive use of additional crushed aggregate, cement or lime treatment, or other special measures, at considerable additional cost compared to earthwork performed under dry-weather conditions.

6.3 Keyways and Benching for Engineered Fill on Slopes

Engineered fill to be placed in sloping areas inclining steeper than 20% grade should be constructed on a keyway and benches in accordance with the typical design shown in Figure 4. Keyways should have a minimum depth of 2 feet and minimum width of 10 feet. Additional removals of potentially unstable soils may be required depending on conditions observed during construction. Both benches and keyways should be roughly horizontal in the down slope direction, but may slope up to 20% grade along topographic contour. Keyways sloping more than 20% grade along topographic contour should be benched.

The keyway should include a subdrain consisting of a minimum 3-inch-diameter, ADS Heavy Duty grade (or equivalent), perforated plastic pipe enveloped in a minimum of 3 cubic feet per lineal foot of 2”- ½”, open-graded gravel drain rock wrapped with geotextile filter fabric (Mirafi 140N or equivalent). GeoPacific should inspect keyways, subdrains and benching prior to fill placement. Areas of potential seepage observed during construction may require a rock blanket drain in the keyway bottom.

We recommend that permanent fill and cut slopes be constructed no steeper than 2H:1V (50% grade). Fill slopes should be overbuilt a minimum of 3 feet horizontally beyond finish grade and then trimmed back to finish grade as shown in figure in order to achieve a well compacted slope face.

6.4 Excavating Conditions and Utility Trench Backfill

We anticipate that onsite soils can generally be excavated using conventional heavy equipment. Bedrock was not encountered within our subsurface explorations which extended to a maximum depth of 11 feet bgs. However, dense to very dense conglomerate was encountered at depths between 2 and 8.5 feet below the ground surface which may present difficult or slow excavating conditions during deep cuts or during utility trench excavation. The depth and location where dense to very dense conglomerate was observed during our site investigation is presented on Figures 2 and 3.

All temporary cuts in excess of 4 feet in height should be sloped in accordance with U.S. Occupational Safety and Health Administration (OSHA) regulations (29 CFR Part 1926) or be shored. The existing native fine-grained soils classify as Type B Soil and temporary excavation side slope inclinations as steep as 1H:1V may be assumed for planning purposes, and the existing native coarse-grained soils classify as Type C soil and temporary excavation side slope inclinations as steep as 1.5H:1V may be assumed for planning purposes. This cut slope inclination is applicable to excavations above the water table only. Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the contractor. Actual slope inclinations at the time of construction should be determined based on safety requirements and actual soil and groundwater conditions.

Saturated soils and groundwater may be encountered in utility trenches, particularly during the wet season. We anticipate that dewatering systems consisting of ditches, sumps and pumps would be adequate for control of perched groundwater. Regardless of the dewatering system used, it should be installed and operated such that in-place soils are prevented from being removed along with the groundwater.

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

PVC pipe should be installed in accordance with the procedures specified in ASTM D2321. We recommend that trench backfill be compacted to at least 95% of the maximum dry density obtained by Standard Proctor ASTM D698 or equivalent. Initial backfill lift thickness for a ¾”-0 crushed aggregate base may need to be as great as 4 feet to reduce the risk of flattening underlying flexible pipe. Subsequent lift thickness should not exceed 1 foot. If imported granular fill material is used, then the lifts for large vibrating plate-compaction equipment (e.g. hoe compactor attachments) may be up to 2 feet, provided that proper compaction is being achieved and each lift is tested. Use of large vibrating compaction equipment should be carefully monitored near existing structures and improvements due to the potential for vibration-induced damage.

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

6.5 Erosion Control Considerations

During our field exploration program, we did not observe soil and topographic conditions which are considered highly susceptible to erosion. In our opinion, the primary concern regarding erosion potential will occur during construction in areas that have been stripped of vegetation. Erosion at the site during construction can be minimized by implementing the project erosion control plan, which should include judicious use of straw waddles, fiber rolls, and silt fences. If used, these erosion control devices should remain in place throughout site preparation and construction.

Erosion and sedimentation of exposed soils can also be minimized by quickly re-vegetating exposed areas of soil, and by staging construction such that large areas of the project site are not denuded and exposed at the same time. Areas of exposed soil requiring immediate and/or temporary protection against exposure should be covered with either mulch or erosion control netting/blankets. Areas of exposed soil requiring permanent stabilization should be seeded with an approved grass seed mixture, or hydroseeded with an approved seed-mulch-fertilizer mixture.

6.6 Wet Weather Earthwork

Soils underlying the site are likely to be moisture sensitive and will be difficult to handle or traverse with construction equipment during periods of wet weather. Earthwork is typically most economical when performed under dry weather conditions. Earthwork performed during the wet-weather season will require expensive measures such as cement treatment or imported granular material to compact areas where fill may be proposed to the recommended engineering specifications. If earthwork is to be performed or fill is to be placed in wet weather or under wet conditions when soil moisture content is difficult to control, the following recommendations should be incorporated into the contract specifications.

- Earthwork should be performed in small areas to minimize exposure to wet weather. Excavation or the removal of unsuitable soils should be followed promptly by the placement and compaction of clean engineered fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance. Under some circumstances, it may be necessary to excavate soils with a backhoe to minimize subgrade disturbance caused by equipment traffic;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Material used as engineered fill should consist of clean, granular soil containing less than 5 percent passing the No. 200 sieve. The fines should be non-plastic. Alternatively, cement treatment of on-site soils may be performed to facilitate wet weather placement;
- The ground surface within the construction area should be sealed by a smooth drum vibratory roller, or equivalent, and under no circumstances should be left uncompacted and exposed to moisture. Soils which become too wet for compaction should be removed and replaced with clean granular materials;

- Excavation and placement of fill should be observed by the geotechnical engineer to verify that all unsuitable materials are removed and suitable compaction and site drainage is achieved; and
- Geotextile silt fences, straw wattles, and fiber rolls should be strategically located to control erosion.

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

6.7 Spread Foundations

GeoPacific understands that development at the site will include demolition of the existing home and development of residential building lots supporting construction of new single-family residential homes. We expect the homes to be constructed with typical spread foundations incorporating continuous strip footings, and square column footings, with post and beam wood-framing above.

The proposed structures may be supported on shallow foundations bearing on stiff, native soils and/or engineered fill, appropriately designed and constructed as recommended in this report. Foundation design, construction, and setback requirements should conform to the applicable building code at the time of construction. For maximization of bearing strength and protection against frost heave, spread footings should be embedded at a minimum depth of 18 inches below exterior grade. If soft soil conditions are encountered at footing subgrade elevation, they should be removed and replaced with compacted crushed aggregate.

The anticipated allowable soil bearing pressure is 2,000 lbs/ft^2 for footings bearing on competent, native soil and/or engineered fill. The recommended maximum allowable bearing pressure may be increased by 1/3 for short-term transient conditions such as wind and seismic loading. For loads heavier than 35 kips, the geotechnical engineer should be consulted. If heavier loads than described above are proposed, it may be necessary to over-excavate point load areas and replace with additional compacted crushed aggregate to achieve a higher allowable bearing capacity. The coefficient of friction between on-site soil and poured-in-place concrete may be taken as 0.42, which includes no factor of safety. The maximum anticipated total and differential footing movements (generally from soil expansion and/or settlement) are 1 inch and ¾ inch over a span of 20 feet, respectively. We anticipate that the majority of the estimated settlement will occur during construction, as loads are applied. Excavations near structural footings should not extend within a 1H:1V plane projected downward from the bottom edge of footings.

Footing excavations should penetrate through topsoil and any disturbed soil to competent subgrade that is suitable for bearing support. All footing excavations should be trimmed neat, and all loose or softened soil should be removed from the excavation bottom prior to placing reinforcing steel bars. Due to the moisture sensitivity of on-site native soils, foundations constructed during the wet weather season may require over-excavation of footings and backfill with compacted, crushed aggregate.

Our recommendations are for residential construction incorporating raised wood floors and conventional spread footing foundations. After site development, a Final Soil Engineer's Report should either confirm or modify the above recommendations.

6.8 Concrete Slabs-on-Grade

Preparation of areas beneath concrete slab-on-grade floors should be performed as described in Section 6.1, *Site Preparation Recommendations* and Section 6.6, *Spread Foundations*. Care should be taken during excavation for foundations and floor slabs, to avoid disturbing subgrade soils. If subgrade soils have been adversely impacted by wet weather or otherwise disturbed, the surficial soils should be scarified to a minimum depth of 8 inches, moisture conditioned to within about 3 percent of optimum moisture content and compacted to engineered fill specifications. Alternatively, disturbed soils may be removed, and the removal zone backfilled with additional crushed rock.

For evaluation of the concrete slab-on-grade floors using the beam on elastic foundation method, a modulus of subgrade reaction of 150 kcf (87 pci) should be assumed for the stiff, fine -grained soils anticipated to be present at foundation subgrade elevation following adequate site preparation as described above. This value assumes the concrete slab system is designed and constructed as recommended herein, with a minimum thickness of 8 inches of 1½"-0 crushed aggregate beneath the slab. The total thickness of crushed aggregate will be dependent on the subgrade conditions at the time of construction and should be verified visually by proof-rolling. Under-slab aggregate should be compacted to at least 95 percent of its maximum dry density as determined by ASTM D1557 (Modified Proctor) or equivalent.

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

6.9 Footing and Roof Drains

Construction should include typical measures for controlling subsurface water beneath the structures, including positive crawlspace drainage to an adequate low-point drain exiting the foundation, visqueen covering the exposed ground in the crawlspace, and crawlspace ventilation (foundation vents). The client should be informed and educated that some slow flowing water in the crawlspaces is considered normal and not necessarily detrimental to the structures given these other design elements incorporated into construction. Appropriate design professionals should be consulted regarding crawlspace ventilation, building material selection and mold prevention issues, which are outside GeoPacific's area of expertise.

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

Perimeter footing drains may be eliminated at the discretion of the geotechnical engineer based on soil conditions encountered at the site and experience with standard local construction practices. Where it is desired to reduce the potential for moist crawl spaces, footing drains may be installed. If concrete slab-on-grade floors are used, perimeter footing drains should be installed as recommended below.

Where deemed necessary, perimeter footing drains should consist of 3 or 4-inch diameter, perforated plastic pipe embedded in a minimum of 1 ft^3 per lineal foot of clean, free-draining drain rock. The drain-pipe and surrounding drain rock should be wrapped in non-woven geotextile (Mirafi 140N, or approved equivalent) to minimize the potential for clogging and/or ground loss due to piping. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. In our opinion, footing drains may outlet at the curb, or on the back sides of lots where sufficient fall is not available to allow drainage to meet the street.

6.10 Permanent Below-Grade Walls

Lateral earth pressures against below-grade retaining walls will depend upon the inclination of any adjacent slopes, type of backfill, degree of wall restraint, method of backfill placement, degree of backfill compaction, drainage provisions, and magnitude and location of any adjacent surcharge loads. At-rest soil pressure is exerted on a retaining wall when it is restrained against rotation. In contrast, active soil pressure will be exerted on a wall if its top is allowed to rotate or yield a distance of roughly 0.001 times its height or greater.

If the subject retaining walls will be free to rotate at the top, they should be designed for an active earth pressure equivalent to that generated by a fluid weighing 35 pcf for level backfill against the wall. For restrained wall, an at-rest equivalent fluid pressure of 55 pcf should be used in design, again assuming level backfill against the wall. These values assume that the recommended drainage provisions are incorporated, hydrostatic pressures are not allowed to develop against the wall, and walls are backfilled with engineered fill. Additional fluid pressures for different sloping conditions are presented on Table 2 below.

Table 2: Retaining Wall Pressures

Backslope	Active Pressure (psf)	At Rest (psf)
Level	35	55
3H:1V	45	65
2H:1V	55	75

During a seismic event, lateral earth pressures acting on below-grade structural walls will increase by an incremental amount that corresponds to the earthquake loading. Based on the Mononobe-Okabe equation and peak horizontal accelerations appropriate for the site location, seismic loading should be modeled using the active or at-rest earth pressures recommended above, plus an incremental rectangular-shaped seismic load of magnitude 6.5H, where H is the total height of the wall. Additional seismic loading for different sloping conditions is presented on Table 5 below.

Table 3: Seismic Load for Retaining Walls

Backslope	Mononobe Okabe
Level	6.5H
3H:1V	8H
2H:1V	10H

We assume relatively level ground surface below the base of the walls. As such, we recommend passive earth pressure of 320 pcf for use in design, assuming wall footings are cast against competent native soils or engineered fill. If the ground surface slopes down and away from the base of any of the walls, a lower passive earth pressure should be used and GeoPacific should be contacted for additional recommendations.

A coefficient of friction of 0.45 may be assumed along the interface between the base of the wall footing and subgrade soils. The recommended coefficient of friction and passive earth pressure values do not include a safety factor, and an appropriate safety factor should be included in design. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

The above recommendations for lateral earth pressures assume that the backfill behind the subsurface walls will consist of properly compacted structural fill, and no adjacent surcharge loading. If the walls will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the wall, the walls should be designed for the additional horizontal pressure. For uniform surcharge pressures, a uniformly distributed lateral pressure of 0.3 times the surcharge pressure should be added. Traffic surcharges may be estimated using an additional vertical load of 250 psf (2 feet of additional fill), in accordance with local practice.

The recommended equivalent fluid densities assume a free-draining condition behind the walls so that hydrostatic pressures do not build-up. This can be accomplished by placing a 12- to 18-inch wide zone of sand and gravel containing less than 5 percent fines against the walls. A 3-inch minimum diameter perforated, plastic drain pipe should be installed at the base of the walls and connected to a suitable discharge point to remove water in this zone of sand and gravel. The drain pipe should be wrapped in filter fabric (Mirafi 140N or other as approved by the geotechnical engineer) to minimize clogging.

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

Structures should be located a horizontal distance of at least 1.5H away from the back of the retaining wall, where H is the total height of the wall. GeoPacific should be contacted for additional foundation recommendations where structures are located closer than 1.5H to the top of any wall. The upper 12 inches of soil should be neglected in passive pressure computations unless it is protected by pavement or slabs on grade.

The above recommendations for lateral earth pressures assume that the backfill behind the subsurface walls will consist of properly compacted structural fill, and no adjacent surcharge loading. If the walls will be subjected to the influence of surcharge loading within a horizontal distance equal to or less than the height of the wall, the walls should be designed for the additional horizontal pressure. For uniform surcharge pressures, a uniformly distributed lateral pressure of 0.3 times the surcharge pressure should be added. Traffic surcharges may be estimated using an additional vertical load of 250 psf (2 feet of additional fill), in accordance with local practice.

The recommended equivalent fluid densities assume a free-draining condition behind the walls so that hydrostatic pressures do not build-up. This can be accomplished by placing a 12 to 18-inch wide zone of sand and gravel containing less than 5 percent passing the No. 200 sieve against the walls. A 3-inch minimum diameter perforated, plastic drain-pipe should be installed at the base of the walls and connected to a suitable discharge point to remove water in this zone of sand and gravel. The drain-pipe should be wrapped in filter fabric (Mirafi 140N or other as approved by the geotechnical engineer) to minimize clogging.

Wall drains are recommended to prevent detrimental effects of surface water runoff on foundations – not to dewater groundwater. Drains should not be expected to eliminate all potential sources of water entering a basement or beneath a slab-on-grade. An adequate grade to a low point outlet drain in the crawlspace is required by code. Underslab drains are sometimes added beneath the slab when placed over soils of low permeability and shallow, perched groundwater.

Water collected from the wall drains should be directed into the local storm drain system or other suitable outlet. A minimum 0.5 percent fall should be maintained throughout the drain and non-perforated pipe outlet. Down spouts and roof drains should not be connected to the wall drains in order to reduce the potential for clogging. The drains should include clean-outs to allow periodic maintenance and inspection. Grades around the proposed structure should be sloped such that surface water drains away from the building.

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

7.0 Flexible Pavement Design

We understand that new flexible pavement sections will be constructed at the subdivision which may include construction of a new streets providing access to the new homes.

7.1 Flexible Pavement Design: Private Streets, 20-Year Criteria

As indicated on Figure 3, we understand new interior street construction will consist of construction of private streets throughout the subdivision. For analysis and design purposes, we conservatively assume that the native subgrade soils will exhibit a resilient modulus of 6,000 psi under saturated conditions, which correlates to a CBR value of 4.

We assume that the streets will be subjected to vehicle traffic primarily consisting of light duty passenger vehicles, weekly trash trucks, and occasional fire trucks weighing up to 75,000 lbs. Based upon the anticipated traffic, we calculated an anticipated 18-kip ESAL count of approximately 56,322 over 20 years (through 2041). Table 4 presents our flexible pavement design input parameters and required structural number based on the anticipated traffic impacts to the roadways over a 20-year period. Table 5 presents our recommended minimum dry-weather pavement section supporting 20 years of vehicle traffic per Clark County standards.

Table 4: Flexible Pavement Section Design Input Parameters

Input Parameter	Design Value
18-kip ESAL Initial Performance Period (20 Years)	56,322
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability Level	90 Percent
Overall Standard Deviation	0.5
Roadbed Soil Resilient Modulus (PSI)	6,000
Structural Number	**2.41**

Table 5: Recommended Minimum Dry-Weather Pavement Section: Private Streets

Material Layer	Section Thickness (in.)	Structural Coefficient	Compaction Standard
Asphaltic Concrete (AC)	3 in.	.42	91%/ 92% of Rice Density AASHTO T-209
Crushed Aggregate Base ¾”-0 (leveling course)	2 in.	.10	95% of Modified Proctor AASHTO T-180
Crushed Aggregate Base 1½”-0	10 in.	.10	95% of Modified Proctor AASHTO T-180
Subgrade	12 in.	6,000 PSI	95% of Standard Proctor AASHTO T-99 or equivalent
Total Calculated Structural Number		**2.46**	

7.2 Subgrade Preparation

Roadway subgrade soils should be compacted and inspected by GeoPacific prior to the placement of crushed aggregate base for pavement. Typically, a proofroll with a fully loaded water or haul truck is conducted by travelling slowly across the grade and observing the subgrade for rutting, deflection, or movement. Any pockets of organic debris or loose fill encountered during ripping or tilling should be removed and replaced with engineered fill (see Section 6.1, *Site Preparation Recommendations*). In order to verify subgrade strength, we recommend proof-rolling directly on subgrade with a loaded dump truck during dry weather and on top of base course in wet weather. Soft areas that pump, rut, or weave should be stabilized prior to paving.

If pavement areas are to be constructed during wet weather, the subgrade and construction plan should be reviewed by the project geotechnical engineer at the time of construction so that condition specific recommendations can be provided. The moisture sensitive subgrade soils make the site a difficult wet weather construction project. General recommendations for wet weather pavement sections are provided below.

During placement of pavement section materials, density testing should be performed to verify compliance with project specifications. Generally, one subgrade, one base course, and one asphalt compaction test is performed for every 100 to 200 linear feet of paving.

7.3 Wet Weather Construction Pavement Section

This section presents our recommendations for wet weather pavement sections and construction for new pavement sections at the project. These wet weather pavement section recommendations are intended for use in situations where it is not feasible to compact the subgrade soils to project requirements, due to wet subgrade soil conditions, and/or construction during wet weather. Based on our site review, we recommend a wet weather section with a minimum subgrade deepening of 6 to 12 inches to accommodate a working subbase of additional 1½"-0 crushed rock. Geotextile fabric, Mirafi 500x or equivalent, should be placed on subgrade soils prior to placement of base rock.

In some instances, it may be preferable to use a subbase material in combination with over-excavation and increasing the thickness of the rock section. GeoPacific should be consulted for additional recommendations regarding use of additional subbase in wet weather pavement sections if it is desired to pursue this alternative. Cement treatment of the subgrade may also be considered instead of over-excavation. For planning purposes, we anticipate that treatment of the onsite soils would involve mixing cement powder to approximately 6 percent cement content and a mixing depth on the order of 12 to 18 inches.

With implementation of the above recommendations, it is our opinion that the resulting pavement section will provide equivalent or greater structural strength than the dry weather pavement section currently planned. However, it should be noted that construction in wet weather is risky and the performance of pavement subgrades depend on a number of factors including the weather conditions, the contractor's methods, and the amount of traffic the road is subjected to. There is a potential that soft spots may develop even with implementation of the wet weather provisions recommended in this letter. If soft spots in the subgrade are identified during roadway excavation, or develop prior to paving, the soft spots should be over-excavated and backfilled with additional crushed rock.

During subgrade excavation, care should be taken to avoid disturbing the subgrade soils. Removals should be performed using an excavator with a smooth-bladed bucket. Truck traffic should be limited until an adequate working surface has been established. We suggest that the crushed rock be spread using bulldozer equipment rather than dump trucks, to reduce the amount of traffic and potential disturbance of subgrade soils. Care should be taken to avoid over-compaction of the base course materials, which could create pumping, unstable subgrade soil conditions. Heavy and/or vibratory compaction efforts should be applied with caution. Following placement and compaction of the crushed rock to project specifications (95 percent of Modified Proctor), a finish proof-roll should be performed before paving.

The above recommendations are subject to field verification. GeoPacific should be on-site during construction to verify subgrade strength and to take density tests on the engineered fill, base rock and asphaltic pavement materials.

8.0 SEISMIC DESIGN

Structures should be designed to resist earthquake loading in accordance with the methodology described in the 2018 International Building Code (IBC). We recommend Site Class C be used for design per the OSSC, and as defined in ASCE 7. Design values determined for the site using the

ATC (Applied Technology Council) *ASCE 7-16 Hazards by Location online Tool* website are summarized in Table 6 and are based upon existing soil conditions.

Table 6: Recommended Earthquake Ground Motion Parameters (ASCE-7-16)

Parameter	Value
Location (Lat, Long), degrees	45.744, -123.633
Probabilistic Ground Motion Values, 2% Probability of Exceedance in 50 yrs	
Peak Ground Acceleration PGA_M	0.445 g
Short Period, S_s	0.796 g
1.0 Sec Period, S_1	0.369 g
Soil Factors for Site Class C:	
F_a	1.182
F_v	1.931
$SD_s = 2/3 \times F_a \times S_s$	0.627 g
$SD_1 = 2/3 \times F_v \times S_1$	0.475 g
Seismic Design Category	D

8.1 Soil Liquefaction

Soil liquefaction is a phenomenon wherein saturated soil deposits temporarily lose strength and behave as a liquid in response to ground shaking caused by strong earthquakes. Soil liquefaction is generally limited to loose, sands and granular soils located below the water table, and fine-grained soils with a plasticity index less than 15. Static groundwater was not encountered in explorations which extended to a maximum depth of 11 feet below the ground surface. According to *Clark County Maps Online*, the static groundwater table in the vicinity of the subject site is expected to be present at depths ranging from 10 to 40 feet bgs, and the site is being mapped as being in an area considered to be at low risk to very low risk for soil liquefaction.

The subsurface profile observed within our explorations and our experience with geologic conditions in the site vicinity indicate that the site is underlain by fine-grained, clayey soils, and very dense conglomerate below the water table which are not considered to be at risk for liquefaction. Based on the results of our subsurface investigation and our understanding of the geologic conditions in the site vicinity, it is our opinion that the risk of liquefaction at the site is very low.

9.0 UNCERTAINTIES AND LIMITATIONS

We have prepared this report for the owner and their consultants for use in design of this project only. This report should be provided in its entirety to prospective contractors for bidding and estimating purposes; however, the conclusions and interpretations presented in this report should not be construed as a warranty of the subsurface conditions. Experience has shown that soil and groundwater conditions can vary significantly over small distances. Inconsistent conditions can occur between explorations that may not be detected by a geotechnical study. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, GeoPacific should be notified for review of the recommendations of this report, and revision of such if necessary.

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

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

We appreciate this opportunity to be of service.

Sincerely,

GEOPACIFIC ENGINEERING, INC.

JAMES D. IMBRIE
STATE OF WASHINGTON
27177
REGISTERED
PROFESSIONAL ENGINEER
Exp. 3-31-22

Thomas J. Torkelson
Engineering Staff

James D. Imbrie, P.E.
Principal Engineer

REFERENCES

ATC Hazards by Location, (https://hazards.atcouncil.org).

Atwater, B.F., 1992, Geologic evidence for earthquakes during the past 2,000 years along the Copalis River, southern coastal Washington: Journal of Geophysical Research, v. 97, p. 1901-1919.

Carver, G.A., 1992, Late Cenozoic tectonics of coastal northern California: American Association of Petroleum Geologists-SEPM Field Trip Guidebook, 1992.

Gannet, Marshall W., and Caldwell, Rodney R., Generalized Geologic Map of the Willamette Lowland, U.S. Department of the interior, U.S. Geological Survey, 1998.

Goldfinger, C., Kulm, L.D., Yeats, R.S., Appelgate, B, MacKay, M.E., and Cochrane, G.R., 1996, Active strike-slip faulting and folding of the Cascadia Subduction-Zone plate boundary and forearc in central and northern Oregon: in Assessing earthquake hazards and reducing risk in the Pacific Northwest, v. 1: U.S. Geological Survey Professional Paper 1560, P. 223-256.

Ma, L., Madin, I.P., Duplantis, S., and Williams, K.J., 2012, Lidar-based Surficial Geologic Map and Database of the Greater Portland, Oregon, Area, Clackamas, Columbia, Marion, Multnomah, Washington, and Yamhill Counties, Oregon, and Clark County, Washington, DOGAMI Open-File Report O-12-02

Mabey, M.A., Madin, I.P., and Black G.L., 1996, Relative Earthquake Hazard Map of the Lake Oswego Quadrangle, Clackamas, Multnomah and Washington Counties, Oregon: Oregon Department of Geology and Mineral Industries

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

Oregon Department of Geology and Mineral Industries, Statewide Geohazards Viewer, www.oregongeology.org/hazvu.

Peterson, C.D., Darioenzo, M.E., Burns, S.F., and Burris, W.K., 1993, Field trip guide to Cascadia paleoseismic evidence along the northern California coast: evidence of subduction zone seismicity in the central Cascadia margin: Oregon Geology, v. 55, p. 99-144.

Preliminary Geologic Map of the Buxton 7.5’ Quadrangle, Washington County, Oregon Dinterman, Philip A., and Duvall, Allison, R., U.S. Department of the Interior, U.S. Geological Survey, Open File Report 2009-1186, 2009.

United States Geological Survey, USGS Earthquake Hazards Program Website (earthquake.usgs.gov).

Unruh, J.R., Wong, I.G., Bott, J.D., Silva, W.J., and Lettis, W.R., 1994, Seismotectonic evaluation: Scoggins Dam, Tualatin Project, Northwest Oregon: unpublished report by William Lettis and Associates and Woodward Clyde Federal Services, Oakland, CA, for U. S. Bureau of Reclamation, Denver CO (in Geomatrix Consultants, 1995).

Web Soil Survey, Natural Resources Conservation Service, United States Department of Agriculture *2015 website.*

(http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.).

Werner, K.S., Nabelek, J., Yeats, R.S., Malone, S., 1992, The Mount Angel fault: implications of seismic-reflection data and the Woodburn, Oregon, earthquake sequence of August, 1990: Oregon Geology, v. 54, p. 112-117.

Wong, I. Silva, W., Bott, J., Wright, D., Thomas, P., Gregor, N., Li., S., Mabey, M., Sojourner, A., and Wang, Y., 2000, Earthquake Scenario and Probabilistic Ground Shaking Maps for the Portland, Oregon, Metropolitan Area; State of Oregon Department of Geology and Mineral Industries; Interpretative Map Series IMS-16

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

Yelin, T.S., 1992, An earthquake swarm in the north Portland Hills (Oregon): More speculations on the seismotectonics of the Portland Basin: Geological Society of America, Programs with Abstracts, v. 24, no. 5, p. 92.

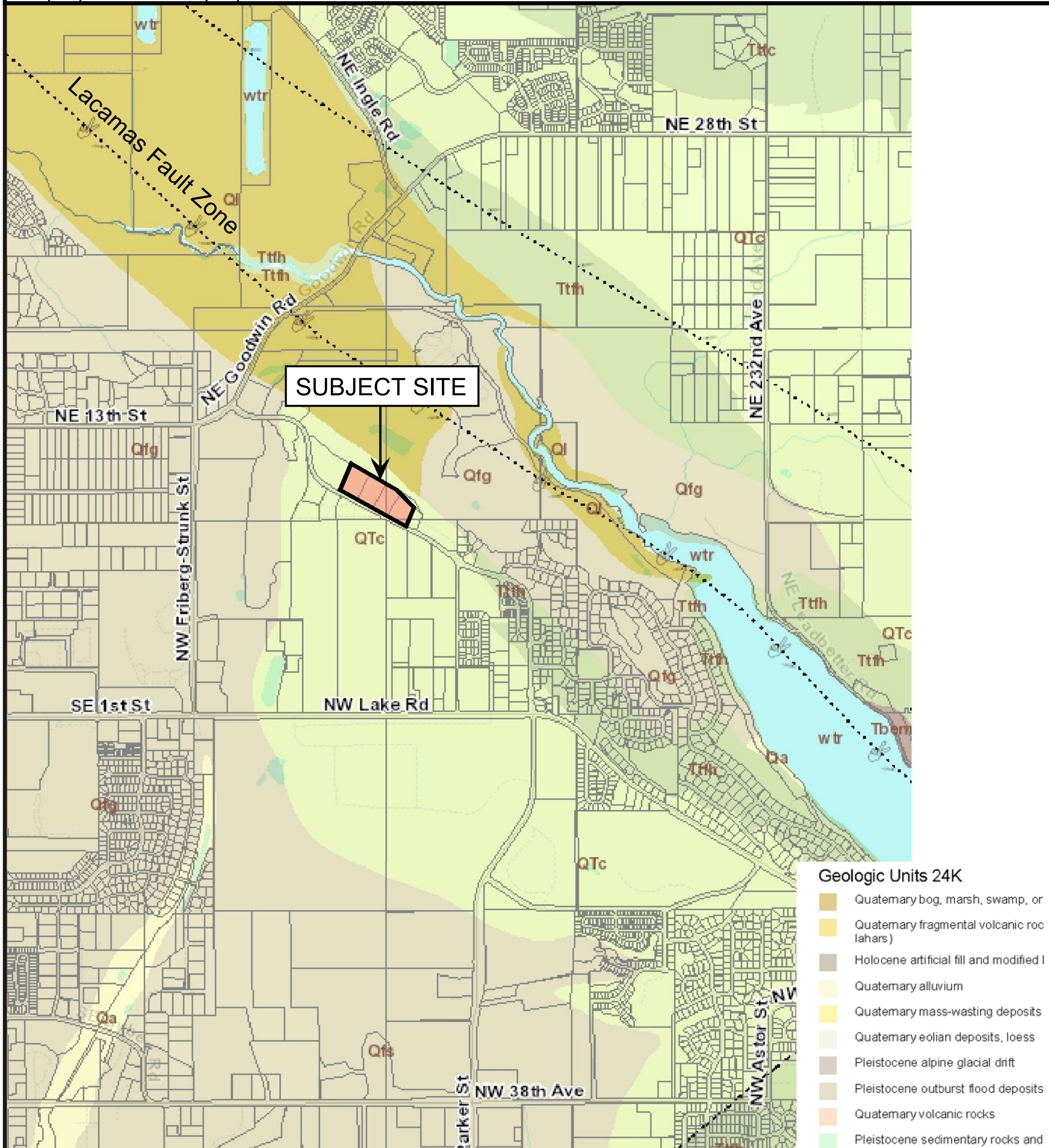
CHECKLIST OF RECOMMENDED GEOTECHNICAL TESTING AND OBSERVATION

Item No.	Procedure	Timing	By Whom	Done
1	Preconstruction meeting	Prior to beginning site work	Contractor, Developer, Civil and Geotechnical Engineers	
2	Fill removal from site or sorting and stockpiling	Prior to mass stripping	Soil Technician/ Geotechnical Engineer	
3	Stripping, aeration, and root-picking operations	During stripping	Soil Technician	
4	Compaction testing of engineered fill (95% of Standard Proctor)	During filling, tested every 2 vertical feet	Soil Technician	
5	Foundation Subgrade Compaction (95% of Modified Proctor)	During Foundation Preparation, Prior to Placement of Reinforcing Steel	Soil Technician/ Geotechnical Engineer	
6	Compaction testing of trench backfill (95% of Standard Proctor)	During backfilling, tested every 4 vertical feet for every 200 linear feet	Soil Technician	
7	Street Subgrade Inspection (95% of Standard Proctor)	Prior to placing base course	Soil Technician	
8	Base course compaction (95% of Modified Proctor)	Prior to paving, tested every 200 linear feet	Soil Technician	
9	Asphalt Compaction (92% Rice Value)	During paving, tested every 100 linear feet	Soil Technician	
10	Final Geotechnical Engineer's Report	Completion of project	Geotechnical Engineer	

FIGURES

GEOPACIFIC
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445 Fax: (503) 941-9281

SITE VICINITY MAP



Base map: Clark County Maps Online, Accessed 12.21.2021
Date: 12/21/2020
Drawn by: TJT

1:24,000
0 0.13 0.25 0.5 mi
0 0.23 0.45 0.9 km

North

Project: Camas Meadows Subdivision, Phase 1 & 2 Camas, Oregon	Project No. 21-5939	FIGURE 1

GEOPACIFIC
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445

SITE AERIAL AND EXPLORATION LOCATIONS

TP-1 Test Pit Designation and Approximate Location

Legend: Base Map Obtained From Google Earth 2021

(1.5') Approximate Depth of Observed Undocumented Fill or Topsoil, Feet

(1.5') Approximate Depth of Dense to Very Dense Conglomerate, Feet

APPROXIMATE SCALE (FEET)

90 0 90 180

Drawn by: TJT

Date: 12/23/2021

North

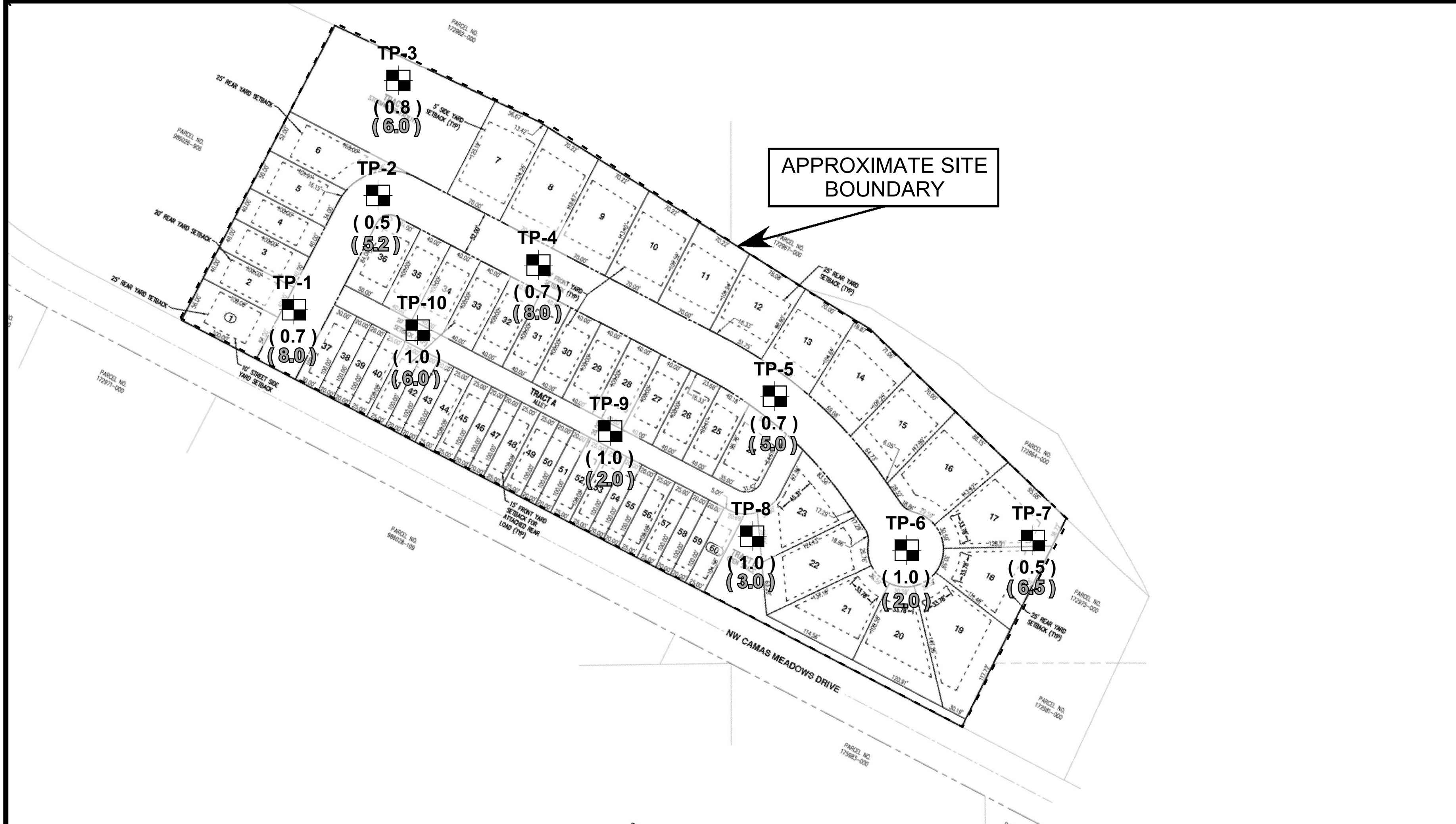
Project: Camas Meadows Subdivision, Phase 1 & 2
Camas, Washington 98607

Project No. 21-5939

FIGURE 2

GEOPACIFIC
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445

SITE PLAN AND EXPLORATION LOCATIONS



TP-1 Test Pit Designation and Approximate Location

(1.0) Approximate Depth of Observed Undocumented Fill or Topsoil, Feet

(1.5') Approximate Depth of Dense to Very Dense Conglomerate, Feet

Legend: Preliminary Site Plan Provided by AKS Engineering and Forestry

APPROXIMATE SCALE (FEET)

90 0 90 180

Drawn by: TJT

Date: 12/23/2021

North

Project: Camas Meadows Subdivision, Phase 1 & 2
Camas, Washington 98607

Project No. 21-5939

FIGURE 3

GEOPACIFIC
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Portland, Oregon 97224
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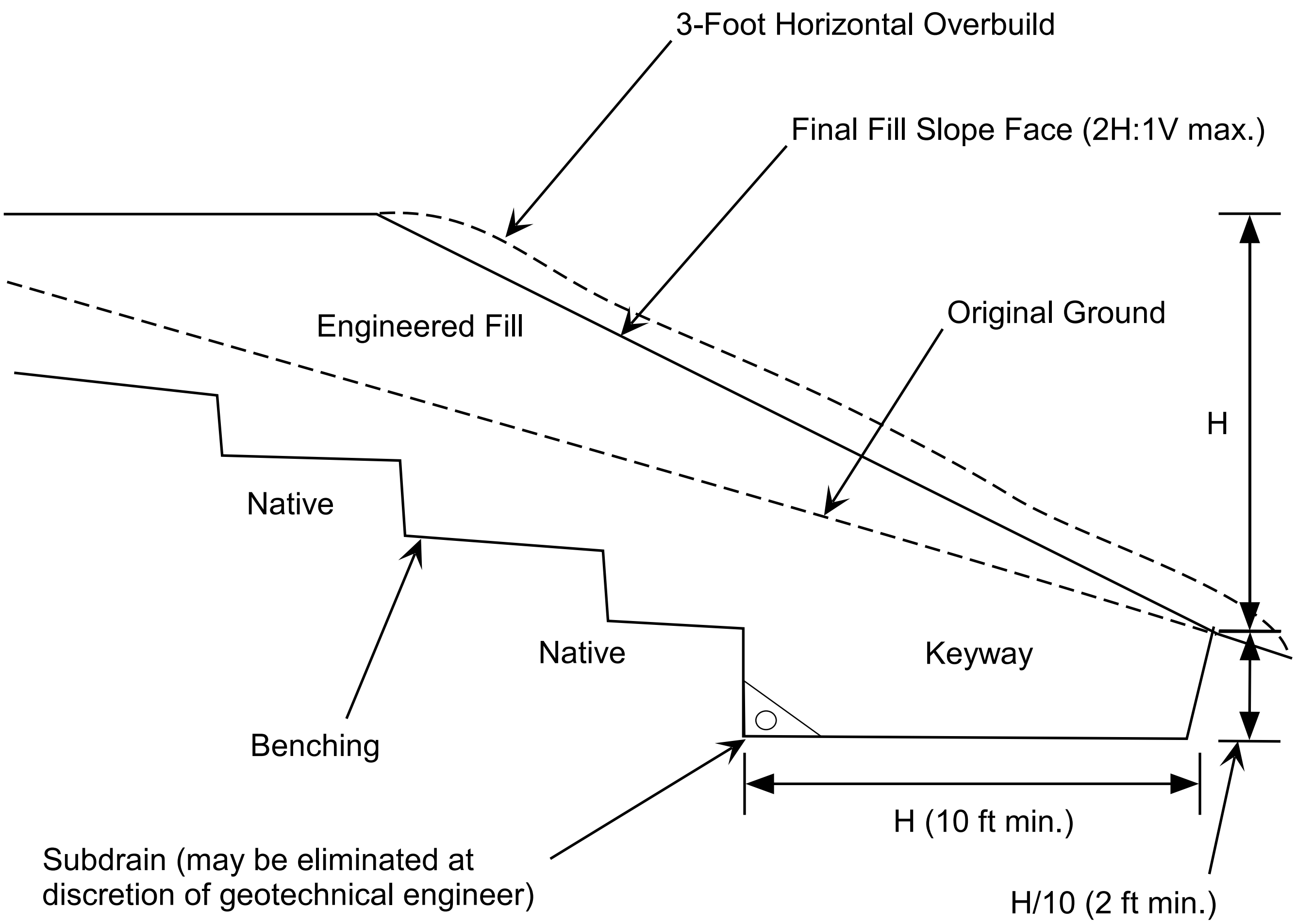
FILL SLOPE DETAIL

TYPICAL KEYWAY, BENCHING & FILL SLOPE DETAIL



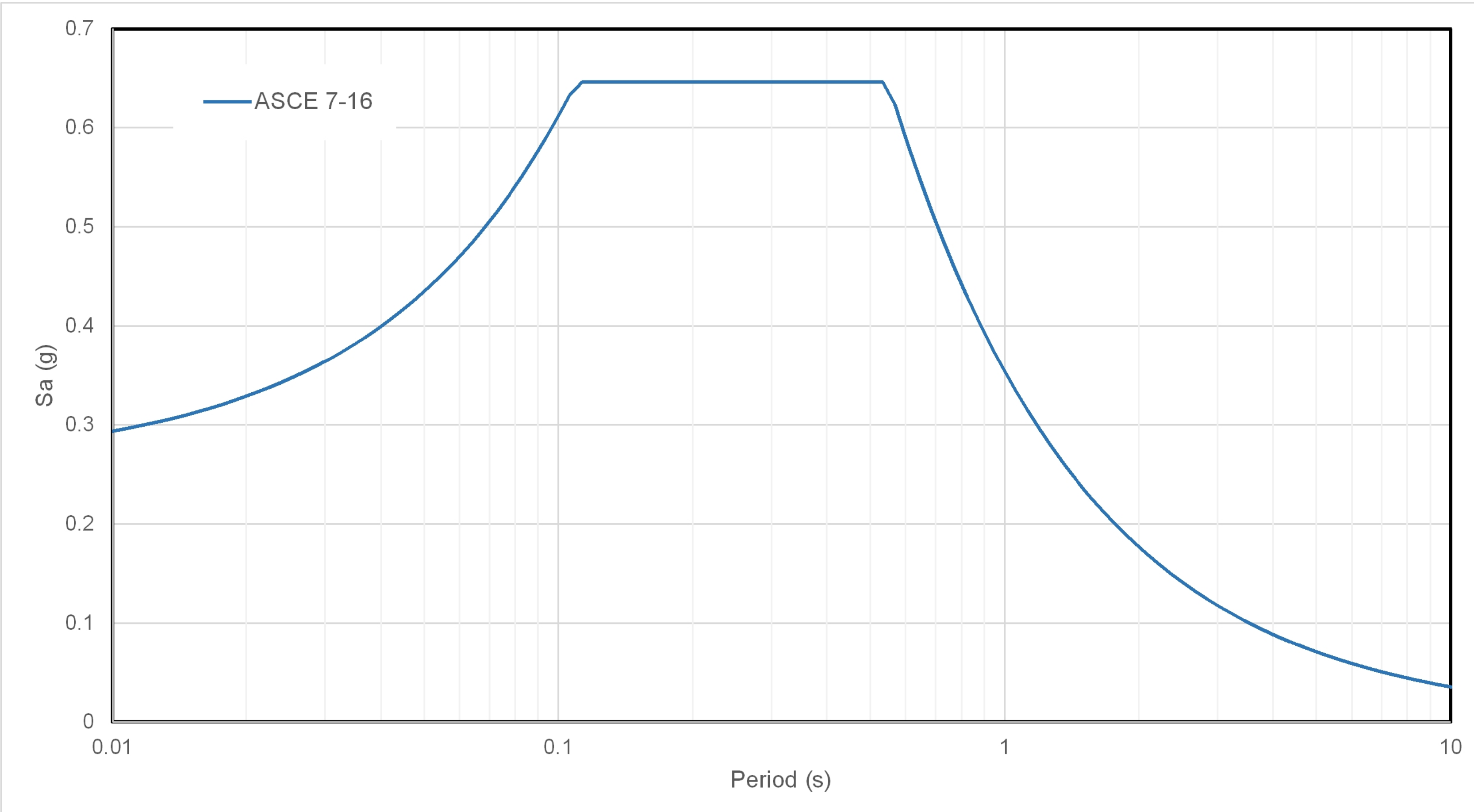
Recommended subdrain is minimum 3-inch-diameter ADS Heavy Duty grade (or equivalent), perforated plastic pipe enveloped in a minimum of 3 cubic feet per lineal foot of 2" to 1/2" open-graded gravel drain rock wrapped with geotextile filter fabric (Mirafi 140N or equivalent).

Project: Camas Meadows Subdivision, 1 & 2 Camas, Washington	Project No. 21-5939	FIGURE 4

GEOPACIFIC
14835 SW 72nd Avenue
Portland, Oregon 97224
Tel: (503) 598-8445

HORIZONTAL DESIGN RESPONSE SPECTRUM ASCE 7-16

SITE CLASS C



Note: Where MCE_R spectrum is required, it shall be determined by multiplying the design response spectrum by 1.5. ASCE 7-16 section 11.4.7.

DATE: 12/15/21
DRAWN BY: TJT

PROJECT: Camas Meadows Subdivision, 1 &2 Camas, Washingotn	Project No. 21-5939	**FIGURE 5**

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EXPLORATION LOGS

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Portland, Oregon 97224
Tel: (503) 598-8445

EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2 Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-1**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.67						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 8-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.0					Silty CLAY (CL-ML), brown, micaceous, low plasticity, medium stiff, very moist.
2	2.5					Grades to very stiff below 2 feet bgs.
3	3.5					Grades to moist below 3 feet bgs.
4	3.5					
5						
6						Silty SAND (SM), brown, sand is fine- to medium-grained, with trace pieces of weathered basalt and rounded sedimentary rock, with clay, low plasticity to non-plastic, cemented, medium dense, moist.
7						
8						Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is highly weathered basalt and rounded sedimentary rock, non-plastic, with orange and yellow mottling, cemented, medium dense, moist.
9						
10						
11						Test pit terminated at 11 feet bgs. No caving encountered. No groundwater or seepage observed.
12						
13						
14						
15						
16						
17						

LEGEND

- Bag Sample (100 to 1,000 g)
- Bucket Sample (5 Gal. Bucket)
- Shelby Tube Sample
- Seepage
- Water Bearing Zone
- Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2
Camas, Washington 98607

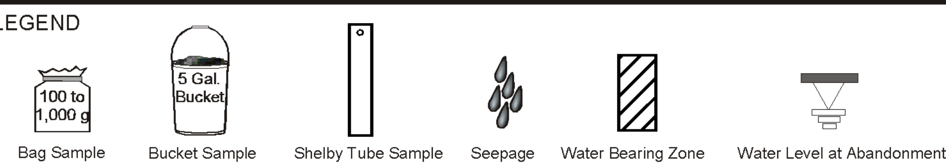
Project No. 21-5939

Exploration No. **TP-2**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.5						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 6-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.5					Clayey SILT with Sand (ML-CL), brown, micaceous, low plasticity, stiff, very moist.
2	2.0					
2.5						Grades to very stiff and with trace rounded rock below 2.5 feet bgs.
3	4.5					Silty SAND (SM), brown and reddish brown, with clay, low plasticity, micaceous, sand is fine- to coarse-grained, medium dense, very moist. [Liquid Limit = 35.1%, Plasticity Index = 9.3%]
4	3.5	Bag Sample (100 to 1,000 g)	28.7	38.7		
5						Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, non-plastic, with orange and yellow mottling, cemented, medium dense, very moist.
7		Bag Sample (100 to 1,000 g)		39.1		
8						Grades to very dense and more gravel below 8 feet bgs, very slow digging.
8.7		Bag Sample (100 to 1,000 g)		40.3		
9						Test pit terminated at 9 feet bgs. No caving encountered. No groundwater or seepage observed.

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

LEGEND



Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2, Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-3**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 10-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.5					Silty CLAY (CL-ML), brown, micaceous, low plasticity, stiff, very moist.
2	2.5					
3	2.5					
4	4.0	Bag Sample (100 to 1,000 g)	44.2	28.0		Silty SAND (SM), brown and reddish brown, with clay, low plasticity, micaceous, sand is fine- to coarse-grained, medium dense, very moist. Infiltration conducted at 4 feet bgs. Infiltration rate = 0.2 in/hr.
5						
6						Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, with orange and yellow mottling, cemented, medium dense, moist.
7						
8					Seepage	Light seepage observed between 8 and 8.5 feet bgs. Grades to very dense and more gravel below 8.5 feet bgs, very slow digging.
9		Bag Sample (100 to 1,000 g)				
10						Test pit terminated at 9.5 feet bgs. No caving encountered. Light seepage observed between 8 and 8.5 feet bgs.
11						
12						
13						
14						
15						
16						
17						

LEGEND

100 to 1,000 g	5 Gal. Bucket				
Bag Sample	Bucket Sample	Shelby Tube Sample	Seepage	Water Bearing Zone	Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2 Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-4**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.67						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 8-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	3.0					Clayey SILT with Sand (ML-CL), brown, micaceous, sand is fine- to medium-grained, low plasticity, very stiff, very moist.
2	4.0					
3	4.5					Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, with orange and yellow mottling, cemented, medium dense, very moist.
4	4.5					
5						Trace sub-rounded, boulder-sized rock encountered below 5 feet bgs.
6						
7						
8						Grades to very dense and more gravel below 8 feet bgs, very slow digging.
9						Test pit terminated at 9 feet bgs. No caving encountered. No groundwater or seepage observed.
10						
11						
12						
13						
14						
15						
16						
17						

LEGEND

Bag Sample | Bucket Sample | Shelby Tube Sample | Seepage | Water Bearing Zone | Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2 Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-5**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.7						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 8-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.5					Clayey SILT with Sand (ML-CL), brown, micaceous, sand is fine- to medium-grained, low plasticity, stiff, very moist.
2	2.5					
3	2.5					
4	3.0	Bag Sample (100 to 1,000 g)				Silty SAND (SM), brown and reddish brown, with clay, low plasticity, micaceous, sand is fine- to medium-grained, medium dense, very moist.
5						Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, with orange and yellow mottling, cemented, medium dense, very moist. Light groundwater seepage between 6 and 7 feet bgs. Grades to very dense and more gravel below 7 feet bgs, very slow digging.
6					Seepage	
7						
8						
9		Bag Sample (100 to 1,000 g)				
10						Test pit terminated at 10 feet bgs. No caving encountered. Light seepage observed between 6 and 7 feet bgs.
11						
12						
13						
14						
15						
16						
17						

LEGEND

100 to 1,000 g — Bag Sample
5 Gal. Bucket — Bucket Sample
Shelby Tube Sample
Seepage
Water Bearing Zone
Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2
Camas, Washington 98607

Project No. 21-5939

Exploration No. **TP-6**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 12-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1–5	1.0 (1 ft) 1.0 (2 ft) 3.0 (3 ft) 2.5 (4 ft)					Clayey SILT with Sand (ML-CL), brown, micaceous, sand is fine-grained, low plasticity, with medium-sized roots to 2.5 feet bgs, medium stiff, very moist. Grades to stiff below 2.5 feet bgs.
5–6.5						Silty SAND (SM), brown and reddish brown, with clay, low plasticity, micaceous, sand is fine- to medium-grained, medium dense, very moist.
6.5–10					Seepage (7.5–8.5 ft)	Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, with orange and yellow mottling, cemented, medium dense, very moist. Light groundwater seepage between 7.5 and 8.5 feet bgs. Grades to very dense and more gravel below 8.5 feet bgs, very slow digging.
10						Test pit terminated at 10 feet bgs. No caving encountered. Light seepage observed between 7.5 and 8.5 feet bgs.

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

LEGEND

- Bag Sample (100 to 1,000 g)
- Bucket Sample (5 Gal. Bucket)
- Shelby Tube Sample
- Seepage
- Water Bearing Zone
- Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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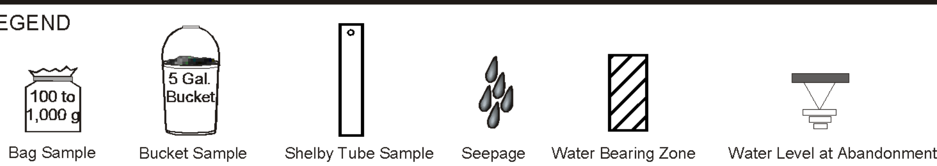
EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2, Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-7**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–0.5						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 6-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.5					Silty CLAY with Sand (CL-ML), brown, micaceous, sand is fine-grained, low plasticity stiff, very moist.
2	1.5					Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, with orange, gray, and yellow mottling, cemented, medium dense, very moist.
3	4.0				Seepage	Moderate groundwater seepage between 3.5 and 4.0 feet bgs.
4	4.0					Grades to very dense and more gravel below 4.5 feet bgs, very slow digging.
5						
6						
7						Test pit terminated at 7.0 feet bgs. No caving encountered. Moderate seepage observed between 3.5 and 4.0 feet bgs.
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						

LEGEND



Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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Tel: (503) 598-8445

EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2, Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-8**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 12-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.0					Silty CLAY with Sand (CL-ML), brown, micaceous, sand is fine-grained, low plasticity stiff, very moist.
2	1.5					
3	2.5					Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with cobble-sized rock, basalt is vesicular, with orange, dark gray, and yellow mottling, cemented, medium dense, very moist.
4	4.5+	Bag Sample (100 to 1,000 g)				
5						Grades to very dense and more weathered rock below 5.0 feet bgs, very slow digging, matrix contains trace gray clay of moderate plasticity.
6						
7		Bag Sample (100 to 1,000 g)				
8						
9		Bag Sample (100 to 1,000 g)				Test pit terminated at 9.0 feet bgs. No caving encountered. No seepage observed.
10–17						

LEGEND: Bag Sample (100 to 1,000 g); Bucket Sample (5 Gal. Bucket); Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2, Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-9**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 12-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	3.0				Seepage	Silty CLAY with Sand (CL-ML), brown, micaceous, sand is fine-grained, low plasticity stiff, wet. Light seepage encountered between 1 and 2 feet bgs.
2	2.5					Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with trace cobble-sized rock, basalt is vesicular, with orange, dark gray, and yellow mottling, cemented, medium dense, wet. Grades to very dense and more weathered rock below 3.0 feet bgs, very slow digging, moist.
3	4.5+					
4	4.5+					
5						
6						Test pit terminated at 6.0 feet bgs. No caving encountered. Light seepage observed between 1 and 2 feet bgs.
7–17						

LEGEND: Bag Sample (100 to 1,000 g); Bucket Sample (5 Gal. Bucket); Shelby Tube Sample; Seepage; Water Bearing Zone; Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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EXPLORATION LOGS

Project: Camas Meadows Subdivision, Ph. 1&2, Camas, Washington 98607	Project No. 21-5939	Exploration No. **TP-10**

Depth (ft)	Pocket Penetrometer (tons/ft²)	Sample Type	Fines Content (%)	Moisture Content (%)	Water Bearing Zone	Material Description
0–1						Moderately Organic SILT (ML-OL), dark brown, with fine- to medium-sized roots, 12-inches-thick, disturbed texture, soft, very moist. (Topsoil).
1	1.5					Silty CLAY (CL-ML), brown, micaceous, low plasticity stiff, very moist.
2	1.5					
3	2.5					
4	3.5					
5						
6						Clayey GRAVEL (GC), brown and reddish brown, matrix consists of reddish brown clay with fine- to coarse-grained sand, gravel is weathered angular basalt and rounded sedimentary rock, with trace cobble-sized rock, basalt is vesicular, dark gray, and red, with orange, dark gray, and yellow mottling, cemented, medium dense, very moist.
7						
8						Grades to very dense and more weathered rock below 8.5 feet bgs, very slow digging, moist.
9						
10						Test pit terminated at 10.0 feet bgs. No caving encountered. No Seepage Observed.
11						
12						
13						
14						
15						
16						
17						

LEGEND

100 to 1,000 g — Bag Sample
5 Gal. Bucket — Bucket Sample
Shelby Tube Sample
Seepage
Water Bearing Zone
Water Level at Abandonment

Date Excavated: 12/01/2021

Logged By: Thomas T.

Surface Elevation:

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LABORATORY TESTING RESULTS

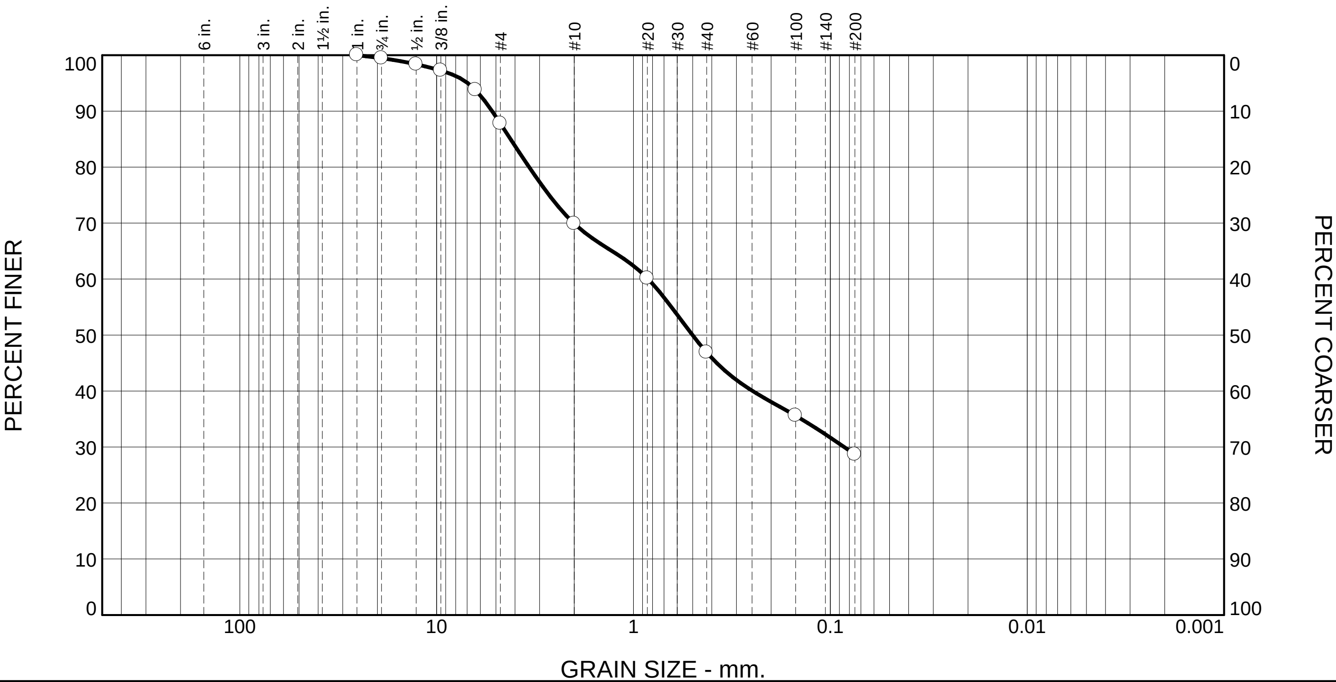
GEOPACIFIC

Project Name:	Camas Meadow Subdivision Phase 2	Project No.:	21-5939
Client:	Romano Development	Date Tested:	12/6/2021
Date Sampled:	12/1/2021	Tested By:	SJC
Sampled By:	TJT		

Moisture Content

Sample ID:	**S21-319**
Location:	**TP-2**
Depth (ft.):	4'
Tare #:	62
Tare (g):	685.0
Tare + Wet (g):	1857.9
Tare + Dry (g):	1530.7
Moisture (%):	**38.7**
Sample ID:	**S21-320**
Location:	**TP-2**
Depth:	7'
Tare #:	9
Tare (g):	266.0
Tare + Wet (g):	729.4
Tare + Dry (g):	599.2
Moisture (%):	**39.1**
Sample ID:	**S21-321**
Location:	**TP-2**
Depth:	9'
Tare #:	10
Tare (g):	265.4
Tare + Wet (g):	679.4
Tare + Dry (g):	560.4
Moisture (%):	**40.3**
Sample ID:	**S21-322**
Location:	**TP-3**
Depth:	4'
Tare #:	1
Tare (g):	682.4
Tare + Wet (g):	1066.0
Tare + Dry (g):	982.2
Moisture (%):	**28.0**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.6	11.6	17.9	23.0	18.2	28.7	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	99.4		
.5	98.4		
.375	97.2		
.25	93.8		
#4	87.8		
#10	69.9		
#20	60.1		
#40	46.9		
#100	35.6		
#200	28.7		

* (no specification provided)

Material Description

Silty Sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 5.2304 D_{85}= 4.2136 D_{60}= 0.8424
D_{50}= 0.5015 D_{30}= 0.0851 D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture 38.7%

Date Received: **Date Tested:** 12/7/2021

Tested By: SJC

Checked By:

Title:

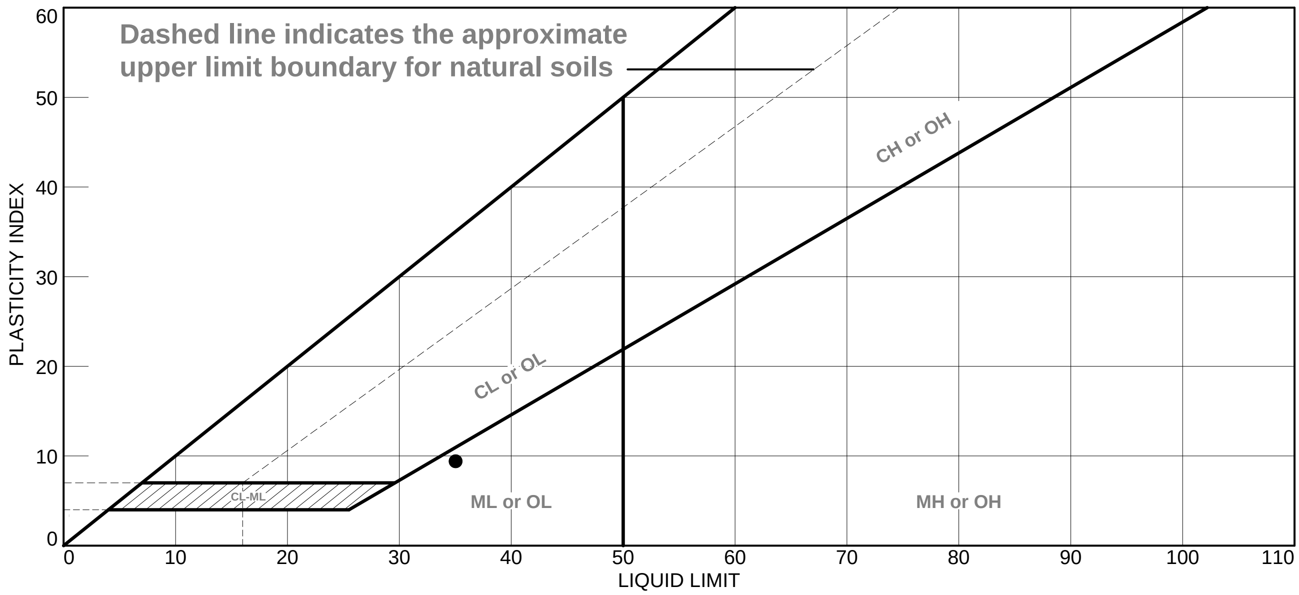
Location: TP-2
Sample Number: S21-319 **Depth:** 4'
Date Sampled: 12/1/2021

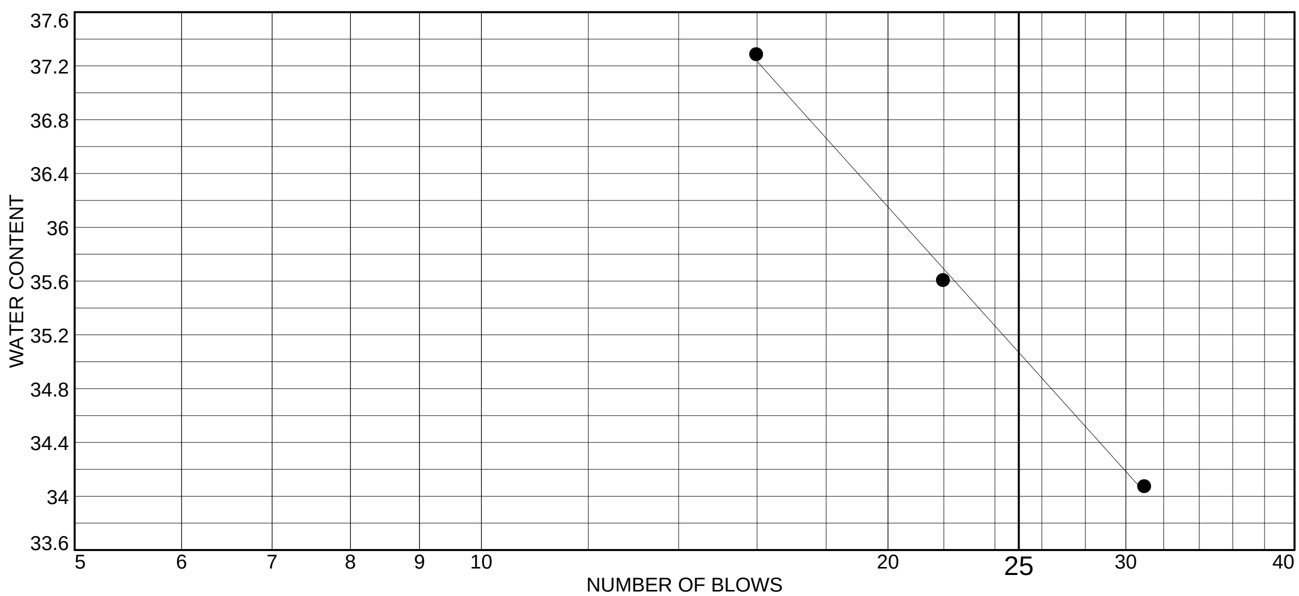
GEOPACIFIC ENGINEERING, INC.

Client: Romano Development
Project: Camas Meadows Subdivision Phase 2

Project No: 21-5939 **Figure**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty Sand	35.1	25.8	9.3	85.7	44.2	SM

Project No. 21-5939 **Client:** Romano Development

Project: Camas Meadows Subdivision Phase 2

Location: TP-3

Sample Number: S21-322 **Depth:** 4'

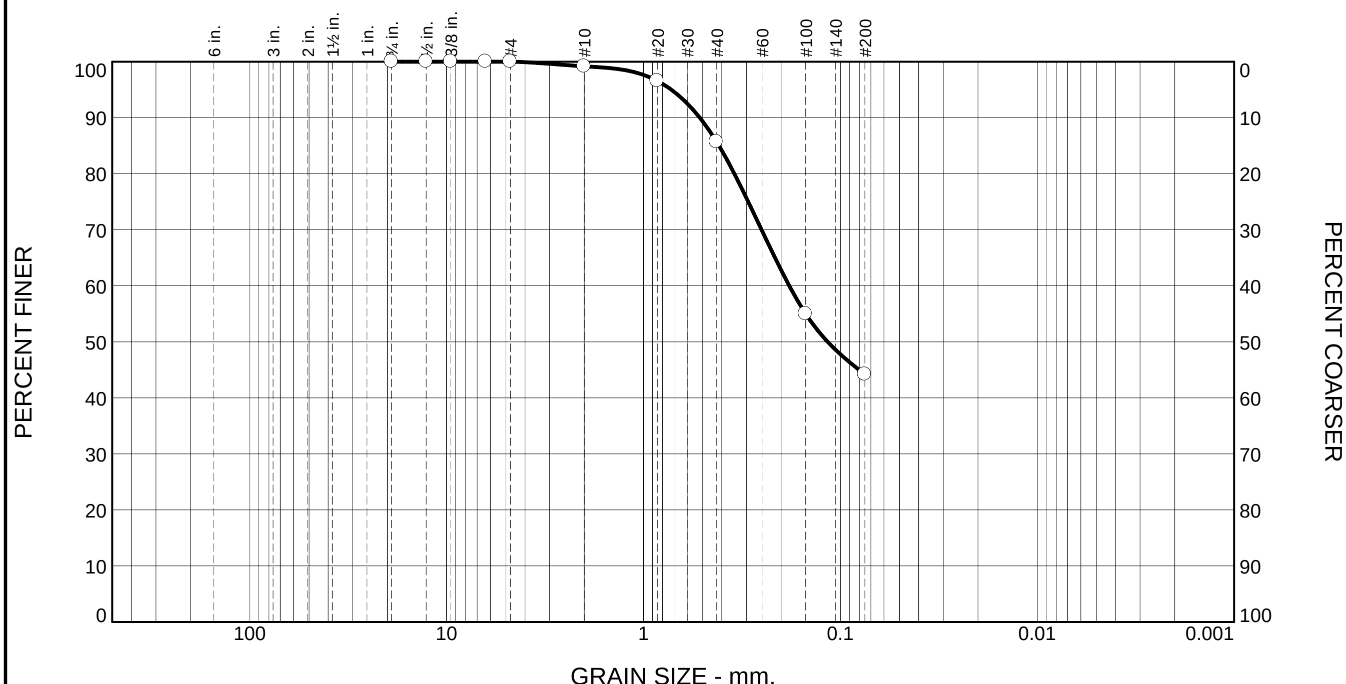
Remarks:

GEOPACIFIC ENGINEERING, INC.

Figure

Tested By: SJC

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	13.5	41.5	44.2	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.5	100.0		
.375	100.0		
.25	100.0		
#4	100.0		
#10	99.2		
#20	96.6		
#40	85.7		
#100	55.0		
#200	44.2		

* (no specification provided)

Material Description

Silty Sand

Atterberg Limits (ASTM D 4318)

PL= 25.8 **LL=** 35.1 **PI=** 9.3

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(1)

Coefficients

D_{90}= 0.5174 D_{85}= 0.4135 D_{60}= 0.1818
D_{50}= 0.1161 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Moisture 28.0%

Date Received: **Date Tested:** 12/7/2021
Tested By: SJC
Checked By:
Title:

Location: TP-3
Sample Number: S21-322 **Depth:** 4'
Date Sampled: 12/1/2021

GEOPACIFIC ENGINEERING, INC.

Client: Romano Development
Project: Camas Meadows Subdivision Phase 2
Project No: 21-5939 **Figure**

SOIL DESCRIPTION AND CLASSIFICATION GUIDELINES

Particle-Size Classification

COMPONENT	ASTM/USCS		AASHTO	
	size range	sieve size range	size range	sieve size range
Cobbles	> 75 mm	greater than 3 inches	> 75 mm	greater than 3 inches
Gravel	75 mm – 4.75 mm	3 inches to No. 4 sieve	75 mm – 2.00 mm	3 inches to No. 10 sieve
Coarse	75 mm – 19.0 mm	3 inches to 3/4-inch sieve	-	-
Fine	19.0 mm – 4.75 mm	3/4-inch to No. 4 sieve	-	-
Sand	4.75 mm – 0.075 mm	No. 4 to No. 200 sieve	2.00 mm – 0.075 mm	No. 10 to No. 200 sieve
Coarse	4.75 mm – 2.00 mm	No. 4 to No. 10 sieve	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve
Medium	2.00 mm – 0.425 mm	No. 10 to No. 40 sieve	-	-
Fine	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve	0.425 mm – 0.075 mm	No. 40 to No. 200 sieve
Fines (Silt and Clay)	< 0.075 mm	Passing No. 200 sieve	< 0.075 mm	Passing No. 200 sieve

Consistency for Cohesive Soil

CONSISTENCY	SPT N-VALUE (BLOWS PER FOOT)	POCKET PENETROMETER (UNCONFINED COMPRESSIVE STRENGTH, tsf)
Very Soft	2	less than 0.25
Soft	2 to 4	0.25 to 0.50
Medium Stiff	4 to 8	0.50 to 1.0
Stiff	8 to 15	1.0 to 2.0
Very Stiff	15 to 30	2.0 to 4.0
Hard	30 to 60	greater than 4.0
Very Hard	greater than 60	-

Relative Density for Granular Soil

RELATIVE DENSITY	SPT N-VALUE (BLOWS PER FOOT)
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Moisture Designations

TERM	FIELD IDENTIFICATION
Dry	No moisture. Dusty or dry.
Damp	Some moisture. Cohesive soils are usually below plastic limit and are moldable.
Moist	Grains appear darkened, but no visible water is present. Cohesive soils will clump. Sand will bulk. Soils are often at or near plastic limit.
Wet	Visible water on larger grains. Sand and silt exhibit dilatancy. Cohesive soil can be readily remolded. Soil leaves wetness on the hand when squeezed. Soil is much wetter than optimum moisture content and is above plastic limit.

AASHTO SOIL CLASSIFICATION SYSTEM

TABLE 1. Classification of Soils and Soil-Aggregate Mixtures

General Classification	Granular Materials (35 Percent or Less Passing .075 mm)			Silt-Clay Materials (More than 35 Percent Passing 0.075)			
Group Classification	A-1	A-3	A-2	A-4	A-5	A-6	A-7
Sieve analysis, percent passing:							
2.00 mm (No. 10)	-	-	-				
0.425 mm (No. 40)	50 max	51 min	-	-	-	-	-
0.075 mm (No. 200)	25 max	10 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)							
Liquid limit				40 max	41 min	40 max	41 min
Plasticity index	6 max	N.P.		10 max	10 max	11 min	11 min
General rating as subgrade	Excellent to good			Fair to poor			

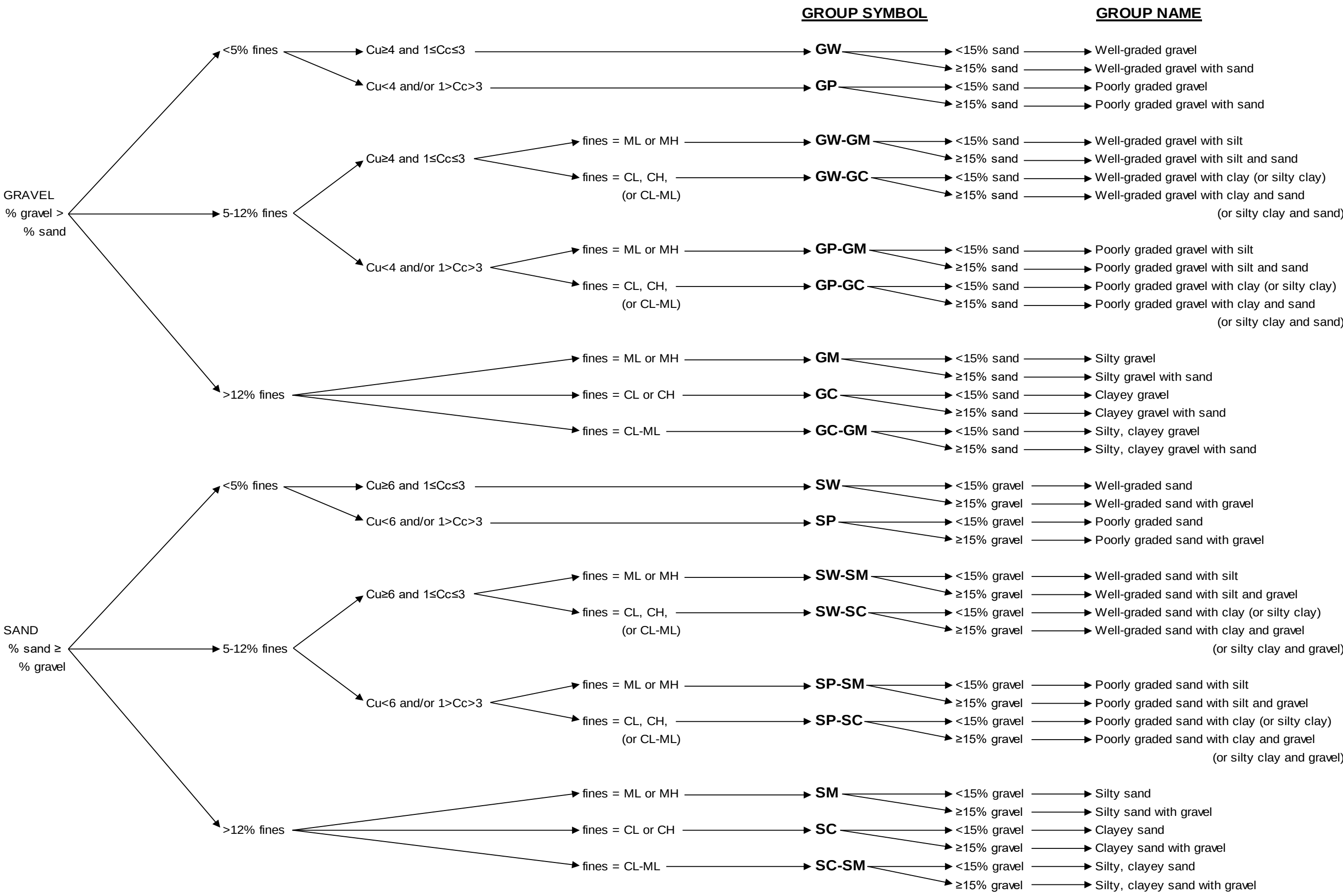
Note: The placing of A-3 before A-2 is necessary in the "left to right elimination process" and does not indicate superiority of A-3 over A-2.

TABLE 2. Classification of Soils and Soil-Aggregate Mixtures

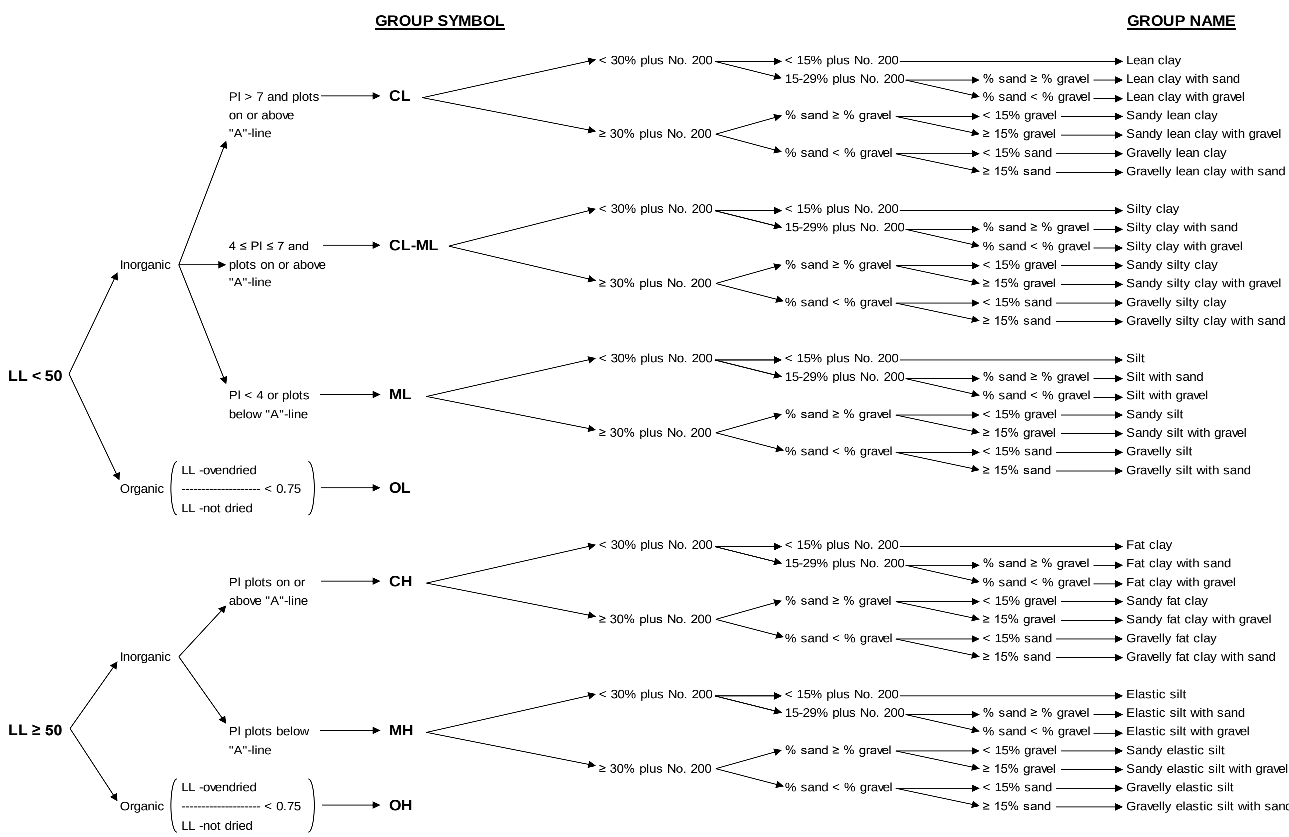
General Classification	Granular Materials (35 Percent or Less Passing 0.075 mm)							Silt-Clay Materials (More than 35 Percent Passing 0.075 mm)			
	A-1			A-2							A-7
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5, A-7-6
Sieve analysis, percent passing:											
2.00 mm (No. 10)	50 max	-	-	-	-	-	-	-	-	-	-
0.425 mm (No. 40)	30 max	50 max	51 min	-	-	-	-	-	-	-	-
0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
Characteristics of fraction passing 0.425 mm (No. 40)											
Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11min
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General ratings as subgrade	Excellent to Good							Fair to poor			

Note: Plasticity index of A-7-5 subgroup is equal to or less than LL minus 30. Plasticity index of A-7-6 subgroup is greater than LL minus 30 (see Figure 2).

AASHTO = American Association of State Highway and Transportation Officials



Flow Chart for Classifying Coarse-Grained Soils (More Than 50% Retained on No. 200 Sieve)



Flow Chart for Classifying Fine-Grained Soil (50% or More Passes No. 200 Sieve)

INFILTRATION TESTING CALCULATIONS

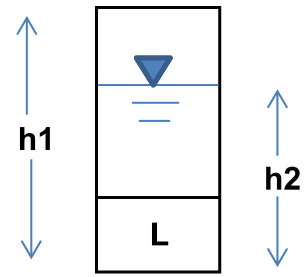
Camas Meadows Subdivision
Project. #: 21-5939

Infiltration Testing

$$K = \frac{2.3 * La}{At} * \log_{10} \frac{h1}{h2}$$

Calculations for Hydraulic Conductivity (K_v)
(single-ring, falling head method)

where:
L = soil embedment
t = drop time
h1 = total tube length
h2= water level drop at time (t)



Test Number: IT-1.1
Test Depth: -4
Location: TP-3
Soil Series: SM
Date: 12/1/2021
USCS: SM

drop	L (in)	t (min)	t (hr)	h1 (in)	h2 (in)	K_v in/hr		
0.68	6	120	2	13.52	12.84	0.2		
					AVG	**0.2**	**0.31**	**0.00010923**
					units:	**inches per hour**	**ft/day**	**cm/s**

Note: Measurements taken after presoak

SITE RESEARCH

Hazards by Location

Search Information

Address: 4200 NW Camas Meadows Dr
USA

Coordinates: 45.62923259999999 -122.4564079

Elevation: 252 ft

Timestamp: 2021-12-22T17:36:05.263Z

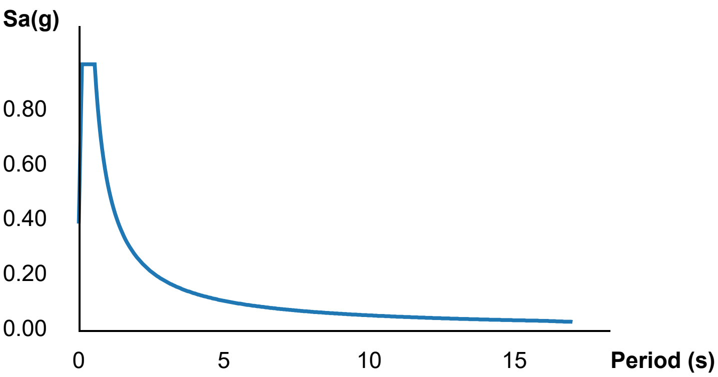
Hazard Type: Seismic

Reference Document: ASCE7-16

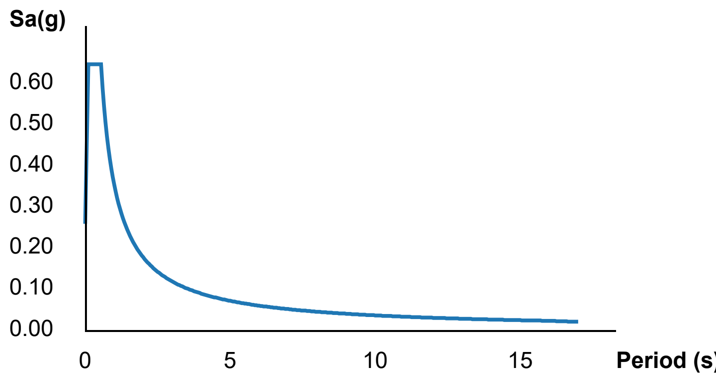
Risk Category: II

Site Class: C

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.807	MCE_R ground motion (period=0.2s)
S_1	0.354	MCE_R ground motion (period=1.0s)
S_{MS}	0.969	Site-modified spectral acceleration value
S_{M1}	0.53	Site-modified spectral acceleration value
S_{DS}	0.646	Numeric seismic design value at 0.2s SA
S_{D1}	0.354	Numeric seismic design value at 1.0s SA

▾Additional Information

Name	Value	Description
SDC	D	Seismic design category
F_a	1.2	Site amplification factor at 0.2s
F_v	1.5	Site amplification factor at 1.0s

CR_S	0.888	Coefficient of risk (0.2s)
CR_1	0.866	Coefficient of risk (1.0s)
PGA	0.362	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	0.435	Site modified peak ground acceleration
T_L	16	Long-period transition period (s)
SsRT	0.807	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.909	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.354	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.408	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.533	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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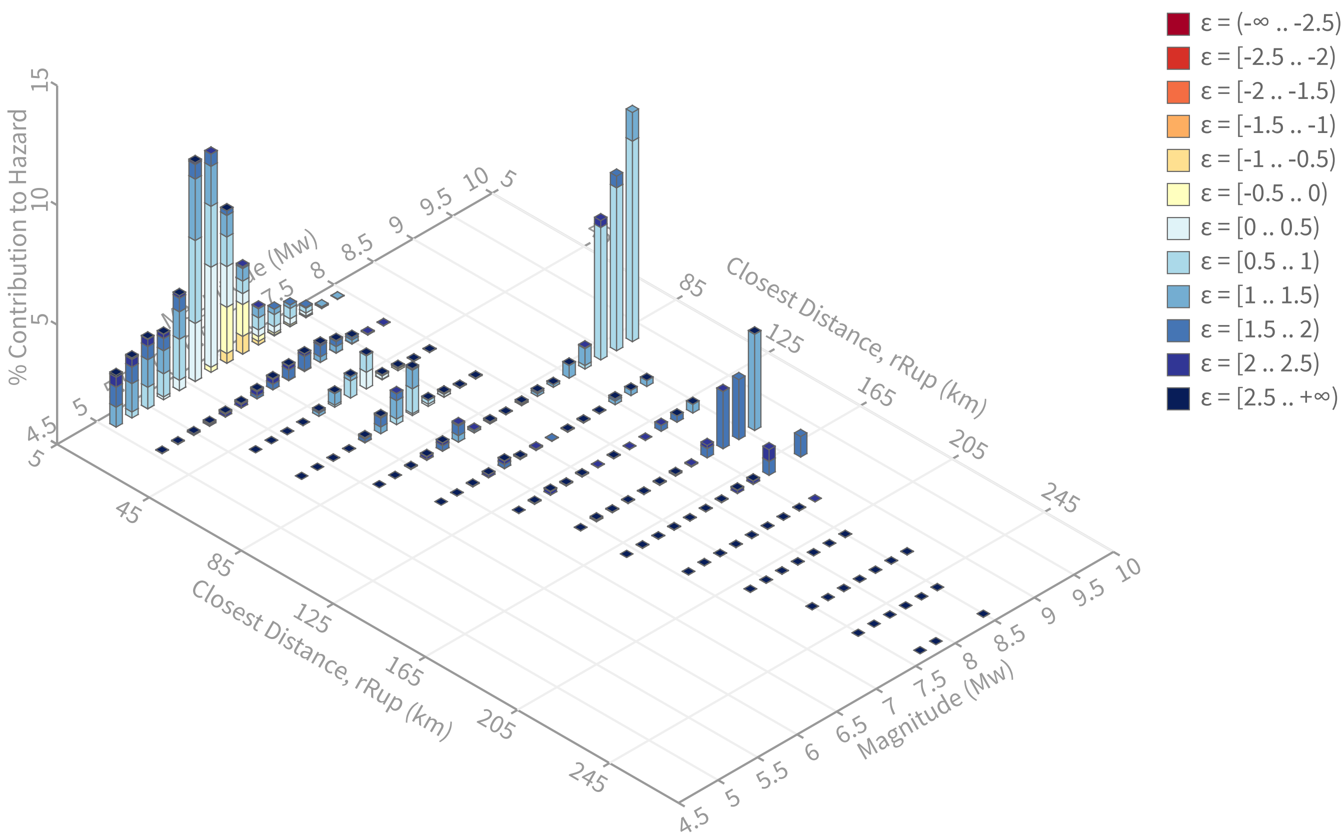
^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.37808623 g

Recovered targets

Return period: 2510.9085 yrs
Exceedance rate: 0.00039826222 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.48 %

Mean (over all sources)

m: 7.35
r: 55.66 km
ε_0: 1.02 σ

Mode (largest m-r bin)

m: 9.34
r: 92.68 km
ε_0: 0.72 σ
Contribution: 9.58 %

Mode (largest m-r-ε_0 bin)

m: 9.34
r: 92.68 km
ε_0: 0.62 σ
Contribution: 8.39 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
sub0_ch_bot.in	Interface							22.30
Cascadia Megathrust - whole CSZ Characteristic		92.68	9.11	0.84	123.599°W	45.501°N	261.25	22.30
Geologic Model Small Mag	Fault							13.47
Grant Butte 50		11.43	6.19	0.78	122.431°W	45.498°N	172.18	7.65
Grant Butte 35		8.67	6.19	0.43	122.431°W	45.498°N	172.18	4.43
sub0_ch_mid.in	Interface							8.55
Cascadia Megathrust - whole CSZ Characteristic		143.01	8.93	1.57	124.330°W	45.489°N	264.53	8.55
coastalOR_deep.in	Slab							6.42
WUSmap_2014_fixSm.ch.in (opt)	Grid							5.15
noPuget_2014_fixSm.ch.in (opt)	Grid							5.15
WUSmap_2014_fixSm.gr.in (opt)	Grid							4.97
noPuget_2014_fixSm.gr.in (opt)	Grid							4.97
Geologic Model Partial Rupture	Fault							2.67
Lacamas Lake		2.37	6.58	-0.33	122.514°W	45.684°N	323.48	2.05
Zeng Model Small Mag	Fault							2.11
Grant Butte 50		11.43	6.19	0.78	122.431°W	45.498°N	172.18	1.20
Geologic Model Full Rupture	Fault							2.02
Lacamas Lake		0.94	6.62	-0.39	122.514°W	45.684°N	323.48	1.62
sub0_ch_top.in	Interface							1.75
Cascadia Megathrust - whole CSZ Characteristic		161.51	8.84	1.86	124.549°W	45.485°N	265.07	1.75
WUSmap_2014_fixSm_M8.in (opt)	Grid							1.61
noPuget_2014_fixSm_M8.in (opt)	Grid							1.61
noPuget_2014_adSm.ch.in (opt)	Grid							1.18
WUSmap_2014_adSm.ch.in (opt)	Grid							1.18
noPuget_2014_adSm.gr.in (opt)	Grid							1.15
WUSmap_2014_adSm.gr.in (opt)	Grid							1.14
coastalOR_deep.in	Slab							1.09
coastalOR_deep.in	Slab							1.05

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PHOTOGRAPHIC LOG

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View of Site from NW Camas Meadows Drive, Facing North

Test Pit TP-8, Facing North

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Dense Conglomerate in Test Pit TP-8


Conglomerate Soils Excavated from Test Pit TP-8

Real-World Geotechnical Solutions
Investigation • Design • Construction Support

Test Pit TP-7, Facing North

Medium-Sized Roots within Test Pit TP-6

Appendix H: Maintenance & Operations

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		(A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.4: Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)
Catch Basin	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.5: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Top slab is free of holes and cracks. Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regrouted and secure at basin wall.
	Settlement/ Mis-alignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Cover/grate is in place, meets design standards, and is secured
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place, meets the design standards, and is installed and aligned with the flow path.