Portland General Electric
Integrated Operations Center

Transportation Impact Study

Tualatin, Oregon

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Executive Summary

Two properties located at the southeast corner of the intersection of SW Tualatin-Sherwood Road at SW 124th Avenue are proposed for construction of the Portland General Electric (PGE) Integrated Operations Center (IOC). The project will include the IOC building, a secure entrance, approximately 300 parking stalls, and various other components necessary for the Operations Center. Along with development of the site, SW Blake Street will be constructed from SW 124th Avenue eastward to the driveway to the site. The projected occupancy date of the site is December 2021, and this report conservatively assumes a buildout year of 2022.

Offsite Impacts

The PGE IOC facility is expected to generate 210 trips during the morning peak hour and 228 trips during the evening peak hour. Operational analysis of the five study intersections, all under Washington County jurisdiction, indicated that four of the five are projected to operate acceptably according to County standards through the 2022 buildout year, with or without the addition of site trips related to the proposed development. The intersection of SW Tualatin-Sherwood Road at SW 124th Avenue is projected to operate with a v/c ratio greater than the maximum allowed by the County under 2022 buildout conditions during the morning peak hour. Washington County plans to widen SW Tualatin-Sherwood Road to a five-lane cross-section in the vicinity of the site, which will add capacity to the roadway and improve operation at the intersection with SW 124th Avenue. The analysis in this report was completed under the assumption that these roadway improvements would not be in place by 2022, the buildout year for the PGE project.

Recommended Improvements

It is recommended that the existing two-way left-turn lane striping on SW 124th Avenue north of the new Blake Street intersection be reconfigured to proivde a dedicated left-turn lane for the southbound left turn movement. Preliminary traffic signal warrants were evaluated for the unsignalized study intersections and indicated that signal warrants are not projected to be met at any of these intersections. No new traffic signals are recommended in conjunction with the proposed project.

It is recommended that SW Blake Street be constructed to the proposed cross-section of two 12-foot travel lanes and a 14-foot center two-way left-turn lane, with the exception that no on-street parking is recommended. Left-turn lane warrants were not projected to be met for left turns into the project site from SW Blake Street under planning horizon traffic volume conditions.

The intersection of SW Blake Street at SW 124th Avenue was analyzed for the planning horizon assuming that a signal would eventually be constructed. To accommodate for the future signal, separate westbound left- and right-turn lanes should be constructed on SW Blake Street at SW 124th Avenue.

Introduction

Two properties located south of SW Tualatin-Sherwood Road and east of SW 124th Avenue in Tualatin, Oregon are proposed for development of the Portland General Electric (PGE) Integrated Operations Center (IOC). The proposed development will include an office building, 300 parking stalls, and various other components. Along with development of the site, SW Blake Street will be constructed from SW 124th Avenue to the site access location. Right-of-way for the continuation of SW Blake Street will extend to the south property line.

The purpose of this report is to examine the potential traffic impacts of the proposed development. The report will include analysis that addresses the operation of each of the study intersections in order to ensure that the transportation system is capable of safely and efficiently supporting the existing land uses in the area in addition to the proposed development.

Project Location and Description

The project site is located along the south side of SW Tualatin-Sherwood Road and the east side of the newly constructed SW 124th Avenue, in Washington County, Oregon. The site is located adjacent to the western boundary of the Tualatin city limits. As part of the project, SW Blake Street will be constructed between SW 124th Avenue and the eastern property line. The site is currently undeveloped. The project location is shown in Figure 1.

The project site includes tax lots 500 and 701, which together comprise 43.73 acres. Access will be provided via a driveway onto SW Blake Street.

Figure 1 – Project Site (outlined in red)

Vicinity Streets

The characteristics of each roadway within the project study area are summarized in Table 1. The scope of work for this report and the project study area was confirmed by both Washington County and City of Tualatin staff.

Table 1 – Characteristics of Study Roadways[1,2]

Roadway	Jurisdiction	Functional Classification	Cross-Section	Speed (mph)	Sidewalks?	Bike Lanes?
SW Tualatin-Sherwood Road	Washington County	Arterial	3 lanes	45 posted	Both Sides	Both Sides
SW 124th Avenue	Washington County	Arterial	5 lanes	40 posted	Both Sides	Both Sides
SW 120th Avenue	City of Tualatin	Connector	2 lanes	25 Statutory	Both Sides	None
SW 115th Avenue	City of Tualatin	Major Collector	2 lanes	25 Statutory	Both Sides	Both Sides
SW Avery Street	City of Tualatin	Minor Arterial	2-3 lanes	35 posted	Both Sides	Both Sides

Study Intersections

Based on the size of the development and Washington County's 10 percent impact requirement outlined in Resolution and Order No. 86-95, the following intersections will be analyzed for the purposes of this study:

- Proposed SW Blake Street at Site Access
- SW 124th Avenue at Proposed SW Blake Street
- SW Tualatin-Sherwood Road at SW 124th Avenue
- SW Tualatin-Sherwood Road at SW 120th Avenue
- SW Tualatin-Sherwood Road at SW 115th Avenue
- SW Tualatin-Sherwood Road at SW Avery Street

Characteristics of the existing study intersections are summarized in Table 2. A vicinity map showing the project site, vicinity streets, and study intersections with their associated lane configurations is shown in Figure 2 on page 6.

[1] *Washington County Transportation System Plan*, 2018. https://s3.amazonaws.com/washcomultimedia/CMSBigFiles/TspReferenceGuide/mobile/index.html.

[2] *City of Tualatin Transportation System Plan Update*, 2014. https://www.tualatinoregon.gov/sites/default/files/fileattachments/community_development/page/4465/2-24-14_revised_adopted_tsp_volume_i.pdf.

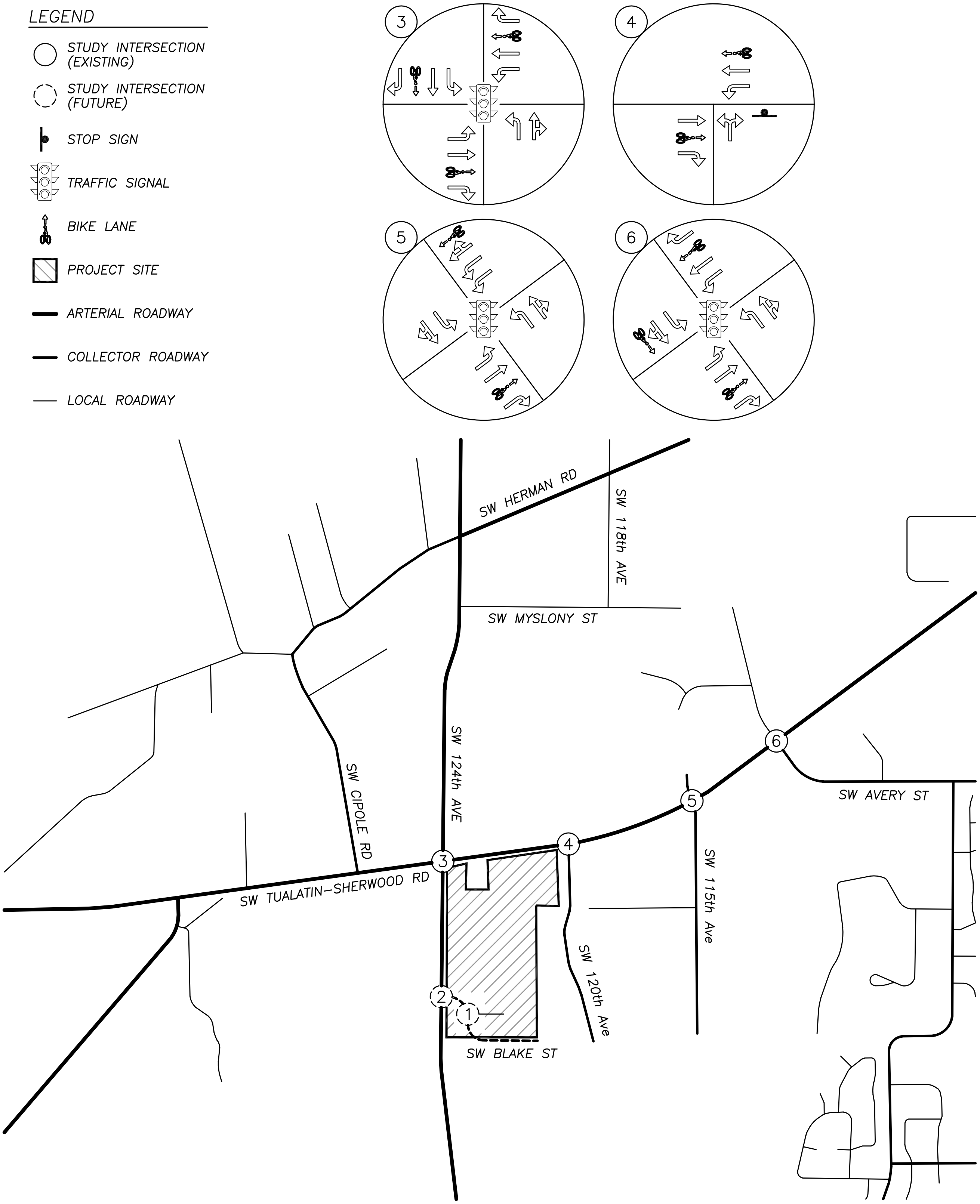
Table 2 – Characteristics of Existing Study Intersections

Name	Geometry	Traffic Control	Phasing/Stopped Approaches
SW Tualatin-Sherwood Road at SW 124th Avenue	Four-legged	Signal	Permitted-protected left-turn phasing for all approaches; right-turn overlap phasing on SB, EB, and WB approaches
SW Tualatin-Sherwood Road at SW 120th Avenue	Three-legged	Stop Control	Northbound
SW Tualatin-Sherwood Road at SW 115th Avenue	Four-legged	Signal	Protected EB and WB left turns, permitted-protected NB and SB left turns, NB right-turn overlap
SW Tualatin-Sherwood Road at SW Avery Street	Four-legged	Signal	All left turns protected

Traffic Counts

Traffic Counts were conducted at the study intersections on Wednesday, February 6, 2019, from 4:00 p.m. to 6:00 p.m. and Thursday, February 7, 2019, from 7:00 a.m. to 9:00 a.m. Data from each intersection's morning and evening peak hours were used for analysis.

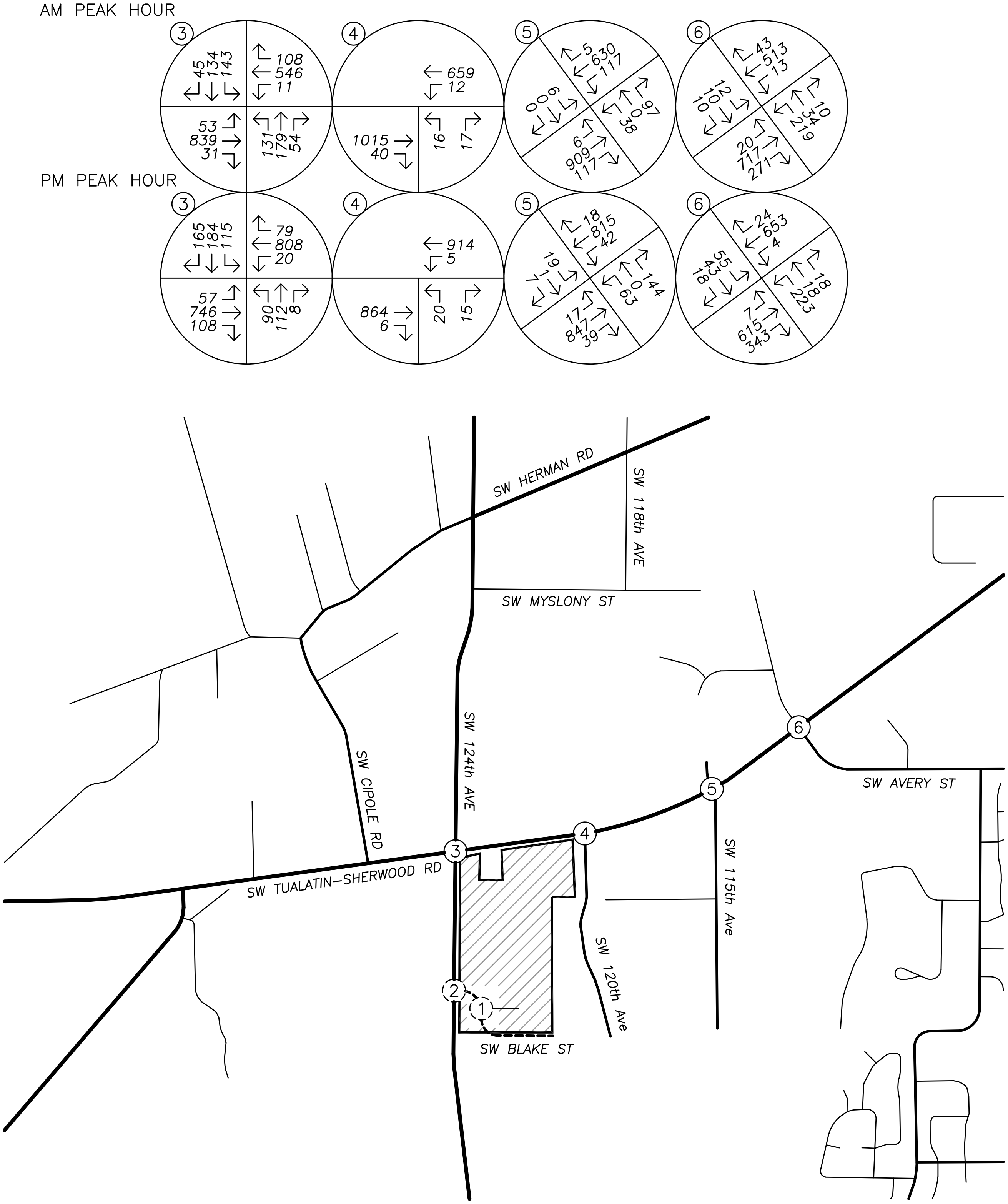
Figure 3 on page 7 shows the existing morning and evening peak hour traffic volumes at the existing study intersections. Detailed count data are included in the appendix to this report.



VICINITY MAP

FIGURE 2

PAGE 6



TRAFFIC VOLUMES
Existing Conditions
AM & PM Peak Hours

no scale

FIGURE 3

Site Trips

The projected trip generation and assumed trip distribution are presented in the following sections.

Trip Generation

The proposed PGE Integrated Operations Center will include office space and other program areas necessary for the operations center. Information from PGE about the number of employees and their working hours was used to estimate the number of trips that will be generated by the proposed development.

When the facility opens, there will be 250 employees, and an additional 50 will be phased in during the months following construction. Most will work a typical office schedule of approximately 8:00 a.m. to 5:00 p.m., Monday through Friday. 12 to 15 employees will work a 6:00 a.m. to 6:00 p.m. shift, and a smaller number will work night and weekend shifts. There will also be some employees working a 3:00 a.m. to 12:00 p.m. shift. Based on this information, it was estimated that approximately 200-220 employees will work a traditional office schedule, and that about 175 would arrive during the morning peak hour and leave during the evening peak hour.

For comparison, trip generation estimates were also calculated using trip rates from the *Trip Generation Manual*.[3] Data for land use code 170 – *Utility* were used to estimate the proposed development's trip generation based on the number of employees. The trip generation calculations showed that the proposed development is expected to generate 210 trips during the morning peak hour and 228 during the evening peak hour. Because the calculation results were similar to the trip generation estimated based on information from PGE, the manual-based trip generation was used for analysis.

Trip generation estimates are summarized in Table 3. Detailed calculations are included in the appendix to this report.

Table 3 – Trip Generation Summary

Land Use Code	Size	Morning Peak Hour			Evening Peak Hour			Weekday Total
		In	Out	Total	In	Out	Total	
170 – Utility	300 Employees	170	40	210	34	194	228	1,234

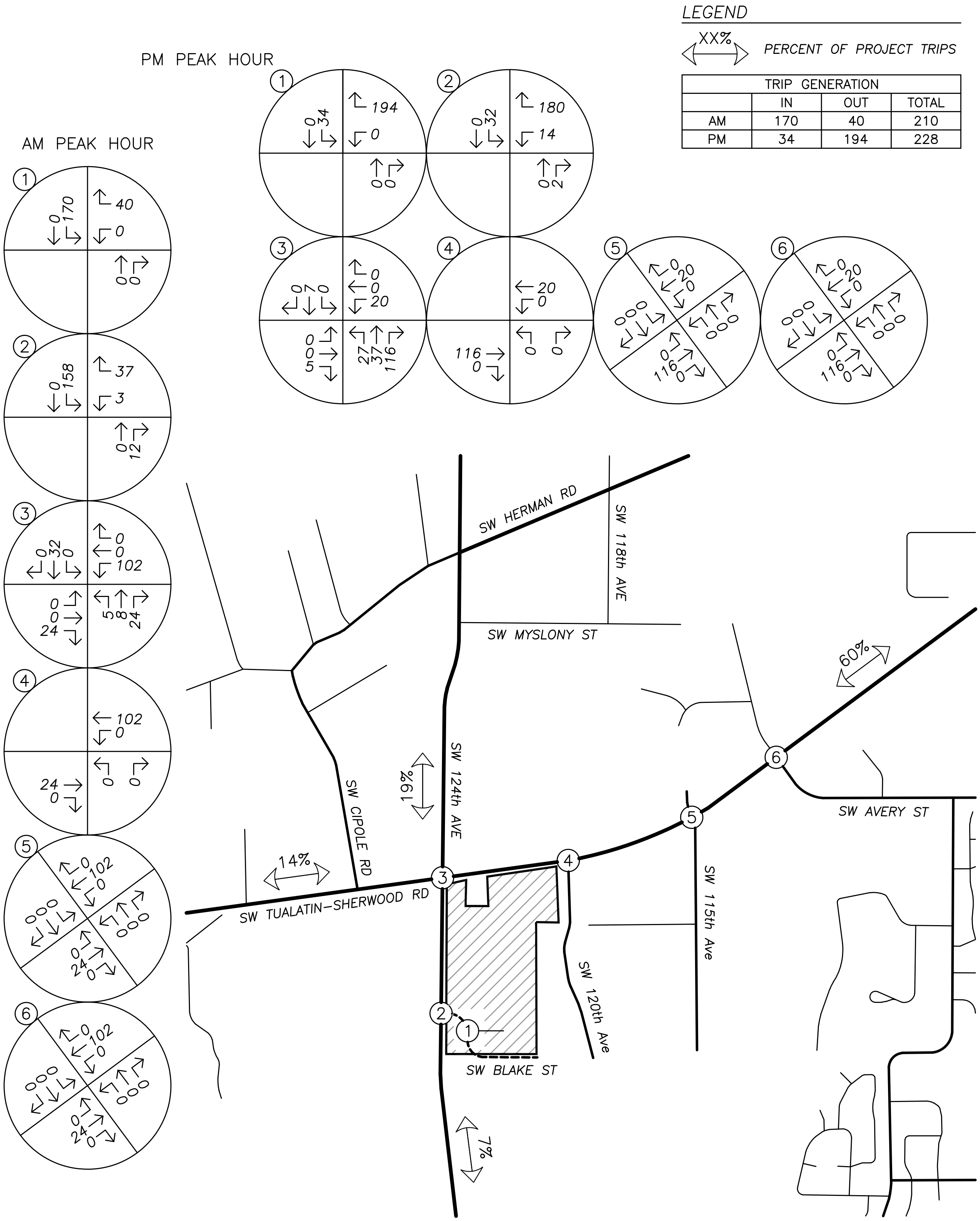
[3] Institute of Transportation Engineers, *Trip Generation Manual*, 10th Edition, 2017.

Trip Distribution

The directional distribution of site trips to and from the project site was estimated based on anonymous employee travel origin data from PGE. Using this data and likely routes that employees would take to and from the site during peak hours, the following trip distribution was estimated and used for analysis:

- 60 percent of site trips will travel to and from the east on SW Tualatin-Sherwood Road;
- 19 percent of site trips will travel to and from the north on SW 124th Avenue;
- 14 percent of site trips will travel to and from the west on SW Tualatin-Sherwood Road; and
- 7 percent of site trips will travel to and from the south on SW 124th Avenue.

The trip distribution and assignment of site trips generated by the proposed development are shown in Figure 4 on page 10 for the morning and evening peak hours.



	TRIP GENERATION		
	IN	OUT	TOTAL
AM	170	40	210
PM	34	194	228

TRIP DISTRIBUTION & ASSIGNMENT
Proposed Development Plan – Site Trips
AM & PM Peak Hours

no scale

FIGURE 4

Future Traffic Volumes

To analyze the impact of the proposed development on the transportation facilities in the site vicinity, an estimate of future traffic volumes is required. A compounded growth rate of two percent per year for an assumed buildout condition of three years was applied to the existing traffic volumes to approximate year 2022 background conditions. The year 2022 was selected because the projected occupancy date of the proposed building is December 2021.

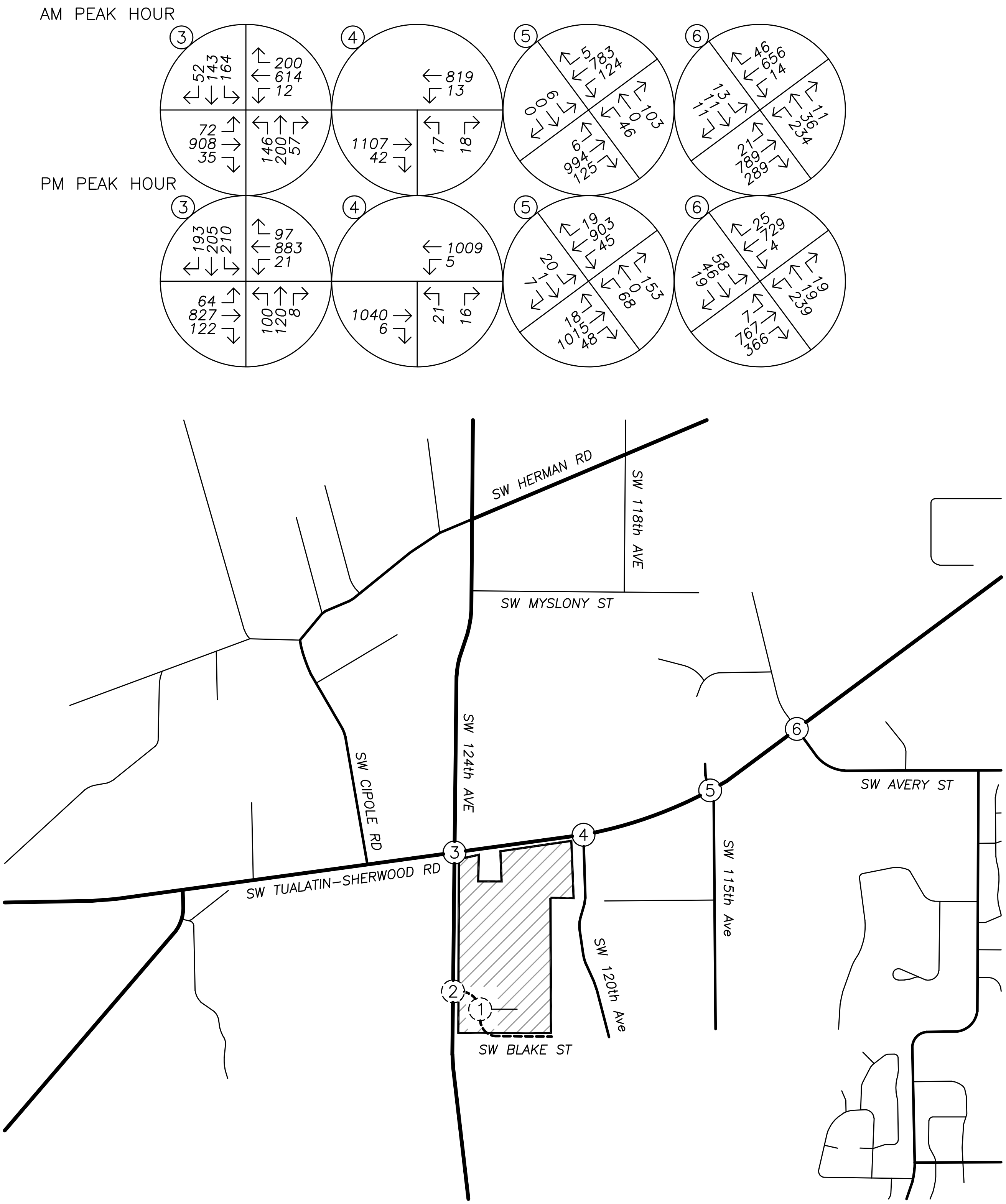
In addition to the expected background traffic growth in the site vicinity, there are four in-process developments that are expected to impact future volumes at the study intersections. In-process developments are projects that are approved but not yet constructed or occupied. These developments are:

- Parkway Village South Recreational/Commercial Development;
- Four S Corporation Distribution Center;
- IPT Development; and
- Cipole Road Industrial Park.

Since these developments will likely be contributing trips to the transportation system by 2022, the site trips they are projected to generate were included in 2022 background traffic volumes.

Peak hour trips calculated to be generated by the proposed development, as described in the Site Trips section, were added to the projected year 2022 background traffic volumes to obtain the expected 2022 buildout volumes.

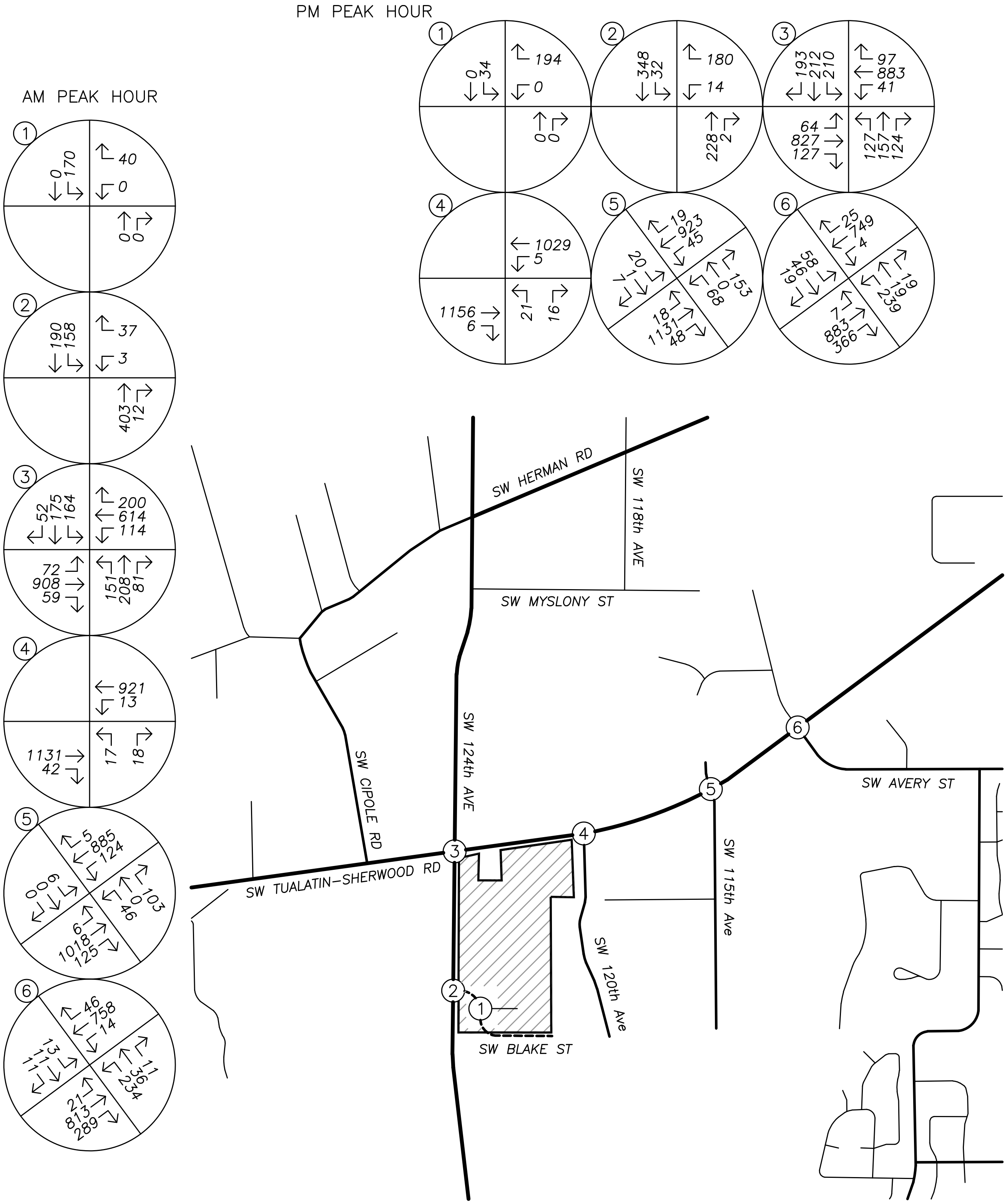
Figure 5 on page 12 shows the projected year 2022 background volumes at the existing study intersections for the morning and evening peak hours. Figure 6 on page 13 shows the projected year 2022 site buildout volumes at all study intersections for the morning and evening peak hours.



TRAFFIC VOLUMES
Year 2022 Background Conditions
AM & PM Peak Hours

no scale

FIGURE 5



TRAFFIC VOLUMES
Year 2022 Buildout Conditions
AM & PM Peak Hours

no scale

FIGURE 6

Operational Analysis

A capacity and delay analysis was conducted for each of the study intersections per the signalized and unsignalized intersection analysis methodologies in the *Highway Capacity Manual*[4] (HCM). Intersections are generally evaluated based on the average control delay experienced by vehicles and are assigned a grade according to their operation. The level of service (LOS) of an intersection can range from LOS A, which indicates very little or no delay experienced by vehicles, to LOS F, which indicates a high degree of congestion and delay. The volume-to-capacity (v/c) ratio is a measure that compares the traffic volumes (demand) against the available capacity of an intersection.

For intersections under Washington County's jurisdiction, the County requires intersections operate with a v/c ratio of 0.99 or less.[5] All intersections along SW Tualatin-Sherwood Road and SW 124th Avenue are under County jurisdiction.

The v/c, delay, and LOS results of the capacity analysis are shown in Table 4 for the morning and evening peak hours. Overall intersection performance metrics are reported for signalized intersections, and results for the worst-performing approach are reported for stop-controlled intersections. Detailed calculations as well as tables showing the relationship between delay and LOS are included in the appendix to this report.

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[4] Transportation Research Board, *Highway Capacity Manual*, 6th Edition, 2016.

[5] Washington County, *Washington County Transportation System Plan*, 2015. https://s3.amazonaws.com/washcomultimedia/CMSBigFiles/TSP/mobile/index.html#p=1.

Table 4 – Intersection Capacity Analysis Summary

	Morning Peak Hour			Evening Peak Hour		
	LOS	Delay (s)	v/c	LOS	Delay (s)	v/c
SW 124th Avenue at SW Blake Street						
2022 Buildout Conditions	B	12	0.16	B	12	0.28
SW Tualatin-Sherwood Road at SW 124th Avenue						
2019 Existing Conditions	C	34	0.86	C	23	0.72
2022 Background Conditions	D	41	0.95	C	27	0.82
2022 Buildout Conditions	D	51	1.00	D	37	0.92
SW Tualatin-Sherwood Road at SW 120th Avenue						
2019 Existing Conditions	B	14	0.10	C	17	0.02
2022 Background Conditions	C	17	0.13	C	19	0.02
2022 Buildout Conditions	C	19	0.15	C	19	0.03
SW Tualatin-Sherwood Road at SW 115th Avenue						
2019 Existing Conditions	C	27	0.72	C	23	0.71
2022 Background Conditions	C	33	0.81	C	35	0.82
2022 Buildout Conditions	D	35	0.84	D	53	0.90
SW Tualatin-Sherwood Road at SW Avery Street						
2019 Existing Conditions	C	23	0.69	C	23	0.64
2022 Background Conditions	C	27	0.76	C	24	0.73
2022 Buildout Conditions	C	31	0.79	C	25	0.80

As shown in Table 4 above, the only scenario in which a study intersection is projected to operate outside Washington County standards is the intersection of SW Tualatin-Sherwood Road at SW 124th Avenue during the morning peak hour, when the v/c ratio is projected to be 1.00, which is greater than the maximum allowable 0.99. Washington County is currently in the design phase of a project that will widen SW Tualatin-Sherwood Road to a five-lane cross-section between SW Teton Avenue and SW Langer Farms Parkway. This area encompasses all of the intersections in this study, and will significantly increase the capacity of SW Tualatin-Sherwood Road. The project is funded by the County's Major Streets Transportation Improvement Program, and is scheduled to be under construction from June 2021 to October 2023.[6] Since the project will already be under construction when occupancy of the proposed PGE IOC begins, no operational mitigation is necessary or recommended in conjunction with the proposed development.

[6] Washington County Engineering and Construction Services, *Tualatin Sherwood Road (Teton Avenue to Langer Farms Parkway).* https://www.co.washington.or.us/LUT/TransportationProjects/tualatinsherwoodroad.cfm?page=About.

Safety Analysis

The following sections comprise a safety analysis for the study intersections, including an analysis of historical crash data and left-turn lane and signal warrants.

Crash Data Analysis

Using data obtained from ODOT's Online Crash Data System, a review was performed of the most recent five years of available crash data (January 2012 through December 2016) at the existing study intersections. The crash data were analyzed based on the type and severity of crashes. Crash severity is based on injuries sustained by people involved in the crash, and includes five categories:

1. PDO – property damage only
2. Injury C – possible injury or complain of pain
3. Injury B – non-incapacitating injury
4. Injury A – incapacitating injury (i.e. bleeding or broken bones)
5. Fatality

Crash rates were calculated under the common assumption that traffic counted during the evening peak hour represents ten percent of annual average daily traffic (AADT) at each intersection. Crash rates for each intersection are reported as crashes per million entering vehicles (CMEV). A crash rate higher than one to two CMEV may be indicative of design deficiencies or the need for mitigation Detailed crash data is provided in the appendix to this report.

The crash data are summarized in Table 5 by type of crash Table 6 by severity and modes involved.

Table 5 – Crash Data Summary by Type

Intersection*	Rear-End		Turning Movement		Angle		Fixed Object		Total Crashes
	Count	%	Count	%	Count	%	Count	%	
SW Tualatin-Sherwood Road at SW 124th Avenue	27	93	1	3.5	0	0	1	3.5	29
SW Tualatin-Sherwood Road at SW 120th Avenue	1	100	0	0	0	0	0	0	1
SW Tualatin-Sherwood Road at SW 115th Avenue	6	55	5	45	0	0	0	0	11
SW Tualatin-Sherwood Road at SW Avery Street	26	87	3	10	1	3	0	0	30

*Signalized intersections are set in **bold**; others are unsignalized

Table 6 – Crash Data Summary by Severity and Modes Involved

Intersection*	By Severity			By Modes Involved			Total Crashes	Crash Rate (CMEV)
	PDO†	Injury	Fatal	Ped	Bike	Car Only		
SW Tualatin-Sherwood Road at SW 124th Avenue	12	17	0	0	0	29	29	0.64
SW Tualatin-Sherwood Road at SW 120th Avenue	1	0	0	0	0	1	1	0.03
SW Tualatin-Sherwood Road at SW 115th Avenue	2	9	11	0	0	11	11	0.30
SW Tualatin-Sherwood Road at SW Avery Street	14	16	0	0	0	30	30	0.81

*Signalized intersections are set in **bold**; others are unsignalized

† "Property damage only," i.e. a crash in which no injury occurred

One of the rear-end crashes at the intersection of SW Tualatin-Sherwood Road at SW 124th Avenue resulted in an incapacitating injury (Injury A). The crash was a rear-end crash where the driver who collided with the stopped car was using a cell phone at the time of the crash. The rear-ended vehicle was pushed into a third vehicle. The driver of the initially struck vehicle suffered the injury.

Two of the crashes at the intersection of SW Tualatin-Sherwood Road at SW Avery Street resulted in incapacitating injuries (Injury A). One was a rear-end crash where the driver who struck the stopped car was determined to have been following too closely. The driver of the stopped vehicle and a passenger in the vehicle both suffered incapacitating injuries. The second crash resulting in an incapacitating injury was a turning movement crash that occurred when a southbound 17-year-old driver using a cell phone while driving disregarded the traffic signal and struck an eastbound vehicle. A passenger in the southbound vehicle suffered the incapacitating injury.

Based on the analysis of the data, there are no apparent safety hazards or design deficiencies at the study intersections. No safety mitigation is recommended.

Left-Turn Lane Warrants

Left-turn lane warrants were examined for the intersection of SW 124th Avenue at SW Blake Street.

A left-turn refuge lane is primarily a safety consideration for the major-street, removing left-turning vehicles from the through traffic stream. The left-turn lane warrants were examined using methodologies provided within the *National Cooperative Highway Research Program's* (NCHRP) *Report 457*. Turn lane warrants were evaluated based on the number of advancing and opposing vehicles as well as the number of turning vehicles, the travel speed, and the number of through lanes.

Left-turn lane warrants are projected to be met for 2022 buildout conditions during the morning peak hour at the intersection of SW 124th Avenue at SW Blake Street. It is recommended that the existing two-way left-turn lane (TWLTL) striping on SW 124th Street be altered to provide a dedicated southbound left-turn lane onto the proposed SW Blake Street.

Signal Warrants

Preliminary traffic signal warrants were examined for the unsignalized study intersections of SW 124th Avenue at SW Blake Street and SW Tualatin-Sherwood Road at SW 120th Avenue to determine whether the installation of a new traffic signal will be warranted at these intersections upon completion of the proposed development.

Due to insufficient traffic volumes, traffic signal warrants are not project to be met at either of the above intersections.

SW Blake Street Configuration

In conjunction with the proposed development, SW Blake Street is to be constructed between SW 124th Avenue at the site access. In the future SW Blake Street is expected to be extended to the south and east of the project site and eventually connect to SW 115th Avenue. The following sections comprise a 2040 planning horizon analysis of the intersections of SW Blake Street at the site access and SW 124th Avenue at SW Blake Street, including volume estimates, capacity analysis, and proposed street configuration.

The City of Sherwood's Transportation System Plan shows SW Blake Street west of SW 124th Avenue on the map of motor vehicle projects, but it is listed as an "aspirational project" that is not expected to be funded by 2035. The TSP's table of fundable projects does not list SW Blake Street.[7] Therefore, for the purposes of this analysis, it was assumed that SW Blake Street will only be constructed east of SW 124th Avenue. It is recognized that development is planned on the west side of SW 124th Avenue, but no detailed information is available at this time. Additionally, primary access to the site west of SW 124th Avenue will be via the traffic signal at SW Tualatin-Sherwood Road at SW Cipole Road. The west leg of Blake Street is expected to be relatively low in volume.

Planning Horizon Traffic Volumes

An analysis of planning horizon conditions was conducted on SW Blake Street at the site access and at the intersection of SW Blake Street and SW 124th Avenue. This analysis was conducted to ensure adequate separation between the site access and SW 124th Avenue and to determine the necessary configuration of Blake Street.

To estimate 2040 planning horizon traffic volumes on SW 124th Avenue and the future SW Blake Street, through volumes on SW 124th Avenue were taken from the highest planning horizon estimate in the April 2013 *Traffic Impact Analysis Hybrid Scenario Report* completed for the SW 124th Avenue extension.[8] Turning movement volumes for traffic turning between SW Blake Street and SW 124th Avenue were determined by adding post-development volumes from the *Majestic SW 115th Avenue Industrial Project Transportation Impact Analysis*[9] to the trip generation projected in this study for the proposed project, as described in the *Site Trips* section above. These turning movement volumes were grown by a compounded rate of 1.5 percent per year for 15 years to estimate planning horizon volumes.

Figure 7 on page 20 shows the estimated 2040 planning horizon traffic volumes at the intersections of SW 124th Avenue at SW Blake Street and SW Blake Street at the site access.

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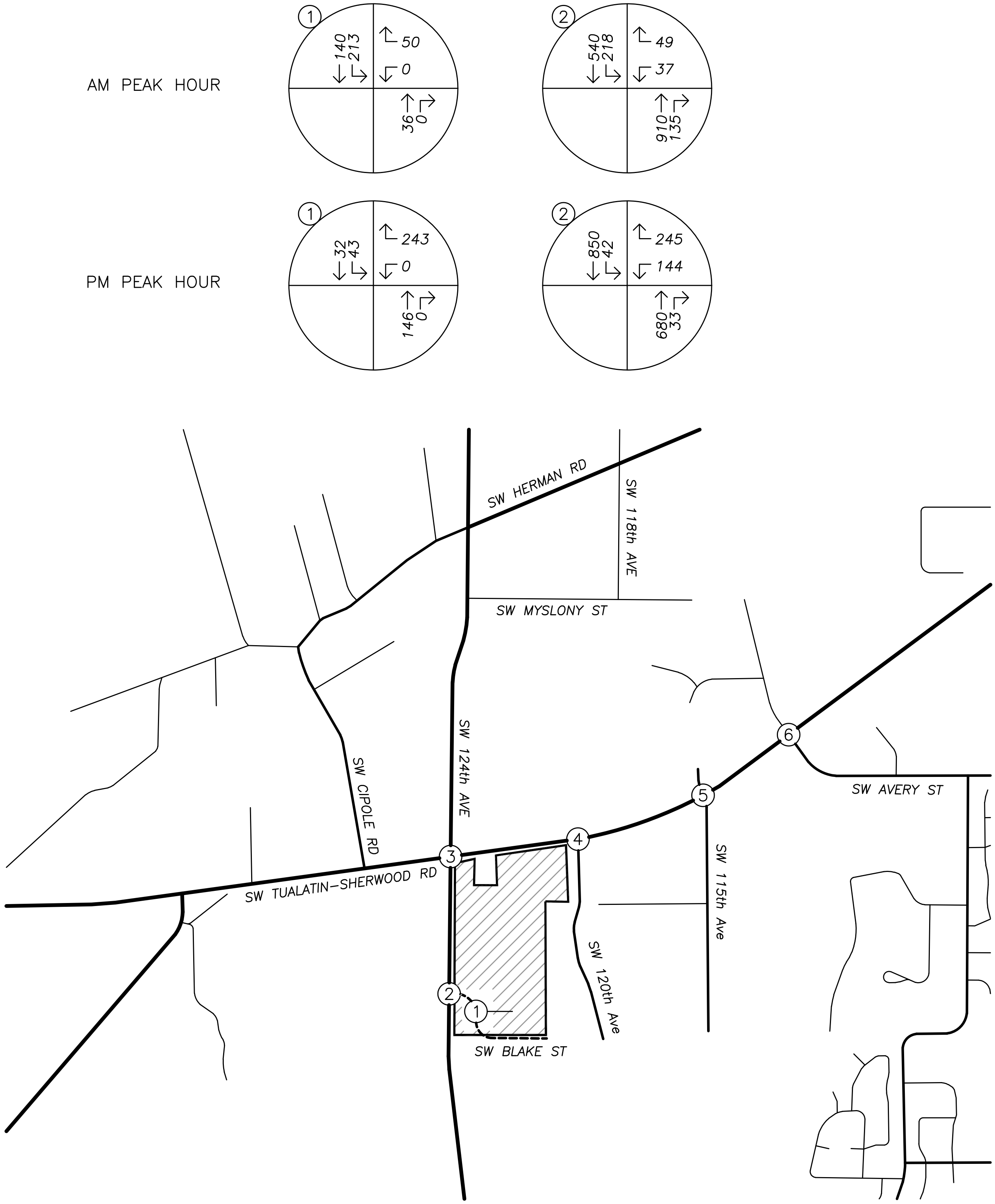
[7] *Sherwood Transportation System Plan*, June 2014. https://www.sherwoodoregon.gov/sites/default/files/fileattachments/Engineering/page/608/sherwood_tsp_final_tsp_volume_1_062714.pdf.

[8] David Evans and Associates and DKS Associates, *SW 124th Avenue Extension: Tualatin-Sherwood Road to Grahams Ferry Road Traffic Impact Analysis Hybrid Scenario Report*, April 2013.

[9] Mackenzie, *Majestic SW 115th Avenue Industrial Project Transportation Impact Analysis*, August 2016. (Revised April 2017). https://www.tualatinoregon.gov/planning/ar17-0002-majestic-building-1.



TRAFFIC VOLUMES
2040 SW Blake Street Estimated Volumes
AM & PM Peak Hours

no scale

FIGURE 7

Left-Turn Lane and Signal Warrants

Left-turn lane warrants were examined for the southbound left turn movement at the intersection of SW Blake Street at the site access using the estimated 2040 traffic volumes. A southbound left-turn lane was not warranted. Even during the morning peak hour, when a high number of left turns into the subject site are expected, opposing traffic volumes are expected to be relatively low, and the reverse is true during the evening peak hour. The analysis of this intersection was completed without a left-turn lane into the project site.

Preliminary signal warrants were examined for the intersection of SW 124th Avenue at SW Blake Street using the estimated 2040 traffic volumes. Signal warrants are projected to be met during the evening peak hour. The analysis of this intersection was completed under the assumption that a signal would be constructed by the year 2040.

Capacity Analysis

A capacity and delay analysis was completed for the intersections of SW 124th Avenue at SW Blake Street and SW Blake Street at the site access using the same methodology described in the *Operational Analysis* section above.

The following observations were noted based on the estimated planning horizon volumes and a capacity analysis at the intersections of SW 124th Avenue at SW Blake Street and SW Blake Street at the site access:

- With a signal in place, the intersection of SW 124th Avenue at SW Blake Street is projected to operate with a v/c ratio of 0.78 during the morning peak hour and 0.69 during the evening peak hour, within Washington County standards.
- The intersection of SW Blake Street at the site access is projected to operate at LOS A during the morning peak hour and LOS B during the evening peak hour. This operation is acceptable according to City of Tualatin standards, which require that unsignalized intersections operate at LOS E or better.[10]
- The maximum 95th percentile queue length for westbound turning movements at the intersection of SW 124th Avenue at SW Blake Street is projected to be 138 feet for left-turning vehicles and 62 feet for right-turning vehicles, with each movement in its own lane.
- Although a left-turn lane for traffic entering the subject site is not warranted, the queue length of westbound traffic on SW Blake Street means there would be space between the end of the westbound turn lane and the site access for a left-turn lane into the site.

[10] City of Tualatin, *Development Code*, Section 74.440(3)(e).

Recommendations

The proposed SW Blake Street should be constructed according to the City's Street Design Standards in the Transportation System Plan.[2] For minor collectors, the preferred standard is one 12-foot travel lane, a 6-foot bike lane, and an 8-foot parking lane in each direction, with a planter strip and sidewalk on both sides of the roadway. The proposed cross-section will include a 12-foot travel lane in each direction and a 14-foot center two-way left-turn lane. Due to the industrial character of the area, which lacks residential or commercial development that may generate foot traffic, and potential security needs of existing and future industrial developments, it is recommended that SW Blake Street be constructed without on-street parking lanes.

The proposed 2040 configuration of the intersections of SW 124th Avenue at SW Blake Street and SW Blake Street at the site access are shown in Figure 8 on page 23. Note that the traffic signal shown at the intersection on SW 124th Avenue at SW Blake Street is not recommended in conjunction with the proposed development, but will likely be constructed by 2040.

LEGEND

STUDY INTERSECTION (EXISTING)

STUDY INTERSECTION (EXISTING)

STOP SIGN

TRAFFIC SIGNAL

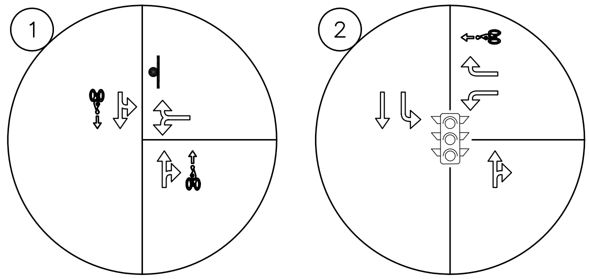
BIKE LANE

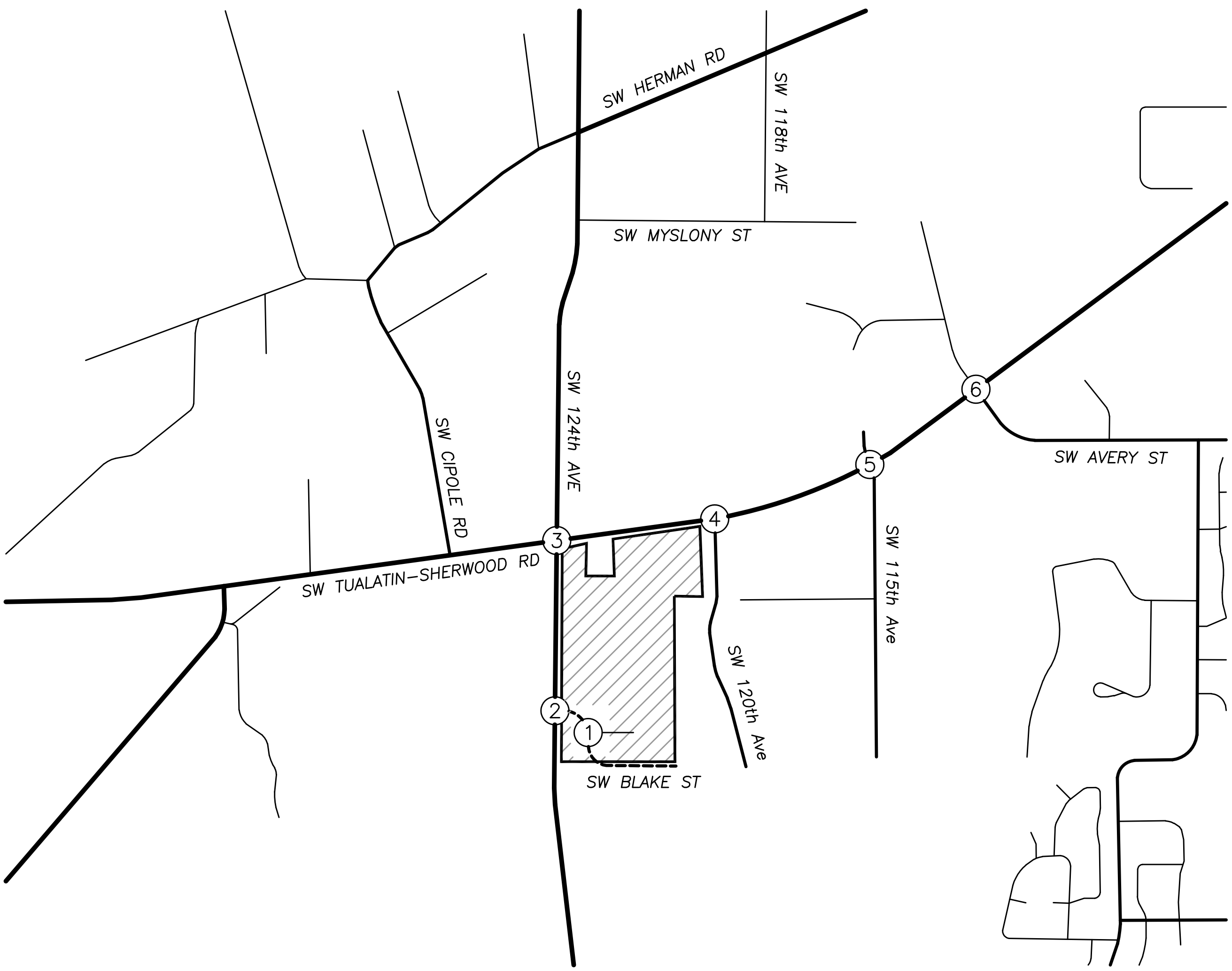
PROJECT SITE

ARTERIAL ROADWAY

COLLECTOR ROADWAY

LOCAL ROADWAY





VICINITY MAP
SW Blake Street – Planning Horizon Intersection Configurations

no scale

FIGURE 8

PAGE 23

Conclusions

Two properties located at the southeast corner of the intersection of SW Tualatin-Sherwood Road at SW 124th Avenue are proposed for construction of the Portland General Electric (PGE) Integrated Operations Center (IOC). The project will include the IOC building, a secure entrance, approximately 300 parking stalls, and various other components necessary for the Operations Center. Along with development of the site, SW Blake Street will be constructed from SW 124th Avenue eastward to the driveway to the site. The projected occupancy date of the site is December 2021, and this report conservatively assumes a buildout year of 2022.

Offsite Impacts

The PGE IOC facility is expected to generate 210 trips during the morning peak hour and 228 trips during the evening peak hour. Operational analysis of the five study intersections, all under Washington County jurisdiction, indicated that four of the five are projected to operate acceptably according to County standards through the 2022 buildout year, with or without the addition of site trips related to the proposed development. The intersection of SW Tualatin-Sherwood Road at SW 124th Avenue is projected to operate with a v/c ratio greater than the maximum allowed by the County under 2022 buildout conditions during the morning peak hour. Washington County plans to widen SW Tualatin-Sherwood Road to a five-lane cross-section in the vicinity of the site, which will add capacity to the roadway and improve operation at the intersection with SW 124th Avenue. The analysis in this report was completed under the assumption that these roadway improvements would not be in place by 2022, the buildout year for the PGE project.

Recommended Improvements

It is recommended that the existing two-way left-turn lane striping on SW 124th Avenue north of the new Blake Street intersection be reconfigured to proivde a dedicated left-turn lane for the southbound left turn movement. Preliminary traffic signal warrants were evaluated for the unsignalized study intersections and indicated that signal warrants are not projected to be met at any of these intersections. No new traffic signals are recommended in conjunction with the proposed project.

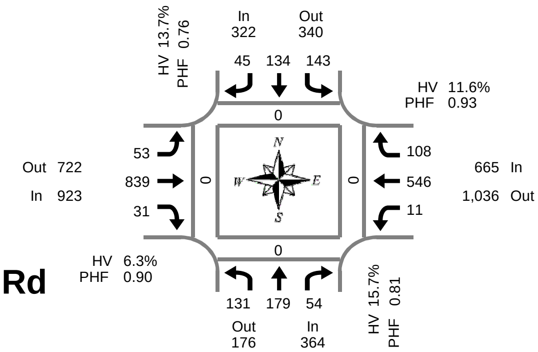
It is recommended that SW Blake Street be constructed to the proposed cross-section of two 12-foot travel lanes and a 14-foot center two-way left-turn lane, with the exception that no on-street parking is recommended. Left-turn lane warrants were not projected to be met for left turns into the project site from SW Blake Street under planning horizon traffic volume conditions.

The intersection of SW Blake Street at SW 124th Avenue was analyzed for the planning horizon assuming that a signal would eventually be constructed. To accommodate for the future signal, separate westbound left- and right-turn lanes should be constructed on SW Blake Street at SW 124th Avenue.

Appendix

Total Vehicle Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740



Peak Hour Summary
7:20 AM to 8:20 AM

SW 124th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave L	T	R	Bikes	Southbound SW 124th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	5	8	2	0	5	7	4	0	5	87	5	0	0	40	7	0	175	0	0	0	0
7:05 AM	13	12	3	0	19	8	3	0	2	69	5	0	0	31	4	0	169	0	0	0	0
7:10 AM	5	10	5	0	3	5	3	0	9	75	1	0	0	39	4	0	159	0	0	0	0
7:15 AM	6	9	6	0	8	4	4	0	9	77	0	0	0	42	5	0	170	0	0	0	0
7:20 AM	15	11	6	0	8	9	0	0	6	71	3	0	1	38	6	0	174	0	0	0	0
7:25 AM	16	7	3	0	20	11	4	0	3	63	1	0	0	48	7	0	183	0	0	0	0
7:30 AM	6	15	2	0	4	3	3	0	4	85	2	1	0	51	10	0	185	0	0	0	0
7:35 AM	8	16	4	0	18	16	2	0	5	64	4	0	2	48	8	0	195	0	0	0	0
7:40 AM	14	15	7	0	11	20	2	0	4	65	4	0	1	47	6	0	196	0	0	0	0
7:45 AM	8	18	8	0	12	23	1	0	4	65	1	0	1	39	10	0	190	0	0	0	0
7:50 AM	9	19	8	0	13	20	4	0	4	67	1	0	0	48	9	0	202	0	0	0	0
7:55 AM	11	23	1	0	16	11	4	0	3	64	2	0	1	53	8	0	197	0	0	0	0
8:00 AM	18	15	8	0	14	9	10	0	6	62	3	0	2	42	16	0	205	0	0	0	0
8:05 AM	11	14	1	0	9	3	2	0	3	82	2	0	1	44	6	0	178	0	0	0	0
8:10 AM	8	14	4	0	10	5	5	0	6	75	5	0	0	43	11	0	186	0	0	0	0
8:15 AM	7	12	2	0	8	4	8	0	5	76	3	0	2	45	11	0	183	0	0	0	0
8:20 AM	3	5	2	0	14	6	5	0	9	91	2	0	0	29	4	0	170	0	0	0	0
8:25 AM	11	9	2	0	4	5	6	0	5	70	8	0	2	49	6	0	177	0	0	0	0
8:30 AM	15	14	2	0	5	5	4	0	3	59	7	0	1	45	7	0	167	0	0	0	0
8:35 AM	3	11	2	0	8	6	6	0	4	69	6	0	1	47	8	0	171	0	0	0	0
8:40 AM	7	8	3	0	7	7	4	0	12	84	8	0	0	59	4	0	203	0	0	0	0
8:45 AM	2	15	0	0	6	2	2	0	9	74	2	0	3	46	5	0	166	0	0	0	0
8:50 AM	6	10	1	0	7	13	3	0	5	73	3	0	0	51	7	0	179	0	0	0	0
8:55 AM	3	9	1	0	9	8	6	0	9	68	2	0	1	56	5	0	177	0	0	0	0
Total Survey	210	299	83	0	238	210	95	0	134	1,735	80	1	19	1,080	174	0	4,357	0	0	0	0

15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave L	T	R	Bikes	Southbound SW 124th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	23	30	10	0	27	20	10	0	16	231	11	0	0	110	15	0	503	0	0	0	0
7:15 AM	37	27	15	0	36	24	8	0	18	211	4	0	1	128	18	0	527	0	0	0	0
7:30 AM	28	46	13	0	33	39	7	0	13	214	10	1	3	146	24	0	576	0	0	0	0
7:45 AM	28	60	17	0	41	54	9	0	11	196	4	0	2	140	27	0	589	0	0	0	0
8:00 AM	37	43	13	0	33	17	17	0	15	219	10	0	3	129	33	0	569	0	0	0	0
8:15 AM	21	26	6	0	26	15	19	0	19	237	13	0	4	123	21	0	530	0	0	0	0
8:30 AM	25	33	7	0	20	18	14	0	19	212	21	0	2	151	19	0	541	0	0	0	0
8:45 AM	11	34	2	0	22	23	11	0	23	215	7	0	4	153	17	0	522	0	0	0	0
Total Survey	210	299	83	0	238	210	95	0	134	1,735	80	1	19	1,080	174	0	4,357	0	0	0	0

Peak Hour Summary
7:20 AM to 8:20 AM

By Approach	Northbound SW 124th Ave In	Out	Total	Bikes	Southbound SW 124th Ave In	Out	Total	Bikes	Eastbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Westbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Total
Volume	364	176	540	0	322	340	662	0	923	722	1,645	1	665	1,036	1,701	0	2,274
%HV	15.7%				13.7%				6.3%				11.6%				10.4%
PHF	0.81				0.76				0.90				0.93				0.94

Pedestrians Crosswalk North	South	East	West
0	0	0	0

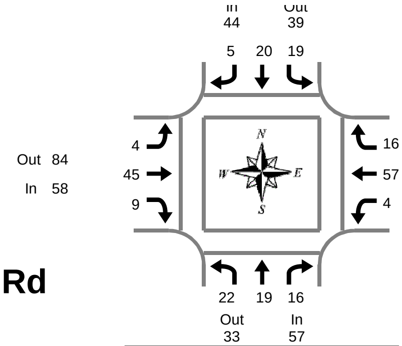
By Movement	Northbound SW 124th Ave L	T	R	Total	Southbound SW 124th Ave L	T	R	Total	Eastbound SW Tualatin Sherwood Rd L	T	R	Total	Westbound SW Tualatin Sherwood Rd L	T	R	Total	Total
Volume	131	179	54	364	143	134	45	322	53	839	31	923	11	546	108	665	2,274
%HV	16.8%	10.6%	29.6%	15.7%	13.3%	14.9%	11.1%	13.7%	7.5%	5.4%	29.0%	6.3%	36.4%	10.4%	14.8%	11.6%	10.4%
PHF	0.82	0.75	0.59	0.81	0.83	0.53	0.63	0.76	0.88	0.90	0.78	0.90	0.69	0.93	0.82	0.93	0.94

Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave L	T	R	Bikes	Southbound SW 124th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	116	163	55	0	137	137	34	0	58	852	29	1	6	524	84	0	2,195	0	0	0	0
7:15 AM	130	176	58	0	143	134	41	0	57	840	28	1	9	543	102	0	2,261	0	0	0	0
7:30 AM	114	175	49	0	133	125	52	0	58	866	37	1	12	538	105	0	2,264	0	0	0	0
7:45 AM	111	162	43	0	120	104	59	0	64	864	48	0	11	543	100	0	2,229	0	0	0	0
8:00 AM	94	136	28	0	101	73	61	0	76	883	51	0	13	556	90	0	2,162	0	0	0	0

Heavy Vehicle Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740



SW 124th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

Peak Hour Summary
7:20 AM to 8:20 AM

Heavy Vehicle 5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	0	1	1	2	1	1	0	2	1	5	0	6	0	4	0	4	14
7:05 AM	1	1	2	4	1	0	0	1	0	2	0	2	0	2	0	2	9
7:10 AM	1	0	0	1	0	0	1	1	1	8	0	9	0	6	0	6	17
7:15 AM	0	1	2	3	0	1	0	1	0	5	0	5	0	1	3	4	13
7:20 AM	5	0	1	6	0	2	0	2	1	1	1	3	1	4	1	6	17
7:25 AM	0	1	1	2	1	0	1	2	0	7	0	7	0	4	1	5	16
7:30 AM	0	3	2	5	0	2	1	3	1	5	2	8	0	7	2	9	25
7:35 AM	0	4	1	5	3	3	0	6	0	5	2	7	0	4	1	5	23
7:40 AM	3	2	1	6	0	3	1	4	0	2	1	3	0	10	3	13	26
7:45 AM	3	2	1	6	1	2	0	3	1	6	0	7	0	5	0	5	21
7:50 AM	3	0	2	5	1	3	0	4	0	3	0	3	0	0	0	0	12
7:55 AM	1	1	0	2	1	2	0	3	0	5	0	5	0	3	3	6	16
8:00 AM	5	1	4	10	4	2	0	6	0	2	0	2	1	4	2	7	25
8:05 AM	0	0	0	0	2	0	0	2	1	2	0	3	1	7	1	9	14
8:10 AM	2	4	3	9	3	0	1	4	0	3	3	6	0	8	0	8	27
8:15 AM	0	1	0	1	3	1	1	5	0	4	0	4	1	1	2	4	14
8:20 AM	0	1	2	3	2	2	0	4	0	9	0	9	0	3	0	3	19
8:25 AM	0	0	2	2	1	1	1	3	0	4	2	6	1	7	0	8	19
8:30 AM	4	1	0	5	1	1	1	3	0	0	2	2	1	8	0	9	19
8:35 AM	2	0	0	2	3	1	0	4	1	11	1	13	0	3	2	5	24
8:40 AM	0	0	1	1	0	1	2	3	1	3	0	4	0	9	1	10	18
8:45 AM	2	3	0	5	1	1	1	3	0	6	1	7	1	6	0	7	22
8:50 AM	1	0	1	2	3	4	1	8	0	8	0	8	0	8	0	8	26
8:55 AM	0	3	1	4	2	3	0	5	1	8	0	9	0	7	1	8	26
Total Survey	33	30	28	91	34	36	12	82	9	114	15	138	7	121	23	151	462

Heavy Vehicle 15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	2	2	3	7	2	1	1	4	2	15	0	17	0	12	0	12	40
7:15 AM	5	2	4	11	1	3	1	5	1	13	1	15	1	9	5	15	46
7:30 AM	3	9	4	16	3	8	2	13	1	12	5	18	0	21	6	27	74
7:45 AM	7	3	3	13	3	7	0	10	1	14	0	15	0	8	3	11	49
8:00 AM	7	5	7	19	9	2	1	12	1	7	3	11	2	19	3	24	66
8:15 AM	0	2	4	6	6	4	2	12	0	17	2	19	2	11	2	15	52
8:30 AM	6	1	1	8	4	3	3	10	2	14	3	19	1	20	3	24	61
8:45 AM	3	6	2	11	6	8	2	16	1	22	1	24	1	21	1	23	74
Total Survey	33	30	28	91	34	36	12	82	9	114	15	138	7	121	23	151	462

Heavy Vehicle Peak Hour Summary
7:20 AM to 8:20 AM

By Approach	Northbound SW 124th Ave			Southbound SW 124th Ave			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	57	33	90	44	39	83	58	84	142	77	80	157	236
PHF	0.75			0.85			0.66			0.71			0.80

By Movement	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	22	19	16	57	19	20	5	44	4	45	9	58	4	57	16	77	236
PHF	0.61	0.53	0.57	0.75	0.53	0.63	0.63	0.85	0.50	0.66	0.45	0.66	0.50	0.68	0.67	0.71	0.80

Heavy Vehicle Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	17	16	14	47	9	19	4	32	5	54	6	65	1	50	14	65	209
7:15 AM	22	19	18	59	16	20	4	40	4	46	9	59	3	57	17	77	235
7:30 AM	17	19	18	54	21	21	5	47	3	50	10	63	4	59	14	77	241
7:45 AM	20	11	15	46	22	16	6	44	4	52	8	64	5	58	11	74	228
8:00 AM	16	14	14	44	25	17	8	50	4	60	9	73	6	71	9	86	253

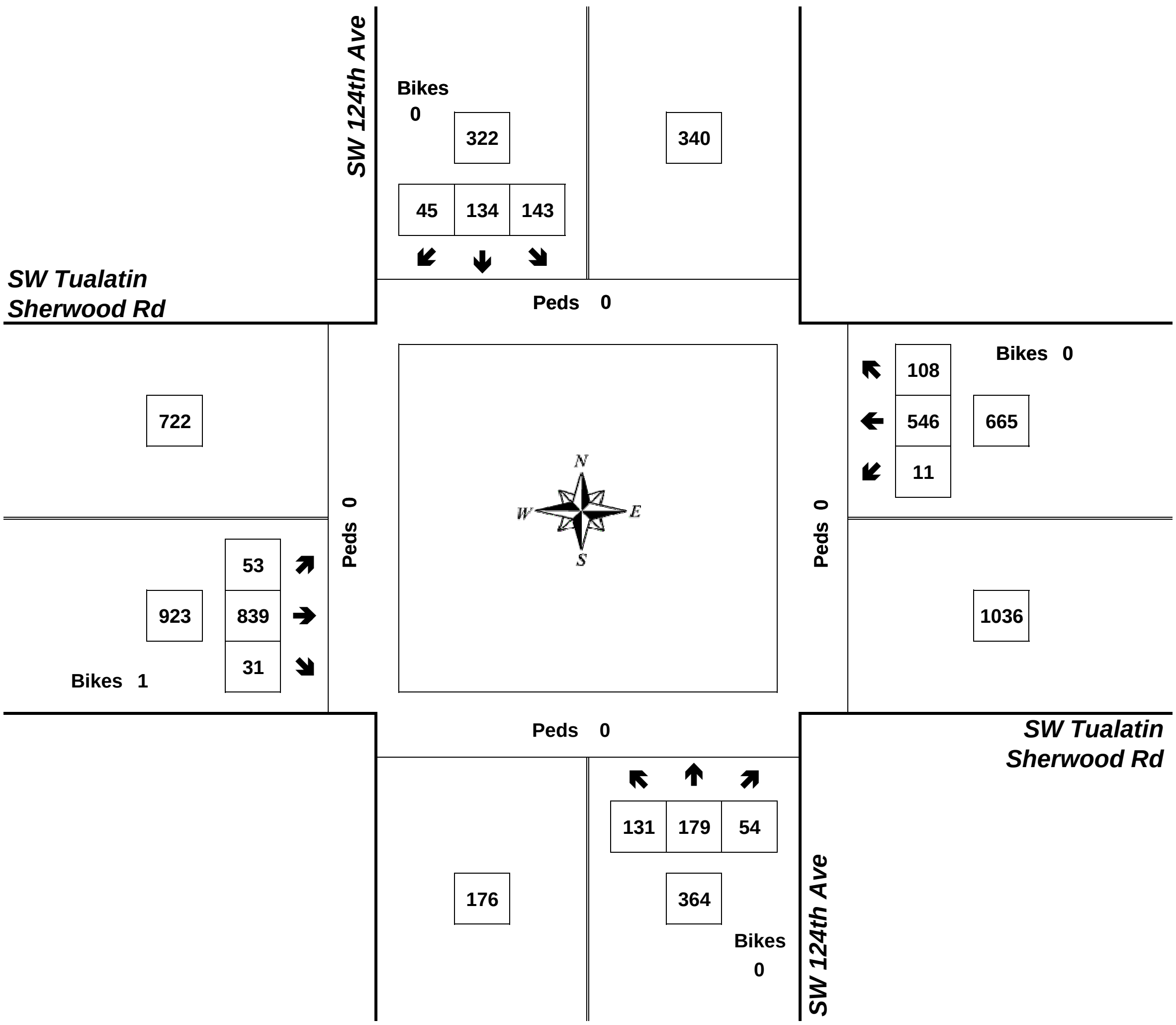
Peak Hour Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740

SW 124th Ave & SW Tualatin Sherwood Rd

7:20 AM to 8:20 AM
Thursday, February 07, 2019

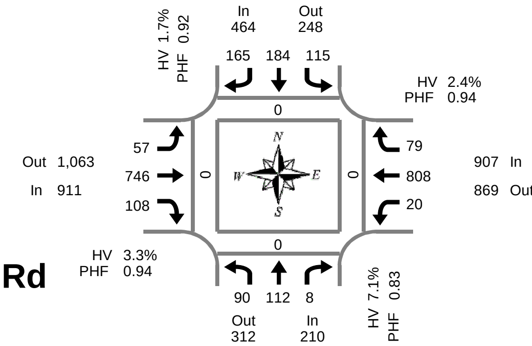


Approach	PHF	HV%	Volume
EB	0.90	6.3%	923
WB	0.93	11.6%	665
NB	0.81	15.7%	364
SB	0.76	13.7%	322
Intersection	0.94	10.4%	2,274

Count Period: 7:00 AM to 9:00 AM

Total Vehicle Summary

Clay Carney
(503) 833-2740



Peak Hour Summary
4:20 PM to 5:20 PM

SW 124th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval	Pedestrians Crosswalk			
Time	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	Total	North	South	East	West
4:00 PM	5	4	0	0	13	21	11	0	5	61	6	0	2	72	12	0	212	0	0	0	0
4:05 PM	4	10	2	0	1	20	9	0	6	67	17	0	6	60	7	0	209	0	0	0	0
4:10 PM	11	13	3	0	4	14	14	0	6	58	9	0	5	66	12	0	215	0	0	0	0
4:15 PM	5	10	0	0	2	11	18	0	1	56	8	0	3	74	6	0	194	0	0	0	0
4:20 PM	14	9	0	0	16	19	11	0	5	66	11	0	1	61	7	0	220	0	0	0	0
4:25 PM	7	7	0	0	7	7	9	0	1	55	9	0	2	70	5	0	179	0	0	0	0
4:30 PM	6	11	0	0	7	13	15	0	7	58	10	0	1	76	4	0	208	0	0	0	0
4:35 PM	5	11	0	0	9	17	16	0	6	62	8	0	1	70	13	0	218	0	0	0	0
4:40 PM	6	7	1	0	10	20	13	0	9	51	4	0	2	64	8	0	195	0	0	0	0
4:45 PM	7	7	1	0	13	16	12	0	2	69	12	0	2	70	6	0	217	0	0	0	0
4:50 PM	12	10	3	0	10	11	10	0	5	52	11	0	1	67	5	0	197	0	0	0	0
4:55 PM	8	15	0	0	6	17	17	0	6	61	7	0	0	56	5	0	198	0	0	0	0
5:00 PM	6	5	0	0	9	16	14	0	5	66	10	0	1	71	6	0	209	0	0	0	0
5:05 PM	5	9	1	0	5	14	17	0	3	60	4	0	6	66	5	0	195	0	0	0	0
5:10 PM	9	12	1	0	12	19	14	0	2	78	10	0	1	73	9	0	240	0	0	0	0
5:15 PM	5	9	1	0	11	15	17	0	6	68	12	0	2	64	6	0	216	0	0	0	0
5:20 PM	10	8	0	0	14	16	24	0	2	62	9	1	0	53	3	0	201	0	0	0	0
5:25 PM	6	5	0	0	1	7	14	0	4	60	6	0	2	82	8	0	195	0	0	0	0
5:30 PM	1	10	0	0	4	7	14	0	6	75	7	0	2	81	4	0	211	0	0	0	0
5:35 PM	8	13	0	0	11	10	15	0	3	48	10	0	1	68	12	1	199	0	0	0	0
5:40 PM	11	7	1	0	9	12	14	0	4	63	14	0	1	65	8	0	209	0	0	0	0
5:45 PM	3	4	2	0	4	5	16	0	2	64	4	0	1	97	6	0	208	0	0	0	0
5:50 PM	4	12	1	0	8	7	10	0	1	57	7	0	0	63	3	0	173	0	0	0	0
5:55 PM	3	7	0	0	9	10	5	0	3	69	4	0	2	69	7	0	188	0	0	0	0
Total Survey	161	215	17	0	195	324	329	0	100	1,486	209	1	45	1,658	167	1	4,906	0	0	0	0

15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval	Pedestrians Crosswalk			
Time	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	Total	North	South	East	West
4:00 PM	20	27	5	0	18	55	34	0	17	186	32	0	13	198	31	0	636	0	0	0	0
4:15 PM	26	26	0	0	25	37	38	0	7	177	28	0	6	205	18	0	593	0	0	0	0
4:30 PM	17	29	1	0	26	50	44	0	22	171	22	0	4	210	25	0	621	0	0	0	0
4:45 PM	27	32	4	0	29	44	39	0	13	182	30	0	3	193	16	0	612	0	0	0	0
5:00 PM	20	26	2	0	26	49	45	0	10	204	24	0	8	210	20	0	644	0	0	0	0
5:15 PM	21	22	1	0	26	38	55	0	12	190	27	1	4	199	17	0	612	0	0	0	0
5:30 PM	20	30	1	0	24	29	43	0	13	186	31	0	4	214	24	1	619	0	0	0	0
5:45 PM	10	23	3	0	21	22	31	0	6	190	15	0	3	229	16	0	569	0	0	0	0
Total Survey	161	215	17	0	195	324	329	0	100	1,486	209	1	45	1,658	167	1	4,906	0	0	0	0

Peak Hour Summary
4:20 PM to 5:20 PM

By Approach	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	
Volume	210	312	522	0	464	248	712	0	911	1,063	1,974	0	907	869	1,776	0	2,492
%HV	7.1%				1.7%				3.3%				2.4%				3.0%
PHF	0.83				0.92				0.94				0.94				0.96

Pedestrians Crosswalk			
North	South	East	West
0	0	0	0

By Movement	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	90	112	8	210	115	184	165	464	57	746	108	911	20	808	79	907	2,492
%HV	5.6%	8.0%	12.5%	7.1%	3.5%	1.6%	0.6%	1.7%	3.5%	3.1%	4.6%	3.3%	0.0%	2.4%	3.8%	2.4%	3.0%
PHF	0.83	0.88	0.40	0.83	0.87	0.87	0.86	0.92	0.65	0.91	0.90	0.94	0.56	0.94	0.73	0.94	0.96

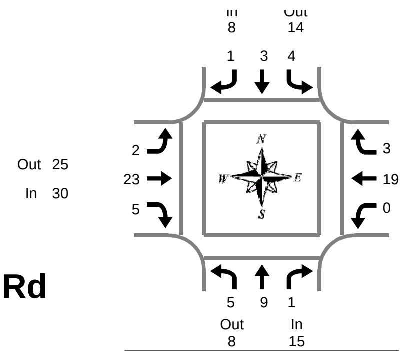
Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval	Pedestrians Crosswalk			
Time	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	Total	North	South	East	West
4:00 PM	90	114	10	0	98	186	155	0	59	716	112	0	26	806	90	0	2,462	0	0	0	0
4:15 PM	90	113	7	0	106	180	166	0	52	734	104	0	21	818	79	0	2,470	0	0	0	0
4:30 PM	85	109	8	0	107	181	183	0	57	747	103	1	19	812	78	0	2,489	0	0	0	0
4:45 PM	88	110	8	0	105	160	182	0	48	762	112	1	19	816	77	1	2,487	0	0	0	0
5:00 PM	71	101	7	0	97	138	174	0	41	770	97	1	19	852	77	1	2,444	0	0	0	0

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



SW 124th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

Peak Hour Summary
4:20 PM to 5:20 PM

Heavy Vehicle 5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	0	0	0	0	1	3	0	4	0	2	1	3	0	0	2	2	9
4:05 PM	0	1	0	1	0	4	0	4	0	5	0	5	0	3	0	3	13
4:10 PM	2	1	1	4	0	0	0	0	0	3	1	4	0	3	1	4	12
4:15 PM	0	2	0	2	0	2	0	2	0	2	2	4	0	1	0	1	9
4:20 PM	0	1	0	1	1	0	0	1	0	3	0	3	0	3	0	3	8
4:25 PM	0	1	0	1	0	1	0	1	0	3	2	5	0	0	0	0	7
4:30 PM	1	1	0	2	1	0	0	1	0	1	1	2	0	2	1	3	8
4:35 PM	0	1	0	1	1	0	0	1	0	1	0	1	0	0	0	0	3
4:40 PM	2	2	0	4	1	1	0	2	1	0	0	1	0	4	0	4	11
4:45 PM	1	0	0	1	0	1	0	1	0	2	0	2	0	0	1	1	5
4:50 PM	0	0	1	1	0	0	0	0	0	1	1	2	0	2	0	2	5
4:55 PM	0	2	0	2	0	0	1	1	0	0	0	0	0	3	0	3	6
5:00 PM	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	2	3
5:05 PM	1	0	0	1	0	0	0	0	0	3	0	3	0	2	0	2	6
5:10 PM	0	1	0	1	0	0	0	0	0	3	1	4	0	1	0	1	6
5:15 PM	0	0	0	0	0	0	0	0	1	5	0	6	0	1	0	1	7
5:20 PM	1	1	0	2	0	0	0	0	0	0	1	1	0	1	0	1	4
5:25 PM	0	0	0	0	0	0	0	0	1	3	1	5	0	0	0	0	5
5:30 PM	0	0	0	0	1	0	0	1	0	1	0	1	0	1	0	1	3
5:35 PM	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	2	3
5:40 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	1	3
5:45 PM	0	0	0	0	2	0	0	2	0	3	0	3	0	0	0	0	5
5:50 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	2	0	2	4
5:55 PM	0	0	0	0	1	0	0	1	0	1	0	1	0	2	0	2	4
Total Survey	8	14	2	24	9	12	1	22	3	48	11	62	0	35	6	41	149

Heavy Vehicle 15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	2	2	1	5	1	7	0	8	0	10	2	12	0	6	3	9	34
4:15 PM	0	4	0	4	1	3	0	4	0	8	4	12	0	4	0	4	24
4:30 PM	3	4	0	7	3	1	0	4	1	2	1	4	0	6	1	7	22
4:45 PM	1	2	1	4	0	1	1	2	0	3	1	4	0	5	1	6	16
5:00 PM	1	1	0	2	0	0	0	0	0	7	1	8	0	4	1	5	15
5:15 PM	1	1	0	2	0	0	0	0	2	8	2	12	0	2	0	2	16
5:30 PM	0	0	0	0	1	0	0	1	0	4	0	4	0	4	0	4	9
5:45 PM	0	0	0	0	3	0	0	3	0	6	0	6	0	4	0	4	13
Total Survey	8	14	2	24	9	12	1	22	3	48	11	62	0	35	6	41	149

Heavy Vehicle Peak Hour Summary
4:20 PM to 5:20 PM

By Approach	Northbound SW 124th Ave			Southbound SW 124th Ave			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	15	8	23	8	14	22	30	25	55	22	28	50	75
PHF	0.54			0.50			0.58			0.79			0.82

By Movement	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	5	9	1	15	4	3	1	8	2	23	5	30	0	19	3	22	75
PHF	0.42	0.56	0.25	0.54	0.33	0.38	0.25	0.50	0.50	0.52	0.42	0.58	0.00	0.79	0.75	0.79	0.82

Heavy Vehicle Rolling Hour Summary
4:00 PM to 6:00 PM

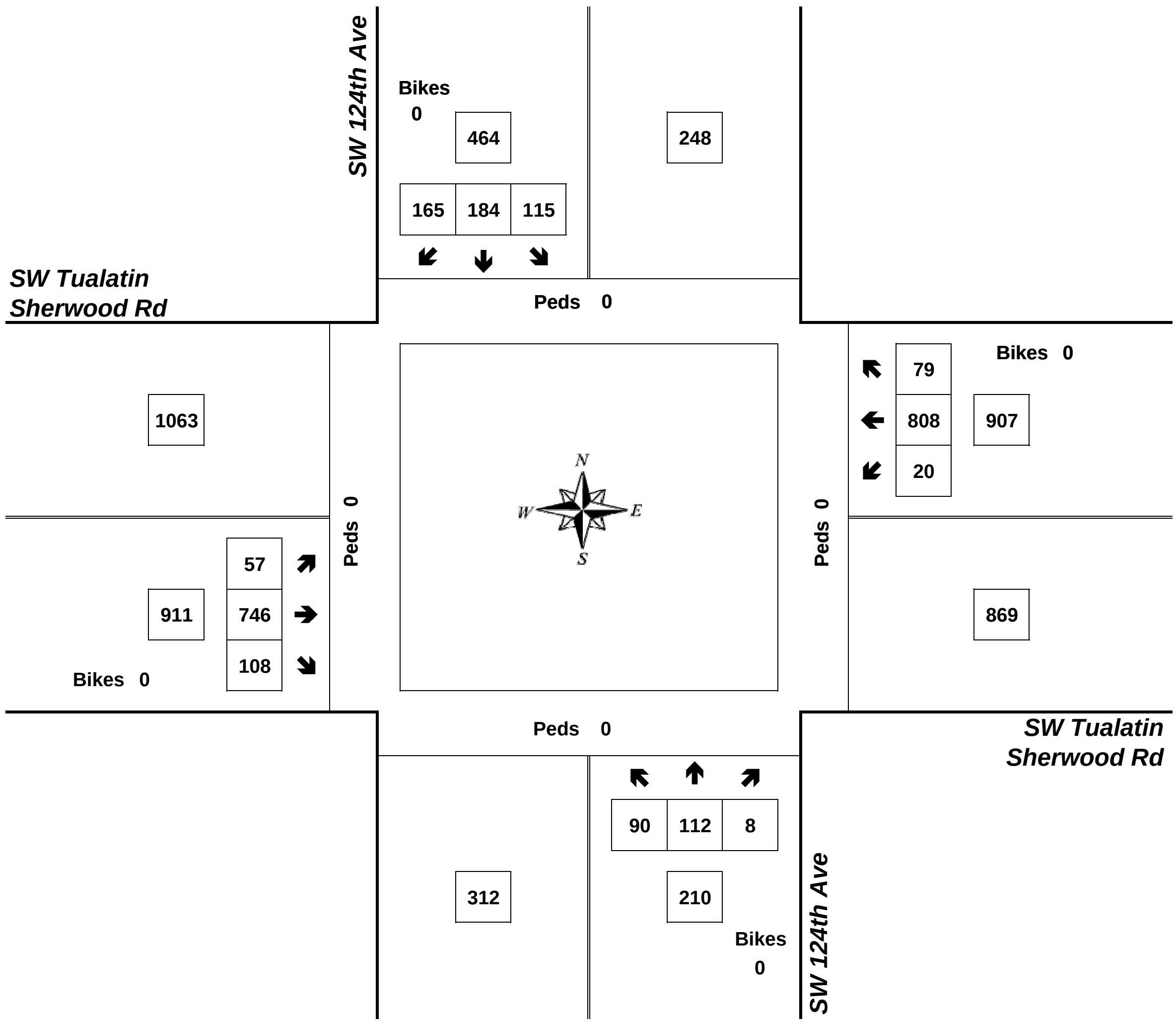
Interval Start Time	Northbound SW 124th Ave				Southbound SW 124th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	6	12	2	20	5	12	1	18	1	23	8	32	0	21	5	26	96
4:15 PM	5	11	1	17	4	5	1	10	1	20	7	28	0	19	3	22	77
4:30 PM	6	8	1	15	3	2	1	6	3	20	5	28	0	17	3	20	69
4:45 PM	3	4	1	8	1	1	1	3	2	22	4	28	0	15	2	17	56
5:00 PM	2	2	0	4	4	0	0	4	2	25	3	30	0	14	1	15	53

Peak Hour Summary

Clay Carney
(503) 833-2740

SW 124th Ave & SW Tualatin Sherwood Rd

4:20 PM to 5:20 PM
Wednesday, February 06, 2019



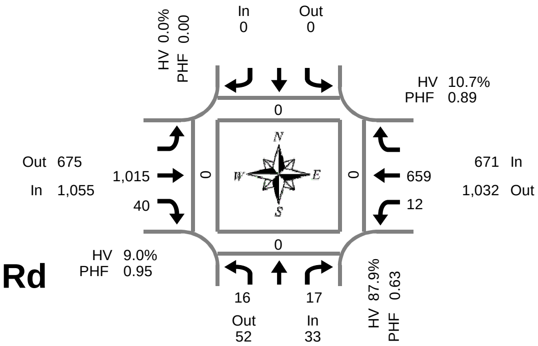
Approach	PHF	HV%	Volume
EB	0.94	3.3%	911
WB	0.94	2.4%	907
NB	0.83	7.1%	210
SB	0.92	1.7%	464
Intersection	0.96	3.0%	2,492

Count Period: 4:00 PM to 6:00 PM

Total Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
7:25 AM to 8:25 AM

SW 120th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
7:00 AM	0		1	0				0		93	1	0	2	32		0	129	0	0	0	0
7:05 AM	1		1	0				0		87	4	0	3	37		0	133	0	0	0	0
7:10 AM	0		0	0				0		83	1	0	2	48		0	134	0	0	0	0
7:15 AM	2		2	0				0		88	3	0	0	49		0	144	0	0	0	0
7:20 AM	2		1	0				0		83	1	0	2	35		0	124	0	0	0	0
7:25 AM	1		0	0				0		83	2	0	4	76		0	166	0	0	0	0
7:30 AM	4		2	0				0		84	3	0	1	48		0	142	0	0	0	0
7:35 AM	0		2	0				0		85	4	0	0	60		0	151	0	0	0	0
7:40 AM	3		2	0				0		79	1	0	0	51		0	136	0	0	0	0
7:45 AM	3		1	0				0		84	6	0	1	64		0	159	0	0	0	0
7:50 AM	0		2	0				0		83	3	0	0	52		0	140	0	0	0	0
7:55 AM	0		2	0				0		81	2	0	1	58		0	144	0	0	0	0
8:00 AM	1		3	0				0		72	9	0	0	62		0	147	0	0	0	0
8:05 AM	0		1	0				0		94	2	0	1	51		0	149	0	0	0	0
8:10 AM	1		0	0				0		86	3	0	1	46		0	137	0	0	0	0
8:15 AM	3		0	0				0		85	2	0	2	46		0	138	0	0	0	0
8:20 AM	0		2	0				0		99	3	0	1	45		0	150	0	0	0	0
8:25 AM	3		2	0				0		71	3	0	0	44		0	123	0	0	0	0
8:30 AM	1		3	0				0		64	2	0	2	59		0	131	0	0	0	0
8:35 AM	3		0	0				0		75	5	0	1	53		0	137	0	0	0	0
8:40 AM	2		0	0				0		92	2	0	2	64		0	162	0	0	0	0
8:45 AM	1		2	0				0		79	1	0	1	55		0	139	0	0	0	0
8:50 AM	3		1	0				0		75	4	0	5	52		0	140	0	0	0	0
8:55 AM	0		3	0				0		74	5	0	0	58		0	140	0	0	0	0
Total Survey	34		33	0				0		1,979	72	0	32	1,245		0	3,395	0	0	0	0

15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
7:00 AM	1		2	0				0		263	6	0	7	117		0	396	0	0	0	0
7:15 AM	5		3	0				0		254	6	0	6	160		0	434	0	0	0	0
7:30 AM	7		6	0				0		248	8	0	1	159		0	429	0	0	0	0
7:45 AM	3		5	0				0		248	11	0	2	174		0	443	0	0	0	0
8:00 AM	2		4	0				0		252	14	0	2	159		0	433	0	0	0	0
8:15 AM	6		4	0				0		255	8	0	3	135		0	411	0	0	0	0
8:30 AM	6		3	0				0		231	9	0	5	176		0	430	0	0	0	0
8:45 AM	4		6	0				0		228	10	0	6	165		0	419	0	0	0	0
Total Survey	34		33	0				0		1,979	72	0	32	1,245		0	3,395	0	0	0	0

Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	
Volume	33	52	85	0	0	0	0	0	1,055	675	1,730	0	671	1,032	1,703	0	1,759
%HV	87.9%				0.0%				9.0%				10.7%				11.1%
PHF	0.63				0.00				0.95				0.89				0.96

Pedestrians Crosswalk			
North	South	East	West
0	0	0	0

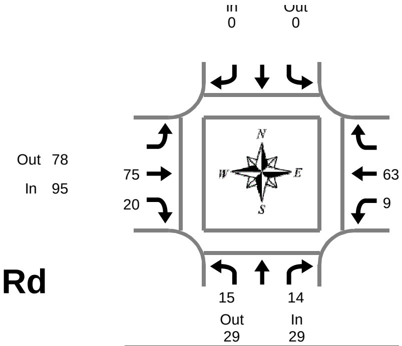
By Movement	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L		R	Total				Total		T	R	Total	L	T		Total	
Volume	16		17	33				0		1,015	40	1,055	12	659		671	1,759
%HV	93.8%	NA	82.4%	87.9%	NA	NA	NA	0.0%	NA	7.4%	50.0%	9.0%	75.0%	9.6%	NA	10.7%	11.1%
PHF	0.57		0.61	0.63				0.00		0.94	0.71	0.95	0.60	0.90		0.89	0.96

Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
7:00 AM	16		16	0				0		1,013	31	0	16	610		0	1,702	0	0	0	0
7:15 AM	17		18	0				0		1,002	39	0	11	652		0	1,739	0	0	0	0
7:30 AM	18		19	0				0		1,003	41	0	8	627		0	1,716	0	0	0	0
7:45 AM	17		16	0				0		986	42	0	12	644		0	1,717	0	0	0	0
8:00 AM	18		17	0				0		966	41	0	16	635		0	1,693	0	0	0	0

Heavy Vehicle Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740



Peak Hour Summary
7:25 AM to 8:25 AM

SW 120th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

Heavy Vehicle 5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
7:00 AM	0		0	0				0		9	1	10	1	3		4	14
7:05 AM	1		0	1				0		3	2	5	2	2		4	10
7:10 AM	0		0	0				0		8	1	9	2	6		8	17
7:15 AM	2		2	4				0		5	1	6	0	4		4	14
7:20 AM	2		1	3				0		4	0	4	1	3		4	11
7:25 AM	1		0	1				0		6	2	8	3	7		10	19
7:30 AM	4		2	6				0		6	2	8	1	4		5	19
7:35 AM	0		2	2				0		9	2	11	0	5		5	18
7:40 AM	3		2	5				0		2	0	2	0	9		9	16
7:45 AM	2		1	3				0		8	2	10	1	4		5	18
7:50 AM	0		2	2				0		4	1	5	0	3		3	10
7:55 AM	0		1	1				0		7	0	7	1	10		11	19
8:00 AM	1		1	2				0		5	5	10	0	3		3	15
8:05 AM	0		1	1				0		3	1	4	1	7		8	13
8:10 AM	1		0	1				0		8	2	10	1	6		7	18
8:15 AM	3		0	3				0		7	1	8	0	2		2	13
8:20 AM	0		2	2				0		10	2	12	1	3		4	18
8:25 AM	3		2	5				0		4	3	7	0	4		4	16
8:30 AM	1		1	2				0		0	1	1	2	6		8	11
8:35 AM	2		0	2				0		10	4	14	0	6		6	22
8:40 AM	2		0	2				0		5	0	5	1	4		5	12
8:45 AM	1		2	3				0		7	0	7	1	5		6	16
8:50 AM	3		1	4				0		7	3	10	1	6		7	21
8:55 AM	0		1	1				0		7	3	10	0	5		5	16
Total Survey	32		24	56				0		144	39	183	20	117		137	376

Heavy Vehicle 15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
7:00 AM	1		0	1				0		20	4	24	5	11		16	41
7:15 AM	5		3	8				0		15	3	18	4	14		18	44
7:30 AM	7		6	13				0		17	4	21	1	18		19	53
7:45 AM	2		4	6				0		19	3	22	2	17		19	47
8:00 AM	2		2	4				0		16	8	24	2	16		18	46
8:15 AM	6		4	10				0		21	6	27	1	9		10	47
8:30 AM	5		1	6				0		15	5	20	3	16		19	45
8:45 AM	4		4	8				0		21	6	27	2	16		18	53
Total Survey	32		24	56				0		144	39	183	20	117		137	376

Heavy Vehicle Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound			Southbound			Eastbound			Westbound			Total
	SW 120th Ave			SW 120th Ave			SW Tualatin Sherwood Rd			SW Tualatin Sherwood Rd			
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	29	29	58	0	0	0	95	78	173	72	89	161	196
PHF	0.56			0.00			0.79			0.82			0.88

By Movement	Northbound				Southbound				Eastbound				Westbound				Total
	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
	L		R	Total				Total		T	R	Total	L	T		Total	
Volume	15		14	29				0		75	20	95	9	63		72	196
PHF	0.54		0.58	0.56				0.00		0.75	0.63	0.79	0.56	0.79		0.82	0.88

Heavy Vehicle Rolling Hour Summary
7:00 AM to 9:00 AM

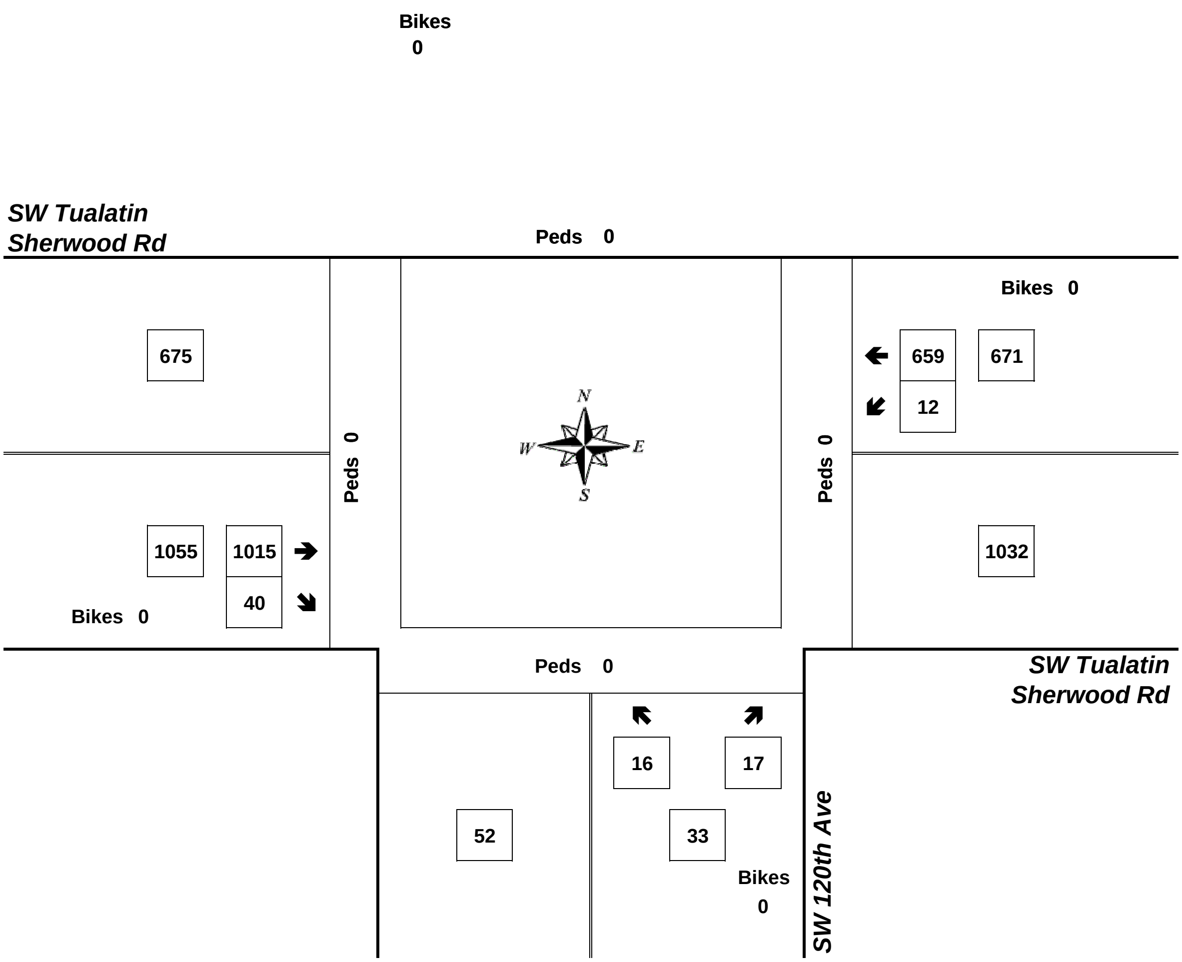
Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
7:00 AM	15		13	28				0		71	14	85	12	60		72	185
7:15 AM	16		15	31				0		67	18	85	9	65		74	190
7:30 AM	17		16	33				0		73	21	94	6	60		66	193
7:45 AM	15		11	26				0		71	22	93	8	58		66	185
8:00 AM	17		11	28				0		73	25	98	8	57		65	191

Peak Hour Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740

SW 120th Ave & SW Tualatin Sherwood Rd

7:25 AM to 8:25 AM
Thursday, February 07, 2019

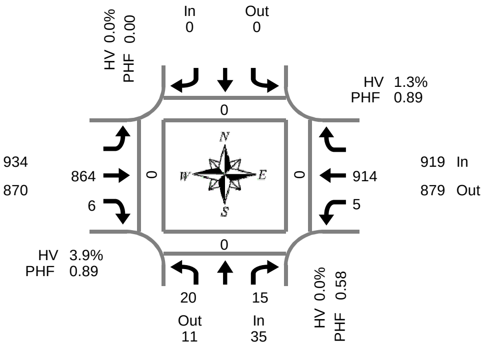


Approach	PHF	HV%	Volume
EB	0.95	9.0%	1,055
WB	0.89	10.7%	671
NB	0.63	87.9%	33
SB	0.00	0.0%	0
Intersection	0.96	11.1%	1,759

Count Period: 7:00 AM to 9:00 AM

Total Vehicle Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740



Peak Hour Summary
5:00 PM to 6:00 PM

SW 120th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
4:00 PM	4		2	0				0		73	1	0	0	79		0	159	0	0	0	0
4:05 PM	3		1	0				0		67	2	0	0	68		0	141	0	0	0	0
4:10 PM	2		2	0				0		63	1	0	1	81		0	150	0	0	0	0
4:15 PM	1		1	0				0		61	0	0	0	86		0	149	0	0	0	0
4:20 PM	1		1	0				0		79	1	0	1	59		0	142	0	0	0	0
4:25 PM	2		2	0				0		63	1	0	0	81		0	149	0	0	0	0
4:30 PM	2		2	0				0		60	3	0	1	79		0	147	0	0	0	0
4:35 PM	1		1	0				0		70	0	0	3	84		0	159	0	0	0	0
4:40 PM	1		1	0				0		63	1	0	2	72		0	140	0	0	0	0
4:45 PM	1		3	0				0		84	0	0	1	72		0	161	0	0	0	0
4:50 PM	0		0	0				0		60	1	0	0	74		0	135	0	0	0	0
4:55 PM	1		2	0				0		67	1	0	1	67		0	139	0	0	0	0
5:00 PM	4		1	0				0		74	0	0	0	69		0	148	0	0	0	0
5:05 PM	1		1	0				0		65	1	0	0	75		0	143	0	0	0	0
5:10 PM	1		1	0				0		88	1	1	0	76		0	167	0	0	0	0
5:15 PM	5		2	0				0		80	0	0	0	70		0	157	0	0	0	0
5:20 PM	0		1	0				0		76	0	0	1	64		0	142	0	0	0	0
5:25 PM	0		0	0				0		63	0	0	0	78		0	141	0	0	0	0
5:30 PM	6		6	0				0		75	0	0	1	87		0	175	0	0	0	0
5:35 PM	1		2	0				0		63	0	0	0	86		0	152	0	0	0	0
5:40 PM	0		0	0				0		71	1	0	0	84		1	156	0	0	0	0
5:45 PM	0		0	0				0		66	1	0	0	87		0	154	0	0	0	0
5:50 PM	1		1	0				0		66	0	0	2	63		0	133	0	0	0	0
5:55 PM	1		0	0				0		77	2	0	1	75		2	156	0	0	0	0
Total Survey	39		33	0				0		1,674	18	1	15	1,816		3	3,595	0	0	0	0

15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
4:00 PM	9		5	0				0		203	4	0	1	228		0	450	0	0	0	0
4:15 PM	4		4	0				0		203	2	0	1	226		0	440	0	0	0	0
4:30 PM	4		4	0				0		193	4	0	6	235		0	446	0	0	0	0
4:45 PM	2		5	0				0		211	2	0	2	213		0	435	0	0	0	0
5:00 PM	6		3	0				0		227	2	1	0	220		0	458	0	0	0	0
5:15 PM	5		3	0				0		219	0	0	1	212		0	440	0	0	0	0
5:30 PM	7		8	0				0		209	1	0	1	257		1	483	0	0	0	0
5:45 PM	2		1	0				0		209	3	0	3	225		2	443	0	0	0	0
Total Survey	39		33	0				0		1,674	18	1	15	1,816		3	3,595	0	0	0	0

Peak Hour Summary
5:00 PM to 6:00 PM

By Approach	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total	Pedestrians Crosswalk			
	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes		North	South	East	West
Volume	35	11	46	0	0	0	0	0	870	934	1,804	1	919	879	1,798	3	1,824	0	0	0	0
%HV	0.0%				0.0%				3.9%				1.3%				2.5%				
PHF	0.58				0.00				0.89				0.89				0.94				

By Movement	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L		R	Total				Total		T	R	Total	L	T		Total	
Volume	20		15	35				0		864	6	870	5	914		919	1,824
%HV	0.0%	NA	0.0%	0.0%	NA	NA	NA	0.0%	NA	3.9%	0.0%	3.9%	0.0%	1.3%	NA	1.3%	2.5%
PHF	0.71		0.47	0.58				0.00		0.89	0.50	0.89	0.42	0.89		0.89	0.94

Rolling Hour Summary
4:00 PM to 6:00 PM

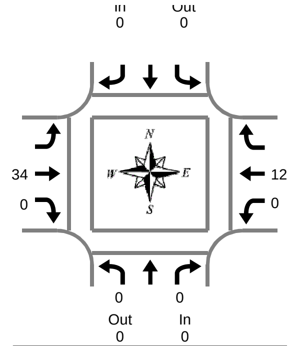
Interval Start Time	Northbound SW 120th Ave				Southbound SW 120th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L		R	Bikes				Bikes		T	R	Bikes	L	T		Bikes		North	South	East	West
4:00 PM	19		18	0				0		810	12	0	10	902		0	1,771	0	0	0	0
4:15 PM	16		16	0				0		834	10	1	9	894		0	1,779	0	0	0	0
4:30 PM	17		15	0				0		850	8	1	9	880		0	1,779	0	0	0	0
4:45 PM	20		19	0				0		866	5	1	4	902		1	1,816	0	0	0	0
5:00 PM	20		15	0				0		864	6	1	5	914		3	1,824	0	0	0	0

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740

Out 12
In 34



Peak Hour Summary
5:00 PM to 6:00 PM

SW 120th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

Heavy Vehicle 5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
4:00 PM	0		0	0				0		4	0	4	0	5		5	9
4:05 PM	0		0	0				0		4	0	4	0	1		1	5
4:10 PM	0		0	0				0		2	0	2	0	4		4	6
4:15 PM	0		0	0				0		2	0	2	0	1		1	3
4:20 PM	0		0	0				0		3	1	4	0	3		3	7
4:25 PM	0		0	0				0		3	0	3	0	1		1	4
4:30 PM	0		0	0				0		2	0	2	0	2		2	4
4:35 PM	0		0	0				0		1	0	1	0	2		2	3
4:40 PM	0		0	0				0		1	0	1	0	2		2	3
4:45 PM	0		0	0				0		2	0	2	0	1		1	3
4:50 PM	0		0	0				0		1	0	1	0	5		5	6
4:55 PM	0		0	0				0		1	0	1	0	1		1	2
5:00 PM	0		0	0				0		1	0	1	0	2		2	3
5:05 PM	0		0	0				0		3	0	3	0	1		1	4
5:10 PM	0		0	0				0		2	0	2	0	2		2	4
5:15 PM	0		0	0				0		7	0	7	0	0		0	7
5:20 PM	0		0	0				0		1	0	1	0	1		1	2
5:25 PM	0		0	0				0		3	0	3	0	0		0	3
5:30 PM	0		0	0				0		4	0	4	0	2		2	6
5:35 PM	0		0	0				0		3	0	3	0	1		1	4
5:40 PM	0		0	0				0		1	0	1	0	0		0	1
5:45 PM	0		0	0				0		5	0	5	0	0		0	5
5:50 PM	0		0	0				0		2	0	2	0	2		2	4
5:55 PM	0		0	0				0		2	0	2	0	1		1	3
Total Survey	0		0	0				0		60	1	61	0	40		40	101

Heavy Vehicle 15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
4:00 PM	0		0	0				0		10	0	10	0	10		10	20
4:15 PM	0		0	0				0		8	1	9	0	5		5	14
4:30 PM	0		0	0				0		4	0	4	0	6		6	10
4:45 PM	0		0	0				0		4	0	4	0	7		7	11
5:00 PM	0		0	0				0		6	0	6	0	5		5	11
5:15 PM	0		0	0				0		11	0	11	0	1		1	12
5:30 PM	0		0	0				0		8	0	8	0	3		3	11
5:45 PM	0		0	0				0		9	0	9	0	3		3	12
Total Survey	0		0	0				0		60	1	61	0	40		40	101

Heavy Vehicle Peak Hour Summary
5:00 PM to 6:00 PM

By Approach	Northbound				Southbound				Eastbound				Westbound				Total
	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
	In	Out	Total		In	Out	Total		In	Out	Total		In	Out	Total		
Volume	0	0	0		0	0	0		34	12	46		12	34	46		46
PHF	0.00				0.00				0.71				0.60				0.77

By Movement	Northbound				Southbound				Eastbound				Westbound				Total
	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
	L		R	Total				Total		T	R	Total	L	T		Total	
Volume	0		0	0				0		34	0	34	0	12		12	46
PHF	0.00		0.00	0.00				0.00		0.71	0.00	0.71	0.00	0.60		0.60	0.77

Heavy Vehicle Rolling Hour Summary
4:00 PM to 6:00 PM

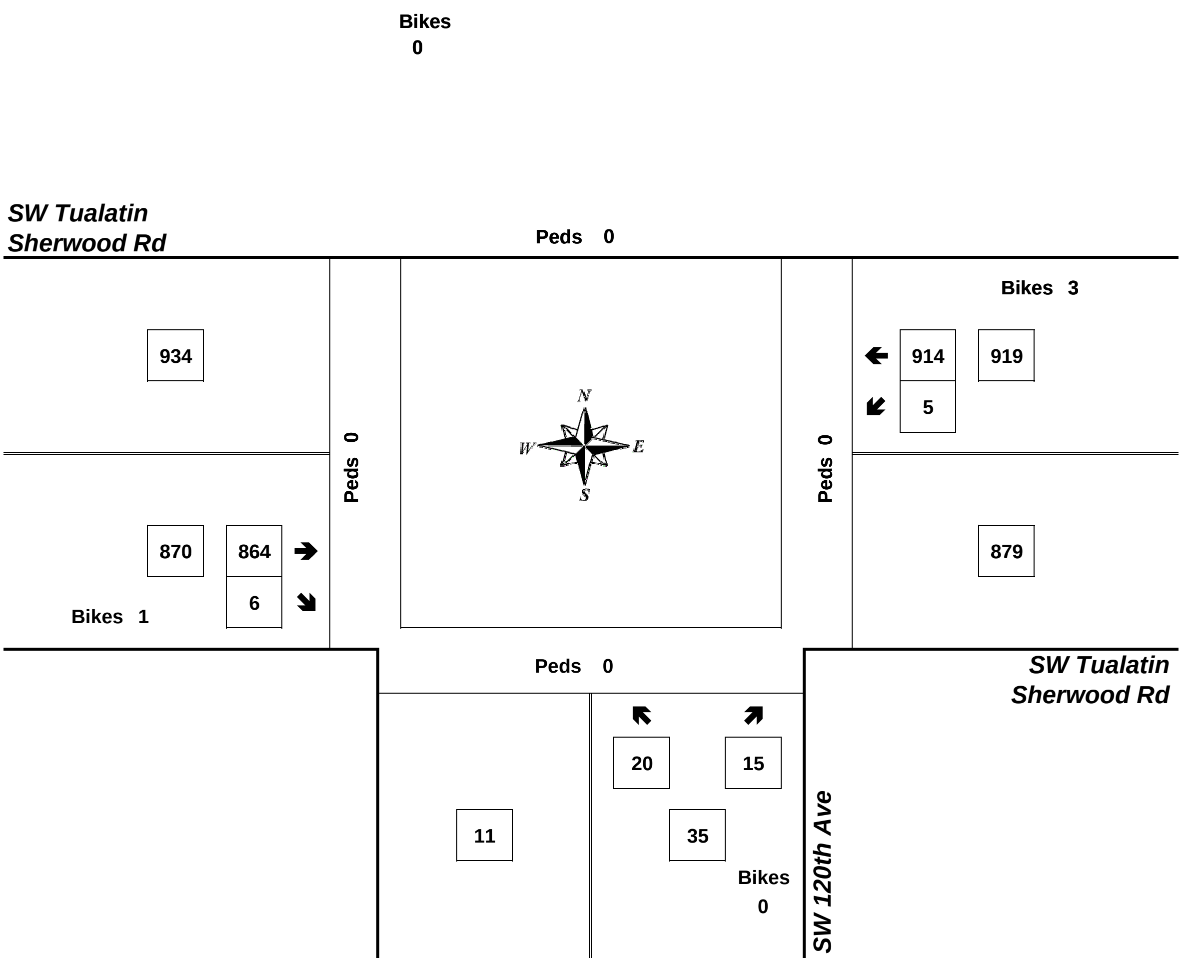
Interval	Northbound				Southbound				Eastbound				Westbound				Interval
Start	SW 120th Ave				SW 120th Ave				SW Tualatin Sherwood Rd				SW Tualatin Sherwood Rd				
Time	L		R	Total				Total		T	R	Total	L	T		Total	Total
4:00 PM	0		0	0				0		26	1	27	0	28		28	55
4:15 PM	0		0	0				0		22	1	23	0	23		23	46
4:30 PM	0		0	0				0		25	0	25	0	19		19	44
4:45 PM	0		0	0				0		29	0	29	0	16		16	45
5:00 PM	0		0	0				0		34	0	34	0	12		12	46

Peak Hour Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740

SW 120th Ave & SW Tualatin Sherwood Rd

5:00 PM to 6:00 PM
Wednesday, February 06, 2019



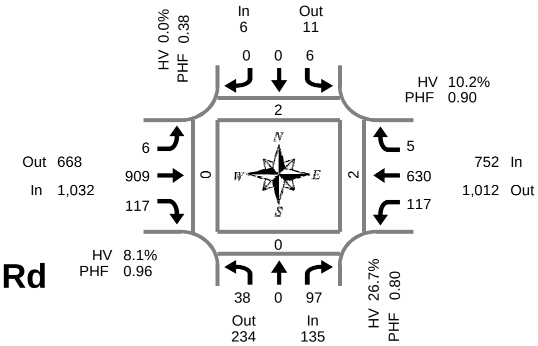
Approach	PHF	HV%	Volume
EB	0.89	3.9%	870
WB	0.89	1.3%	919
NB	0.58	0.0%	35
SB	0.00	0.0%	0
Intersection	0.94	2.5%	1,824

Count Period: 4:00 PM to 6:00 PM

Total Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
7:25 AM to 8:25 AM

SW 115th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 115th Ave L	T	R	Bikes	Southbound SW 115th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	3	0	7	0	0	0	0	0	0	84	9	0	6	31	0	0	140	0	0	0	0
7:05 AM	4	0	11	0	0	0	1	0	1	83	15	0	8	37	1	0	161	0	0	0	0
7:10 AM	2	1	10	0	1	0	0	0	0	69	11	0	6	45	0	0	145	0	0	0	0
7:15 AM	3	0	7	0	2	1	0	0	0	70	7	0	8	51	1	0	150	0	0	0	0
7:20 AM	2	0	5	0	0	0	0	0	0	69	11	1	8	39	0	0	134	0	0	0	0
7:25 AM	3	0	5	0	2	0	0	0	0	75	12	0	14	73	1	0	185	0	0	2	0
7:30 AM	2	0	8	0	2	0	0	0	0	74	14	0	11	42	0	0	153	0	0	0	0
7:35 AM	4	0	9	0	0	0	0	0	0	82	6	0	5	62	0	0	168	0	0	0	0
7:40 AM	2	0	9	0	0	0	0	0	0	85	7	0	10	43	0	0	156	0	0	0	0
7:45 AM	3	0	6	0	0	0	0	0	0	71	11	0	9	63	0	0	163	0	0	0	0
7:50 AM	6	0	13	0	0	0	0	0	0	68	12	0	12	51	1	0	163	0	0	0	0
7:55 AM	3	0	9	0	0	0	0	0	3	68	11	0	13	55	1	0	163	2	0	0	0
8:00 AM	4	0	7	0	0	0	0	0	0	73	11	0	7	57	1	0	160	0	0	0	0
8:05 AM	4	0	4	0	0	0	0	0	1	73	11	0	14	49	0	0	156	0	0	0	0
8:10 AM	4	0	7	0	2	0	0	0	0	79	8	0	7	46	0	0	153	0	0	0	0
8:15 AM	1	0	14	0	0	0	0	0	1	78	6	0	7	44	0	0	151	0	0	0	0
8:20 AM	2	0	6	0	0	0	0	0	1	83	8	0	8	45	1	0	154	0	0	0	0
8:25 AM	3	0	13	0	0	0	0	0	2	70	3	0	8	42	3	0	144	0	0	2	0
8:30 AM	7	0	5	0	0	0	0	0	1	63	1	0	11	61	2	0	151	0	0	0	0
8:35 AM	5	0	5	0	0	0	1	0	0	73	4	0	6	47	0	0	141	0	0	0	0
8:40 AM	3	0	9	0	1	0	0	0	1	90	6	0	3	64	0	0	177	0	0	0	0
8:45 AM	4	0	2	0	0	0	0	0	1	75	2	0	10	49	1	0	144	0	0	0	0
8:50 AM	3	0	4	0	0	0	0	0	1	79	5	0	9	51	4	0	156	0	0	0	0
8:55 AM	4	0	5	0	2	0	1	0	1	59	3	0	5	55	3	0	138	0	0	0	0
Total Survey	81	1	180	0	12	1	3	0	14	1,793	194	1	205	1,202	20	0	3,706	2	0	4	0

15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 115th Ave L	T	R	Bikes	Southbound SW 115th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	9	1	28	0	1	0	1	0	1	236	35	0	20	113	1	0	446	0	0	0	0
7:15 AM	8	0	17	0	4	1	0	0	0	214	30	1	30	163	2	0	469	0	0	2	0
7:30 AM	8	0	26	0	2	0	0	0	0	241	27	0	26	147	0	0	477	0	0	0	0
7:45 AM	12	0	28	0	0	0	0	0	3	207	34	0	34	169	2	0	489	2	0	0	0
8:00 AM	12	0	18	0	2	0	0	0	1	225	30	0	28	152	1	0	469	0	0	0	0
8:15 AM	6	0	33	0	0	0	0	0	4	231	17	0	23	131	4	0	449	0	0	2	0
8:30 AM	15	0	19	0	1	0	1	0	2	226	11	0	20	172	2	0	469	0	0	0	0
8:45 AM	11	0	11	0	2	0	1	0	3	213	10	0	24	155	8	0	438	0	0	0	0
Total Survey	81	1	180	0	12	1	3	0	14	1,793	194	1	205	1,202	20	0	3,706	2	0	4	0

Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound SW 115th Ave In	Out	Total	Bikes	Southbound SW 115th Ave In	Out	Total	Bikes	Eastbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Westbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Total
Volume	135	234	369	0	6	11	17	0	1,032	668	1,700	0	752	1,012	1,764	0	1,925
%HV	26.7%				0.0%				8.1%				10.2%				10.2%
PHF	0.80				0.38				0.96				0.90				0.95

Pedestrians Crosswalk North	South	East	West
2	0	2	0

By Movement	Northbound SW 115th Ave L	T	R	Total	Southbound SW 115th Ave L	T	R	Total	Eastbound SW Tualatin Sherwood Rd L	T	R	Total	Westbound SW Tualatin Sherwood Rd L	T	R	Total	Total
Volume	38	0	97	135	6	0	0	6	6	909	117	1,032	117	630	5	752	1,925
%HV	23.7%	0.0%	27.8%	26.7%	0.0%	0.0%	0.0%	0.0%	0.0%	7.0%	17.1%	8.1%	14.5%	9.5%	0.0%	10.2%	10.2%
PHF	0.73	0.00	0.84	0.80	0.38	0.00	0.00	0.38	0.38	0.94	0.86	0.96	0.86	0.89	0.42	0.90	0.95

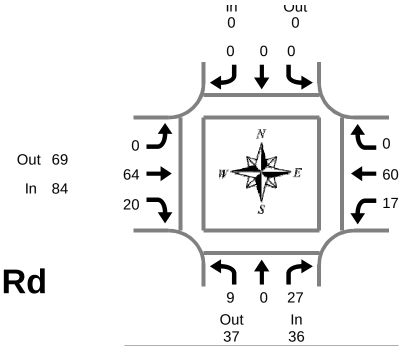
Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 115th Ave L	T	R	Bikes	Southbound SW 115th Ave L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	37	1	99	0	7	1	1	0	4	898	126	1	110	592	5	0	1,881	2	0	2	0
7:15 AM	40	0	89	0	8	1	0	0	4	887	121	1	118	631	5	0	1,904	2	0	2	0
7:30 AM	38	0	105	0	4	0	0	0	8	904	108	0	111	599	7	0	1,884	2	0	2	0
7:45 AM	45	0	98	0	3	0	1	0	10	889	92	0	105	624	9	0	1,876	2	0	2	0
8:00 AM	44	0	81	0	5	0	2	0	10	895	68	0	95	610	15	0	1,825	0	0	2	0

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



SW 115th Ave & SW Tualatin Sherwood Rd

Thursday, February 07, 2019

7:00 AM to 9:00 AM

Peak Hour Summary
7:25 AM to 8:25 AM

Heavy Vehicle 5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	1	0	1	2	0	0	0	0	0	7	2	9	0	3	0	3	14
7:05 AM	0	0	5	5	0	0	0	0	0	4	1	5	1	4	0	5	15
7:10 AM	1	0	2	3	0	0	0	0	0	4	2	6	0	6	0	6	15
7:15 AM	2	0	3	5	0	0	0	0	0	7	1	8	2	2	0	4	17
7:20 AM	0	0	1	1	0	0	0	0	0	3	1	4	0	5	0	5	10
7:25 AM	1	0	3	4	0	0	0	0	0	3	3	6	1	7	0	8	18
7:30 AM	1	0	2	3	0	0	0	0	0	1	5	6	1	4	0	5	14
7:35 AM	1	0	3	4	0	0	0	0	0	12	2	14	1	6	0	7	25
7:40 AM	1	0	3	4	0	0	0	0	0	3	0	3	0	6	0	6	13
7:45 AM	2	0	3	5	0	0	0	0	0	8	0	8	2	1	0	3	16
7:50 AM	2	0	2	4	0	0	0	0	0	4	2	6	2	2	0	4	14
7:55 AM	0	0	2	2	0	0	0	0	0	7	1	8	0	9	0	9	19
8:00 AM	0	0	0	0	0	0	0	0	0	2	2	4	0	7	0	7	11
8:05 AM	0	0	0	0	0	0	0	0	0	4	1	5	0	7	0	7	12
8:10 AM	1	0	3	4	0	0	0	0	0	3	2	5	3	5	0	8	17
8:15 AM	0	0	3	3	0	0	0	0	0	7	1	8	5	2	0	7	18
8:20 AM	0	0	3	3	0	0	0	0	0	10	1	11	2	4	0	6	20
8:25 AM	1	0	4	5	0	0	0	0	0	4	0	4	2	5	0	7	16
8:30 AM	1	0	3	4	0	0	0	0	0	3	1	4	5	10	0	15	23
8:35 AM	3	0	1	4	0	0	0	0	0	8	1	9	1	3	0	4	17
8:40 AM	1	0	2	3	0	0	0	0	0	5	1	6	0	7	0	7	16
8:45 AM	1	0	0	1	0	0	0	0	0	9	0	9	2	5	0	7	17
8:50 AM	0	0	2	2	0	0	0	0	0	8	1	9	3	6	0	9	20
8:55 AM	2	0	3	5	0	0	0	0	0	7	1	8	2	5	0	7	20
Total Survey	22	0	54	76	0	0	0	0	0	133	32	165	35	121	0	156	397

Heavy Vehicle 15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	2	0	8	10	0	0	0	0	0	15	5	20	1	13	0	14	44
7:15 AM	3	0	7	10	0	0	0	0	0	13	5	18	3	14	0	17	45
7:30 AM	3	0	8	11	0	0	0	0	0	16	7	23	2	16	0	18	52
7:45 AM	4	0	7	11	0	0	0	0	0	19	3	22	4	12	0	16	49
8:00 AM	1	0	3	4	0	0	0	0	0	9	5	14	3	19	0	22	40
8:15 AM	1	0	10	11	0	0	0	0	0	21	2	23	9	11	0	20	54
8:30 AM	5	0	6	11	0	0	0	0	0	16	3	19	6	20	0	26	56
8:45 AM	3	0	5	8	0	0	0	0	0	24	2	26	7	16	0	23	57
Total Survey	22	0	54	76	0	0	0	0	0	133	32	165	35	121	0	156	397

Heavy Vehicle Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound SW 115th Ave			Southbound SW 115th Ave			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	36	37	73	0	0	0	84	69	153	77	91	168	197
PHF	0.69			0.00			0.81			0.84			0.86

By Movement	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	9	0	27	36	0	0	0	0	0	64	20	84	17	60	0	77	197
PHF	0.45	0.00	0.75	0.69	0.00	0.00	0.00	0.00	0.00	0.70	0.50	0.81	0.43	0.65	0.00	0.84	0.86

Heavy Vehicle Rolling Hour Summary
7:00 AM to 9:00 AM

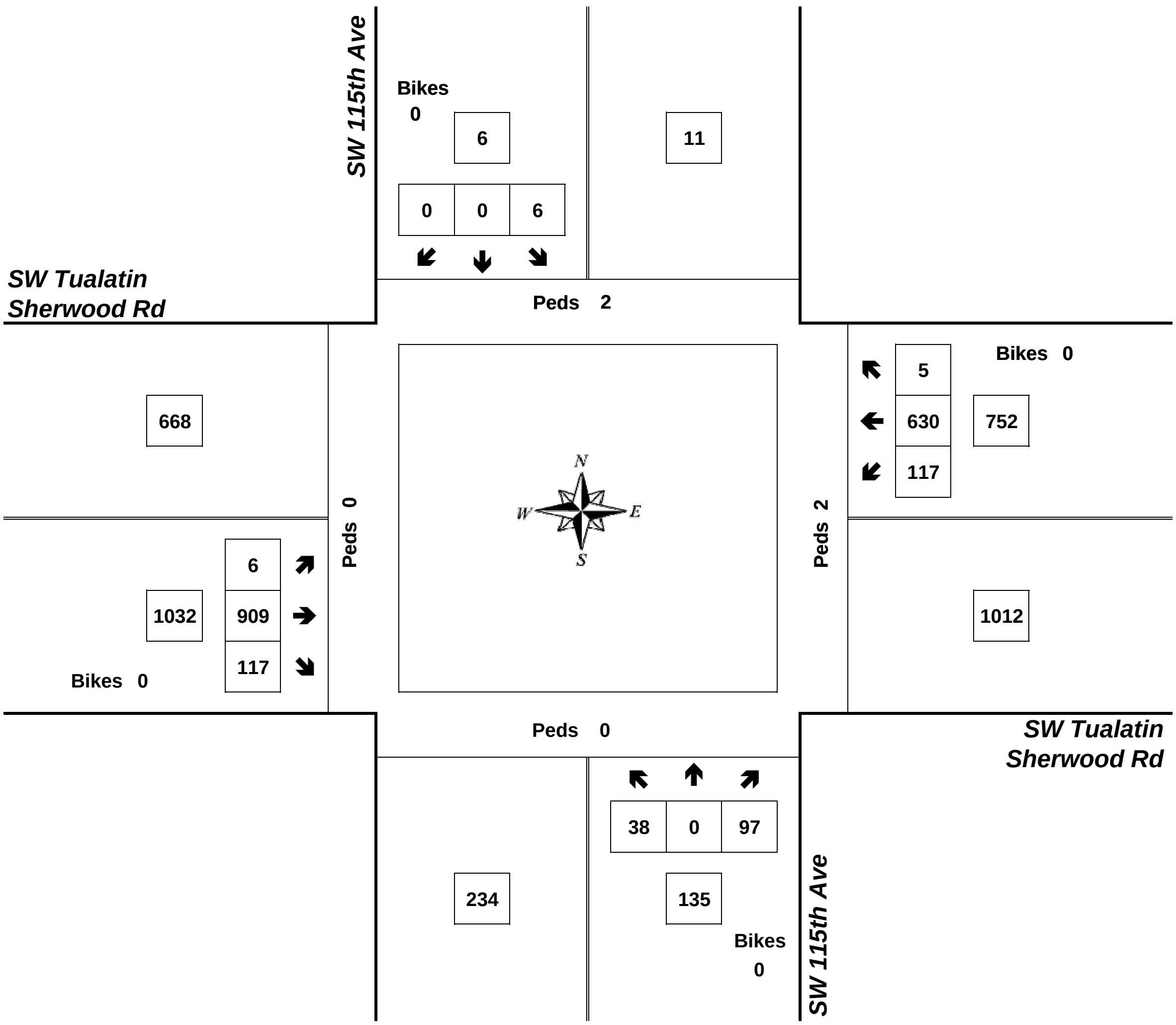
Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	12	0	30	42	0	0	0	0	0	63	20	83	10	55	0	65	190
7:15 AM	11	0	25	36	0	0	0	0	0	57	20	77	12	61	0	73	186
7:30 AM	9	0	28	37	0	0	0	0	0	65	17	82	18	58	0	76	195
7:45 AM	11	0	26	37	0	0	0	0	0	65	13	78	22	62	0	84	199
8:00 AM	10	0	24	34	0	0	0	0	0	70	12	82	25	66	0	91	207

Peak Hour Summary

Clay Carney
(503) 833-2740

SW 115th Ave & SW Tualatin Sherwood Rd

7:25 AM to 8:25 AM
Thursday, February 07, 2019

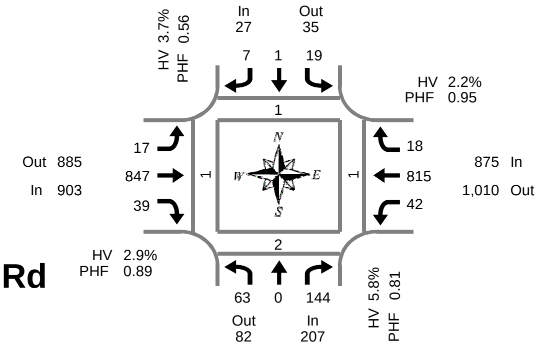


Approach	PHF	HV%	Volume
EB	0.96	8.1%	1,032
WB	0.90	10.2%	752
NB	0.80	26.7%	135
SB	0.38	0.0%	6
Intersection	0.95	10.2%	1,925

Count Period: 7:00 AM to 9:00 AM

Total Vehicle Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740



Peak Hour Summary
4:45 PM to 5:45 PM

SW 115th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	3	1	23	0	2	0	0	0	1	64	3	0	2	64	0	0	163	0	0	0	0
4:05 PM	13	0	21	0	1	0	1	0	1	67	3	0	3	63	1	0	174	0	0	0	0
4:10 PM	10	0	19	0	0	0	0	0	0	53	6	0	8	67	1	0	164	0	0	0	0
4:15 PM	5	1	12	0	2	0	2	0	1	62	3	0	0	73	0	0	161	0	0	0	0
4:20 PM	4	0	6	0	0	0	1	0	2	69	5	0	5	56	2	0	150	0	0	0	0
4:25 PM	5	0	13	0	0	0	0	0	0	69	4	0	4	75	1	0	171	0	0	0	0
4:30 PM	13	0	16	0	2	0	2	0	0	51	2	0	3	61	1	0	151	0	0	0	0
4:35 PM	14	0	13	0	0	0	0	0	0	71	5	0	7	80	1	0	191	0	0	0	0
4:40 PM	10	0	7	0	1	0	1	0	2	48	2	0	0	62	1	0	134	0	0	0	0
4:45 PM	2	0	11	0	0	0	0	0	2	83	2	0	3	72	1	0	176	0	0	0	0
4:50 PM	1	0	16	0	0	1	0	0	1	70	7	0	5	66	3	0	170	0	0	0	0
4:55 PM	4	0	7	0	2	0	0	0	1	60	3	0	6	65	1	0	149	0	0	0	0
5:00 PM	10	0	17	0	4	0	0	0	1	67	4	0	3	61	1	0	168	0	0	0	0
5:05 PM	2	0	12	0	0	0	2	0	1	63	3	0	6	77	2	0	168	0	0	1	0
5:10 PM	9	0	14	0	0	0	0	0	1	74	3	0	6	59	0	0	166	0	0	0	0
5:15 PM	4	0	6	0	1	0	0	0	4	90	3	0	3	72	1	0	184	0	1	0	0
5:20 PM	3	0	10	0	3	0	0	0	2	74	3	0	2	57	2	0	156	1	0	0	0
5:25 PM	8	0	8	0	0	0	2	0	0	59	3	0	2	66	2	0	150	0	0	0	0
5:30 PM	8	0	21	0	4	0	0	0	1	66	2	0	4	79	2	0	187	0	0	0	0
5:35 PM	7	0	9	0	3	0	3	0	1	81	2	0	1	67	3	0	177	0	1	0	1
5:40 PM	5	0	13	0	2	0	0	0	2	60	4	0	1	74	0	0	161	0	0	0	0
5:45 PM	5	0	6	0	1	0	0	0	0	73	4	0	3	80	3	0	175	0	0	0	0
5:50 PM	6	0	12	0	1	0	0	0	0	54	1	0	4	65	0	0	143	0	0	0	0
5:55 PM	5	0	9	0	0	0	2	0	1	83	2	0	1	70	0	0	173	0	0	0	0
Total Survey	156	2	301	0	29	1	16	0	25	1,611	79	0	82	1,631	29	0	3,962	1	2	1	1

15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	26	1	63	0	3	0	1	0	2	184	12	0	13	194	2	0	501	0	0	0	0
4:15 PM	14	1	31	0	2	0	3	0	3	200	12	0	9	204	3	0	482	0	0	0	0
4:30 PM	37	0	36	0	3	0	3	0	2	170	9	0	10	203	3	0	476	0	0	0	0
4:45 PM	7	0	34	0	2	1	0	0	4	213	12	0	14	203	5	0	495	0	0	0	0
5:00 PM	21	0	43	0	4	0	2	0	3	204	10	0	15	197	3	0	502	0	0	1	0
5:15 PM	15	0	24	0	4	0	2	0	6	223	9	0	7	195	5	0	490	1	1	0	0
5:30 PM	20	0	43	0	9	0	3	0	4	207	8	0	6	220	5	0	525	0	1	0	1
5:45 PM	16	0	27	0	2	0	2	0	1	210	7	0	8	215	3	0	491	0	0	0	0
Total Survey	156	2	301	0	29	1	16	0	25	1,611	79	0	82	1,631	29	0	3,962	1	2	1	1

Peak Hour Summary
4:45 PM to 5:45 PM

By Approach	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	
Volume	207	82	289	0	27	35	62	0	903	885	1,788	0	875	1,010	1,885	0	2,012
%HV	5.8%				3.7%				2.9%				2.2%				2.9%
PHF	0.81				0.56				0.89				0.95				0.96

Pedestrians Crosswalk			
North	South	East	West
1	2	1	1

By Movement	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	63	0	144	207	19	1	7	27	17	847	39	903	42	815	18	875	2,012
%HV	3.2%	0.0%	6.9%	5.8%	0.0%	#####	0.0%	3.7%	0.0%	3.0%	2.6%	2.9%	16.7%	1.3%	5.6%	2.2%	2.9%
PHF	0.68	0.00	0.84	0.81	0.53	0.25	0.35	0.56	0.61	0.89	0.70	0.89	0.70	0.93	0.64	0.95	0.96

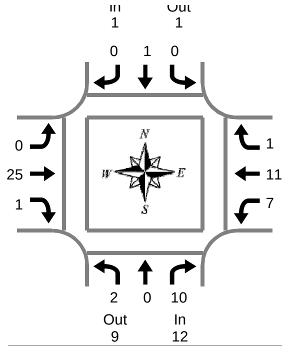
Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	84	2	164	0	10	1	7	0	11	767	45	0	46	804	13	0	1,954	0	0	0	0
4:15 PM	79	1	144	0	11	1	8	0	12	787	43	0	48	807	14	0	1,955	0	0	1	0
4:30 PM	80	0	137	0	13	1	7	0	15	810	40	0	46	798	16	0	1,963	1	1	1	0
4:45 PM	63	0	144	0	19	1	7	0	17	847	39	0	42	815	18	0	2,012	1	2	1	1
5:00 PM	72	0	137	0	19	0	9	0	14	844	34	0	36	827	16	0	2,008	1	2	1	1

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
4:45 PM to 5:45 PM

SW 115th Ave & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

Heavy Vehicle 5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval
Time	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	Total
4:00 PM	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	2	3
4:05 PM	1	0	1	2	0	0	0	0	0	6	0	6	2	1	0	3	11
4:10 PM	0	0	1	1	0	0	0	0	0	2	1	3	2	3	0	5	9
4:15 PM	0	0	2	2	0	0	0	0	0	1	0	1	0	1	0	1	4
4:20 PM	1	0	0	1	0	0	0	0	0	5	1	6	0	2	0	2	9
4:25 PM	1	0	0	1	0	0	0	0	0	4	0	4	1	1	0	2	7
4:30 PM	1	0	2	3	0	0	1	1	0	0	1	1	1	0	0	1	6
4:35 PM	0	0	0	0	0	0	0	0	0	2	1	3	1	3	0	4	7
4:40 PM	2	0	1	3	0	0	0	0	0	1	0	1	0	1	0	1	5
4:45 PM	0	0	1	1	0	0	0	0	0	2	0	2	0	0	1	1	4
4:50 PM	0	0	2	2	0	1	0	1	0	1	1	2	1	2	0	3	8
4:55 PM	1	0	0	1	0	0	0	0	0	1	0	1	1	2	0	3	5
5:00 PM	0	0	2	2	0	0	0	0	0	1	0	1	0	2	0	2	5
5:05 PM	0	0	0	0	0	0	0	0	0	3	0	3	2	1	0	3	6
5:10 PM	1	0	0	1	0	0	0	0	0	3	0	3	0	1	0	1	5
5:15 PM	0	0	0	0	0	0	0	0	0	4	0	4	1	0	0	1	5
5:20 PM	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	2	3
5:25 PM	0	0	1	1	0	0	0	0	0	3	0	3	1	0	0	1	5
5:30 PM	0	0	1	1	0	0	0	0	0	3	0	3	0	1	0	1	5
5:35 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	1	3
5:40 PM	0	0	2	2	0	0	0	0	0	2	0	2	0	0	0	0	4
5:45 PM	0	0	0	0	0	0	0	0	0	4	1	5	1	0	0	1	6
5:50 PM	0	0	0	0	0	0	0	0	0	1	0	1	1	2	0	3	4
5:55 PM	0	0	1	1	0	0	0	0	0	2	1	3	0	1	0	1	5
Total Survey	8	0	18	26	0	1	1	2	0	54	7	61	16	28	1	45	134

Heavy Vehicle 15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval
Time	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	Total
4:00 PM	1	0	2	3	0	0	0	0	0	9	1	10	4	6	0	10	23
4:15 PM	2	0	2	4	0	0	0	0	0	10	1	11	1	4	0	5	20
4:30 PM	3	0	3	6	0	0	1	1	0	3	2	5	2	4	0	6	18
4:45 PM	1	0	3	4	0	1	0	1	0	4	1	5	2	4	1	7	17
5:00 PM	1	0	2	3	0	0	0	0	0	7	0	7	2	4	0	6	16
5:15 PM	0	0	2	2	0	0	0	0	0	7	0	7	3	1	0	4	13
5:30 PM	0	0	3	3	0	0	0	0	0	7	0	7	0	2	0	2	12
5:45 PM	0	0	1	1	0	0	0	0	0	7	2	9	2	3	0	5	15
Total Survey	8	0	18	26	0	1	1	2	0	54	7	61	16	28	1	45	134

Heavy Vehicle Peak Hour Summary
4:45 PM to 5:45 PM

By Approach	Northbound SW 115th Ave			Southbound SW 115th Ave			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	12	9	21	1	1	2	26	13	39	19	35	54	58
PHF	0.60			0.25			0.65			0.59			0.81

By Movement	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	2	0	10	12	0	1	0	1	0	25	1	26	7	11	1	19	58
PHF	0.50	0.00	0.63	0.60	0.00	0.25	0.00	0.25	0.00	0.63	0.25	0.65	0.58	0.46	0.25	0.59	0.81

Heavy Vehicle Rolling Hour Summary
4:00 PM to 6:00 PM

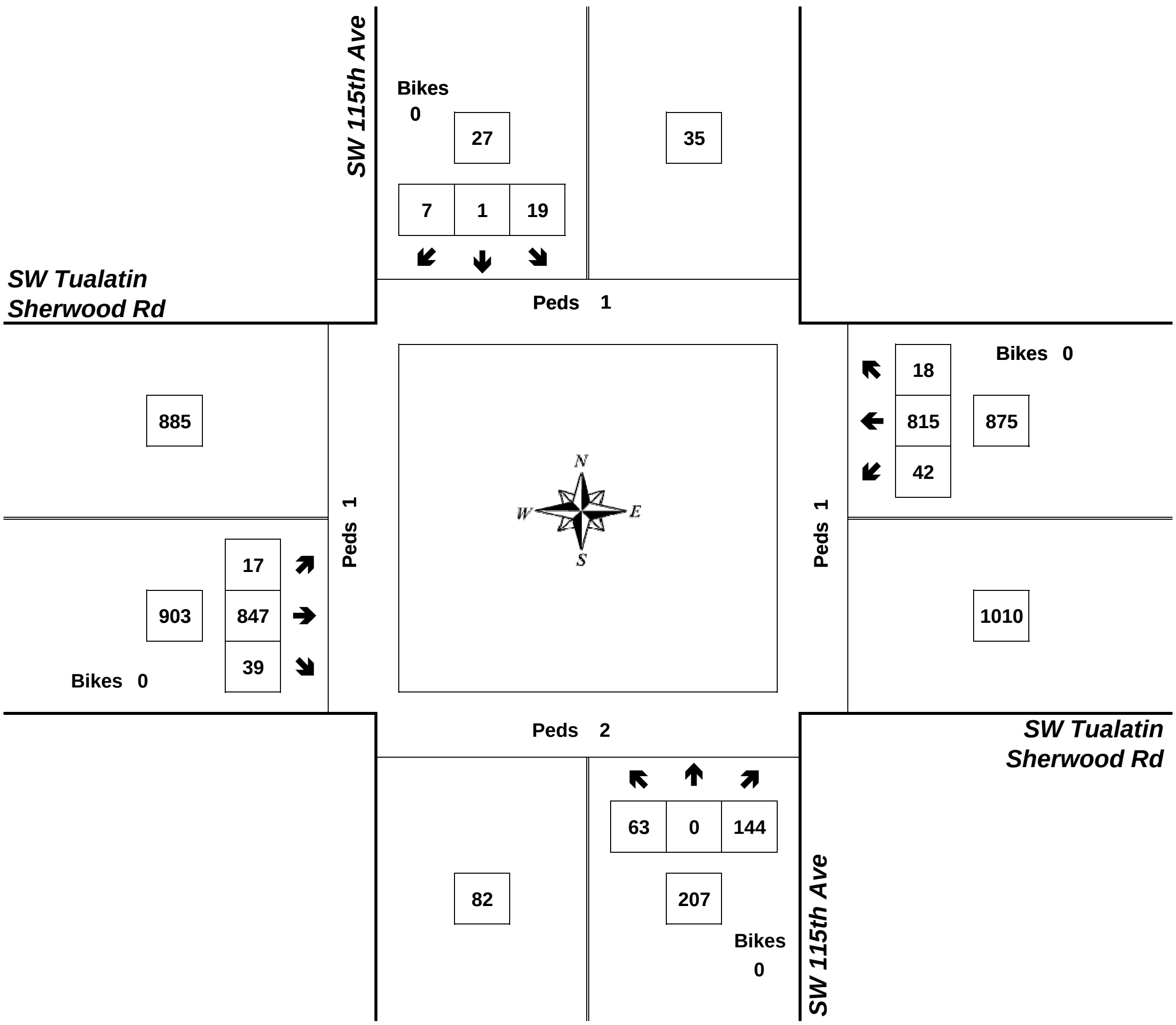
Interval Start	Northbound SW 115th Ave				Southbound SW 115th Ave				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval
Time	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	Total
4:00 PM	7	0	10	17	0	1	1	2	0	26	5	31	9	18	1	28	78
4:15 PM	7	0	10	17	0	1	1	2	0	24	4	28	7	16	1	24	71
4:30 PM	5	0	10	15	0	1	1	2	0	21	3	24	9	13	1	23	64
4:45 PM	2	0	10	12	0	1	0	1	0	25	1	26	7	11	1	19	58
5:00 PM	1	0	8	9	0	0	0	0	0	28	2	30	7	10	0	17	56

Peak Hour Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740

SW 115th Ave & SW Tualatin Sherwood Rd

4:45 PM to 5:45 PM
Wednesday, February 06, 2019



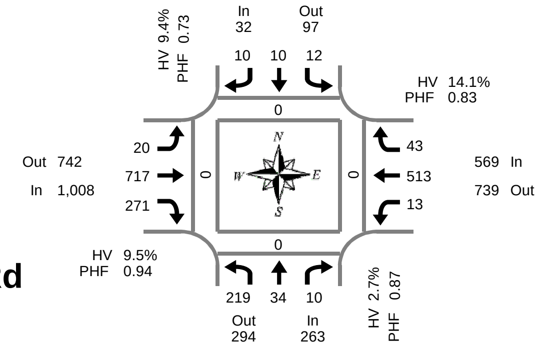
Approach	PHF	HV%	Volume
EB	0.89	2.9%	903
WB	0.95	2.2%	875
NB	0.81	5.8%	207
SB	0.56	3.7%	27
Intersection	0.96	2.9%	2,012

Count Period: 4:00 PM to 6:00 PM

Total Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
7:25 AM to 8:25 AM

SW Avery St & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St L	T	R	Bikes	Southbound SW Avery St L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	10	4	0	0	0	0	2	0	2	75	14	0	0	26	4	0	137	0	0	0	0
7:05 AM	12	6	0	0	0	0	0	0	1	67	20	0	1	37	4	0	148	0	0	0	0
7:10 AM	12	4	2	0	0	0	0	0	2	56	26	0	0	36	1	0	139	0	0	0	0
7:15 AM	22	3	0	0	3	0	1	0	6	59	13	0	1	34	3	0	145	0	0	0	0
7:20 AM	19	2	1	0	1	1	0	0	4	60	12	0	0	21	9	0	130	0	0	0	0
7:25 AM	14	2	0	0	0	2	2	0	2	57	19	0	2	68	11	0	179	0	0	0	0
7:30 AM	21	6	1	0	0	1	1	0	1	61	26	0	1	25	2	0	146	0	0	0	0
7:35 AM	15	0	1	0	1	0	0	0	0	64	26	0	2	52	3	0	164	0	0	0	0
7:40 AM	20	3	1	0	1	2	1	0	2	59	30	0	1	35	3	0	158	0	0	0	0
7:45 AM	21	2	2	0	3	1	1	0	0	46	29	0	0	58	2	1	165	0	0	0	0
7:50 AM	17	7	1	0	0	1	1	0	4	63	18	0	2	43	4	0	161	0	0	0	0
7:55 AM	21	4	1	0	0	1	2	0	1	61	18	0	1	58	3	0	171	0	0	0	0
8:00 AM	22	1	1	0	1	1	1	0	4	56	23	0	1	29	3	0	143	0	0	0	0
8:05 AM	19	3	1	0	0	0	0	0	0	55	22	0	2	40	4	0	146	0	0	0	0
8:10 AM	17	1	1	0	0	0	0	0	1	59	26	0	0	39	3	0	147	0	0	0	0
8:15 AM	16	3	0	0	2	1	1	0	3	69	16	0	1	28	2	0	142	0	0	0	0
8:20 AM	16	2	0	0	4	0	0	0	2	67	18	0	0	38	3	0	150	0	0	0	0
8:25 AM	11	0	1	0	0	1	1	0	1	75	18	0	3	44	4	0	159	0	0	0	0
8:30 AM	9	0	0	0	3	0	0	0	1	66	6	0	0	52	2	0	139	0	0	0	0
8:35 AM	14	0	1	0	3	0	0	0	0	59	18	0	1	51	4	0	151	0	0	0	0
8:40 AM	13	1	0	0	1	0	0	0	0	86	18	0	2	41	0	0	162	0	0	0	0
8:45 AM	13	0	3	0	0	0	0	0	0	59	17	0	0	49	6	0	147	0	0	0	0
8:50 AM	19	3	0	0	0	1	0	0	1	60	18	0	1	44	3	0	150	0	0	0	0
8:55 AM	16	2	0	0	0	1	0	0	0	46	18	0	1	50	6	0	140	0	0	0	0
Total Survey	389	59	18	0	23	14	14	0	38	1,485	469	0	23	998	89	1	3,619	0	0	0	0

15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St L	T	R	Bikes	Southbound SW Avery St L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	34	14	2	0	0	0	2	0	5	198	60	0	1	99	9	0	424	0	0	0	0
7:15 AM	55	7	1	0	4	3	3	0	12	176	44	0	3	123	23	0	454	0	0	0	0
7:30 AM	56	9	3	0	2	3	2	0	3	184	82	0	4	112	8	0	468	0	0	0	0
7:45 AM	59	13	4	0	3	3	4	0	5	170	65	0	3	159	9	1	497	0	0	0	0
8:00 AM	58	5	3	0	1	1	1	0	5	170	71	0	3	108	10	0	436	0	0	0	0
8:15 AM	43	5	1	0	6	2	2	0	6	211	52	0	4	110	9	0	451	0	0	0	0
8:30 AM	36	1	1	0	7	0	0	0	1	211	42	0	3	144	6	0	452	0	0	0	0
8:45 AM	48	5	3	0	0	2	0	0	1	165	53	0	2	143	15	0	437	0	0	0	0
Total Survey	389	59	18	0	23	14	14	0	38	1,485	469	0	23	998	89	1	3,619	0	0	0	0

Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound SW Avery St In	Out	Total	Bikes	Southbound SW Avery St In	Out	Total	Bikes	Eastbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Westbound SW Tualatin Sherwood Rd In	Out	Total	Bikes	Total
Volume	263	294	557	0	32	97	129	0	1,008	742	1,750	0	569	739	1,308	1	1,872
%HV	2.7%				9.4%				9.5%				14.1%				9.9%
PHF	0.87				0.73				0.94				0.83				0.94

Pedestrians Crosswalk North	South	East	West
0	0	0	0

By Movement	Northbound SW Avery St L	T	R	Total	Southbound SW Avery St L	T	R	Total	Eastbound SW Tualatin Sherwood Rd L	T	R	Total	Westbound SW Tualatin Sherwood Rd L	T	R	Total	Total
Volume	219	34	10	263	12	10	10	32	20	717	271	1,008	13	513	43	569	1,872
%HV	2.7%	0.0%	10.0%	2.7%	25.0%	0.0%	0.0%	9.4%	5.0%	12.0%	3.3%	9.5%	38.5%	13.6%	11.6%	14.1%	9.9%
PHF	0.88	0.65	0.63	0.87	0.50	0.63	0.63	0.73	0.56	0.92	0.80	0.94	0.65	0.81	0.67	0.83	0.94

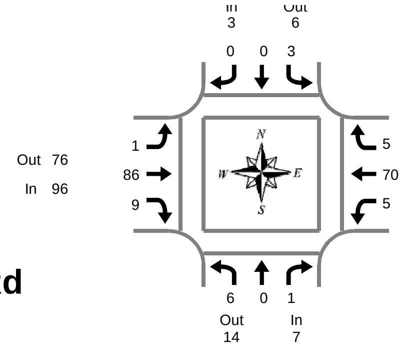
Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St L	T	R	Bikes	Southbound SW Avery St L	T	R	Bikes	Eastbound SW Tualatin Sherwood Rd L	T	R	Bikes	Westbound SW Tualatin Sherwood Rd L	T	R	Bikes	Interval Total	Pedestrians Crosswalk North	South	East	West
7:00 AM	204	43	10	0	9	9	11	0	25	728	251	0	11	493	49	1	1,843	0	0	0	0
7:15 AM	228	34	11	0	10	10	10	0	25	700	262	0	13	502	50	1	1,855	0	0	0	0
7:30 AM	216	32	11	0	12	9	9	0	19	735	270	0	14	489	36	1	1,852	0	0	0	0
7:45 AM	196	24	9	0	17	6	7	0	17	762	230	0	13	521	34	1	1,836	0	0	0	0
8:00 AM	185	16	8	0	14	5	3	0	13	757	218	0	12	505	40	0	1,776	0	0	0	0

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
7:25 AM to 8:25 AM

SW Avery St & SW Tualatin Sherwood Rd

Thursday, February 07, 2019
7:00 AM to 9:00 AM

Heavy Vehicle 5-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	0	0	0	0	0	0	0	0	0	7	1	8	0	4	0	4	12
7:05 AM	0	0	0	0	0	0	0	0	0	10	0	10	0	5	0	5	15
7:10 AM	0	0	0	0	0	0	0	0	0	4	0	4	0	5	0	5	9
7:15 AM	0	0	0	0	1	0	0	1	0	11	0	11	0	4	0	4	16
7:20 AM	4	0	0	4	0	0	0	0	0	3	0	3	0	2	1	3	10
7:25 AM	0	0	0	0	0	0	0	0	0	7	1	8	1	9	1	11	19
7:30 AM	0	0	0	0	0	0	0	0	0	3	0	3	0	4	0	4	7
7:35 AM	1	0	0	1	1	0	0	1	0	10	2	12	1	7	1	9	23
7:40 AM	1	0	0	1	0	0	0	0	0	8	1	9	0	6	0	6	16
7:45 AM	0	0	0	0	0	0	0	0	0	7	0	7	0	3	0	3	10
7:50 AM	0	0	0	0	0	0	0	0	1	7	1	9	2	5	0	7	16
7:55 AM	0	0	0	0	0	0	0	0	0	11	0	11	0	7	0	7	18
8:00 AM	1	0	1	2	1	0	0	1	0	3	0	3	0	7	0	7	13
8:05 AM	2	0	0	2	0	0	0	0	0	4	0	4	0	6	1	7	13
8:10 AM	0	0	0	0	0	0	0	0	0	7	1	8	0	8	0	8	16
8:15 AM	0	0	0	0	1	0	0	1	0	6	2	8	1	4	1	6	15
8:20 AM	1	0	0	1	0	0	0	0	0	13	1	14	0	4	1	5	20
8:25 AM	3	0	0	3	0	0	0	0	0	6	2	8	0	8	0	8	19
8:30 AM	0	0	0	0	0	0	0	0	0	8	0	8	0	9	0	9	17
8:35 AM	0	0	1	1	1	0	0	1	0	8	1	9	0	4	1	5	16
8:40 AM	0	0	0	0	0	0	0	0	0	6	0	6	0	7	0	7	13
8:45 AM	1	0	0	1	0	0	0	0	0	7	1	8	0	9	1	10	19
8:50 AM	0	0	0	0	0	1	0	1	0	7	2	9	0	6	1	7	17
8:55 AM	0	0	0	0	0	0	0	0	0	7	1	8	0	7	0	7	15
Total Survey	14	0	2	16	5	1	0	6	1	170	17	188	5	140	9	154	364

Heavy Vehicle 15-Minute Interval Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	0	0	0	0	0	0	0	0	0	21	1	22	0	14	0	14	36
7:15 AM	4	0	0	4	1	0	0	1	0	21	1	22	1	15	2	18	45
7:30 AM	2	0	0	2	1	0	0	1	0	21	3	24	1	17	1	19	46
7:45 AM	0	0	0	0	0	0	0	0	1	25	1	27	2	15	0	17	44
8:00 AM	3	0	1	4	1	0	0	1	0	14	1	15	0	21	1	22	42
8:15 AM	4	0	0	4	1	0	0	1	0	25	5	30	1	16	2	19	54
8:30 AM	0	0	1	1	1	0	0	1	0	22	1	23	0	20	1	21	46
8:45 AM	1	0	0	1	0	1	0	1	0	21	4	25	0	22	2	24	51
Total Survey	14	0	2	16	5	1	0	6	1	170	17	188	5	140	9	154	364

Heavy Vehicle Peak Hour Summary
7:25 AM to 8:25 AM

By Approach	Northbound SW Avery St			Southbound SW Avery St			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	7	14	21	3	6	9	96	76	172	80	90	170	186
PHF	0.44			0.75			0.80			0.83			0.91

By Movement	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	6	0	1	7	3	0	0	3	1	86	9	96	5	70	5	80	186
PHF	0.50	0.00	0.25	0.44	0.75	0.00	0.00	0.75	0.25	0.83	0.56	0.80	0.63	0.83	0.63	0.83	0.91

Heavy Vehicle Rolling Hour Summary
7:00 AM to 9:00 AM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
7:00 AM	6	0	0	6	2	0	0	2	1	88	6	95	4	61	3	68	171
7:15 AM	9	0	1	10	3	0	0	3	1	81	6	88	4	68	4	76	177
7:30 AM	9	0	1	10	3	0	0	3	1	85	10	96	4	69	4	77	186
7:45 AM	7	0	2	9	3	0	0	3	1	86	8	95	3	72	4	79	186
8:00 AM	8	0	2	10	3	1	0	4	0	82	11	93	1	79	6	86	193

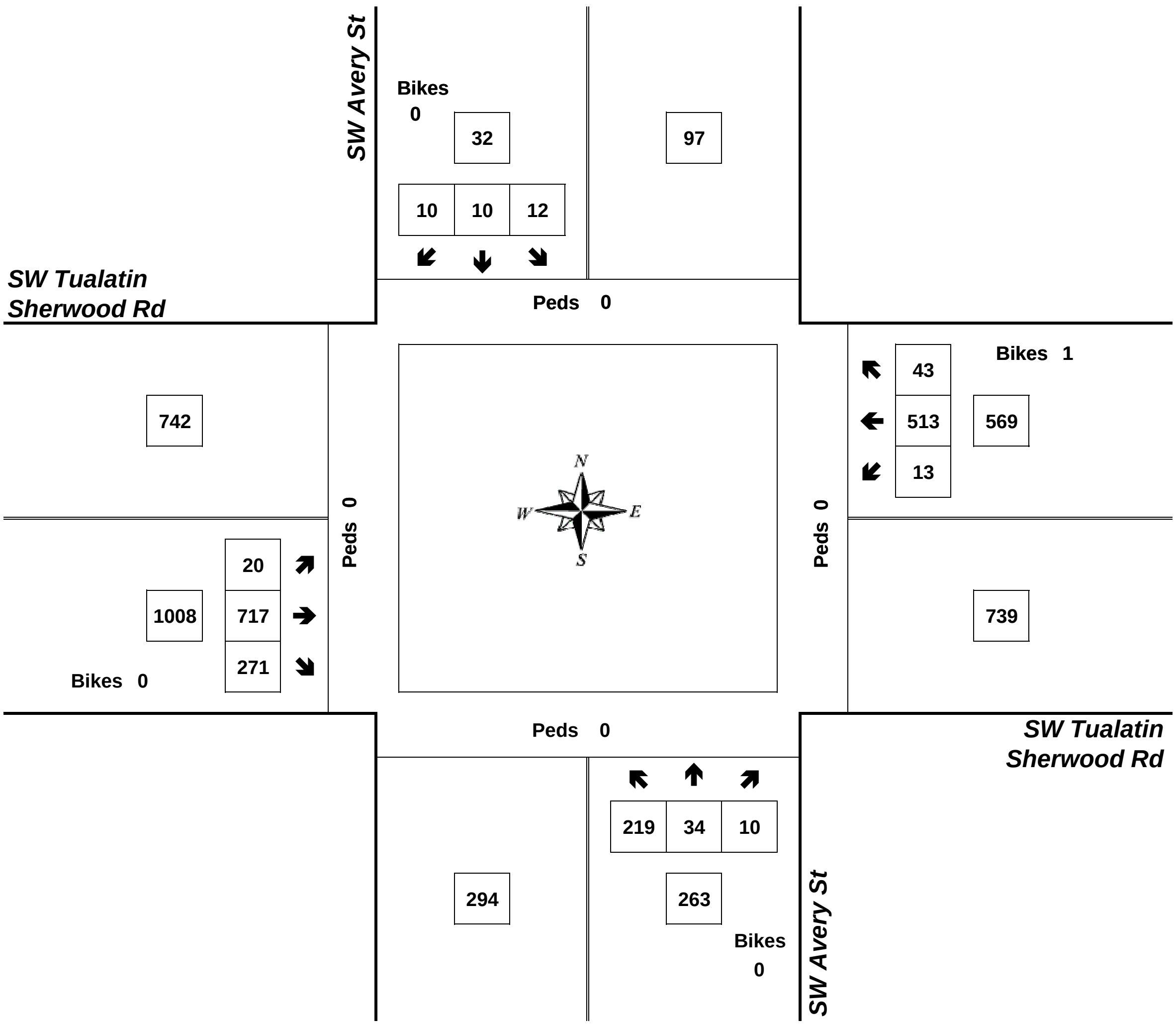
Peak Hour Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740

SW Avery St & SW Tualatin Sherwood Rd

7:25 AM to 8:25 AM
Thursday, February 07, 2019



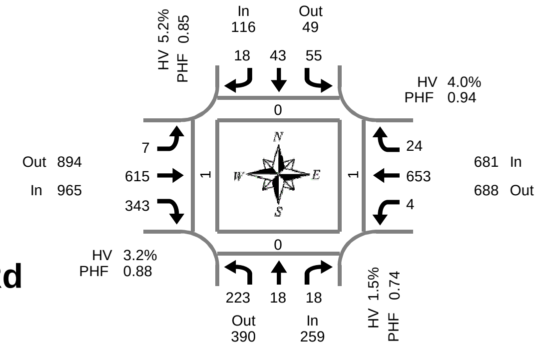
Approach	PHF	HV%	Volume
EB	0.94	9.5%	1,008
WB	0.83	14.1%	569
NB	0.87	2.7%	263
SB	0.73	9.4%	32
Intersection	0.94	9.9%	1,872

Count Period: 7:00 AM to 9:00 AM

Total Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



SW Avery St & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019

4:00 PM to 6:00 PM

Peak Hour Summary
4:25 PM to 5:25 PM

5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	25	0	2	0	8	4	3	0	0	53	25	0	0	46	4	0	170	0	0	0	0
4:05 PM	13	2	1	0	1	2	1	0	3	66	23	0	0	47	5	0	164	0	0	1	0
4:10 PM	22	1	2	0	7	0	0	0	1	51	26	1	0	54	1	0	165	0	0	0	0
4:15 PM	10	1	0	0	4	3	3	0	2	52	24	1	0	67	1	0	167	0	0	0	0
4:20 PM	16	1	0	0	5	0	1	0	0	49	21	0	0	52	2	0	147	0	0	0	0
4:25 PM	11	3	3	0	7	3	3	0	0	51	26	0	0	59	1	0	167	0	0	0	0
4:30 PM	25	2	2	0	4	2	1	0	0	41	28	0	0	55	0	0	160	0	0	0	0
4:35 PM	26	2	3	0	6	7	1	0	0	57	22	0	0	61	2	0	187	0	0	0	0
4:40 PM	24	1	3	0	4	4	3	0	1	39	21	0	1	51	2	0	154	0	0	0	0
4:45 PM	14	1	1	0	1	2	0	0	2	62	25	0	1	54	2	0	165	0	0	1	0
4:50 PM	20	2	0	0	6	6	0	0	1	56	29	0	0	56	4	0	180	0	0	0	0
4:55 PM	12	2	1	0	2	1	1	0	1	44	23	0	0	64	1	0	152	0	0	0	0
5:00 PM	25	2	0	0	9	4	2	0	0	51	33	0	1	41	4	0	172	0	0	0	0
5:05 PM	18	0	2	0	3	2	2	0	1	54	24	0	0	52	4	0	162	0	0	0	1
5:10 PM	25	3	3	0	2	2	2	0	0	57	35	0	0	50	1	0	180	0	0	0	0
5:15 PM	10	0	0	0	4	6	3	0	1	53	39	0	0	62	3	0	181	0	0	0	0
5:20 PM	13	0	0	0	7	4	0	0	0	50	38	0	1	48	0	0	161	0	0	0	0
5:25 PM	8	2	1	0	5	4	0	0	1	44	26	0	1	63	2	0	157	0	0	0	0
5:30 PM	19	1	2	0	5	0	1	0	3	47	33	0	0	50	1	0	162	0	0	0	1
5:35 PM	11	4	1	0	4	0	1	0	3	68	30	0	0	61	1	0	184	0	0	0	0
5:40 PM	24	3	1	0	5	0	0	0	0	40	25	0	0	58	3	0	159	0	0	0	0
5:45 PM	14	3	0	0	2	0	2	0	1	63	22	0	0	56	0	0	163	0	0	0	0
5:50 PM	18	1	1	0	2	1	1	0	2	53	18	0	1	61	1	0	160	0	0	0	0
5:55 PM	14	1	0	0	4	1	1	0	6	59	22	0	0	56	4	0	168	0	0	0	0
Total Survey	417	38	29	0	107	58	32	0	29	1,260	638	2	6	1,324	49	0	3,987	0	0	2	2

15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	60	3	5	0	16	6	4	0	4	170	74	1	0	147	10	0	499	0	0	1	0
4:15 PM	37	5	3	0	16	6	7	0	2	152	71	1	0	178	4	0	481	0	0	0	0
4:30 PM	75	5	8	0	14	13	5	0	1	137	71	0	1	167	4	0	501	0	0	0	0
4:45 PM	46	5	2	0	9	9	1	0	4	162	77	0	1	174	7	0	497	0	0	1	0
5:00 PM	68	5	5	0	14	8	6	0	1	162	92	0	1	143	9	0	514	0	0	0	1
5:15 PM	31	2	1	0	16	14	3	0	2	147	103	0	2	173	5	0	499	0	0	0	0
5:30 PM	54	8	4	0	14	0	2	0	6	155	88	0	0	169	5	0	505	0	0	0	1
5:45 PM	46	5	1	0	8	2	4	0	9	175	62	0	1	173	5	0	491	0	0	0	0
Total Survey	417	38	29	0	107	58	32	0	29	1,260	638	2	6	1,324	49	0	3,987	0	0	2	2

Peak Hour Summary
4:25 PM to 5:25 PM

By Approach	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	In	Out	Total	Bikes	
Volume	259	390	649	0	116	49	165	0	965	894	1,859	0	681	688	1,369	0	2,021
%HV	1.5%				5.2%				3.2%				4.0%				3.4%
PHF	0.74				0.85				0.88				0.94				0.97

Pedestrians Crosswalk			
North	South	East	West
0	0	1	1

By Movement	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	223	18	18	259	55	43	18	116	7	615	343	965	4	653	24	681	2,021
%HV	0.0%	11.1%	11.1%	1.5%	7.3%	4.7%	0.0%	5.2%	14.3%	3.9%	1.7%	3.2%	50.0%	3.5%	8.3%	4.0%	3.4%
PHF	0.74	0.64	0.56	0.74	0.81	0.83	0.64	0.85	0.44	0.94	0.77	0.88	0.50	0.93	0.67	0.94	0.97

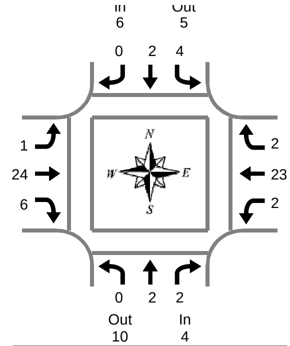
Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total	Pedestrians Crosswalk			
	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes	L	T	R	Bikes		North	South	East	West
4:00 PM	218	18	18	0	55	34	17	0	11	621	293	2	2	666	25	0	1,978	0	0	2	0
4:15 PM	226	20	18	0	53	36	19	0	8	613	311	1	3	662	24	0	1,993	0	0	1	1
4:30 PM	220	17	16	0	53	44	15	0	8	608	343	0	5	657	25	0	2,011	0	0	1	1
4:45 PM	199	20	12	0	53	31	12	0	13	626	360	0	4	659	26	0	2,015	0	0	1	2
5:00 PM	199	20	11	0	52	24	15	0	18	639	345	0	4	658	24	0	2,009	0	0	0	2

Heavy Vehicle Summary

All Traffic Data Services Inc.

Clay Carney
(503) 833-2740



Peak Hour Summary
4:25 PM to 5:25 PM

SW Avery St & SW Tualatin Sherwood Rd

Wednesday, February 06, 2019
4:00 PM to 6:00 PM

Heavy Vehicle 5-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	0	0	0	0	0	0	1	1	0	1	1	2	0	2	0	2	5
4:05 PM	0	0	0	0	0	0	0	0	0	7	0	7	0	4	0	4	11
4:10 PM	1	0	0	1	1	0	0	1	1	2	0	3	0	4	0	4	9
4:15 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	3	0	3	5
4:20 PM	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	2
4:25 PM	0	1	0	1	0	0	0	0	0	2	1	3	0	1	0	1	5
4:30 PM	0	0	0	0	0	0	0	0	0	2	1	3	0	1	0	1	4
4:35 PM	0	0	0	0	2	0	0	2	0	1	0	1	0	4	0	4	7
4:40 PM	0	0	0	0	0	0	0	0	0	1	1	2	0	0	1	1	3
4:45 PM	0	0	1	1	0	1	0	1	0	3	0	3	1	1	0	2	7
4:50 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	5	0	5	7
4:55 PM	0	0	0	0	0	0	0	0	1	1	1	3	0	4	0	4	7
5:00 PM	0	1	0	1	0	0	0	0	0	1	1	2	1	1	1	3	6
5:05 PM	0	0	1	1	0	0	0	0	0	4	0	4	0	1	0	1	6
5:10 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	1	3
5:15 PM	0	0	0	0	1	1	0	2	0	4	1	5	0	2	0	2	9
5:20 PM	0	0	0	0	1	0	0	1	0	1	0	1	0	2	0	2	4
5:25 PM	0	0	0	0	0	0	0	0	0	4	1	5	0	1	0	1	6
5:30 PM	0	0	0	0	0	0	0	0	0	3	0	3	0	1	0	1	4
5:35 PM	0	0	0	0	0	0	0	0	0	3	0	3	0	1	0	1	4
5:40 PM	0	0	0	0	0	0	0	0	0	2	0	2	0	1	0	1	3
5:45 PM	0	0	0	0	0	0	0	0	0	5	1	6	0	1	0	1	7
5:50 PM	0	0	0	0	0	0	0	0	0	1	0	1	1	2	1	4	5
5:55 PM	0	0	0	0	0	0	0	0	0	3	0	3	0	1	2	3	6
Total Survey	1	2	2	5	5	2	1	8	2	58	10	70	3	44	5	52	135

Heavy Vehicle 15-Minute Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	1	0	0	1	1	0	1	2	1	10	1	12	0	10	0	10	25
4:15 PM	0	1	0	1	0	0	0	0	0	5	2	7	0	4	0	4	12
4:30 PM	0	0	0	0	2	0	0	2	0	4	2	6	0	5	1	6	14
4:45 PM	0	0	1	1	0	1	0	1	1	6	1	8	1	10	0	11	21
5:00 PM	0	1	1	2	0	0	0	0	0	7	1	8	1	3	1	5	15
5:15 PM	0	0	0	0	2	1	0	3	0	9	2	11	0	5	0	5	19
5:30 PM	0	0	0	0	0	0	0	0	0	8	0	8	0	3	0	3	11
5:45 PM	0	0	0	0	0	0	0	0	0	9	1	10	1	4	3	8	18
Total Survey	1	2	2	5	5	2	1	8	2	58	10	70	3	44	5	52	135

Heavy Vehicle Peak Hour Summary
4:25 PM to 5:25 PM

By Approach	Northbound SW Avery St			Southbound SW Avery St			Eastbound SW Tualatin Sherwood Rd			Westbound SW Tualatin Sherwood Rd			Total
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	
Volume	4	10	14	6	5	11	31	23	54	27	30	57	68
PHF	0.50			0.50			0.70			0.56			0.81

By Movement	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	0	2	2	4	4	2	0	6	1	24	6	31	2	23	2	27	68
PHF	0.00	0.50	0.50	0.50	0.50	0.50	0.00	0.50	0.25	0.60	0.75	0.70	0.50	0.58	0.50	0.56	0.81

Heavy Vehicle Rolling Hour Summary
4:00 PM to 6:00 PM

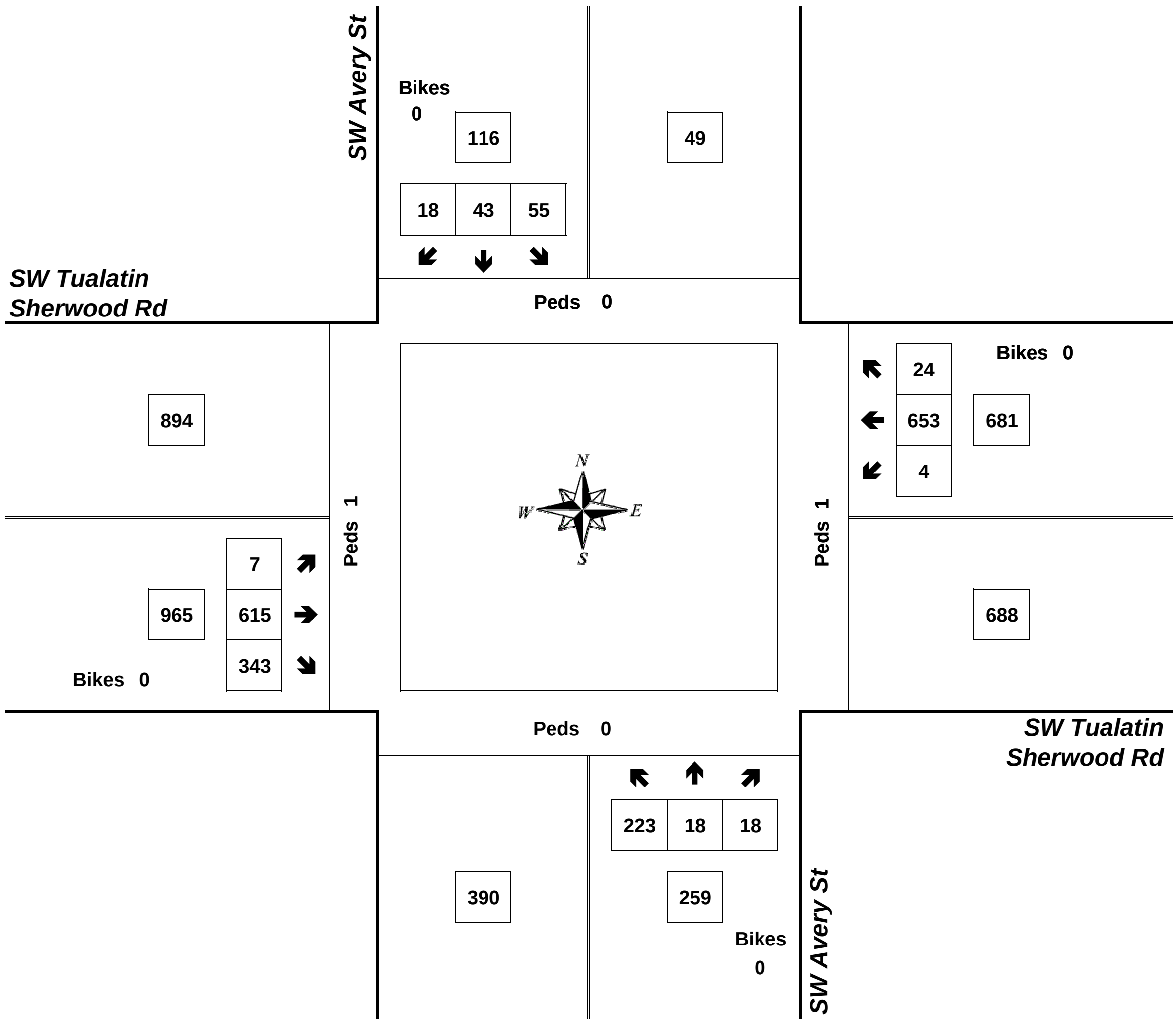
Interval Start Time	Northbound SW Avery St				Southbound SW Avery St				Eastbound SW Tualatin Sherwood Rd				Westbound SW Tualatin Sherwood Rd				Interval Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
4:00 PM	1	1	1	3	3	1	1	5	2	25	6	33	1	29	1	31	72
4:15 PM	0	2	2	4	2	1	0	3	1	22	6	29	2	22	2	26	62
4:30 PM	0	1	2	3	4	2	0	6	1	26	6	33	2	23	2	27	69
4:45 PM	0	1	2	3	2	2	0	4	1	30	4	35	2	21	1	24	66
5:00 PM	0	1	1	2	2	1	0	3	0	33	4	37	2	15	4	21	63

Peak Hour Summary

All Traffic Data Services Inc.
Clay Carney
(503) 833-2740

SW Avery St & SW Tualatin Sherwood Rd

4:25 PM to 5:25 PM
Wednesday, February 06, 2019



Approach	PHF	HV%	Volume
EB	0.88	3.2%	965
WB	0.94	4.0%	681
NB	0.74	1.5%	259
SB	0.85	5.2%	116
Intersection	0.97	3.4%	2,021

Count Period: 4:00 PM to 6:00 PM

TRIP GENERATION CALCULATIONS

Land Use: Utility
Land Use Code: 170
Variable: Employees
Variable Quantity: 300

AM PEAK HOUR

Trip Rate: 0.7

	Enter	Exit	Total
Directional Distribution	81%	19%	
Trip Ends	**170**	**40**	**210**

PM PEAK HOUR

Trip Rate: 0.76

	Enter	Exit	Total
Directional Distribution	15%	85%	
Trip Ends	**34**	**194**	**228**

WEEKDAY

Trip Rate: 4.11

	Enter	Exit	Total
Directional Distribution	50%	50%	
Trip Ends	**617**	**617**	**1,234**

Source: TRIP GENERATION, Tenth Edition

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	53	839	31	11	546	108	131	179	54	143	134	45
Future Volume (vph)	53	839	31	11	546	108	131	179	54	143	134	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1703	1792	1496	1612	1696	1442	1556	1581		1583	1667	1417
Flt Permitted	0.28	1.00	1.00	0.15	1.00	1.00	0.52	1.00		0.28	1.00	1.00
Satd. Flow (perm)	498	1792	1496	255	1696	1442	856	1581		458	1667	1417
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	56	893	33	12	581	115	139	190	57	152	143	48
RTOR Reduction (vph)	0	0	11	0	0	41	0	9	0	0	0	38
Lane Group Flow (vph)	56	893	22	12	581	74	139	238	0	152	143	10
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	6%	6%	6%	12%	12%	12%	16%	16%	16%	14%	14%	14%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	70.0	70.0	79.8	67.9	67.9	77.4	30.3	20.5		29.7	20.2	24.3
Effective Green, g (s)	70.0	70.0	79.8	67.9	67.9	77.4	30.3	20.5		29.7	20.2	24.3
Actuated g/C Ratio	0.58	0.58	0.66	0.57	0.57	0.65	0.25	0.17		0.25	0.17	0.20
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	331	1045	994	166	959	984	273	270		202	280	340
v/s Ratio Prot	0.01	c0.50	0.00	0.00	c0.34	0.01	0.04	c0.15		c0.06	0.09	0.00
v/s Ratio Perm	0.09		0.01	0.04		0.05	0.09			0.13		0.01
v/c Ratio	0.17	0.85	0.02	0.07	0.61	0.08	0.51	0.88		0.75	0.51	0.03
Uniform Delay, d1	13.5	20.8	6.8	33.1	17.2	7.9	36.9	48.6		38.3	45.4	38.4
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.2	8.9	0.0	0.2	2.8	0.0	1.5	31.2		14.6	6.5	0.0
Delay (s)	13.8	29.7	6.8	33.3	20.0	8.0	38.4	79.8		52.9	51.9	38.4
Level of Service	B	C	A	C	C	A	D	E		D	D	D
Approach Delay (s)		28.0			18.3			64.9			50.5	
Approach LOS		C			B			E			D	

Intersection Summary			
HCM 2000 Control Delay	34.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.86		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.0%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Intersection						
Int Delay, s/veh	0					

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1015	40	12	659	16	17
Future Vol, veh/h	1015	40	12	659	16	17
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	9	9	11	11	88	88
Mvmt Flow	1057	42	13	686	17	18

Major/Minor	Minor2		Major2	
Conflicting Flow All	712	686	0	0
Stage 1	712	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.59	6.29	4.21	-
Critical Hdwy Stg 1	5.59	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.081	3.381	2.299	-
Pot Cap-1 Maneuver	~ 349	436	-	-
Stage 1	~ 426	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	436	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	436	-	-
HCM Lane V/C Ratio	-	0.096	-	-
HCM Control Delay (s)	-	14.1	-	-
HCM Lane LOS	-	B	-	-
HCM 95th %tile Q(veh)	-	0.3	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	6	909	117	117	630	5	6	0	0	38	0	97
Future Volume (vph)	6	909	117	117	630	5	6	0	0	38	0	97
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00				1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00				1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95				0.95	1.00
Satd. Flow (prot)	1671	1759	1495	3183	1725		1763				1421	1248
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.62				0.76	1.00
Satd. Flow (perm)	1671	1759	1495	3183	1725		1155				1133	1248
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	6	957	123	123	663	5	6	0	0	40	0	102
RTOR Reduction (vph)	0	0	33	0	0	0	0	0	0	0	0	75
Lane Group Flow (vph)	6	957	90	123	668	0	6	0	0	0	40	27
Confl. Peds. (#/hr)						2	2					2
Heavy Vehicles (%)	8%	8%	8%	10%	10%	10%	2%	2%	2%	27%	27%	27%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt			Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	1.0	83.3	83.3	11.9	94.2		31.3				25.8	37.7
Effective Green, g (s)	1.0	83.3	83.3	11.9	94.2		31.3				25.8	37.7
Actuated g/C Ratio	0.01	0.59	0.59	0.09	0.67		0.22				0.18	0.27
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0				3.0	3.0
Lane Grp Cap (vph)	11	1046	889	270	1160		262				208	336
v/s Ratio Prot	0.00	c0.54		c0.04	c0.39		c0.00					0.01
v/s Ratio Perm			0.06				0.00				c0.04	0.02
v/c Ratio	0.55	0.91	0.10	0.46	0.58		0.02				0.19	0.08
Uniform Delay, d1	69.3	25.2	12.2	61.0	12.2		42.4				48.3	38.2
Progression Factor	1.00	1.00	1.00	0.83	0.27		1.00				1.00	1.00
Incremental Delay, d2	45.6	13.6	0.2	1.0	1.6		0.0				2.0	0.1
Delay (s)	114.9	38.8	12.4	51.5	5.0		42.5				50.3	38.3
Level of Service	F	D	B	D	A		D				D	D
Approach Delay (s)		36.3			12.2			42.5			41.7	
Approach LOS		D			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	27.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	72.6%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	12	10	10	219	34	10	20	717	271	13	513	43
Future Volume (vph)	12	10	10	219	34	10	20	717	271	13	513	43
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.93		1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1656	1612		1752	1780		1641	1727	1468	1583	1667	1387
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1656	1612		1752	1780		1641	1727	1468	1583	1667	1387
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	13	11	11	233	36	11	21	763	288	14	546	46
RTOR Reduction (vph)	0	10	0	0	8	0	0	0	58	0	0	22
Lane Group Flow (vph)	13	12	0	233	39	0	21	763	230	14	546	24
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	9%	9%	9%	3%	3%	3%	10%	10%	10%	14%	14%	14%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	2.2	18.0		24.8	40.6		4.7	77.2	77.2	2.0	74.5	74.5
Effective Green, g (s)	2.2	18.0		24.8	40.6		4.7	77.2	77.2	2.0	74.5	74.5
Actuated g/C Ratio	0.02	0.13		0.18	0.29		0.03	0.55	0.55	0.01	0.53	0.53
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	26	207		310	516		55	952	809	22	887	738
v/s Ratio Prot	0.01	0.01		c0.13	c0.02		0.01	c0.44		0.01	c0.33	
v/s Ratio Perm									0.16			0.02
v/c Ratio	0.50	0.06		0.75	0.08		0.38	0.80	0.28	0.64	0.62	0.03
Uniform Delay, d1	68.4	53.6		54.7	36.1		66.2	25.2	16.7	68.6	22.8	15.6
Progression Factor	1.00	1.00		1.00	1.00		0.74	0.29	0.10	1.00	1.00	1.00
Incremental Delay, d2	14.3	0.6		9.8	0.3		2.7	4.4	0.5	47.5	3.2	0.1
Delay (s)	82.7	54.1		64.5	36.4		51.5	11.8	2.3	116.1	26.0	15.7
Level of Service	F	D		E	D		D	B	A	F	C	B
Approach Delay (s)		64.7			59.8			10.0			27.3	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	23.2	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	64.0%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	57	746	108	20	808	79	90	112	8	115	184	165
Future Volume (vph)	57	746	108	20	808	79	90	112	8	115	184	165
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1845	1568	1770	1863	1583	1687	1759		1770	1863	1583
Flt Permitted	0.15	1.00	1.00	0.21	1.00	1.00	0.36	1.00		0.60	1.00	1.00
Satd. Flow (perm)	286	1845	1568	392	1863	1583	637	1759		1110	1863	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	59	777	112	21	842	82	94	117	8	120	192	172
RTOR Reduction (vph)	0	0	36	0	0	31	0	2	0	0	0	134
Lane Group Flow (vph)	59	777	77	21	842	51	94	123	0	120	192	38
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	7%	7%	7%	2%	2%	2%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	81.4	74.9	81.5	70.6	68.6	74.4	25.9	19.3		24.3	18.5	26.8
Effective Green, g (s)	81.4	74.9	81.5	70.6	68.6	74.4	25.9	19.3		24.3	18.5	26.8
Actuated g/C Ratio	0.68	0.62	0.68	0.59	0.57	0.62	0.22	0.16		0.20	0.15	0.22
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	295	1151	1064	253	1065	981	195	282		256	287	353
v/s Ratio Prot	c0.01	c0.42	0.00	0.00	c0.45	0.00	c0.03	0.07		0.02	c0.10	0.01
v/s Ratio Perm	0.12		0.04	0.05		0.03	0.08			0.07		0.02
v/c Ratio	0.20	0.68	0.07	0.08	0.79	0.05	0.48	0.44		0.47	0.67	0.11
Uniform Delay, d1	28.8	14.6	6.5	26.9	20.1	9.0	39.4	45.4		41.3	47.9	37.1
Progression Factor	1.00	1.00	1.00	0.27	0.42	0.22	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.3	3.2	0.0	0.1	4.8	0.0	1.9	4.9		1.4	11.7	0.1
Delay (s)	29.2	17.8	6.5	7.4	13.2	2.0	41.3	50.3		42.7	59.6	37.2
Level of Service	C	B	A	A	B	A	D	D		D	E	D
Approach Delay (s)		17.2			12.1			46.4			47.5	
Approach LOS		B			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	23.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	73.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	864	6	5	914	20	15
Future Vol, veh/h	864	6	5	914	20	15
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	4	4	2	2	2	2
Mvmt Flow	919	6	5	972	21	16

Major/Minor	Minor2		Major2	
Conflicting Flow All	982	972	0	0
Stage 1	982	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.54	6.24	4.12	-
Critical Hdwy Stg 1	5.54	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.036	3.336	2.218	-
Pot Cap-1 Maneuver	~ 247	304	-	-
Stage 1	~ 325	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	304	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB		WB
HCM Control Delay, s			
HCM LOS	-		

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	304	-	-
HCM Lane V/C Ratio	-	0.021	-	-
HCM Control Delay (s)	-	17.1	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.1	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	17	847	39	42	815	18	19	1	7	63	0	144
Future Volume (vph)	17	847	39	42	815	18	19	1	7	63	0	144
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00		1.00	0.98			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.87			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00			0.95	1.00
Satd. Flow (prot)	1752	1845	1543	3433	1856		1732	1555			1697	1498
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.71	1.00			0.75	1.00
Satd. Flow (perm)	1752	1845	1543	3433	1856		1302	1555			1344	1498
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	18	882	41	44	849	19	20	1	7	66	0	150
RTOR Reduction (vph)	0	0	18	0	1	0	0	5	0	0	0	109
Lane Group Flow (vph)	18	882	23	44	867	0	20	3	0	0	66	41
Confl. Peds. (#/hr)			2			1	1		1	1		1
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	2.0	67.1	67.1	9.2	74.3		30.2	30.2			23.7	32.9
Effective Green, g (s)	2.0	67.1	67.1	9.2	74.3		30.2	30.2			23.7	32.9
Actuated g/C Ratio	0.02	0.56	0.56	0.08	0.62		0.25	0.25			0.20	0.27
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	29	1031	862	263	1149		334	391			265	466
v/s Ratio Prot	0.01	c0.48		0.01	c0.47		c0.00	0.00				0.01
v/s Ratio Perm			0.01				0.01				c0.05	0.02
v/c Ratio	0.62	0.86	0.03	0.17	0.75		0.06	0.01			0.25	0.09
Uniform Delay, d1	58.6	22.4	11.8	51.8	16.3		34.1	33.7			40.6	32.4
Progression Factor	1.00	1.00	1.00	0.77	0.34		1.00	1.00			1.00	1.00
Incremental Delay, d2	34.8	9.1	0.1	0.2	3.5		0.1	0.0			2.2	0.1
Delay (s)	93.4	31.4	11.9	40.0	9.1		34.2	33.7			42.9	32.5
Level of Service	F	C	B	D	A		C	C			D	C
Approach Delay (s)		31.8			10.6			34.1			35.7	
Approach LOS		C			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	23.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	79.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	55	43	18	223	18	18	7	615	343	4	653	24
Future Volume (vph)	55	43	18	223	18	18	7	615	343	4	653	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.95		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	57	44	19	230	19	19	7	634	354	4	673	25
RTOR Reduction (vph)	0	13	0	0	14	0	0	0	95	0	0	12
Lane Group Flow (vph)	57	50	0	230	24	0	7	634	259	4	673	13
Confl. Peds. (#/hr)			1			1						
Heavy Vehicles (%)	5%	5%	5%	2%	2%	2%	3%	3%	3%	4%	4%	4%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	7.3	18.0		21.2	31.9		1.0	61.8	61.8	1.0	61.8	61.8
Effective Green, g (s)	7.3	18.0		21.2	31.9		1.0	61.8	61.8	1.0	61.8	61.8
Actuated g/C Ratio	0.06	0.15		0.18	0.27		0.01	0.51	0.51	0.01	0.51	0.51
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	104	257		312	452		14	950	807	14	940	799
v/s Ratio Prot	0.03	c0.03		c0.13	0.01		0.00	c0.34		0.00	c0.37	
v/s Ratio Perm									0.17			0.01
v/c Ratio	0.55	0.20		0.74	0.05		0.50	0.67	0.32	0.29	0.72	0.02
Uniform Delay, d1	54.7	44.7		46.8	32.8		59.3	21.5	16.9	59.1	22.4	14.2
Progression Factor	1.00	1.00		1.00	1.00		0.76	0.36	0.08	1.00	1.00	1.00
Incremental Delay, d2	5.8	1.7		8.8	0.2		18.1	2.6	0.7	10.9	4.7	0.0
Delay (s)	60.5	46.4		55.5	33.0		63.1	10.3	2.1	70.1	27.0	14.3
Level of Service	E	D		E	C		E	B	A	E	C	B
Approach Delay (s)		53.1			52.3			7.8			26.8	
Approach LOS		D			D			A			C	

Intersection Summary			
HCM 2000 Control Delay	22.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	60.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	72	908	35	12	614	200	146	200	57	164	143	52
Future Volume (vph)	72	908	35	12	614	200	146	200	57	164	143	52
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.97		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1703	1792	1496	1612	1696	1442	1556	1583		1583	1667	1417
Flt Permitted	0.22	1.00	1.00	0.09	1.00	1.00	0.54	1.00		0.20	1.00	1.00
Satd. Flow (perm)	394	1792	1496	158	1696	1442	884	1583		338	1667	1417
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	77	966	37	13	653	213	155	213	61	174	152	55
RTOR Reduction (vph)	0	0	13	0	0	77	0	8	0	0	0	43
Lane Group Flow (vph)	77	966	24	13	653	136	155	266	0	174	152	12
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	6%	6%	6%	12%	12%	12%	16%	16%	16%	14%	14%	14%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	69.2	69.2	78.5	66.5	66.5	76.6	30.0	20.7		31.6	21.5	26.2
Effective Green, g (s)	69.2	69.2	78.5	66.5	66.5	76.6	30.0	20.7		31.6	21.5	26.2
Actuated g/C Ratio	0.58	0.58	0.65	0.55	0.55	0.64	0.25	0.17		0.26	0.18	0.22
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	278	1033	978	111	939	974	273	273		193	298	362
v/s Ratio Prot	0.01	c0.54	0.00	0.00	c0.38	0.01	0.04	c0.17		c0.08	0.09	0.00
v/s Ratio Perm	0.15		0.01	0.06		0.08	0.10			0.16		0.01
v/c Ratio	0.28	0.94	0.02	0.12	0.70	0.14	0.57	0.97		0.90	0.51	0.03
Uniform Delay, d1	15.6	23.3	7.3	41.6	19.4	8.6	37.8	49.4		38.6	44.5	36.9
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.5	16.2	0.0	0.5	4.2	0.1	2.7	48.1		38.4	6.1	0.0
Delay (s)	16.1	39.5	7.3	42.0	23.6	8.7	40.5	97.5		77.0	50.6	37.0
Level of Service	B	D	A	D	C	A	D	F		E	D	D
Approach Delay (s)		36.7			20.3			76.9			60.7	
Approach LOS		D			C			E			E	

Intersection Summary			
HCM 2000 Control Delay	41.0	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	90.0%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Intersection						
Int Delay, s/veh	0					

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1107	42	13	819	17	18
Future Vol, veh/h	1107	42	13	819	17	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	9	9	11	11	88	88
Mvmt Flow	1153	44	14	853	18	19

Major/Minor	Minor2		Major2	
Conflicting Flow All	881	853	0	0
Stage 1	881	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.59	6.29	4.21	-
Critical Hdwy Stg 1	5.59	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.081	3.381	2.299	-
Pot Cap-1 Maneuver	~ 278	349	-	-
Stage 1	~ 355	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	349	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	349	-	-
HCM Lane V/C Ratio	-	0.125	-	-
HCM Control Delay (s)	-	16.8	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.4	-	-

Notes
~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	6	994	125	124	783	5	6	0	0	46	0	103
Future Volume (vph)	6	994	125	124	783	5	6	0	0	46	0	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00				1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00				1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95				0.95	1.00
Satd. Flow (prot)	1671	1759	1495	3183	1725		1763				1421	1247
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.62				0.76	1.00
Satd. Flow (perm)	1671	1759	1495	3183	1725		1145				1133	1247
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	6	1046	132	131	824	5	6	0	0	48	0	108
RTOR Reduction (vph)	0	0	33	0	0	0	0	0	0	0	0	80
Lane Group Flow (vph)	6	1046	99	131	829	0	6	0	0	0	48	28
Confl. Peds. (#/hr)						2	2					2
Heavy Vehicles (%)	8%	8%	8%	10%	10%	10%	2%	2%	2%	27%	27%	27%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt			Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	1.0	84.3	84.3	11.1	94.4		31.1				25.6	36.7
Effective Green, g (s)	1.0	84.3	84.3	11.1	94.4		31.1				25.6	36.7
Actuated g/C Ratio	0.01	0.60	0.60	0.08	0.67		0.22				0.18	0.26
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0				3.0	3.0
Lane Grp Cap (vph)	11	1059	900	252	1163		258				207	326
v/s Ratio Prot	0.00	c0.59		0.04	c0.48		c0.00					0.01
v/s Ratio Perm			0.07				0.00				c0.04	0.02
v/c Ratio	0.55	0.99	0.11	0.52	0.71		0.02				0.23	0.09
Uniform Delay, d1	69.3	27.3	11.9	61.9	14.3		42.6				48.8	39.0
Progression Factor	1.00	1.00	1.00	0.79	0.26		1.00				1.00	1.00
Incremental Delay, d2	45.6	24.9	0.2	1.1	2.4		0.0				2.6	0.1
Delay (s)	114.9	52.2	12.1	50.2	6.1		42.6				51.4	39.1
Level of Service	F	D	B	D	A		D				D	D
Approach Delay (s)		48.1			12.1			42.6			42.9	
Approach LOS		D			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	32.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	75.6%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	13	11	11	234	36	11	21	789	289	14	656	46
Future Volume (vph)	13	11	11	234	36	11	21	789	289	14	656	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.93		1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1656	1612		1752	1778		1641	1727	1468	1583	1667	1387
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1656	1612		1752	1778		1641	1727	1468	1583	1667	1387
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	14	12	12	249	38	12	22	839	307	15	698	49
RTOR Reduction (vph)	0	10	0	0	8	0	0	0	58	0	0	23
Lane Group Flow (vph)	14	14	0	249	42	0	22	839	249	15	698	26
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	9%	9%	9%	3%	3%	3%	10%	10%	10%	14%	14%	14%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	2.2	18.0		26.2	42.0		3.9	75.8	75.8	2.0	73.9	73.9
Effective Green, g (s)	2.2	18.0		26.2	42.0		3.9	75.8	75.8	2.0	73.9	73.9
Actuated g/C Ratio	0.02	0.13		0.19	0.30		0.03	0.54	0.54	0.01	0.53	0.53
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	26	207		327	533		45	935	794	22	879	732
v/s Ratio Prot	c0.01	0.01		c0.14	c0.02		0.01	c0.49		0.01	c0.42	
v/s Ratio Perm									0.17			0.02
v/c Ratio	0.54	0.07		0.76	0.08		0.49	0.90	0.31	0.68	0.79	0.04
Uniform Delay, d1	68.4	53.6		53.9	35.1		67.1	28.6	17.7	68.7	26.9	15.9
Progression Factor	1.00	1.00		1.00	1.00		0.73	0.30	0.09	1.00	1.00	1.00
Incremental Delay, d2	19.8	0.6		10.0	0.3		4.2	7.4	0.5	62.1	7.3	0.1
Delay (s)	88.2	54.2		64.0	35.4		53.1	16.0	2.1	130.8	34.2	16.0
Level of Service	F	D		E	D		D	B	A	F	C	B
Approach Delay (s)		66.7			59.2			13.0			34.9	
Approach LOS		E			E			B			C	

Intersection Summary			
HCM 2000 Control Delay	27.4	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	64	827	122	21	883	97	100	120	8	210	205	193
Future Volume (vph)	64	827	122	21	883	97	100	120	8	210	205	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1845	1568	1770	1863	1583	1687	1760		1770	1863	1583
Flt Permitted	0.09	1.00	1.00	0.16	1.00	1.00	0.42	1.00		0.46	1.00	1.00
Satd. Flow (perm)	166	1845	1568	289	1863	1583	741	1760		860	1863	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	67	861	127	22	920	101	104	125	8	219	214	201
RTOR Reduction (vph)	0	0	44	0	0	35	0	2	0	0	0	119
Lane Group Flow (vph)	67	861	83	22	920	66	104	131	0	219	214	82
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	7%	7%	7%	2%	2%	2%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	76.8	71.3	78.1	71.8	68.8	78.5	24.8	18.0		30.6	20.9	26.4
Effective Green, g (s)	76.8	71.3	78.1	71.8	68.8	78.5	24.8	18.0		30.6	20.9	26.4
Actuated g/C Ratio	0.64	0.59	0.65	0.60	0.57	0.65	0.21	0.15		0.26	0.17	0.22
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	178	1096	1079	209	1068	1094	206	264		292	324	407
v/s Ratio Prot	c0.02	0.47	0.00	0.00	c0.49	0.00	0.03	0.07		c0.06	0.11	0.01
v/s Ratio Perm	0.22		0.05	0.06		0.04	0.08			c0.13		0.04
v/c Ratio	0.38	0.79	0.08	0.11	0.86	0.06	0.50	0.50		0.75	0.66	0.20
Uniform Delay, d1	20.5	18.5	7.7	15.9	21.6	7.5	40.4	46.8		39.7	46.2	38.2
Progression Factor	1.00	1.00	1.00	0.34	0.41	0.20	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	1.3	5.7	0.0	0.2	6.8	0.0	1.9	6.6		10.3	10.1	0.2
Delay (s)	21.9	24.2	7.7	5.6	15.6	1.5	42.4	53.4		50.0	56.4	38.5
Level of Service	C	C	A	A	B	A	D	D		D	E	D
Approach Delay (s)		22.1			14.0			48.6			48.5	
Approach LOS		C			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	27.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	82.9%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Intersection						
Int Delay, s/veh	0					

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↱	↰	↑	Y	
Traffic Vol, veh/h	1040	6	5	1009	21	16
Future Vol, veh/h	1040	6	5	1009	21	16
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	4	4	2	2	2	2
Mvmt Flow	1106	6	5	1073	22	17

Major/Minor	Minor2		Major2	
Conflicting Flow All	1083	1073	0	0
Stage 1	1083	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.54	6.24	4.12	-
Critical Hdwy Stg 1	5.54	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.036	3.336	2.218	-
Pot Cap-1 Maneuver	~ 215	265	-	-
Stage 1	~ 291	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	265	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	265	-	-
HCM Lane V/C Ratio	-	0.024	-	-
HCM Control Delay (s)	-	18.9	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.1	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	18	1015	48	45	903	19	20	1	7	68	0	153
Future Volume (vph)	18	1015	48	45	903	19	20	1	7	68	0	153
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00		1.00	0.98			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.87			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00			0.95	1.00
Satd. Flow (prot)	1752	1845	1543	3433	1856		1733	1555			1697	1497
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.60	1.00			0.75	1.00
Satd. Flow (perm)	1752	1845	1543	3433	1856		1090	1555			1344	1497
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	19	1057	50	47	941	20	21	1	7	71	0	159
RTOR Reduction (vph)	0	0	21	0	1	0	0	5	0	0	0	117
Lane Group Flow (vph)	19	1057	29	47	960	0	21	3	0	0	71	42
Confl. Peds. (#/hr)			2			1	1		1	1		1
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	2.0	68.5	68.5	7.8	74.3		30.2	30.2			23.7	31.5
Effective Green, g (s)	2.0	68.5	68.5	7.8	74.3		30.2	30.2			23.7	31.5
Actuated g/C Ratio	0.02	0.57	0.57	0.06	0.62		0.25	0.25			0.20	0.26
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	29	1053	880	223	1149		285	391			265	392
v/s Ratio Prot	0.01	c0.57		0.01	c0.52		c0.00	0.00				0.01
v/s Ratio Perm			0.02				0.02				c0.05	0.02
v/c Ratio	0.66	1.00	0.03	0.21	0.84		0.07	0.01			0.27	0.11
Uniform Delay, d1	58.7	25.8	11.3	53.2	18.0		34.1	33.7			40.8	33.6
Progression Factor	1.00	1.00	1.00	0.78	0.41		1.00	1.00			1.00	1.00
Incremental Delay, d2	42.6	28.7	0.1	0.3	4.8		0.1	0.0			2.5	0.1
Delay (s)	101.2	54.4	11.3	41.8	12.2		34.2	33.7			43.3	33.7
Level of Service	F	D	B	D	B		C	C			D	C
Approach Delay (s)		53.3			13.6			34.1			36.6	
Approach LOS		D			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	34.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	89.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	58	46	19	239	19	19	7	767	366	4	729	25
Future Volume (vph)	58	46	19	239	19	19	7	767	366	4	729	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	60	47	20	246	20	20	7	791	377	4	752	26
RTOR Reduction (vph)	0	13	0	0	15	0	0	0	83	0	0	12
Lane Group Flow (vph)	60	54	0	246	25	0	7	791	294	4	752	14
Confl. Peds. (#/hr)			1			1						
Heavy Vehicles (%)	5%	5%	5%	2%	2%	2%	3%	3%	3%	4%	4%	4%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	7.8	18.0		20.3	30.5		1.0	62.7	62.7	1.0	62.7	62.7
Effective Green, g (s)	7.8	18.0		20.3	30.5		1.0	62.7	62.7	1.0	62.7	62.7
Actuated g/C Ratio	0.06	0.15		0.17	0.25		0.01	0.52	0.52	0.01	0.52	0.52
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	111	257		299	432		14	964	819	14	954	811
v/s Ratio Prot	0.03	c0.03		c0.14	0.01		0.00	c0.43		0.00	c0.41	
v/s Ratio Perm									0.19			0.01
v/c Ratio	0.54	0.21		0.82	0.06		0.50	0.82	0.36	0.29	0.79	0.02
Uniform Delay, d1	54.4	44.8		48.1	33.9		59.3	23.9	16.8	59.1	23.3	13.8
Progression Factor	1.00	1.00		1.00	1.00		0.73	0.30	0.08	1.00	1.00	1.00
Incremental Delay, d2	5.3	1.9		16.5	0.3		13.7	4.2	0.6	10.9	6.6	0.0
Delay (s)	59.6	46.6		64.6	34.1		56.7	11.4	2.0	70.1	29.8	13.8
Level of Service	E	D		E	C		E	B	A	E	C	B
Approach Delay (s)		52.8			60.3			8.6			29.5	
Approach LOS		D			E			A			C	

Intersection Summary			
HCM 2000 Control Delay	24.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	67.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Intersection						
Int Delay, s/veh	2.4					

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	3	37	403	12	158	190
Future Vol, veh/h	3	37	403	12	158	190
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	150	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	12	12	14	14
Mvmt Flow	3	40	438	13	172	207

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	996	445	0	0	451	0
Stage 1	445	-	-	-	-	-
Stage 2	551	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.24	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.326	-
Pot Cap-1 Maneuver	271	613	-	-	1049	-
Stage 1	646	-	-	-	-	-
Stage 2	577	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	227	613	-	-	1049	-
Mov Cap-2 Maneuver	311	-	-	-	-	-
Stage 1	540	-	-	-	-	-
Stage 2	577	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.8	0	4.1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	571	1049	-
HCM Lane V/C Ratio	-	-	0.076	0.164	-
HCM Control Delay (s)	-	-	11.8	9.1	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	0.2	0.6	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	72	908	59	114	614	200	151	208	81	164	175	52
Future Volume (vph)	72	908	59	114	614	200	151	208	81	164	175	52
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.96		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1703	1792	1496	1612	1696	1442	1556	1569		1583	1667	1417
Flt Permitted	0.26	1.00	1.00	0.06	1.00	1.00	0.45	1.00		0.18	1.00	1.00
Satd. Flow (perm)	464	1792	1496	102	1696	1442	743	1569		296	1667	1417
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	77	966	63	121	653	213	161	221	86	174	186	55
RTOR Reduction (vph)	0	0	24	0	0	78	0	11	0	0	0	43
Lane Group Flow (vph)	77	966	39	121	653	135	161	296	0	174	186	12
Confl. Bikes (#/hr)			1									
Heavy Vehicles (%)	6%	6%	6%	12%	12%	12%	16%	16%	16%	14%	14%	14%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	69.2	65.0	74.5	72.6	66.7	76.6	31.6	22.1		32.4	22.5	26.7
Effective Green, g (s)	69.2	65.0	74.5	72.6	66.7	76.6	31.6	22.1		32.4	22.5	26.7
Actuated g/C Ratio	0.57	0.54	0.62	0.60	0.55	0.63	0.26	0.18		0.27	0.19	0.22
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	308	963	977	134	935	967	258	286		184	310	365
v/s Ratio Prot	0.01	c0.54	0.00	c0.04	0.38	0.01	0.05	c0.19		c0.08	0.11	0.00
v/s Ratio Perm	0.13		0.02	0.50		0.08	0.11			0.18		0.01
v/c Ratio	0.25	1.00	0.04	0.90	0.70	0.14	0.62	1.03		0.95	0.60	0.03
Uniform Delay, d1	14.4	28.0	9.1	32.4	19.8	8.9	37.4	49.4		39.0	45.1	37.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	0.4	29.8	0.0	49.3	2.3	0.1	4.6	62.1		50.3	8.3	0.0
Delay (s)	14.8	57.7	9.1	81.7	22.1	9.0	42.1	111.5		89.4	53.4	37.0
Level of Service	B	E	A	F	C	A	D	F		F	D	D
Approach Delay (s)		52.0			26.5			87.6			66.3	
Approach LOS		D			C			F			E	

Intersection Summary			
HCM 2000 Control Delay	51.1	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	120.9	Sum of lost time (s)	18.0
Intersection Capacity Utilization	94.1%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Vol, veh/h	1131	42	13	921	17	18
Future Vol, veh/h	1131	42	13	921	17	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	9	9	11	11	88	88
Mvmt Flow	1178	44	14	959	18	19

Major/Minor	Minor2		Major2	
Conflicting Flow All	987	959	0	0
Stage 1	987	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.59	6.29	4.21	-
Critical Hdwy Stg 1	5.59	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.081	3.381	2.299	-
Pot Cap-1 Maneuver	~ 241	302	-	-
Stage 1	~ 317	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	302	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	302	-	-
HCM Lane V/C Ratio	-	0.145	-	-
HCM Control Delay (s)	-	18.9	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.5	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	6	1018	125	124	885	5	6	0	0	46	0	103
Future Volume (vph)	6	1018	125	124	885	5	6	0	0	46	0	103
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00				1.00	1.00
Frpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00				1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00				1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95				0.95	1.00
Satd. Flow (prot)	1671	1759	1495	3183	1726		1763				1421	1247
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.62				0.76	1.00
Satd. Flow (perm)	1671	1759	1495	3183	1726		1145				1133	1247
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	6	1072	132	131	932	5	6	0	0	48	0	108
RTOR Reduction (vph)	0	0	33	0	0	0	0	0	0	0	0	80
Lane Group Flow (vph)	6	1072	99	131	937	0	6	0	0	0	48	28
Confl. Peds. (#/hr)						2	2					2
Heavy Vehicles (%)	8%	8%	8%	10%	10%	10%	2%	2%	2%	27%	27%	27%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt			Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	1.0	84.3	84.3	11.1	94.4		31.1				25.6	36.7
Effective Green, g (s)	1.0	84.3	84.3	11.1	94.4		31.1				25.6	36.7
Actuated g/C Ratio	0.01	0.60	0.60	0.08	0.67		0.22				0.18	0.26
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5				4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0				3.0	3.0
Lane Grp Cap (vph)	11	1059	900	252	1163		258				207	326
v/s Ratio Prot	0.00	c0.61		0.04	c0.54		c0.00					0.01
v/s Ratio Perm			0.07				0.00				c0.04	0.02
v/c Ratio	0.55	1.01	0.11	0.52	0.81		0.02				0.23	0.09
Uniform Delay, d1	69.3	27.9	11.9	61.9	16.3		42.6				48.8	39.0
Progression Factor	1.00	1.00	1.00	0.78	0.30		1.00				1.00	1.00
Incremental Delay, d2	45.6	30.7	0.2	0.9	3.1		0.0				2.6	0.1
Delay (s)	114.9	58.6	12.1	49.3	8.0		42.6				51.4	39.1
Level of Service	F	E	B	D	A		D				D	D
Approach Delay (s)		53.8			13.0			42.6			42.9	
Approach LOS		D			B			D			D	

Intersection Summary			
HCM 2000 Control Delay	35.2	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	76.1%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	13	11	11	234	36	11	21	813	289	14	758	46
Future Volume (vph)	13	11	11	234	36	11	21	813	289	14	758	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.93		1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1656	1612		1752	1778		1641	1727	1468	1583	1667	1387
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1656	1612		1752	1778		1641	1727	1468	1583	1667	1387
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	14	12	12	249	38	12	22	865	307	15	806	49
RTOR Reduction (vph)	0	10	0	0	8	0	0	0	56	0	0	23
Lane Group Flow (vph)	14	14	0	249	42	0	22	865	251	15	806	26
Confl. Bikes (#/hr)												1
Heavy Vehicles (%)	9%	9%	9%	3%	3%	3%	10%	10%	10%	14%	14%	14%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	2.2	18.0		25.2	41.0		3.9	76.8	76.8	2.0	74.9	74.9
Effective Green, g (s)	2.2	18.0		25.2	41.0		3.9	76.8	76.8	2.0	74.9	74.9
Actuated g/C Ratio	0.02	0.13		0.18	0.29		0.03	0.55	0.55	0.01	0.54	0.54
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	26	207		315	520		45	947	805	22	891	742
v/s Ratio Prot	c0.01	0.01		c0.14	c0.02		0.01	c0.50		0.01	c0.48	
v/s Ratio Perm									0.17			0.02
v/c Ratio	0.54	0.07		0.79	0.08		0.49	0.91	0.31	0.68	0.90	0.04
Uniform Delay, d1	68.4	53.6		54.9	35.9		67.1	28.6	17.2	68.7	29.3	15.4
Progression Factor	1.00	1.00		1.00	1.00		0.72	0.29	0.08	1.00	1.00	1.00
Incremental Delay, d2	19.8	0.6		12.7	0.3		3.9	7.9	0.5	62.1	14.4	0.1
Delay (s)	88.2	54.2		67.5	36.2		52.5	16.1	1.8	130.8	43.7	15.5
Level of Service	F	D		E	D		D	B	A	F	D	B
Approach Delay (s)		66.7			62.3			13.1			43.6	
Approach LOS		E			E			B			D	

Intersection Summary			
HCM 2000 Control Delay	31.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	69.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Intersection	
Int Delay, s/veh	3.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	14	180	228	2	32	348
Future Vol, veh/h	14	180	228	2	32	348
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	150	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	7	7	2	2
Mvmt Flow	15	196	248	2	35	378

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	697	249	0	0	250	0
Stage 1	249	-	-	-	-	-
Stage 2	448	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	407	790	-	-	1316	-
Stage 1	792	-	-	-	-	-
Stage 2	644	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	396	790	-	-	1316	-
Mov Cap-2 Maneuver	486	-	-	-	-	-
Stage 1	771	-	-	-	-	-
Stage 2	644	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.6	0	0.7
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	756	1316	-
HCM Lane V/C Ratio	-	-	0.279	0.026	-
HCM Control Delay (s)	-	-	11.6	7.8	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	1.1	0.1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	64	827	127	41	883	97	127	157	124	210	212	193
Future Volume (vph)	64	827	127	41	883	97	127	157	124	210	212	193
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.93		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1752	1845	1568	1770	1863	1583	1687	1658		1770	1863	1583
Flt Permitted	0.06	1.00	1.00	0.11	1.00	1.00	0.48	1.00		0.16	1.00	1.00
Satd. Flow (perm)	112	1845	1568	203	1863	1583	846	1658		303	1863	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	67	861	132	43	920	101	132	164	129	219	221	201
RTOR Reduction (vph)	0	0	51	0	0	37	0	23	0	0	0	104
Lane Group Flow (vph)	67	861	81	43	920	64	132	270	0	219	221	97
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	7%	7%	7%	2%	2%	2%
Turn Type	pm+pt	NA	pm+ov	pm+pt	NA	pm+ov	pm+pt	NA		pm+pt	NA	pm+ov
Protected Phases	7	4	5	3	8	1	5	2		1	6	7
Permitted Phases	4		4	8		8	2			6		6
Actuated Green, G (s)	71.0	65.7	73.4	68.4	64.4	76.2	28.2	20.5		36.4	24.6	29.9
Effective Green, g (s)	71.0	65.7	73.4	68.4	64.4	76.2	28.2	20.5		36.4	24.6	29.9
Actuated g/C Ratio	0.59	0.55	0.61	0.57	0.54	0.64	0.23	0.17		0.30	0.21	0.25
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5		4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	138	1010	1017	167	999	1064	252	283		236	381	453
v/s Ratio Prot	c0.02	0.47	0.01	0.01	c0.49	0.01	0.03	0.16		c0.09	0.12	0.01
v/s Ratio Perm	0.26		0.05	0.14		0.03	0.09			c0.19		0.05
v/c Ratio	0.49	0.85	0.08	0.26	0.92	0.06	0.52	0.95		0.93	0.58	0.21
Uniform Delay, d1	24.3	23.0	9.5	20.0	25.5	8.3	38.3	49.3		35.0	43.0	35.7
Progression Factor	1.00	1.00	1.00	0.47	0.47	0.17	1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	2.7	9.1	0.0	0.6	11.2	0.0	2.0	42.8		38.9	6.3	0.2
Delay (s)	27.0	32.1	9.5	9.9	23.3	1.4	40.2	92.0		74.0	49.4	36.0
Level of Service	C	C	A	A	C	A	D	F		E	D	D
Approach Delay (s)		29.0			20.7			75.9			53.6	
Approach LOS		C			C			E			D	

Intersection Summary			
HCM 2000 Control Delay	37.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	91.9%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Intersection	
Int Delay, s/veh	0

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑	↱	↰	↑	⋎	
Traffic Vol, veh/h	1156	6	5	1029	21	16
Future Vol, veh/h	1156	6	5	1029	21	16
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	130	440	-	0	-
Veh in Median Storage, #	0	-	-	0	16974	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	4	4	2	2	2	2
Mvmt Flow	1230	6	5	1095	22	17

Major/Minor	Minor2		Major2	
Conflicting Flow All	1105	1095	0	0
Stage 1	1105	-	-	-
Stage 2	0	-	-	-
Critical Hdwy	6.54	6.24	4.12	-
Critical Hdwy Stg 1	5.54	-	-	-
Critical Hdwy Stg 2	-	-	-	-
Follow-up Hdwy	4.036	3.336	2.218	-
Pot Cap-1 Maneuver	~ 209	257	-	-
Stage 1	~ 284	-	-	-
Stage 2	-	-	-	-
Platoon blocked, %				-
Mov Cap-1 Maneuver	0	257	-	-
Mov Cap-2 Maneuver	0	-	-	-
Stage 1	0	-	-	-
Stage 2	0	-	-	-

Approach	EB	WB
HCM Control Delay, s		
HCM LOS	-	

Minor Lane/Major Mvmt	EBLn1	EBLn2	WBL	WBT
Capacity (veh/h)	-	257	-	-
HCM Lane V/C Ratio	-	0.025	-	-
HCM Control Delay (s)	-	19.4	-	-
HCM Lane LOS	-	C	-	-
HCM 95th %tile Q(veh)	-	0.1	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Movement	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	18	1131	48	45	923	19	20	1	7	68	0	153
Future Volume (vph)	18	1131	48	45	923	19	20	1	7	68	0	153
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Lane Util. Factor	1.00	1.00	1.00	0.97	1.00		1.00	1.00			1.00	1.00
Frpb, ped/bikes	1.00	1.00	0.98	1.00	1.00		1.00	0.98			1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00		1.00	1.00			1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	0.87			1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00			0.95	1.00
Satd. Flow (prot)	1752	1845	1543	3433	1856		1733	1555			1697	1497
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.60	1.00			0.75	1.00
Satd. Flow (perm)	1752	1845	1543	3433	1856		1090	1555			1344	1497
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	19	1178	50	47	961	20	21	1	7	71	0	159
RTOR Reduction (vph)	0	0	21	0	1	0	0	5	0	0	0	104
Lane Group Flow (vph)	19	1178	29	47	980	0	21	3	0	0	71	55
Confl. Peds. (#/hr)			2			1	1		1	1		1
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	4%	4%	4%	6%	6%	6%
Turn Type	Prot	NA	Perm	Prot	NA		pm+pt	NA		Perm	NA	pm+ov
Protected Phases	7	4		3	8		1	6			2	3
Permitted Phases			4				6			2		2
Actuated Green, G (s)	2.0	68.5	68.5	7.8	74.3		30.2	30.2			23.7	31.5
Effective Green, g (s)	2.0	68.5	68.5	7.8	74.3		30.2	30.2			23.7	31.5
Actuated g/C Ratio	0.02	0.57	0.57	0.06	0.62		0.25	0.25			0.20	0.26
Clearance Time (s)	4.5	4.5	4.5	4.5	4.5		4.5	4.5			4.5	4.5
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0			3.0	3.0
Lane Grp Cap (vph)	29	1053	880	223	1149		285	391			265	392
v/s Ratio Prot	0.01	c0.64		0.01	c0.53		c0.00	0.00				0.01
v/s Ratio Perm			0.02				0.02				c0.05	0.03
v/c Ratio	0.66	1.12	0.03	0.21	0.85		0.07	0.01			0.27	0.14
Uniform Delay, d1	58.7	25.8	11.3	53.2	18.4		34.1	33.7			40.8	33.9
Progression Factor	1.00	1.00	1.00	0.80	0.43		1.00	1.00			1.00	1.00
Incremental Delay, d2	42.6	66.4	0.1	0.3	5.1		0.1	0.0			2.5	0.2
Delay (s)	101.2	92.1	11.3	42.7	13.0		34.2	33.7			43.3	34.0
Level of Service	F	F	B	D	B		C	C			D	C
Approach Delay (s)		89.0			14.4			34.1			36.9	
Approach LOS		F			B			C			D	

Intersection Summary			
HCM 2000 Control Delay	53.4	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	0.90		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	95.4%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Traffic Volume (vph)	58	46	19	239	19	19	7	883	366	4	749	25
Future Volume (vph)	58	46	19	239	19	19	7	883	366	4	749	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	1.00	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.93		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Flt Permitted	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	1719	1716		1770	1703		1752	1845	1568	1736	1827	1553
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	60	47	20	246	20	20	7	910	377	4	772	26
RTOR Reduction (vph)	0	13	0	0	15	0	0	0	73	0	0	12
Lane Group Flow (vph)	60	54	0	246	25	0	7	910	304	4	772	14
Confl. Peds. (#/hr)			1			1						
Heavy Vehicles (%)	5%	5%	5%	2%	2%	2%	3%	3%	3%	4%	4%	4%
Turn Type	Prot	NA		Prot	NA		Prot	NA	Perm	Prot	NA	Perm
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases									4			8
Actuated Green, G (s)	7.9	18.0		18.6	28.7		1.0	64.4	64.4	1.0	64.4	64.4
Effective Green, g (s)	7.9	18.0		18.6	28.7		1.0	64.4	64.4	1.0	64.4	64.4
Actuated g/C Ratio	0.07	0.15		0.16	0.24		0.01	0.54	0.54	0.01	0.54	0.54
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	113	257		274	407		14	990	841	14	980	833
v/s Ratio Prot	0.03	c0.03		c0.14	0.01		0.00	c0.49		0.00	c0.42	
v/s Ratio Perm									0.19			0.01
v/c Ratio	0.53	0.21		0.90	0.06		0.50	0.92	0.36	0.29	0.79	0.02
Uniform Delay, d1	54.3	44.8		49.8	35.2		59.3	25.4	16.0	59.1	22.3	13.0
Progression Factor	1.00	1.00		1.00	1.00		0.70	0.25	0.06	1.00	1.00	1.00
Incremental Delay, d2	4.7	1.9		29.1	0.3		9.3	6.0	0.4	10.9	6.4	0.0
Delay (s)	59.0	46.6		78.9	35.5		50.9	12.4	1.4	70.1	28.7	13.0
Level of Service	E	D		E	D		D	B	A	E	C	B
Approach Delay (s)		52.5			72.8			9.4			28.4	
Approach LOS		D			E			A			C	

Intersection Summary			
HCM 2000 Control Delay	24.9	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	73.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

City of Tualatin
www.tualatinoregon.gov

Hydraulic Modeling Fee

Water supply modeling is necessary for larger projects to determine the impact of the project's water demand on the water supply system. Water supply modeling will be performed by a consulting engineer based on the most recent version of the Tualatin Water System Master Plan.

Due to possible impacts to the water supply system, the following projects in Tualatin require hydraulic modeling based on the size and type of the project and projected water use for the finished project. The outcome of modeling could require offsite improvements to the water supply system in order to ensure that adequate water supply is available to serve the project and reduce impacts to the overall system.

Hydraulic modeling of the water supply system is required for the following project type/sizes/demand:

Project Type	Criteria	Permit Fee
Commercial or Industrial Building	Building floor area greater than 48,300 square feet **or** Anticipated daily water demand greater than 870 gallons per acre per day	$ 300 per building
Residential development	More than 49 dwelling units	$ 1,000
Multi-family development	More than 49 dwelling units **or** a combined building floor area greater than 48,300 square feet	$ 300 per building

Please complete this form and submit the form and required fee (if applicable) with your land-use application (architectural review, subdivision, etc.).

☒ Commercial or Industrial Development

- Building floor area ~130,000 SF square feet
- Anticipated water demand (if known) ~2,150 gallons per day
- Described planned building use Utility offices and power management center

☐ Residential Development

- Number of dwelling units or single family home lots ____________________

☐ Multi-Family Residential Development

- Number of dwelling units____________________
- Building floor area (sum of all building) ____________________
- Number of multi-family buildings____________________

Permit fee required based on the information provided above $ 300

- If no fee is required, enter $0.

NOTE: Water Supply Modeling does not replace the requirement for fire hydrant flow testing. Flow testing of fire hydrants will still be required to verify adequate fire flow of finished system

R&W ENGINEERING, INC.
"Engineering Integrated Solutions"

December 14, 2018 | 122.111

Mark Reuland, P.E.
KPFF Portland Civil + Survey
111 SW Fifth Avenue, Ste.2500
Portland, OR 97204

Subject: Hydrant Flow Test – SW Tualatin Sherwood Rd. & SW 124th Ave.
Tualatin, OR. 97062

Dear Mr. Reuland:

The public water system was flow tested on Friday, December 14, 2018, as requested. Test results are as follows:

HYDRANTS (see map, hydrant indicated as A27-89 and A27-90)

Flow Hydrant (A27-89) = 2nd Hydrant East of SW 124th Ave. (see map)
Pressure Hydrant (A27-90) = 1st Hydrant East of SW 124th Ave. (see map)
Static Pressure (A27-90) = 45-psig
Residual Pressure (A27-90) = 40-psig
Pitot Pressure (A27-89) = 26-psig
Observed Flow (A27-89) = 1,688-gpm
Calculated Flow @ 20psi (A27-89) = 4,029-gpm
Test Nozzle = 1 ea. 4 ½" Hose Monster

Thank you for the opportunity to work with you on this project.
Please call if there are any questions.

Sincerely,

Edward A Carlisle
2018.12.14 12:48:56-08'00'
Edward Carlisle, P.E.
Mechanical Engineer

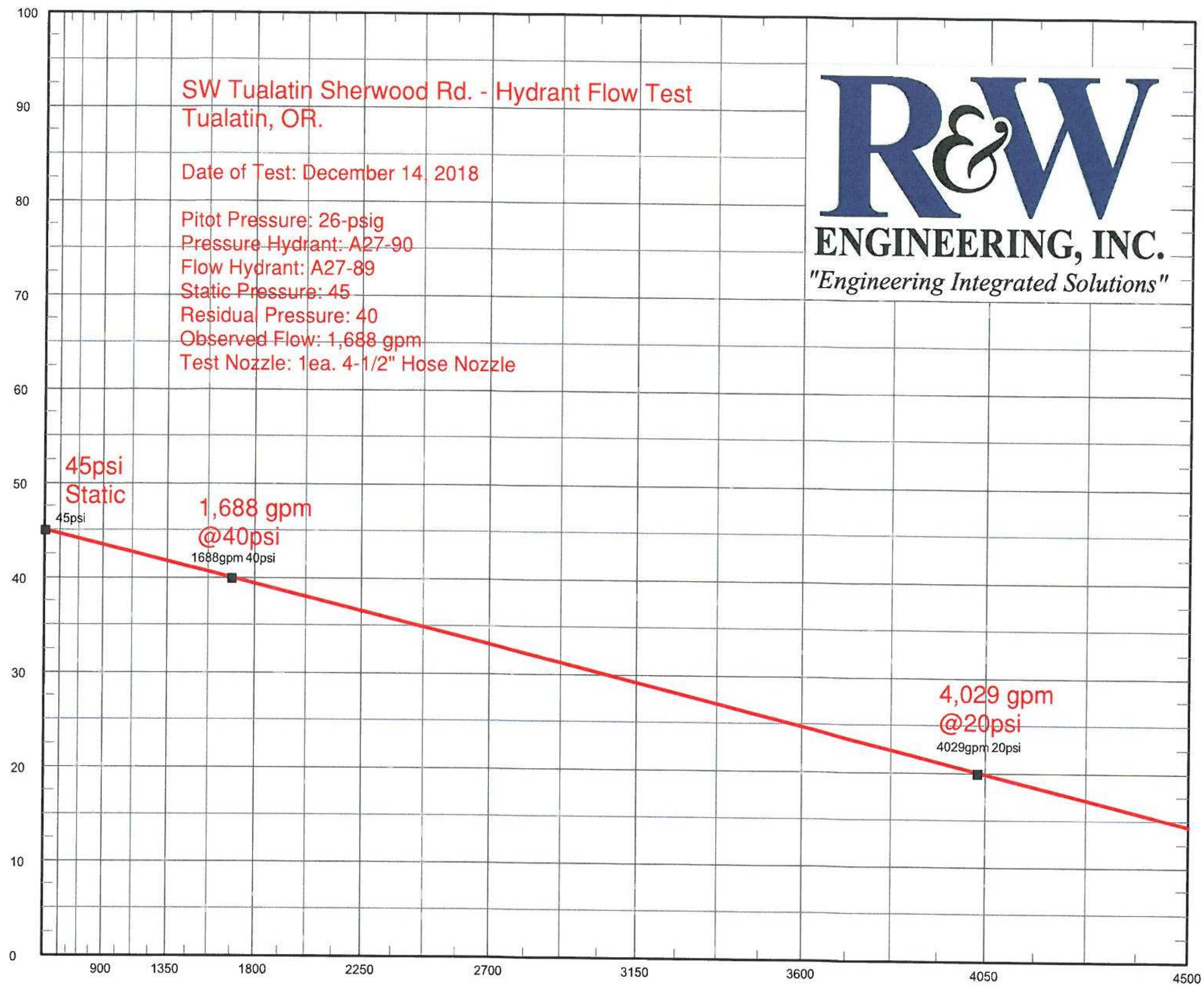
C: Nick Westendorf

REGISTERED PROFESSIONAL ENGINEER
19698
OREGON
MAY 5, 1998
EDWARD A. CARLISLE
EXPIRES 12/31/19

2018.12.14 12:49:22-08'00'

204 SE Stone Mill Drive, Suite 280
Vancouver, WA 98684
Phone: 503.292.6000

9615 SW Allen Boulevard, Suite 107
Beaverton, OR 97005
Phone: 503.292.6000 • Fax: 503.726.3326
Toll Free: 877.9RW.ENGR


SW Tualatin Sherwood Rd. - Hydrant Flow Test
Tualatin, OR.
Date of Test: December 14, 2018
Pitot Pressure: 26-psig
Pressure Hydrant: A27-90
Flow Hydrant: A27-89
Static Pressure: 45
Residual Pressure: 40
Observed Flow: 1,688 gpm
Test Nozzle: 1ea. 4-1/2" Hose Nozzle
R&W
ENGINEERING, INC.
"Engineering Integrated Solutions"
45psi
Static
45psi
1,688 gpm
@40psi
1688gpm 40psi
4,029 gpm
@20psi
4029gpm 20psi
100
90
80
70
60
50
40
30
20
10
0
900
1350
1800
2250
2700
3150
3600
4050
4500

HOSE MONSTER™

4" & 4 ½" CONNECTION
FLOW CHART

PSI	4" GPM	4 ½" GPM
10	1074	1047
11	1126	1098
12	1177	1147
13	1225	1194
14	1271	1239
15	1315	1282
16	1359	1324
17	1400	1365
18	1441	1405
19	1481	1443
20	1519	1481
21	1556	1517
22	1593	1553
23	1629	1588
24	1664	1622
25	1698	1655
26	1732	1688
27	1765	1720
28	1797	1752
29	1829	1783
30	1860	1813
31	1891	1843
32	1921	1873
33	1951	1902
34	1980	1930
35	2009	1959
36	2038	1986
37	2066	2014
38	2094	2041
39	2121	2068
40	2148	2094
41	2175	2120
42	2201	2146

PSI	4" GPM	4 ½" GPM
43	2227	2171
44	2253	2196
45	2278	2221
46	2304	2245
47	2329	2270
48	2353	2294
49	2378	2317
50	2402	2341
51	2426	2364
52	2449	2387
53	2473	2410
54	2496	2433
55	2519	2455
56	2542	2478
57	2564	2500
58	2587	2521
59	2609	2543
60	2631	2564
61	2653	2586
62	2674	2607
63	2696	2628
64	2717	2649
65	2738	2669
66	2759	2690
67	2780	2710
68	2801	2730
69	2821	2750
70	2842	2770
71	2862	2790
72	2882	2809
73	2902	2829
74	2922	2848
75	2941	2867

The readings on this chart are based on the orifice plate diameter.
It is the user's responsibility to verify that the correct chart and column is being used.

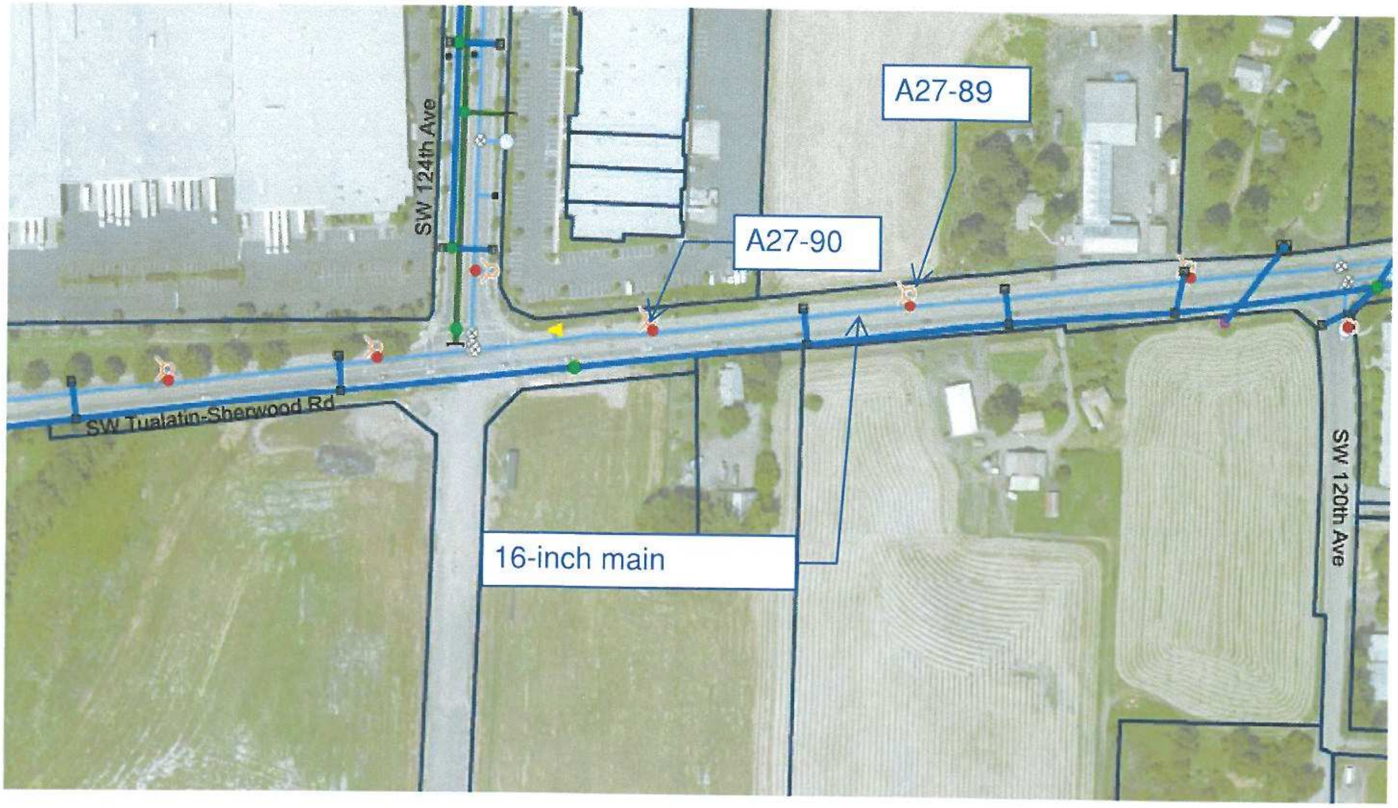
- **4"** Use this column if the connection to the Hose Monster is 4".
- **4 ½"** Use this column if the connection to the Hose Monster is 4 ½".

This chart is FM Approved for flow rate accuracy. Please call us or instruct the Authority Having Jurisdiction to call us if there are any questions. Additional copies of flow charts are available at: www.hosemonster.com

FM APPROVED

HOSE MONSTER COMPANY™

MANUFACTURED BY:
The Hose Monster Company
(888) 202-9987 Toll Free
(847) 434-0073 Fax
Service@FlowTest.com
www.HoseMonster.com


A27-89
A27-90
SW 124th Ave
SW Tualatin-Sherwood Rd
16-inch main
SW 120th Ave

WETLAND DELINEATION / DETERMINATION REPORT COVER FORM

This form must be included with any wetland delineation report submitted to the Department of State Lands for review and approval. A wetland delineation report submittal is not "complete" unless the fully completed and signed report cover form and the required fee are submitted. Attach this form to the front of an unbound report or include a hard copy of the completed form with a CD/DVD that includes a single PDF file of the report cover form and report (minimum 300 dpi resolution) and submit to: **Oregon Department of State Lands, 775 Summer Street NE, Suite 100, Salem, OR 97301-1279.** A single PDF attachment of the completed cover from and report may be e-mailed to **Wetland_Delineation@dsl.state.or.us**. For submittal of PDF files larger than 10 MB, e-mail instructions on how to access the file from your ftp or other file sharing website. Fees can be paid by check or credit card. Make the check payable to the Oregon Department of State Lands. To pay the fee by credit card, call 503-986-5200.

☒ Applicant ☐ Owner Name, Firm and Address:
Colin MacLaren, PWS, CERP, Wetland Ecologist
Portland General Electric Environmental Services
P.O. Box 4438
Portland, OR 97208

Business phone # **503-464-8061**
Mobile phone # (optional) **503-407-1923**
E-mail: **Colin.MacLaren@pgn.com**

☐ Authorized Legal Agent, Name and Address:

Business phone #
Mobile phone #
E-mail:

I either own the property described below or I have legal authority to allow access to the property. I authorize the Department to access the property for the purpose of confirming the information in the report, after prior notification to the primary contact.
Typed/Printed Name: Colin MacLaren Signature: C. L MacL
Date: 7-30-18 Special instructions regarding site access: Contact consultant.

Project and Site Information (using decimal degree format for lat/long.,enter centroid of site or start & end points of linear project)

Project Name: **12150 SW Tualatin-Sherwood Road**	Latitude: **45.366743** Longitude: **−122.803233**
Proposed Use: **Land use feasibility study**	Tax Map # **2S 1 27C**
Project Street Address (or other descriptive location): **12150 SW Tualatin-Sherwood Road**	Township **2 S** Range **1 W** Section **27** QQ **C** (SW) Tax Lot(s) **500 and 701**
City: **(none - mailing address is Tualatin)** County: **Washington**	Waterway: **N/A** River Mile: **N/A** NWI Quad(s): **Sherwood**

Wetland Delineation Information

Wetland Consultant Name, Firm and Address:
C. Mirth Walker, PWS
SWCA Environmental Consultants
1220 SW Morrison Street, Suite 700
Portland, OR 97205-2235

Phone # **503-224-0333 ext. 6250**
Mobile phone # **503-860-1708**
E-mail: **cmwalker@swca.com**

The information and conclusions on this form and in the attached report are true and correct to the best of my knowledge.
Consultant Signature: C. Mirth Walker
Date: **July 24, 2018**

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

Wetland/Waters Present? ☒ Yes ☐ No | Study Area size: **43.73** | Total Wetland Acreage: **0.15**

Check Box Below if Applicable:

☐ R-F permit application submitted
☐ Mitigation bank site
☐ Wetland restoration/enhancement project (not mitigation)
☐ Industrial Land Certification Program Site
☐ Reissuance of a recently expired delineation
Previous DSL # Expiration date _____

Fees:

☒ Fee payment submitted **$437 to be paid by c.c.**
☐ Fee ($100) for resubmittal of rejected report
☐ No fee for request for reissuance of an expired report

Other Information:

	Y	N	
Has previous delineation/application been made on parcel?	☒	☐	If known, previous DSL # WD2015-0137 and
Does LWI, if any, show wetland or waters on parcel?	☐	☒	WD2017-0121 (both off-site determinations)

For Office Use Only

DSL Reviewer: ______ Fee Paid Date: ___/___/___ DSL WD # ______
Date Delineation Received: ___/___/___ DSL Project # ______ DSL Site # ______
Scanned: ☐ Final Scan: ☐ DSL WN # ______ DSL App. # ______

12150 SW TUALATIN-SHERWOOD ROAD WETLAND DELINEATION REPORT

JULY 2018

PREPARED FOR

Hahn and Associates, Inc.

Portland General Electric

PREPARED BY

SWCA Environmental Consultants

12150 SW TUALATIN-SHERWOOD ROAD
WETLAND DELINEATION REPORT
TOWNSHIP 2 SOUTH, RANGE 1 WEST, SECTION 27C,
TAX LOTS 500 AND 701
WASHINGTON COUNTY, OREGON

Prepared for

Hahn and Associates, Inc.
434 NW 6th Avenue, Suite 203
Portland, OR 97209

and

Portland General Electric
P.O. Box 4438
Portland, OR 97208

Prepared by

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Portland, OR 97205
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www.swca.com

July 2018

SWCA Project No. 51141.01

CONTENTS

Appendices

Figures

Tables

1 INTRODUCTION

SWCA Environmental Consultants (SWCA) conducted a wetland delineation on a property located at 12150 SW Tualatin-Sherwood Road, Washington County, Oregon (Figure 1). The approximately 43.73-acre study area includes the entirety of Tax Lots 500 and 701 on Tax Map 2S 1 27C, Washington County (Figures 2 and 3). The center of the study area is located at 45.366743° N and −122.803233° W. This report presents the results of the delineation of three small wetlands and a short segment of stream that emerges from a drain tile on the site.

No wetland delineations have previously been conducted within the study area but two off-site wetland determinations (WDs) were made by the Oregon Department of State Lands (DSL) under WD2015-0137 and WD2017-0121. Both determinations stated that there may be wetlands or waterways on the property.

2 LANDSCAPE SETTING AND LAND USE

The study area is within the Saum Creek–Tualatin River (Hydrologic Unit Code 170900100504) watershed (McCune et al. 2018), and within the Willamette Valley Prairie Terraces ecoregion (Thorson et al. 2003). The study area consists of young mixed deciduous-coniferous forest in the southwest, a road construction staging area with large piles of soil in the northwest, a residence with several barns and outbuildings in the north, and hayfields and pastures in the east. The site is bordered by SW Tualatin-Sherwood Road to the north, SW 120th Avenue to the east, Tigard Sand and Gravel to the southeast and south, and the ongoing construction of SW 124th Avenue to the west. Surrounding land use varies greatly and consists of agriculture, light industrial, recreation, and resource extraction. The Tigard Sand and Gravel operation immediately adjacent to the eastern study area boundary contains two ponds. A large drain pipe with flowing water was observed east of the study area on the Tigard Sand and Gravel site; it is likely that this feeds into the drain tile system on the subject site, which discharges immediately south of Tualatin-Sherwood Road.

Topography within the study area generally slopes down moderately to the northeast. The plant community in the agricultural areas was dominated by pasture grasses such as tall fescue (*Schedonorus arundinaceus*) and weedy forbs, including lesser hawkbit (*Leontodon saxatilis*), English plantain (*Plantago lanceolata*), and many others. The young forest in the southwest was dominated by Douglas-fir (*Pseudotsuga menziesii*), English hawthorn (*Crataegus monogyna*), and Himalayan blackberry (*Rubus armeniacus*). The ruderal pasture in the southeast part of the study area contained weedy herbs and shrubs such as sweet vernal grass (*Anthoxanthum odoratum*) and Himalayan blackberry, remnant prairie species such as common woolly sunflower (*Eriophyllum lanatum*), and remnant dry forest species such as yerba buena (*Clinopodium douglasii*).

3 SITE ALTERATIONS

The study area has been significantly altered from its natural condition. The Oregon Rapid Wetland Protocol (ORWAP) and Stream Functional Assessment Method (SFAM) map viewer (McCune et al. 2018) describes the pre-settlement vegetation class as being dominated by Douglas-fir. The study area is currently dominated by non-native pasture grasses and weedy herbs. The young mixed deciduous-coniferous forest in the southwest corner of the study area was cleared sometime between 1994 and 2000 (Google Earth 2018). The ruderal pasture in the southeast part of the study area was historically forested but cleared between 2003 and 2004 (Google Earth 2018). Aerial photographs are included in Appendix A.

A residence was removed from the study area along SW 120th Avenue between 2014 and 2015 (Google Earth 2018). Construction of a new segment of SW 124th Avenue began along the western study area boundary in 2016. Large amounts of soil have been stockpiled in the western part of the study area as part of construction operations. Drain tile discharges into a small stream basin in the northeast part of the study area, immediately south of Tualatin-Sherwood Road. The farmer of the land confirmed the presence and location of the drain tile during our site visit.

4 PRECIPITATION DATA AND ANALYSIS

The WETS (short for wetlands climate analysis) station used to obtain historic precipitation data for the project site was the Portland- Hillsboro Airport, OR3908 station (National Oceanic and Atmospheric Administration [NOAA] 2018). The WETS table shows that the study area receives an average of 38.53 inches of rainfall per year. The WETS table lists the growing season start and end dates as February 23 to November 18, for a total of 269 days.

Recent precipitation data and daily normals were obtained from the Portland- Hillsboro Airport weather station via the NOAA Regional Climate Centers Applied Climate Information System AgACIS website (NOAA 2018). Table 1 shows the monthly precipitation averages for the 3 months prior to SWCA's July 3, 2018, site visit.

Table 1. Precipitation Data – Monthly Averages Based on the Climate Period 1971–2000

Month	Average (inches)	30% Chance Will Have		Observed Precipitation (inches)	Within Normal Range?
		Less Than	More Than		
		(inches)			
June	1.46	0.87	1.78	0.65	Below normal (44%)
May	1.90	1.13	2.30	0.11	Below normal (6%)
April	2.46	1.65	2.94	3.32	Above normal (134%)

Source: NOAA 2018.

Rainfall for the water year to date was 28.53 inches at the time of the July 3 site visit, which is 6.92 inches below normal. The 2 weeks before the site visit received 0.06 inch of rainfall. Overall precipitation was drier than normal at the time of the site visit. Precipitation data are included in Appendix B.

5 METHODS

The methodology used for determining the presence of wetlands followed the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (Version 2.0)* (United States Army Corps of Engineers [USACE] 2010), used by both USACE and DSL. Fieldwork for documenting site conditions and delineating the wetland and waters boundaries was conducted on July 3, 2018, by C. Mirth Walker, Professional Wetland Scientist (PWS), Tom Dee, PWS, and Stacy Benjamin, Principal Ecologist with Wetland Solutions Northwest, LLC. Soils, vegetation, and hydrology were documented at 10 sample plot locations on standardized wetland determination data forms (Appendix C). Wetland boundaries and sample point locations were marked in the field with pin flags and streamers, which were removed after the locations were collected with a resource-grade Trimble GeoXT global positioning system (GPS) unit. The sample plots and wetland/water boundaries can be relocated in the field if requested by the agencies. Representative ground-level site photographs are included in Appendix D. A list of vegetation observed on-site and the wetland indicator status of plants is included in Appendix E.

Non-wetland waters were delineated according to *Regulatory Guidance Letter 05-05* (Riley 2005) and Oregon Administrative Rules (OARs) (DSL 2013). Ordinary High Water Line (OHWL) determinations were based on observations of scour, sediment deposition, and debris wracks. The OHWL of the stream (drain tile outflow) was recorded with the GPS unit.

The Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS 2018a) depicts nine soil units within the study area (Figure 4). Huberly silt loam is listed as a hydric soil, and Aloha and Quatama may contain hydric inclusions of Huberly or Verboort soils. (NRCS 2018b) (Table 2).

Table 2. Soil Map Units

Map Unit Symbol	Map Unit Name	Hydric	Hydric Inclusion
1	Aloha silt loam	No	Huberly
5B, D	Briedwell stony silt loam, 0%-7%, 12-20% slopes	No	–
21B	Hillsboro loam, 3 to 7 percent slopes	No	–
22	Huberly silt loam	Yes	Verboort
37A, B, C	Quatama loam, 0%-3%, 3%-7%, 7%-12% slopes	No	Huberly
38C	Saum silt loam, 7%-12% slopes	No	–

Source: NRCS 2018a, b.

6 DESCRIPTION OF ALL WETLANDS AND OTHER NON-WETLAND WATERS

6.1 Wetlands

Three wetlands were identified within the study area, totaling 0.15 acre (Figures 6a and 6b). The wetlands are described below in detail.

Wetland A (0.10 acre)

Wetland A is classified as a palustrine emergent (PEM) wetland using the *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979) and classified as a Valley Slope (SV) wetland using the *Guidebook for Hydrogeomorphic (HGM)-based Assessment of Oregon Wetland and Riparian Sites: Statewide Classification and Profiles* (Adamus 2001). The wetland is in the central eastern part of the study area, about 350 feet south of the residence. Hydrology is provided primarily by a high groundwater table in addition to direct precipitation and surface runoff. Hydrophytic vegetation was dominated by perennial rye grass (*Lolium perenne*) and western marsh cudweed (*Gnaphalium palustre*). Wetland A is contained entirely within the study area. The wetland boundary was determined by a rise in topography, change in plant community, and absence of hydrology indicators.

Wetland B (0.03 acre)

Wetland B is classified as a PEM wetland and as a SV wetland. The wetland is in the southeast part of the study area. Hydrology is provided by a high groundwater table associated with the large pond to the east on the Tigard Sand and Gravel site. Hydrophytic vegetation was dominated by black bent (*Agrostis gigantea*) and lamp rush (*Juncus effusus*). Wetland B extends outside the study area to the east.

Wetland C (0.02 acre)

Wetland C is classified as a palustrine emergent PEM wetland and as a depressional closed non-permanently flooded wetland. The wetland is in the southeast corner of the study area. Hydrology is provided by surface runoff, direct precipitation, and groundwater. Hydrophytic vegetation was dominated by black bent and reed canary grass (*Phalaris arundinacea*). Wetland C is contained entirely within the study area. The wetland is located in a small depression.

6.2 Non-wetland Waters

One stream was identified within the study area. The feature is described below and presented in Figures 6a, 6b, 7a, and 7c.

Stream 1 (0.002 acre)

Stream 1 is located in the northeast part of the study area. This reach of the stream is classified as riverine upper perennial (R3) and riverine flow-through. A drain tile outlets into a small basin, about 8 feet wide and 10 feet long, where the toe of slope meets SW Tualatin-Sherwood Road. The abundance of water emanating from the outlet during a period of prolonged dry, hot weather indicates a high likelihood of perennial flow. Site topography indicates that the area upslope from the outlet was likely historically a stream channel that was altered by tiling and farming practices. Shadows of the likely location of the drain tiles can be seen in the August 2012 aerial photograph in Appendix A.

The bed and banks within the small basin are stable and armored with large rock. The stream flows north and outside the study area through two 32-inch concrete culverts under Tualatin-Sherwood Road. Vegetation is dominated by reed canary grass.

6.3 Uplands

The majority of the site was upland. The young mixed deciduous-coniferous forest in the southwest portion of the study area was dominated by upland plants such as Douglas-fir, big-leaf maple (*Acer macrophyllum*), oceanspray or creambush (*Holodiscus discolor*), and madrone (*Arbutus menziesii*). The ruderal pasture contained upland species such as sweet vernal grass, cheat grass (*Bromus tectorum*), common woolly sunflower, and yerba buena. Uplands within the agricultural portions of the site were dominated by pasture grasses and weedy herbs such as lesser hawkbit and English plantain. Wetlands within the study area occurred in concave swales or depressions and uplands typically occurred on convex slopes or flat areas. Drain tile effectively conveys water from the site.

7 DEVIATION FROM LWI OR NWI

The National Wetlands Inventory does not depict wetlands within the study area (Figure 5). The ponds to the east on the Tigard Sand and Gravel property and a wetland off-site to the southeast are illustrated. The Tualatin Local Wetland Inventory does not include the study area.

8 MAPPING METHOD

The wetland boundaries, OHWL, and sample plot locations were collected with a Trimble GeoXT GPS unit. Map accuracy is within 1 m. The delineation is illustrated on Figures 6a and 6b.

9 ADDITIONAL INFORMATION

The study area is not within a 100-year floodplain (Federal Emergency Management Agency 2016). The stream is not mapped as Essential Salmonid Habitat (McCune et al. 2018; StreamNet 2018) and it is unlikely that any fish can access this small basin.

10 RESULTS AND CONCLUSION

Three wetlands and one stream were delineated within the study area. Each feature is summarized in Table 3.

Table 3. Wetland Delineation Summary

Feature ID	Size (acres)	Cowardin	HGM	Centroid Latitude	Centroid Longitude
Wetland A	0.10	PEM	Slope	45.368189	-122.802068
Wetland B	0.03	PEM	Slope	45.364701	-122.801902
Wetland C	0.02	PEM	Depressional	45.364379	-122.801863
Stream 1	0.002	R3	Riverine	45.369612	-122.801260

11 REQUIRED DISCLAIMER

This report documents the investigation, best professional judgment, and conclusions of the investigators. It is correct and complete to the best of our knowledge. It should be considered a Preliminary Jurisdictional Determination of wetlands and other waters and used at your own risk unless it has been reviewed and approved in writing by the Oregon DSL in accordance with Oregon Administrative Rules 141-090-0005 through 141-090-0055.

12 LIST OF PREPARERS

Tom Dee, PWS
Wetland Scientist

and

C. Mirth Walker, PWS
Senior Wetland Scientist

13 LITERATURE CITED AND REVIEWED

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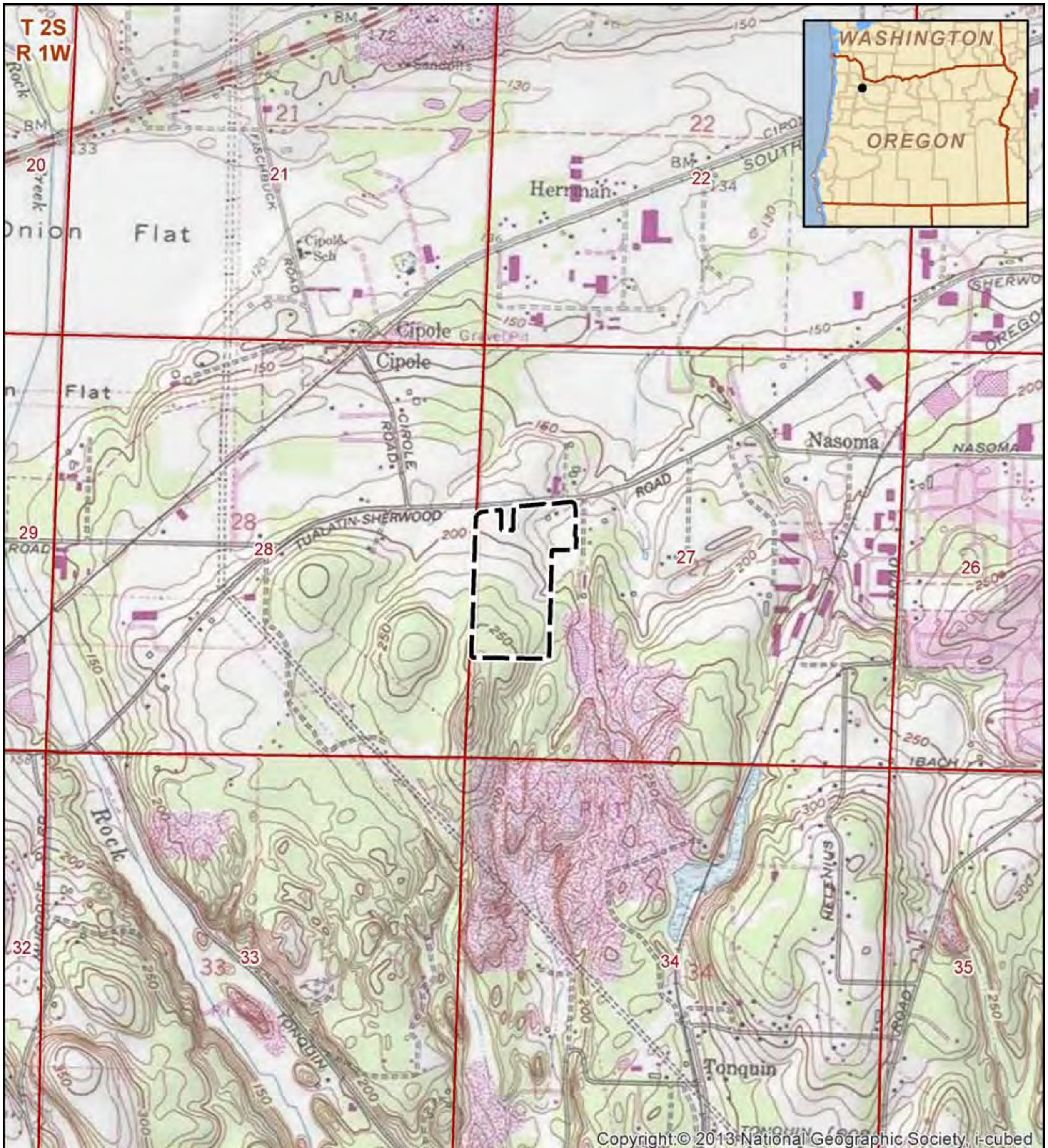

Legend

Study Area

0 1,000 2,000 Feet

0 250 500 Meters

Source: USGS 7.5' topographic quadrangle: Sherwood, OR (1986).

12150 SW Tualatin-Sherwood Road
Wetland Delineation
Washington County, OR

SWCA ENVIRONMENTAL CONSULTANTS
1220 SW Morrison, Suite 700
Portland, OR 97205-2235
www.swca.com
503.224.0333

Project: 51141.01

July 10, 2018

Figure 1. Site location map.

Figure 2. Tax lot map with aerial photograph.

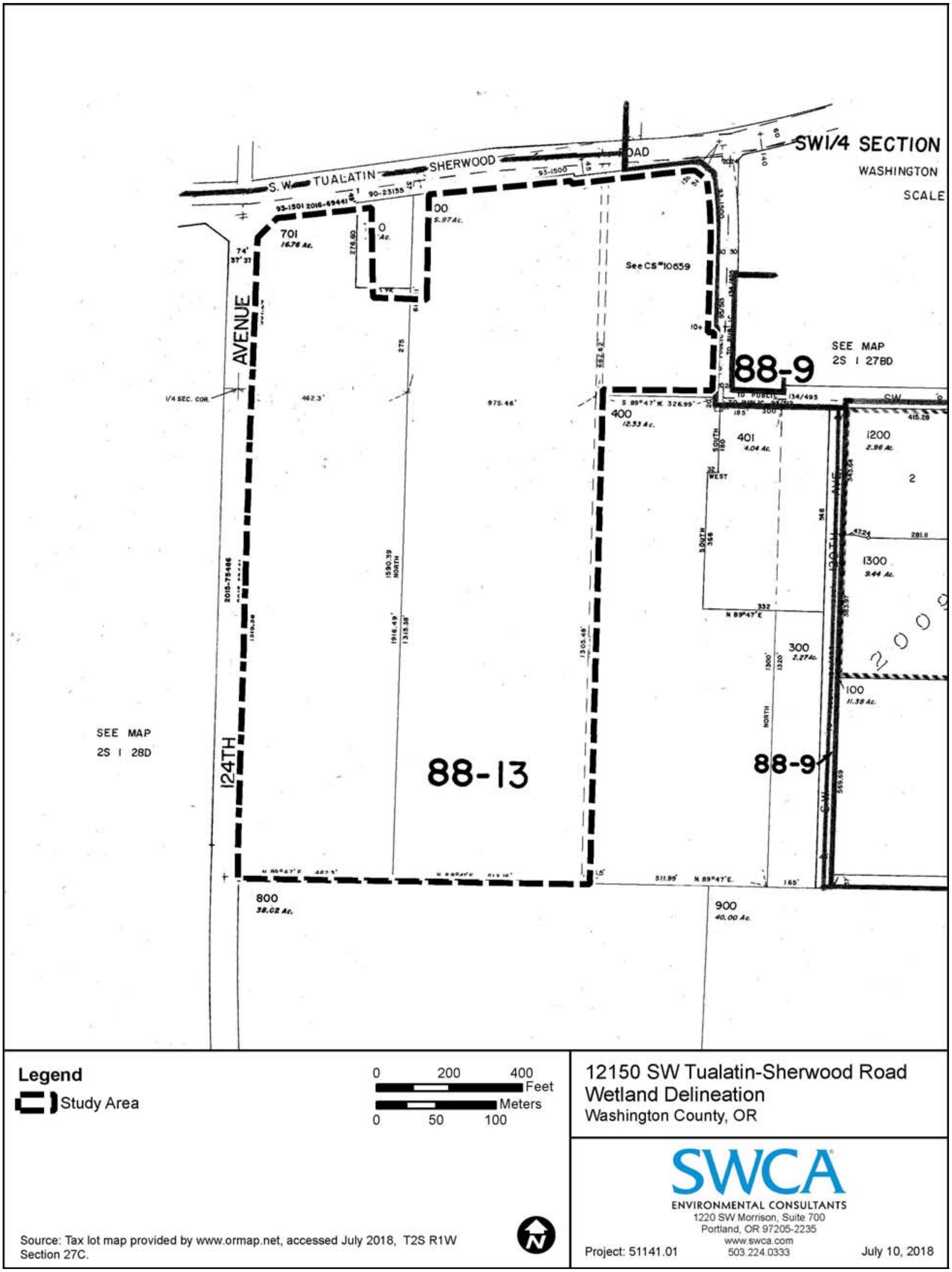

Figure 3. Tax lot map from ORmap with paper base.

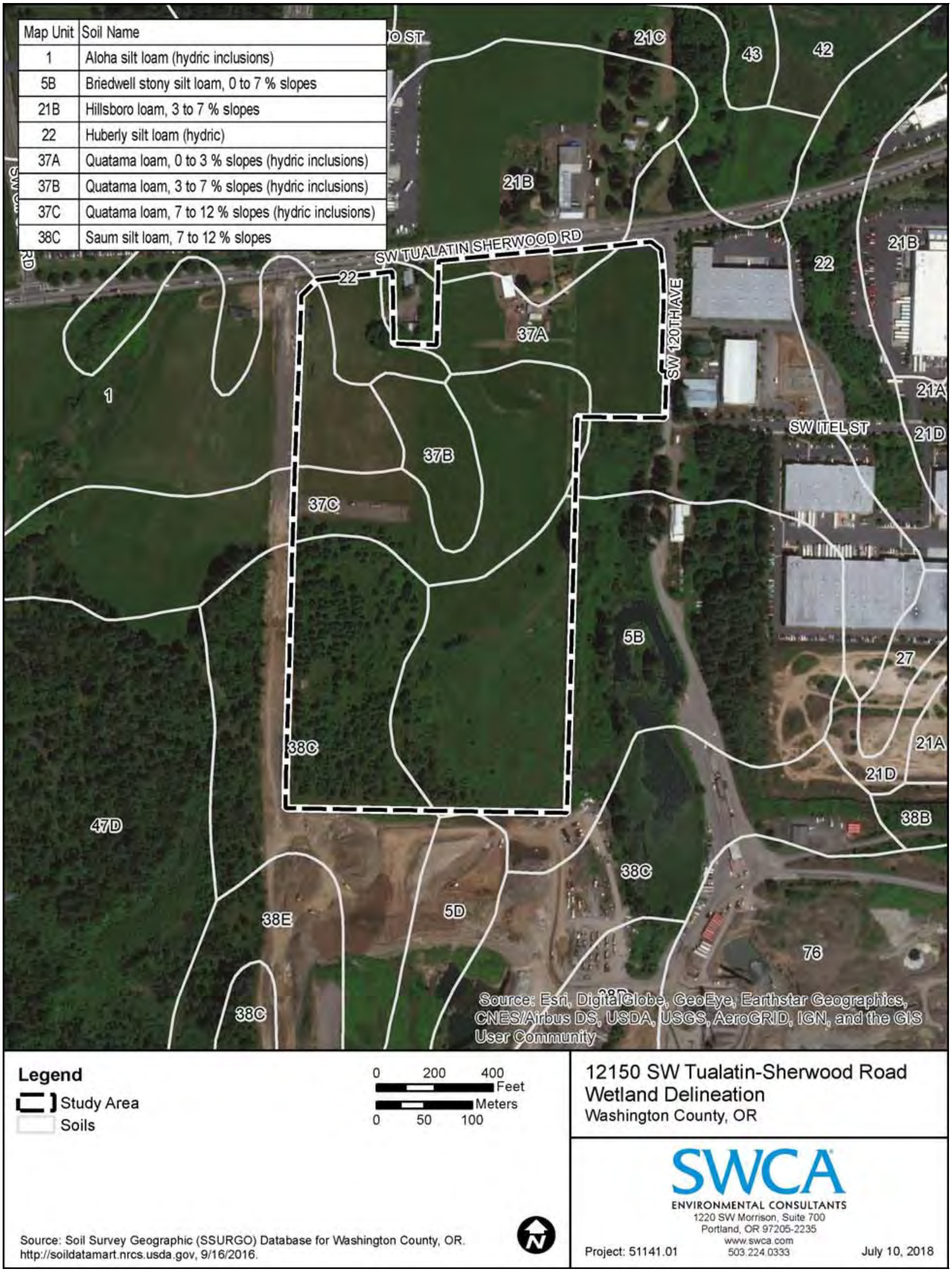

Figure 4. Soils map.

Figure 5. National Wetlands Inventory map.

Figure 6a. Wetland and waters delineation map (color north).

Figure 6b. Wetland and waters delineation map (color south).

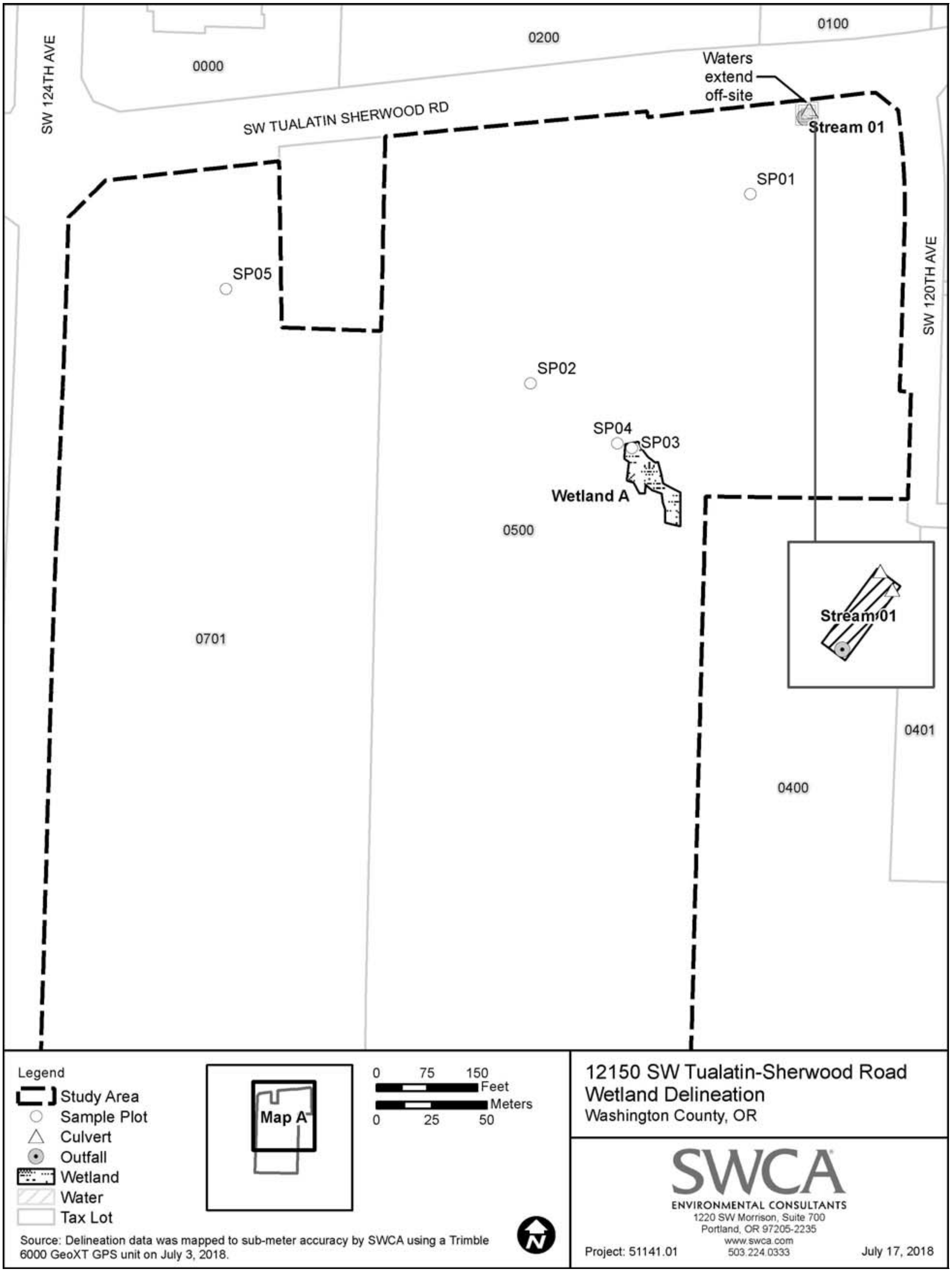

Figure 7a. Wetland and waters delineation map (black and white north).

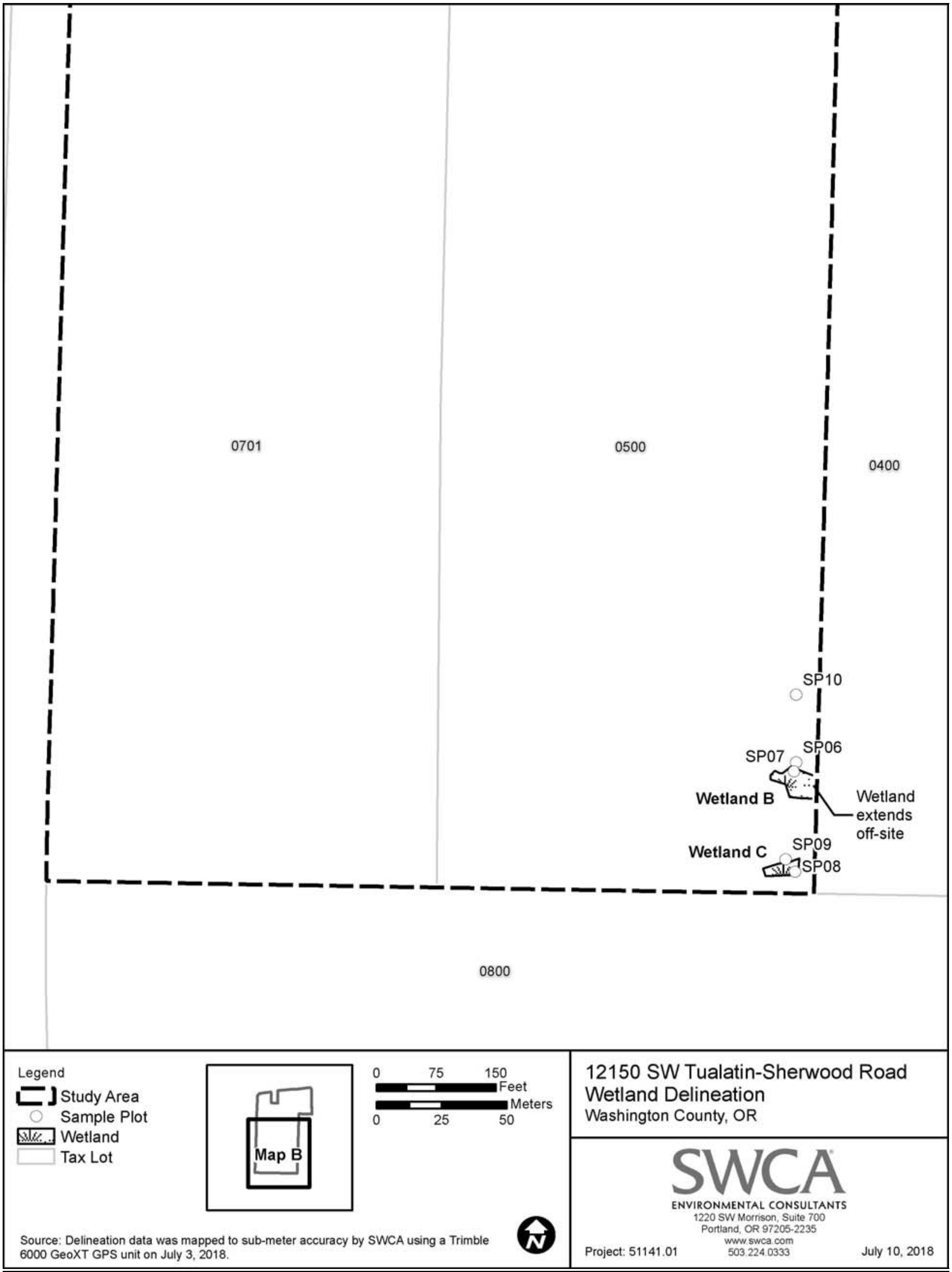

Figure 7b. Wetland and waters delineation map (black and white south).

APPENDIX A

Aerial Photographs


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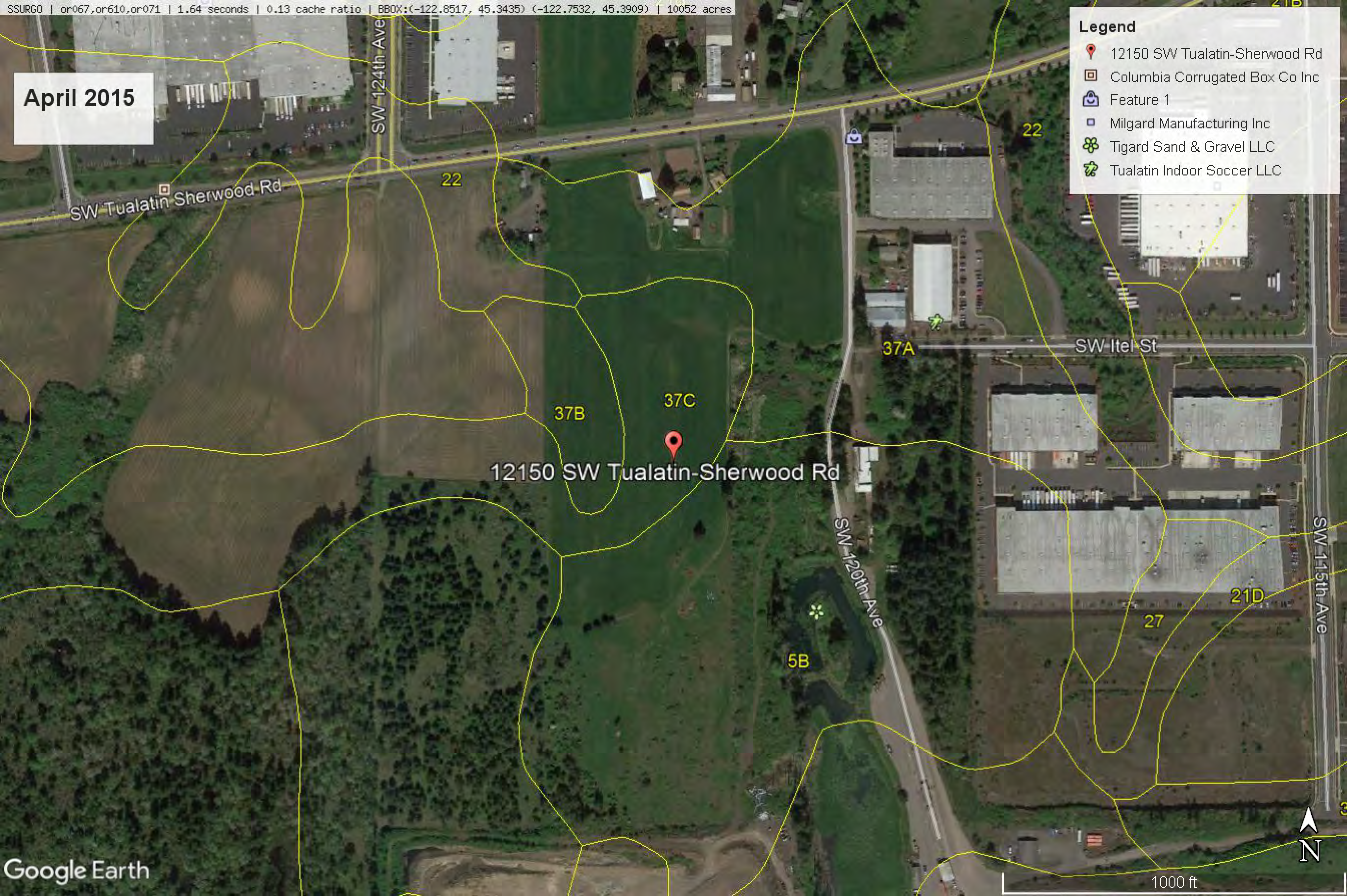
May 2017
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW Tualatin Sherwood Rd
22
37A
37B
37C
5B
21D
27
SW Itel St
SW 120th Ave
SW 115th Ave
12150 SW Tualatin-Sherwood Rd
Google Earth
1000 ft
N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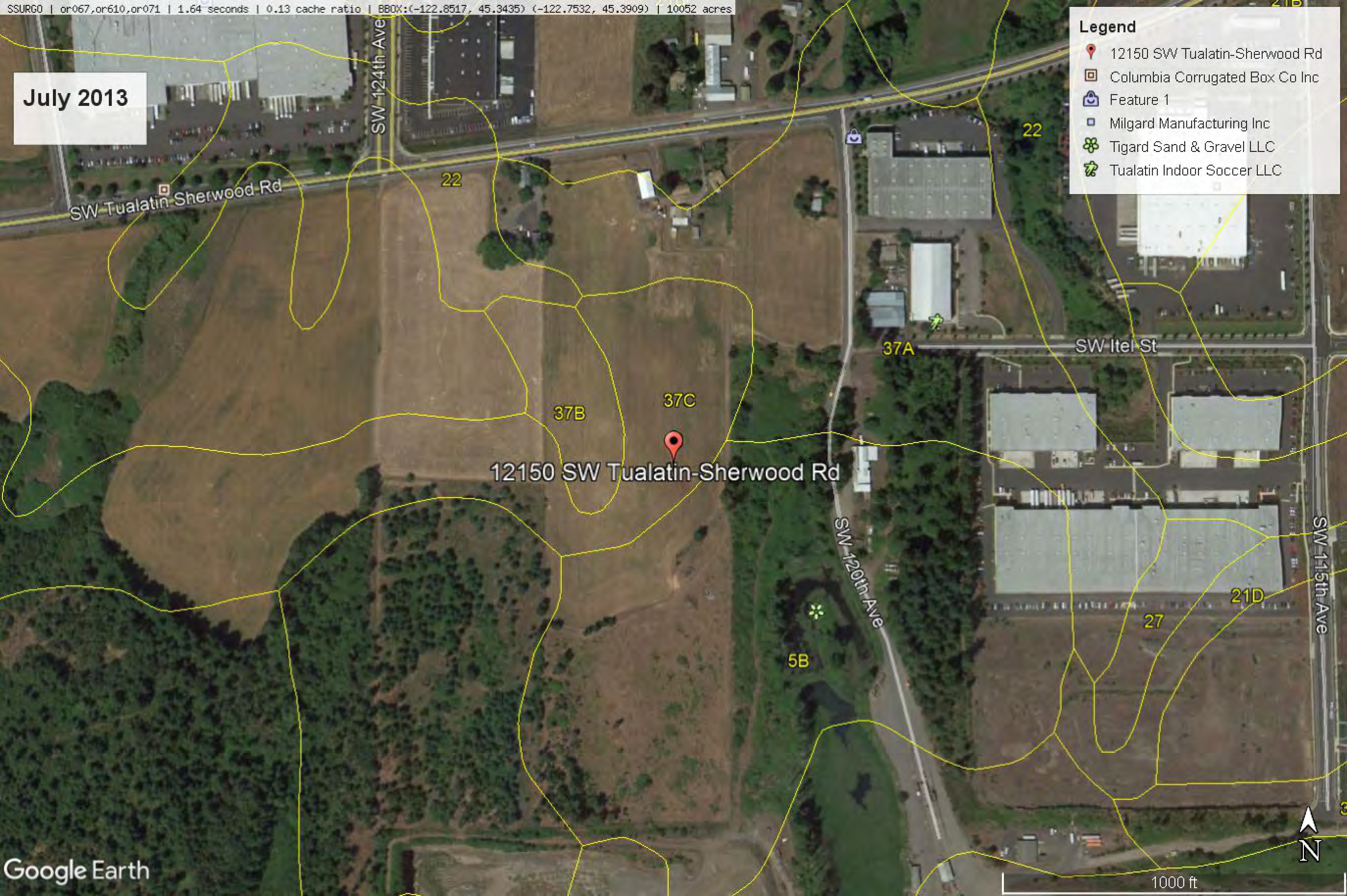
April 2015
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin Sherwood Rd
SW Itel St
SW 120th Ave
SW 115th Ave
22
37A
37B
37C
5B
27
21D
12150 SW Tualatin-Sherwood Rd
1000 ft
N
Google Earth


SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
December 2013
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin Sherwood Rd
22
22
37A
SW Itel St
37B
37C
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
SW 115th Ave
21D
27
5B
N
1000 ft
Google Earth


SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
July 2013
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin-Sherwood Rd
22
37A
SW Itel St
37B
37C
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
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5B
1000 ft
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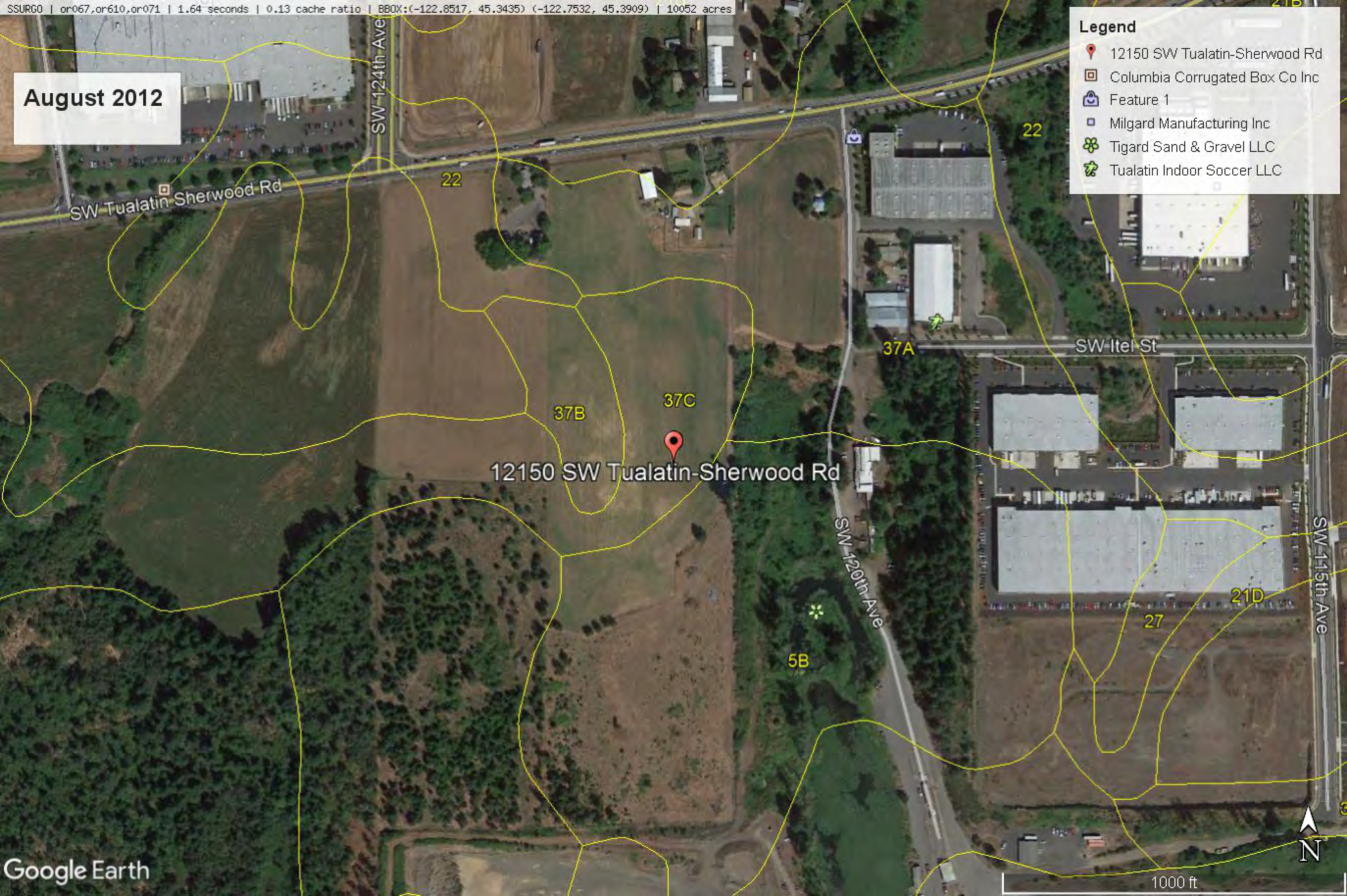
Google Earth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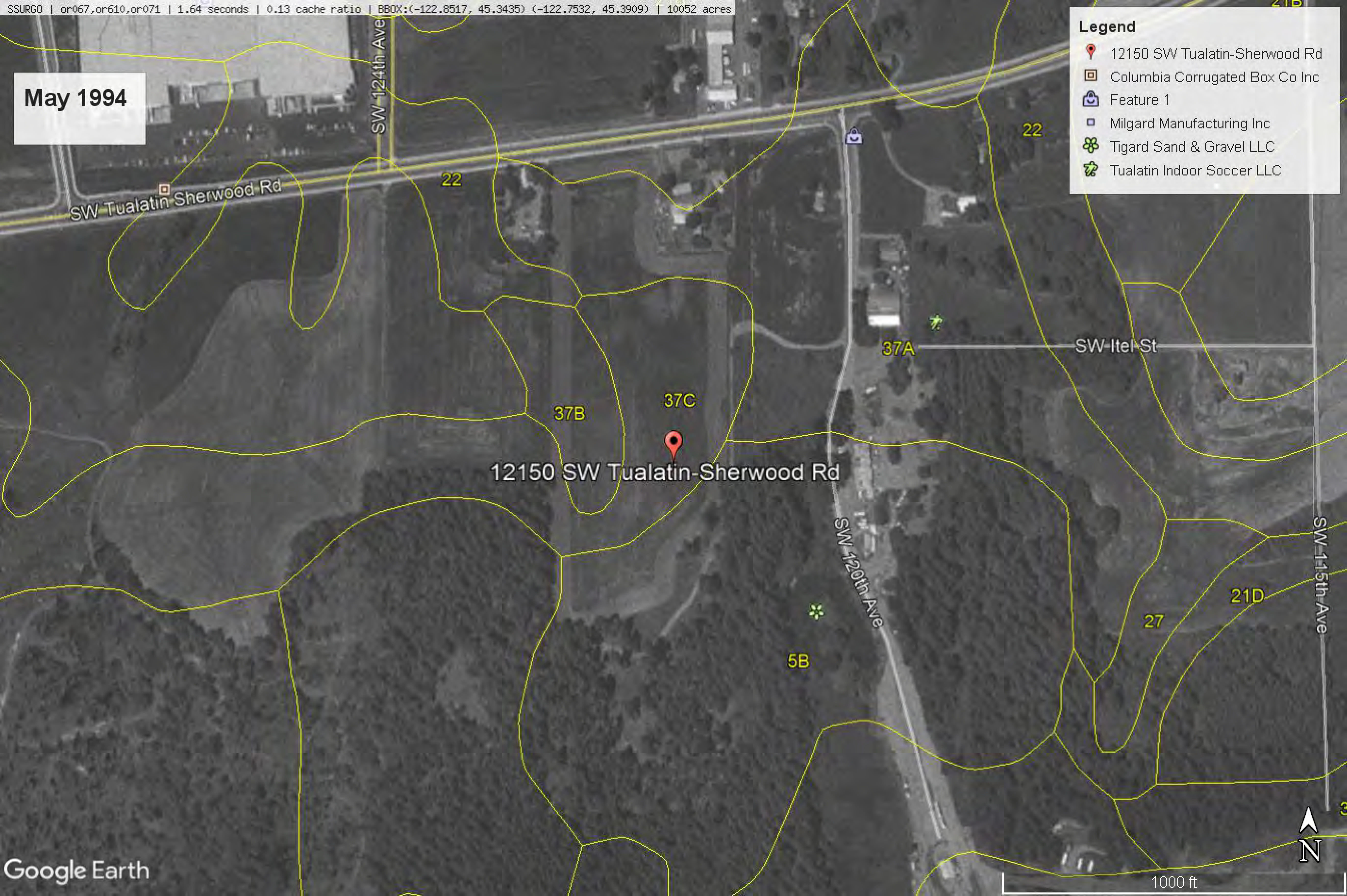
August 2012
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin Sherwood Rd
SW Itel St
SW 120th Ave
SW 115th Ave
22
37A
37B
37C
5B
21D
27
12150 SW Tualatin-Sherwood Rd
1000 ft
N
Google Earth

SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
November 2011
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin Sherwood Rd
22
37A
37B
37C
SW Itel St
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
SW 115th Ave
21D
27
5B
N
1000 ft
Google Earth


SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
May 2010
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin Sherwood Rd
22
22
37A
SW Itel St
37B
37C
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
5B
21D
27
SW 115th Ave
1000 ft
N
Google Earth


SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
June 2006
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW Tualatin Sherwood Rd
SW 124th Ave
SW Itel St
SW 120th Ave
SW 115th Ave
22
37A
37B
37C
5B
27
21D
12150 SW Tualatin-Sherwood Rd
1000 ft
N
Google Earth

SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
July 2000
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin-Sherwood Rd
22
37A
SW Itel St
37B
37C
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
SW 115th Ave
5B
27
21D
1000 ft
N
Google Earth


SSURGO | or067,or610,or071 | 1.64 seconds | 0.13 cache ratio | BBOX:(-122.8517, 45.3435) (-122.7532, 45.3909) | 10052 acres
May 1994
Legend
12150 SW Tualatin-Sherwood Rd
Columbia Corrugated Box Co Inc
Feature 1
Milgard Manufacturing Inc
Tigard Sand & Gravel LLC
Tualatin Indoor Soccer LLC
SW 124th Ave
SW Tualatin-Sherwood Rd
22
37A
SW Itel St
37B
37C
12150 SW Tualatin-Sherwood Rd
SW 120th Ave
SW 115th Ave
21D
27
5B
N
1000 ft
Google Earth

APPENDIX B

Precipitation Data

Assessing Rainfall for the Preceding 3-Month Period (Antecedent Rainfall)
WETS Station: Hillsboro OR3908, 1971-2000
Measured Rainfall: PORTLAND-HILLSBORO Airport, 2017-2018 Water Year

Prior Month Most Recent First		WETS Rainfall Percentile 30th (inches)	WETS Rainfall Percentile 70th (inches)	Measured Rainfall inches	Condition Dry, Wet, Normal	Condition Value (1=dry, 2=normal, 3=wet)	Month Weight	Multiply previous 2 columns
1st	June	0.87	1.78	0.65	Dry	1	3	3
2nd	May	1.13	2.30	0.11	Dry	1	2	2
3rd	April	1.65	2.94	3.32	Wet	3	1	3
				4.08				

Month	30th	70th	Measured Rainfall	*Normals*
Jan-18	3.70	6.93	5.17	*5.76*
Feb-18	3.17	5.65	2.15	*4.72*
Mar-18	2.96	4.59	2.79	*3.93*
Apr-18	1.65	2.94	3.32	*2.46*
May-18	1.13	2.30	0.11	*1.90*
Jun-18	0.87	1.78	0.65	*1.46*
Jul-18	0.22	0.76		*0.61*
Aug-18	0.25	1.12		*0.93*
Sep-18	0.72	2.03		*1.61*
Oct-17	1.45	3.27	4.04	*2.68*
Nov-17	4.07	7.21	7.38	*6.03*
Dec-17	4.44	7.67	2.92	*6.44*
	24.63	46.25	28.53	*38.53*

Sum **8**

Rainfall of prior period was: **drier** than normal (sum is 6-9), **normal** (sum is 10-14), **wetter** than normal (sum is 15-18) — **Drier than Normal**

Climate Period 1981-2010	
Oct. 1	Jan. 1
Departure from Normal*	Departure from Normal*
-6.92	**-6.11**
WYTD*	CYTD*
28.53	14.19
Normal	*Normal*
35.45	*20.30*
*As of survey on:	7/3/2018

Measured Rainfall source: http://agacis.rcc-acis.org/
Washington County FIPS: 41067
Normals are calculated based on climate period 1971 - 2000

APPENDIX C

Wetland Determination Data Forms

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP1**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): 3

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.369281 Long: -122.801548 Datum: NAD 1983

Soil Map Unit Name: 37A Quatama loam, 0-3% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)

Are Vegetation ____ ,Soil ____ , or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____ ,Soil ____ , or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ____	No **X**
Hydric Soil Present?	Yes ____	No **X**
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Precipitation prior to fieldwork: Drier than normal

Remarks:

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0% = Total Cover		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
	0% = Total Cover		
Herb Stratum (Plot size: 5' r)			
1. *Schedonorus arundinaceus*	55%	Yes	FAC
2. *Dactylis glomerata*	30%	Yes	FACU
3. *Cirsium arvense*	5%	No	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	90% = Total Cover		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
	0% = Total Cover		

% Bare Ground in Herb Stratum 10%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	60	x 3 =	180
FACU species	30	x 4 =	120
UPL species	0	x 5 =	0
Column Totals:	90 (A)		300 (B)

Prevalence Index = B/A = 3.33

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation

____ 2 - Dominance Test is >50%

____ 3 - Prevalence Index is ≤3.0[1]

____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

____ 5 - Wetland Non-Vascular Plants[1]

____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? **Yes** ____ **No** **X**

Remarks: Entered by: KL QC by: TJD/cmv

SOIL

Sampling Point: **SP1**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-5	7.5YR 3/2	100					SiL	
5-16	7.5YR 3/2	98	5YR 4/6	2	C	M	SiCL	& concretions of the same color

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Dry color redox 5YR 6/6 at 5-16"

Depth (inches): ____

Hydric Soil Present? **Yes** ____ **No** **X**

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)
One piece white porcelain tile at 4", 1.5" triangle.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	-
Water Table Present?		X	-
Saturation Present? (includes capillary fringe)		X	-

Wetland Hydrology Present? **Yes** ____ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Drain tiled; outflow at T-S Road

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP2**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): 1

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.368481 Long: -122.802790 Datum: NAD 1983

Soil Map Unit Name: 37C Quatama loam, 7-12% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks)

Are Vegetation ___ ,Soil ___ , or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___ ,Soil ___ , or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?		X
Hydric Soil Present?	X	
Wetland Hydrology Present?		X
Is the Sampled Area within a Wetland?		X

Precipitation prior to fieldwork: Drier than normal

Remarks:
Barely hydric.

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0%	= Total Cover	
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
	0%	= Total Cover	
Herb Stratum (Plot size: 5' r)			
1. *Agrostis species*	15%	Yes	FAC ?
2. *Lolium perenne*	15%	Yes	FAC
3. *Leontodon saxatilis*	15%	Yes	FACU
4. *Anthoxanthum odoratum*	15%	Yes	FACU
5. *Daucus carota*	15%	Yes	FACU
6. *Holcus lanatus*	10%	No	FAC
7. *Plantago lanceolata*	5%	No	FACU
8. *Dactylis glomerata*	5%	No	FACU
9. *Crepis species*	5%	No	FACU/NOL
10.			
11.			
	100%	= Total Cover	
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
	0%	= Total Cover	
% Bare Ground in Herb Stratum	0%		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	40	x 3 =	120
FACU species	55	x 4 =	220
UPL species	0	x 5 =	0
Column Totals:	95 (A)		340 (B)

Prevalence Index = B/A = 3.58

Hydrophytic Vegetation Indicators:

___ 1 - Rapid Test for Hydrophytic Vegetation
___ 2 - Dominance Test is >50%
___ 3 - Prevalence Index is ≤3.0[1]
___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
___ 5 - Wetland Non-Vascular Plants[1]
___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes ___ No X

Remarks: Entered by: KL QC by: TJD/cmv
90 is difficult, hayed field. Probably more upland spp not ID'd

SOIL

Sampling Point: **SP2**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 4/1	98	5YR 4/6	2	C	M,PL	SiL	ORZ
3-6	10YR 4/1	95	7.5YR 5/6	3	C	M	SiCL	
			5YR 4/6	2	C	PL		
6-16	7.5YR 3/2	99	7.5YR 4/6	1	C	M	SiCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
X Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)
Surface grass layer plowed into subsurface soils at 12". Less redox at depth.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
X Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches):	-
Water Table Present?	Yes ___	No X	Depth (inches):	-
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches):	-

Wetland Hydrology Present? **Yes** ___ **No** X

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Entered by: KL QC by: TJD/cmv
ORZ 0-6 inches only. Surface compacted from machinery. Land form would not pond; tiled.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP3**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): 1

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.368229 Long: -122.802193 Datum: NAD 1983

Soil Map Unit Name: 37C Quatama loam, 7-12% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks)

Are Vegetation ___ ,Soil ___ , or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___ ,Soil ___ , or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ___	**Is the Sampled Area within a Wetland?** Yes **X** No ___
Hydric Soil Present?	Yes **X**	No ___	
Wetland Hydrology Present?	Yes **X**	No ___	

Precipitation prior to fieldwork: Drier than normal

Remarks: Wetland A

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0%		
Herb Stratum (Plot size: 5' r)			
1. *Lolium perenne*	40%	Yes	FAC
2. *Gnaphalium palustre*	20%	Yes	FACW
3. *Schedonorus arundinaceus*	10%	No	FAC
4. *Anthemis cotula*	5%	No	FACU
5. *Rorippa curvisiliqua*	5%	No	OBL
6. *Kickxia elatine*	5%	No	FAC
7. *Raphanus sativus*	3%	No	NOL
8. *Leontodon saxatilis*	2%	No	FACU
9.			
10.			
11.			
= Total Cover	90%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		

% Bare Ground in Herb Stratum 10%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	5	x 1 = 5
FACW species	20	x 2 = 40
FAC species	55	x 3 = 165
FACU species	7	x 4 = 28
UPL species	3	x 5 = 15
Column Totals:	90 (A)	253 (B)

Prevalence Index = B/A = 2.81

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes **X** No ___

Remarks: Entered by: KL QC by: TJD/cmw

SOIL

Sampling Point: **SP3**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-5	10YR 3/2	95	7.5YR 5/8	5	C	M	SiCL	
5-13	10YR 3/2	95	2.5YR 3/6	5	C	M	SiCL	
13-18	10Y 3/1	98	5YR 4/6	2	C	M	CL	gley1

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- X Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes **X** No ___

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- X Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): -
Water Table Present?	Yes ___	No X	Depth (inches): -
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): -

Wetland Hydrology Present? Yes **X** No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Moist, tire ruts

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP4**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): 1

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.368246 Long: -122.8022778 Datum: NAD 1983

Soil Map Unit Name: 37C Quatama loam, 7-12% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)

Are Vegetation ____ ,Soil ____ , or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____ ,Soil ____ , or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes X	No	**Is the Sampled Area within a Wetland?**	**Yes ____ No X**
Hydric Soil Present?	Yes X	No		
Wetland Hydrology Present?	Yes	No X		

Precipitation prior to fieldwork: Drier than normal

Remarks:
12' West of Wetland A

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0% = Total Cover		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
	0% = Total Cover		
Herb Stratum (Plot size: 5' r)			
1. *Schedonorus arundinaceus*	25%	Yes	FAC
2. *Agrostis species*	25%	Yes	FAC ?
3. *Lolium perenne*	20%	Yes	FAC
4. *Leontodon saxatilis*	10%	No	FACU
5. *Plantago lanceolata*	5%	No	FACU
6. *Anthemis cotula*	5%	No	FACU
7. *Gnaphalium palustre*	5%	No	FACW
8. *Rorippa curvisiliqua*	3%	No	OBL
9. *Plantago major*	2%	No	FAC
10.			
11.			
	100% = Total Cover		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
	0% = Total Cover		

% Bare Ground in Herb Stratum 0%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	3	x 1 =	3
FACW species	5	x 2 =	10
FAC species	72	x 3 =	216
FACU species	20	x 4 =	80
UPL species	0	x 5 =	0
Column Totals:	100 (A)		309 (B)

Prevalence Index = B/A = 3.09

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ 5 - Wetland Non-Vascular Plants[1]
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Entered by: KL QC by: TJD/cmv

SOIL

Sampling Point: **SP4**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/2	98	7.5YR 5/6	2	C	M	grSiCL	
4-12	7.5YR 4/2	95	5YR 4/6	3	C	M	grSiCL	
			7.5YR 4/6	2	C	M		

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
_X_ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? **Yes** **X** **No** ___

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)
With angular gravels

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
_X_ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): -
Water Table Present?	Yes ___	No X	Depth (inches): -
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): -

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

Dry (not moist). Tiled.

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP5**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 0

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.368833 Long: -122.804572 Datum: NAD 1983

Soil Map Unit Name: 22 Huberly silt loam NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)

Are Vegetation ____ ,Soil ____ , or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____ ,Soil ____ , or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ____
Hydric Soil Present?	Yes ____	No **X**
Wetland Hydrology Present?	Yes ____	No **X**

Is the Sampled Area within a Wetland? **Yes** ____ **No** **X**

Precipitation prior to fieldwork: Drier than normal

Remarks:

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1. *Acer species*	2%	Yes	FAC ?
2.			
3.			
4.			
5.			
= Total Cover	2%		
Herb Stratum (Plot size: 5' r)			
1. *Lolium perenne*	50%	Yes	FAC
2. *Agrostis gigantea*	20%	Yes	FAC
3. *Anthoxanthum odoratum*	10%	No	FACU
4. *Dactylis glomerata*	5%	No	FACU
5. *Phleum pratense*	5%	No	FAC
6. *Alopecurus pratensis*	5%	No	FAC
7. *Holcus lanatus*	3%	No	FAC
8. *Daucus carota*	2%	No	FACU
9. *Avena sativa*	1%	No	UPL
10. *Sonchus asper*	1%	No	FACU
11. *Centaurium erythraea*	1%	No	FAC
= Total Cover	103%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		

% Bare Ground in Herb Stratum 0%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	86	x 3 =	258
FACU species	18	x 4 =	72
UPL species	1	x 5 =	5
Column Totals:	105 (A)		335 (B)

Prevalence Index = B/A = 3.19

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? **Yes** **X** **No** ____

Remarks: Entered by: KL QC by: TJD/cmv

Non-native maple trees on corner of house tax lot.

SOIL

Sampling Point: **SP5**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR 3/2	100					SiL	
8-16+	10YR 3/2	98	7.5YR 5/6	2	C	M	SiCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ______

Depth (inches): ______

Hydric Soil Present? Yes ______ **No** **X**

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ______	No X	Depth (inches):	-
Water Table Present?	Yes ______	No X	Depth (inches):	-
Saturation Present? (includes capillary fringe)	Yes ______	No X	Depth (inches):	-

Wetland Hydrology Present? Yes ______ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018
Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP6**
Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701
Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): convex Slope (%): 3
Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.364754 Long: -122.801851 Datum: NAD 1983
Soil Map Unit Name: 5B Briedwell stony silt loam, 0-7% slopes NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)
Are Vegetation ____ ,Soil ____ , or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____ ,Soil ____ , or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No			
Hydrophytic Vegetation Present?	X		Is the Sampled Area within a Wetland?	Yes	No X
Hydric Soil Present?		X			
Wetland Hydrology Present?		X			

Precipitation prior to fieldwork: Drier than normal
Remarks:

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0% = Total Cover		
Sapling/Shrub Stratum (Plot size: 10' r)			
1. *Rubus armeniacus*	10%	Yes	FAC
2.			
3.			
4.			
5.			
	10% = Total Cover		
Herb Stratum (Plot size: 5' r)			
1. *Agrostis gigantea*	40%	Yes	FAC
2. *Holcus lanatus*	20%	Yes	FAC
3. *Festuca species*	20%	Yes	FAC ?
4. *Dactylis glomerata*	5%	No	FACU
5. *Leucanthemum vulgare*	5%	No	FACU
6. *Parentucellia viscosa*	5%	No	FAC
7. *Centaurium erythraea*	5%	No	FAC
8. *Jacobaea vulgaris*	1%	No	FACU
9. *Oenothera biennis*	1%	No	FACU
10. *Madia elegans*	1%	No	NOL
11.			
	103% = Total Cover		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
	0% = Total Cover		
% Bare Ground in Herb Stratum 0%			

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 4 (A)
Total Number of Dominant Species Across All Strata: 4 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	100	x 3 =	300
FACU species	12	x 4 =	48
UPL species	1	x 5 =	5
Column Totals:	113 (A)		353 (B)

Prevalence Index = B/A = 3.12

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ 5 - Wetland Non-Vascular Plants[1]
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Entered by: KL QC by: TJD/cmw

SOIL

Sampling Point: **SP6**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	5YR 3/2	99	5YR 4/4	1	C	M	Stoney SiL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Stone

Depth (inches): 8

Hydric Soil Present? Yes ___ No **X**

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): -
Water Table Present?	Yes ___	No X	Depth (inches): -
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): -

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road | City/County: - / Washington | Sampling Date: 7/3/2018
Applicant/Owner: PGE - Hahn and Associates / Ken Itel | State: OR | Sampling Point: **SP7**
Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin | Section, Township, Range: 27C, 2S, 1W, TLs 500/701
Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): concave | Slope (%): 0
Subregion (LRR): A, Northwest Forests and Coasts | Lat: 45.364722 | Long: -122.801860 | Datum: NAD 1983
Soil Map Unit Name: 5B Briedwell stony silt loam, 0-7% slopes | NWI classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?	X	
Hydric Soil Present?	X	
Wetland Hydrology Present?	X	

Is the Sampled Area within a Wetland? Yes X No ____

Precipitation prior to fieldwork: Drier than normal
Remarks: Wetland B
12' south of SP6

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0%		
Herb Stratum (Plot size: 5' r)			
1. *Agrostis gigantea*	60%	Yes	FAC
2. *Holcus lanatus*	20%	Yes	FAC
3. *Schedonorus arundinaceus*	10%	No	FAC
4. *Parentucellia viscosa*	5%	No	FAC
5. *Ranunculus repens*	5%	No	FAC
6. *Phleum pratense*	1%	No	FAC
7.			
8.			
9.			
10.			
11.			
= Total Cover	101%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		

% Bare Ground in Herb Stratum: 0%

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)
Total Number of Dominant Species Across All Strata: 2 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	101	x 3 =	303
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	101 (A)		303 (B)

Prevalence Index = B/A = 3.00

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Entered by: KL QC by: TJD/cmw
JUNEFF in wetland and JUNTEN

SOIL

Sampling Point: **SP7**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	5YR 2.5/1	100					grSiL	
4-9	5YR 3/3	90	5YR 4/1	10	D	M	grSiL	
9-16	7.5YR 3/4	80	5YR 4/1	20	D	M	grSiL	w/ MN nodules

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
X Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? Yes **X** No ___

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)
1/2 - 4" gravels

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

X Surface Water (A1)
X High Water Table (A2)
X Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes X	No ___	Depth (inches):	1/2" nearby
Water Table Present?	Yes X	No ___	Depth (inches):	4
Saturation Present? (includes capillary fringe)	Yes X	No ___	Depth (inches):	2

Wetland Hydrology Present? Yes **X** No ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP8**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): 0

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.364374 Long: -122.801840 Datum: NAD 1983

Soil Map Unit Name: 5B Briedwell stony silt loam, 0-7% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ___ (If no, explain in Remarks)

Are Vegetation ___ ,Soil ___ , or Hydrology ___ significantly disturbed? Are "Normal Circumstances" present? Yes X No ___

Are Vegetation ___ ,Soil ___ , or Hydrology ___ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No ___
Hydric Soil Present?	Yes **X**	No ___
Wetland Hydrology Present?	Yes **X**	No ___

Is the Sampled Area within a Wetland? **Yes X No ___**

Precipitation prior to fieldwork: Drier than normal

Remarks: Wetland C

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0%		
Herb Stratum (Plot size: 5' r)			
1. *Agrostis gigantea*	20%	Yes	FAC
2. *Phalaris arundinacea*	10%	Yes	FACW
3. *Schedonorus arundinaceus*	5%	No	FAC
4. *Rumex crispus*	2%	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover	37%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		
% Bare Ground in Herb Stratum	63%		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	10	x 2 =	20
FAC species	27	x 3 =	81
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	37 (A)		101 (B)

Prevalence Index = B/A = 2.73

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ 5 - Wetland Non-Vascular Plants[1]
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? **Yes X No ___**

Remarks: Entered by: KL QC by: TJD/cmv

SOIL

Sampling Point: **SP8**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-7	10YR 3/3	100					CL	blocky + platy
7-14	10YR 2/1	98	5YR 4/6	2	C	M	L	
14-18	10Y 2.5/1	98	5YR 4/6	2	C	M,PL	grSiL	gley 1

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- X Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: ___

Depth (inches): ___

Hydric Soil Present? **Yes** X **No** ___

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- X Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- X Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- X Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- X Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes		No	X	Depth (inches):	-
Water Table Present?	Yes	X	No		Depth (inches):	13
Saturation Present? (includes capillary fringe)	Yes	X	No		Depth (inches):	10

Wetland Hydrology Present? **Yes** X **No** ___

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road City/County: - / Washington Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel State: OR Sampling Point: **SP9**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): convex Slope (%): 3

Subregion (LRR): A, Northwest Forests and Coasts Lat: 45.364416 Long: -122.801888 Datum: NAD 1983

Soil Map Unit Name: 5B Briedwell stony silt loam, 0-7% slopes NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)

Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes **X**	No	**Is the Sampled Area within a Wetland?**	
Hydric Soil Present?	Yes	No **X**		
Wetland Hydrology Present?	Yes	No **X**	**Yes** ____	**No X**

Precipitation prior to fieldwork: Drier than normal

Remarks:

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0%		
Herb Stratum (Plot size: 5' r)			
1. *Trifolium pratense*	30%	Yes	FACU
2. *Holcus lanatus*	20%	Yes	FAC
3. *Agrostis gigantea*	20%	Yes	FAC
4. *Parentucellia viscosa*	10%	No	FAC
5. *Daucus carota*	10%	No	FACU
6. *Leucanthemum vulgare*	2%	No	FACU
7. *Centaurium erythraea*	1%	No	FAC
8. *Hypericum perforatum*	1%	No	FACU
9. *Rumex crispus*	1%	No	FAC
10. *Trifolium arvense*	1%	No	NOL
11.			
= Total Cover	96%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		
% Bare Ground in Herb Stratum	4% rock		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 67% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	52	x 3 =	156
FACU species	43	x 4 =	172
UPL species	1	x 5 =	5
Column Totals:	96 (A)		333 (B)

Prevalence Index = B/A = 3.47

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ 5 - Wetland Non-Vascular Plants[1]
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes **X** No ____

Remarks: Entered by: KL QC by: TJD/cmw

SOIL

Sampling Point: **SP9**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 3/2	100					Stoney SiL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10)
- ___ Red Parent Material (TF2)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Refusal

Depth (inches): Large rocks (basalt outcrop)

Hydric Soil Present? Yes ___ **No** **X**

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Surface Soil Cracks (B6)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ___ Salt Crust (B11)
- ___ Aquatic Invertebrates (B13)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres along Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Stunted or Stressed Plants (D1) (**LRR A**)
- ___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ___ Drainage Patterns (B10)
- ___ Dry-Season Water Table (C2)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ FAC-Neutral Test (D5)
- ___ Raised Ant Mounds (D6) (**LRR A**)
- ___ Frost-Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?		X	-
Water Table Present?		X	-
Saturation Present? (includes capillary fringe)		X	-

Wetland Hydrology Present? Yes ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys and Coast Region

Project/Site: 12150 SW Tualatin-Sherwood Road   City/County: - / Washington   Sampling Date: 7/3/2018

Applicant/Owner: PGE - Hahn and Associates / Ken Itel   State: OR   Sampling Point: **SP10**

Investigator(s): C. Mirth Walker, Tom Dee, and Stacy Benjamin   Section, Township, Range: 27C, 2S, 1W, TLs 500/701

Landform (hillslope, terrace, etc.): hillslope   Local relief (concave, convex, none): concave   Slope (%): 1

Subregion (LRR): A, Northwest Forests and Coasts   Lat: 45.364987   Long: -122.801859   Datum: NAD 1983

Soil Map Unit Name: 5B Briedwell stony silt loam, 0-7% slopes   NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No ____ (If no, explain in Remarks)

Are Vegetation ____ ,Soil ____ , or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes X No ____

Are Vegetation ____ ,Soil ____ , or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

	Yes	No
Hydrophytic Vegetation Present?	X	
Hydric Soil Present?		X
Wetland Hydrology Present?		X

Is the Sampled Area within a Wetland? Yes ____ No X

Precipitation prior to fieldwork: Drier than normal

Remarks:

VEGETATION

Tree Stratum (Plot size: 30' r)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover	0%		
Sapling/Shrub Stratum (Plot size: 10' r)			
1.			
2.			
3.			
4.			
5.			
= Total Cover	0%		
Herb Stratum (Plot size: 5' r)			
1. *Alopecurus pratensis*	20%	Yes	FAC
2. *Holcus lanatus*	20%	Yes	FAC
3. *Schedonorus arundinaceus*	20%	Yes	FAC
4. *Juncus tenuis*	20%	Yes	FAC
5. *Danthonia californica*	20%	Yes	FAC
6. *Carex leptopoda*	2%	No	FAC
7.			
8.			
9.			
10.			
11.			
= Total Cover	102%		
Woody Vine Stratum (Plot size: 10' r)			
1.			
2.			
= Total Cover	0%		
% Bare Ground in Herb Stratum	0%		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	0	x 2 =	0
FAC species	102	x 3 =	306
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	102 (A)		306 (B)

Prevalence Index = B/A = 3.00

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- X 2 - Dominance Test is >50%
- ____ 3 - Prevalence Index is ≤3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ 5 - Wetland Non-Vascular Plants[1]
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

Hydrophytic Vegetation Present? Yes X No ____

Remarks: Entered by: KL   QC by: TJD/cmv

SOIL

Sampling Point: **SP10**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 2/2	100					SiL	
6-12+	10YR 3/1	99	7.5YR 4/6	1	C	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

___ Histosol (A1)
___ Histic Epipedon (A2)
___ Black Histic (A3)
___ Hydrogen Sulfide (A4)
___ Depleted Below Dark Surface (A11)
___ Thick Dark Surface (A12)
___ Sandy Mucky Mineral (S1)
___ Sandy Gleyed Matrix (S4)
___ Sandy Redox (S5)
___ Stripped Matrix (S6)
___ Loamy Mucky Mineral (F1) **(except MLRA 1)**
___ Loamy Gleyed Matrix (F2)
___ Depleted Matrix (F3)
___ Redox Dark Surface (F6)
___ Depleted Dark Surface (F7)
___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

___ 2 cm Muck (A10)
___ Red Parent Material (TF2)
___ Very Shallow Dark Surface (TF12)
___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: Clay

Depth (inches): 12"

Hydric Soil Present? Yes ___ No **X**

Remarks: S = sand; Si = silt; C = clay; L = loam or loamy; co = coarse; f = fine; vf = very fine; + = heavy (more clay); - = light (less clay)
Dry compacted clay refusal at 12"

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

___ Surface Water (A1)
___ High Water Table (A2)
___ Saturation (A3)
___ Water Marks (B1)
___ Sediment Deposits (B2)
___ Drift Deposits (B3)
___ Algal Mat or Crust (B4)
___ Iron Deposits (B5)
___ Surface Soil Cracks (B6)
___ Inundation Visible on Aerial Imagery (B7)
___ Sparsely Vegetated Concave Surface (B8)
___ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
___ Salt Crust (B11)
___ Aquatic Invertebrates (B13)
___ Hydrogen Sulfide Odor (C1)
___ Oxidized Rhizospheres along Living Roots (C3)
___ Presence of Reduced Iron (C4)
___ Recent Iron Reduction in Tilled Soils (C6)
___ Stunted or Stressed Plants (D1) (**LRR A**)
___ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

___ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
___ Drainage Patterns (B10)
___ Dry-Season Water Table (C2)
___ Saturation Visible on Aerial Imagery (C9)
___ Geomorphic Position (D2)
___ Shallow Aquitard (D3)
___ FAC-Neutral Test (D5)
___ Raised Ant Mounds (D6) (**LRR A**)
___ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ___	No X	Depth (inches): -
Water Table Present?	Yes ___	No X	Depth (inches): -
Saturation Present? (includes capillary fringe)	Yes ___	No X	Depth (inches): -

Wetland Hydrology Present? **Yes** ___ **No** **X**

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Entered by: KL QC by: TJD/cmv

APPENDIX D

Ground-level Site Photographs


Photo-Location Map 1 (North)
July 3, 2018
SW Tualatin-Sherwood Rd
SW 120th Ave
PP3-N & PP4-E
PP1-W
SP01
PP5-W
PP21-N & PP22-SE
PP6-N
SP02
PP2-N
SP04
SP03
PP8-S
PP9-NW & PP11-S
PP7-SE
PP10-W
PP12-NW
PP13-SE & PP20-E
300 ft
N
Google Earth
©2018 Google

Photo-Location Map 2 (Wetland A)

July 3, 2018

Photo-Location Map 3 (South)

July 3, 2018


Photo-Location Map 4 (Wetlands B and C)
July 3, 2018
SP10
PP16-E
SP06
SP07
PP15-N
PP19-S
SP09
PP19-S
PP17-W
SP08
Google Earth
©2018 Google
N
100 ft

Photopoint 1. View west of house and outbuildings.

Photopoint 2. View north of house and outbuildings.

Photopoint 3. View north of two culverts under Tualatin-Sherwood Road.

Photopoint 4. View east of culverts and SW 120th Avenue in background.

Photopoint 5. Drain tile staged near barn.

Photopoint 6. Drain tile staged near garden.

Photopoint 7. High water table in tire divot in Wetland A.

Photopoint 8. View south of Wetland A.

Photopoint 9. View northwest of Wetland A.

Photopoint 10. View west of Wetland A.

Photopoint 11. View south of Wetland A and tire divot.

Photopoint 12. View northwest of Wetland A and drain tile signature.

Photopoint 13. View off-site to the southeast of Wetland A – typical wetland vegetation near the off-site pipe.

Photopoint 14. View south of typical upland vegetation on higher terrace.

Photopoint 15. View north of Wetland B.

Photopoint 16. High water table in Wetland B (SP7).

Photopoint 17. High water table in Wetland C (SP8).

Photopoint 18. View south from Wetland C towards Tigard Sand and Gravel equipment and large cut tree trunks.

Photopoint 19. View south from Wetland B towards Wetland C in corner and slope up to Tigard Sand and Gravel site.

Photopoint 20. Off-site pipe with flowing water.

Photopoint 21. View north from SP5.

Photopoint 22. View southeast from SP5.

APPENDIX E

Vegetation List

12150 SW Tualatin-Sherwood Road Wetland Delineation Vegetation List July 3, 2018			
Common Name	Scientific Name	Wetland Indicator Status	Native and Invasive, Noxious
maple	*Acer species*	FAC ?	non-native
black bent	*Agrostis gigantea*	FAC	non-native
bentgrass	*Agrostis species*	FAC ?	-
field meadow-foxtail	*Alopecurus pratensis*	FAC	non-native
bur chervil	*Anthriscus caucalis*	NOL	non-native
stinking chamomile	*Anthemis cotula*	FACU	non-native
large sweet vernal grass	*Anthoxanthum odoratum*	FACU	non-native
madrone	*Arbutus menziesii*	NOL	native
oat	*Avena sativa*	UPL	non-native
downy cheat grass	*Bromus tectorum*	NOL	non-native
spiny plumeless thistle	*Carduus acanthoides*	NOL	noxious
taper-fruit short-scale sedge	*Carex leptopoda*	FAC	native
European centaury	*Centaurium erythraea*	FAC	non-native
Canadian thistle	*Cirsium arvense*	FAC	invasive, noxious
bull thistle	*Cirsium vulgare*	FACU	invasive, noxious
yerba buena; Oregon-tea	*Clinopodium douglasii*	FACU	native
English hawthorn	*Crataegus monogyna*	FAC	non-native
hawksbeard	*Crepis species*	FACU/NOL	-
hedgehog dogtail	*Cynosurus echinatus*	NOL	non-native
orchard grass	*Dactylis glomerata*	FACU	non-native
California wild oat grass	*Danthonia californica*	FAC	native
Queen Anne's-lace	*Daucus carota*	FACU	non-native
common woolly sunflower	*Eriophyllum lanatum*	NOL	native
fescue	*Festuca species*	FAC to NOL	-
western marsh cudweed	*Gnaphalium palustre*	FACW	native
oceanspray or creambush	*Holodiscus discolor*	FACU	native
common velvet grass	*Holcus lanatus*	FAC	non-native
common St. John's-wort	*Hypericum perforatum*	FACU	noxious
stinking willie	*Jacobaea vulgaris*	FACU	noxious
lamp rush	*Juncus effusus*	FACW	native
lesser poverty rush	*Juncus tenuis*	FAC	native
sharp-leaf cancerwort	*Kickxia elatine*	FAC	non-native
lesser hawkbit	*Leontodon saxatilis*	FACU	non-native
ox-eye daisy	*Leucanthemum vulgare*	FACU	non-native
perennial rye grass	*Lolium perenne*	FAC	non-native
common madia	*Madia elegans*	NOL	native
Chile tarweed	*Madia sativa*	NOL	native
king's-cureall, common evening primrose	*Oenothera biennis*	FACU	native

Common Name	Scientific Name	Wetland Indicator Status	Native and Invasive, Noxious
yellow glandweed	*Parentucellia viscosa*	FAC	non-native
reed canary grass	*Phalaris arundinacea*	FACW	invasive
common timothy	*Phleum pratense*	FAC	non-native
English plantain	*Plantago lanceolata*	FACU	non-native
great plantain	*Plantago major*	FAC	non-native
common selfheal	*Prunella vulgaris*	FACU	non-native
creeping buttercup	*Ranunculus repens*	FAC	non-native
wild radish	*Raphanus sativus*	NOL	non-native
curve-pod yellowcress	*Rorippa curvisiliqua*	OBL	native
clustered rose	*Rosa pisocarpa*	FAC	native
Himalayan blackberry	*Rubus armeniacus*	FAC	invasive, noxious
curly dock	*Rumex crispus*	FAC	non-native
tall fescue	*Schedonorus arundinaceus*	FAC	non-native
spiny-leaf sow-thistle	*Sonchus asper*	FACU	non-native
common snowberry	*Symphoricarpos albus*	FACU	native
Pacific poison-oak	*Toxicodendron diversilobum*	FAC	native
hare's-foot clover	*Trifolium arvense*	NOL	non-native
red clover	*Trifolium pratense*	FACU	non-native
great mullein	*Verbascum thapsus*	FACU	non-native

Wetland Indicator Status and taxonomy for the Western Mountains, Valleys, and Coast Region per the National Wetland Plant List 2
Accessed May 3, 2016. http://rsgisias.crrel.usace.army.mil/NWPL/

Native per Hitchcock & Cronquist 1973 and http://plants.usda.gov/
Invasive per Clean Water Services 2017: http://cleanwaterservices.org/permits-development/design-construction-standard
Noxious per ODA 2018:
https://www.oregon.gov/ODA/programs/Weeds/OregonNoxiousWeeds/Pages/AboutOregonWeeds.aspx

WETLAND INDICATOR STATUS (WIS)	
OBL	**Obligate Wetland** Plant – Almost always occurs in wetlands (hydrophyte), rarely in uplands
FACW	**Facultative Wetland** Plant - Usually occur in wetlands (hydrophyte), but may occur found in non-wetlands
FAC	**Facultative** Plant – Occurs in wetlands (hydrophyte) and uplands (nonhydrophyte)
FACU	**Facultative Upland** Plant - Usually occur in non-wetlands (non-hydrophyte), but may occur in wetlands
UPL	**Upland** Plant - Almost always occurs in uplands (non-hydrophyte), almost never occurs in wetlands. UPL plants have a WIS in other regions
NOL	**Not Listed** - Plants that are not on the National Wetland Plant List are assumed to be UPL and have no WIS in any region

DRAFT

Stormwater Management Report

PGE Integrated Operations Center

Prepared for: Dreyfuss + Blackford
Prepared by: James Sweeney, EIT
Project Engineer: Mark Reuland, PE

April 2019 | KPFF Project #1800045

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Table of Contents

Tables and Figures

Appendices

Appendix C-1: Soil Map

Appendix C-2: NRCS Ch.7 Soil Group Classification

Appendix C-3: Design Storm Distribution Chart

Appendix D-1: Geotechnical Report

Project Description

This report has been prepared to outline the existing and proposed conditions for the new Portland General Electric Integrated Operations Center (PGE IOC) project. The site consists of approximately 41.4 acres of disturbed area and is located in Tualatin, Oregon. The site is located on the southeast corner of the intersection of SW 124th Avenue and SW Tualatin-Sherwood Road. The site is bounded to the north by SW Tualatin-Sherwood Road, to the east by SW 120th Avenue, to the south by an active quarry, and to the west by SW 124th Avenue (see appendix A-1). The site is comprised of two tax lots (2S-1-27C 701 and 2S-1-27C 500).

The proposed development includes the construction of two new buildings, a site road loop, surface parking facilities, a mechanical equipment yard, and an approximately 150 foot tall communication tower. Adjacent public improvements will occur on SW 124th Avenue, SW 120th Avenue and future Blake Street (Appendix A-2), and are not part of this stormwater management plan. The right-of-way will be dedicated through the site to facilitate the development of future Blake Street. The area of the site isolated by this street, which is entirely pervious, has been approved to drain to a public stormwater management facility.

Existing Conditions

Existing site topography consists predominantly of grassy field except for the southern portion, which consists of thick shrubs and small trees. For stormwater calculations, the existing site is considered to be entirely pervious. The site has a significant elevation change of over 80 feet from the highest to lowest points. Runoff currently meanders through the site and ultimately outfalls to two 21-inch culverts. A tile drain line conveys runoff from an active quarry through the site. The drain line will be rerouted through the site to ensure existing conveyance remains unchanged. Geotechnical investigations were performed by Geotechnical Resources, Inc. GRI on March 7, 2019 (see Appendix D-1).

Proposed Storm Drainage

The proposed development will increase the impervious area to approximately 24% of the site. Storm runoff from impervious areas will be conveyed into stormwater facilities via subsurface pipes and sheet flow. A low impact development approach (LIDA) has been taken for the design of stormwater facilities. The type of facility used for both detention and water quality is based upon an extended dry basin.

The City of Tualatin Municipal Code requires that facilities adhere to city code as well as requirements outlined in Clean Water Services Design and Construction Standards, 2017 (hereafter referred to as CWS). According to CWS (4.03.4-b), on-site facilities are required to capture runoff such that the post-development runoff rates do not exceed the pre-development runoff rates from the site based on 24-hour storm events ranging from the 2-year design storm to the 25-year design storm. Rainfall depths are based on the CWS Design Storm Distribution Chart (see Appendix C-3).

Rainfall events have been calculated using Autodesk Storm and Sanitary Analysis 2018 (SSA). The selected computational method for runoff calculation is the Santa Barbara Urban Hydrograph (SBUH) method; based on an NRCS Type 1A rainfall distribution. Hydrographs of design storm year peak flows for both pre-development and proposed conditions can be found in Appendix B-1. Facility modeling calculations can be found in Appendix B-2.

Table 1: Basin Area Breakdown Calculations

Basin	Basin Area (sf)	Impervious Area (sf)	Pervious Area (sf)	Total (AC)	% Impervious
1	208,758	2,654	206,104	4.79	1.3
2	239,060	207,518	31,542	5.49	86.8
3	413,765	0	413,765	9.50	0.0
4	102,290	0	102,290	2.35	0.0
5	72,755	71,493	0	1.64	100.0
6	101,616	94,517	7,099	2.33	93.0
7	428,339	0	428,339	9.83	0.0
Total	**1,565,321**	**376,182**	**1,189,139**	**35.9**	

Plan Narrative

Stormwater Pollutants Generated by Project

Pollutants of concern are those typically expected for roadway and commercial development runoff. Pollutants include polycyclic aromatic hydrocarbons (PAH), heat, total suspended solids (TSS), and nutrients from fertilizer ingredients. This facility will generate these stormwater pollutants.

The proposed development is located within the Hedges Creek Basin area and will discharge into Hedges Creek.

Low Impact Development Applications

The following Low Impact Development (LID) techniques have been implemented into the design of this site:

- All stormwater management facilities contain a vegetated surface element.
- The Extended Dry Basin is considered a low impact development technique by CWS.
- Vegetative curb island parking features are utilized for conveyance.
- Existing site contours have been maintained to the maximum extent practicable.

Geotechnical investigations show that infiltration of stormwater is not feasible (Appendix D-1).

Stormwater Management Plan

Treatment Capacity and Effectiveness against Target Pollutants

An extended dry basin is a shallow landscaped depression that collects and holds stormwater runoff. It uses detention as a method of treatment by allowing sediment and other attached pollutants to settle out as the water is discharged at a slow rate. The basin has been sized to accommodate the volume needed for treatment as well as the volume needed for detention. A flow control structure has been designed to release flows at the required rate for a given storm. The CWS treatment volume is slowly released over 48 hours. The extended dry basin is located in the northeast corner of the site. A pretreatment water quality manhole will be installed prior to water being discharged into the conveyance channel which leads to the extended dry basin.

Water Quality Design Parameters

Clean Water Services

The water quality design requirements per CWS design standards are shown below:

4.05.6 Water Quality Approach Sizing Methods

a. Water Quality Volumes and Flows (applies to approaches in Section 4.05.3.c.1 (A)-(C))

1. Water Quality Storm
The water quality storm is the storm required by regulations to be treated. The storm defines both the volume and rate of runoff. The water quality storm is defined in Subsection 4.05.4 (d).

2. Water Quality Volume (WQV)
The WQV is the volume of water that is produced by the water quality storm. The WQV equals 0.36 inches over the impervious area that is required to be treated as shown in the formula below:

$$\text{Water Quality Volume (cu.ft.)} = \frac{0.36 \text{ (in.)} \times \text{Area (sq.ft.)}}{12 \text{ (in./ft.)}}$$

3. Water Quality Flow (WQF)
The WQF is the average design flow anticipated from the water quality storm as shown in the formulas below:

$$\text{Water Quality Flow (cfs)} = \frac{\text{Water Quality Volume (cu.ft.)}}{14{,}400 \text{ seconds}}$$

or

$$\text{Water Quality Flow (cfs)} = \frac{0.36 \text{ (in.)} \times \text{Area (sq.ft.)}}{12\text{(in/ft)}(4 \text{ hr})(60 \text{ min/hr})(60 \text{ sec/min})}$$

Figure 1: CWS Water Quality Sizing Methodology

Per CWS LIDA Handbook, extended dry basins are sized based on the Water Quality Volume (WQV).

Water Quantity Detention Design Parameters

The Santa Barbara Urban Hydrograph method was used to calculate flow rates in Storm and Sanitary Analysis 2018 software by Autodesk. The storm distribution is SCS Type 1A. The following CN values were used for the different land cover types with a Hydrologic Soil group C:

- Existing Conditions
  - Woods – Grass Combination (Fair Condition) – 76
- Developed Conditions
  - Impervious Area – 98

- Landscaped Area (Good Condition (grass over >75%) – 74

The extended dry basin is able to fully detain peak flows for the 100-year storm (4.5 inches) within the mandated 1-foot of design freeboard above the maximum 25-year peak flow water level within the facility.

BMP Residence Time

The extended dry basin is designed for a draw down time of 48 hours for the CWS water quality storm.

Natural Resource Conservation Service Soil Type

The Natural Resource Conservation Service (NRCS) describes the soils in this site as hydrologic soil group B, C, and C/D (see Appendix C-1). Given this information, the most descriptive hydrologic soil group for the site is C (see Appendix C-2).

Downstream Analysis

Conveyance Calculations

Stormwater Operations & Maintenance Plan

Site O&M Responsible Party

Conclusion

Appendix A-1

Vicinity Map

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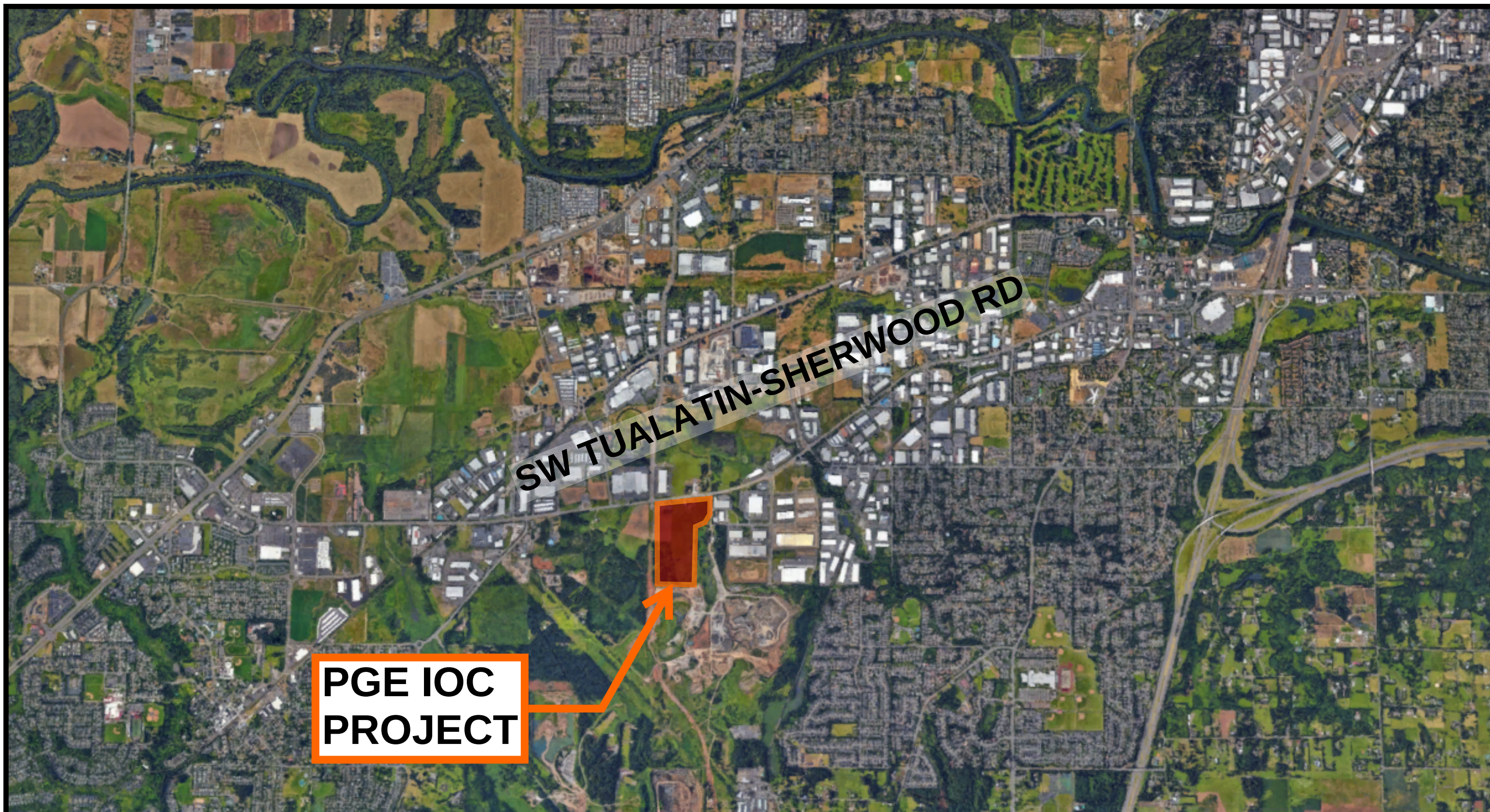

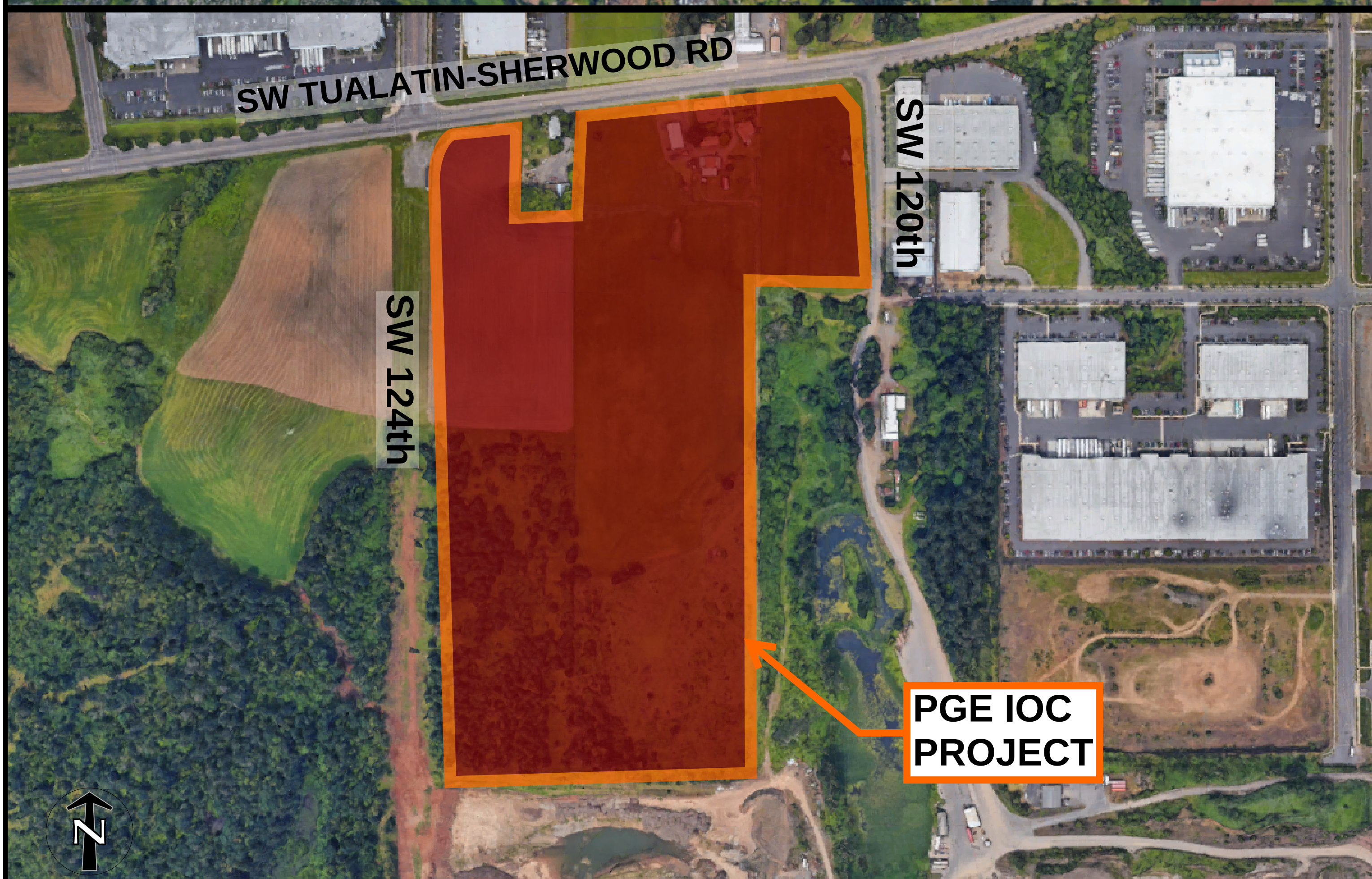

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PGE INTEGRATED OPERATIONS CENTER
VICINITY MAP

A-1

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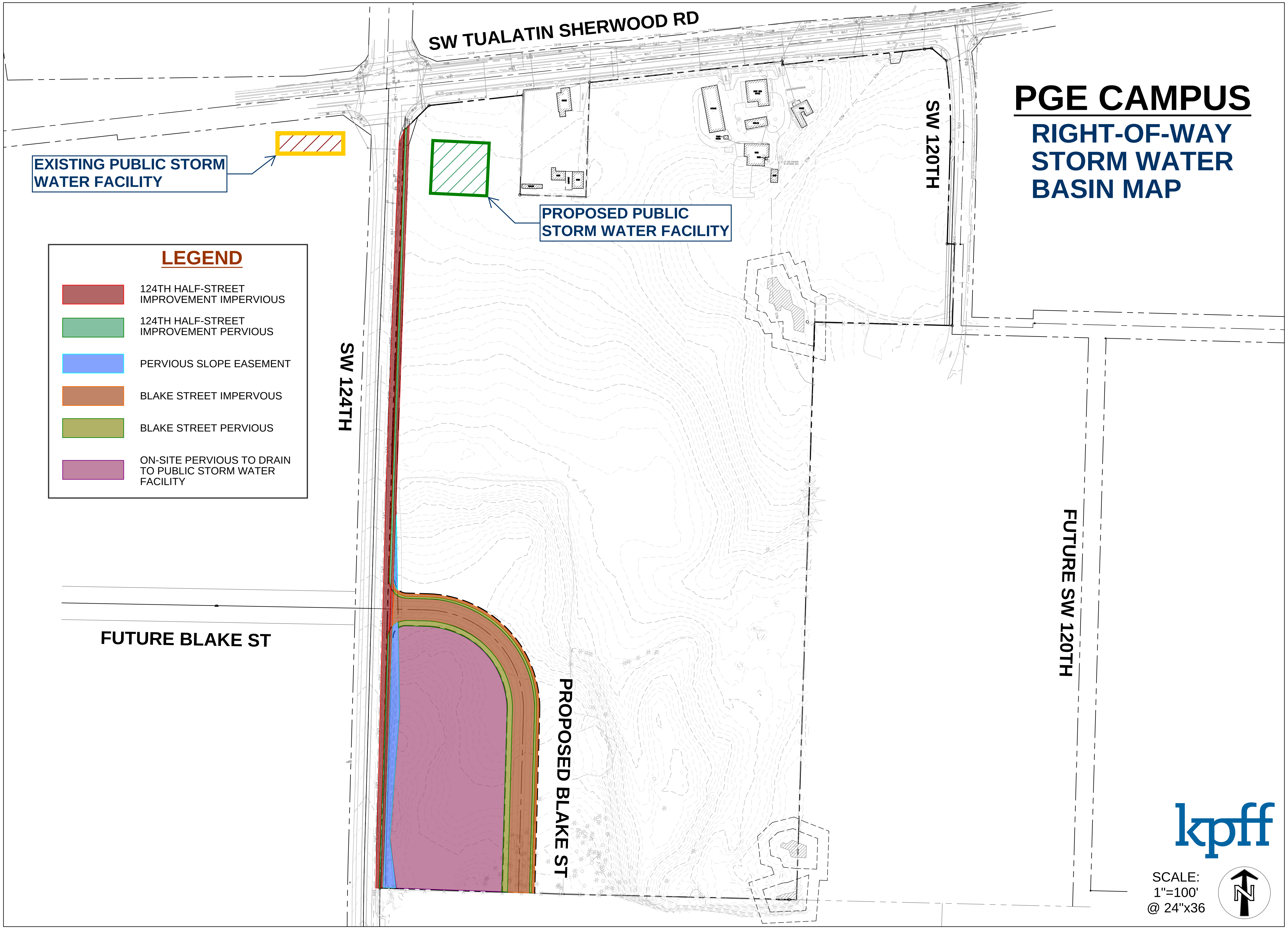
Appendix A-2

ROW Basin Map



PGE CAMPUS
RIGHT-OF-WAY STORM WATER BASIN MAP
SW TUALATIN SHERWOOD RD
SW 124TH
SW 120TH
FUTURE SW 120TH
FUTURE BLAKE ST
PROPOSED BLAKE ST
EXISTING PUBLIC STORM WATER FACILITY
PROPOSED PUBLIC STORM WATER FACILITY
LEGEND
124TH HALF-STREET IMPROVEMENT IMPERVIOUS
124TH HALF-STREET IMPROVEMENT PERVIOUS
PERVIOUS SLOPE EASEMENT
BLAKE STREET IMPERVOUS
BLAKE STREET PERVIOUS
ON-SITE PERVIOUS TO DRAIN TO PUBLIC STORM WATER FACILITY
SCALE: 1"=100' @ 24"x36
kpff

Appendix A-3

On-Site Basin Map

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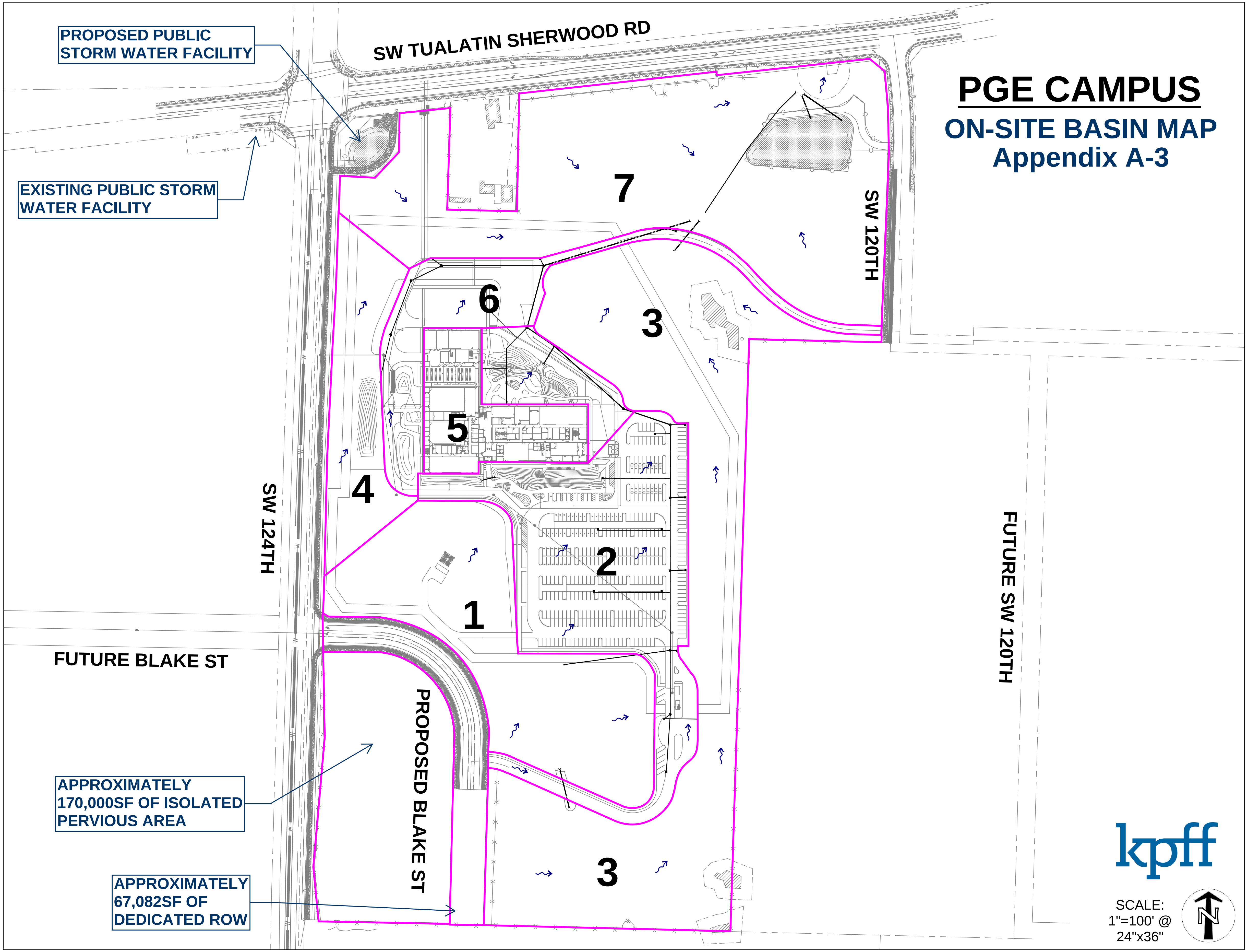
PGE CAMPUS

ON-SITE BASIN MAP
Appendix A-3



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Appendix B-1

Cumulative Hydrographs

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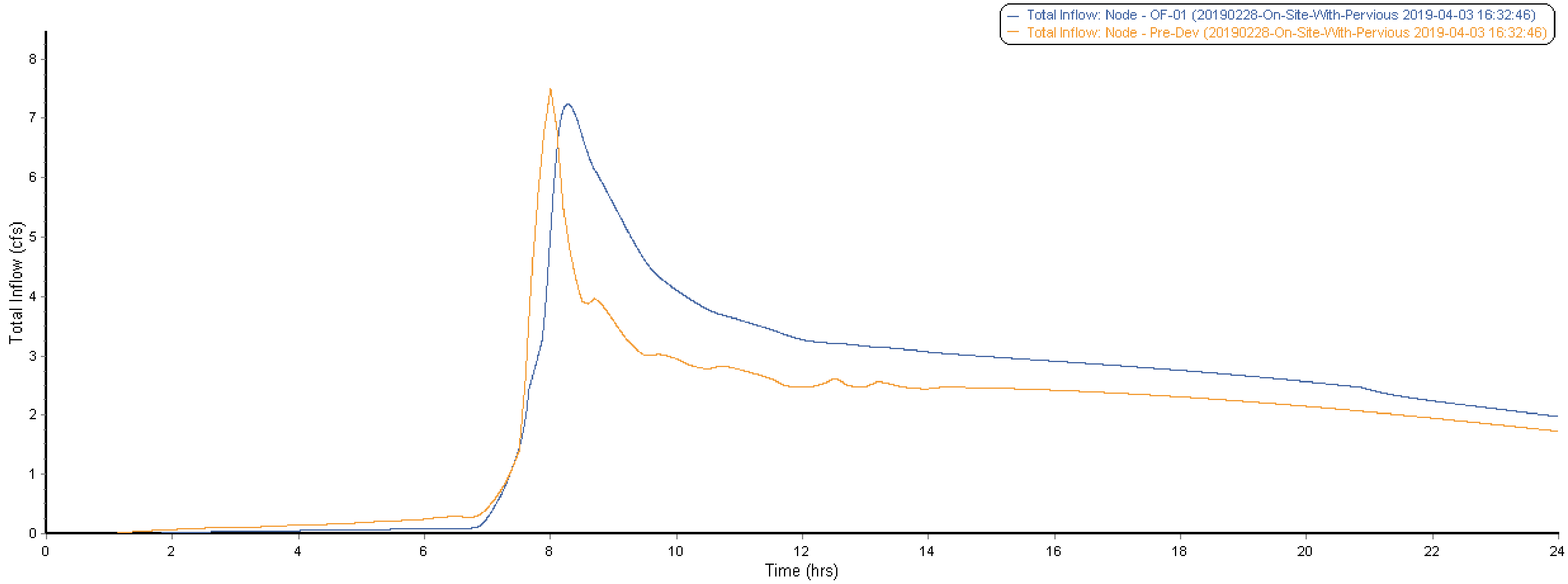
APPENDIX B-1

PGE INTEGRATED OPERATIONS CENTER
TWO-YEAR CUMULATIVE PEAK FLOWS

2



Total Inflow Summary Table

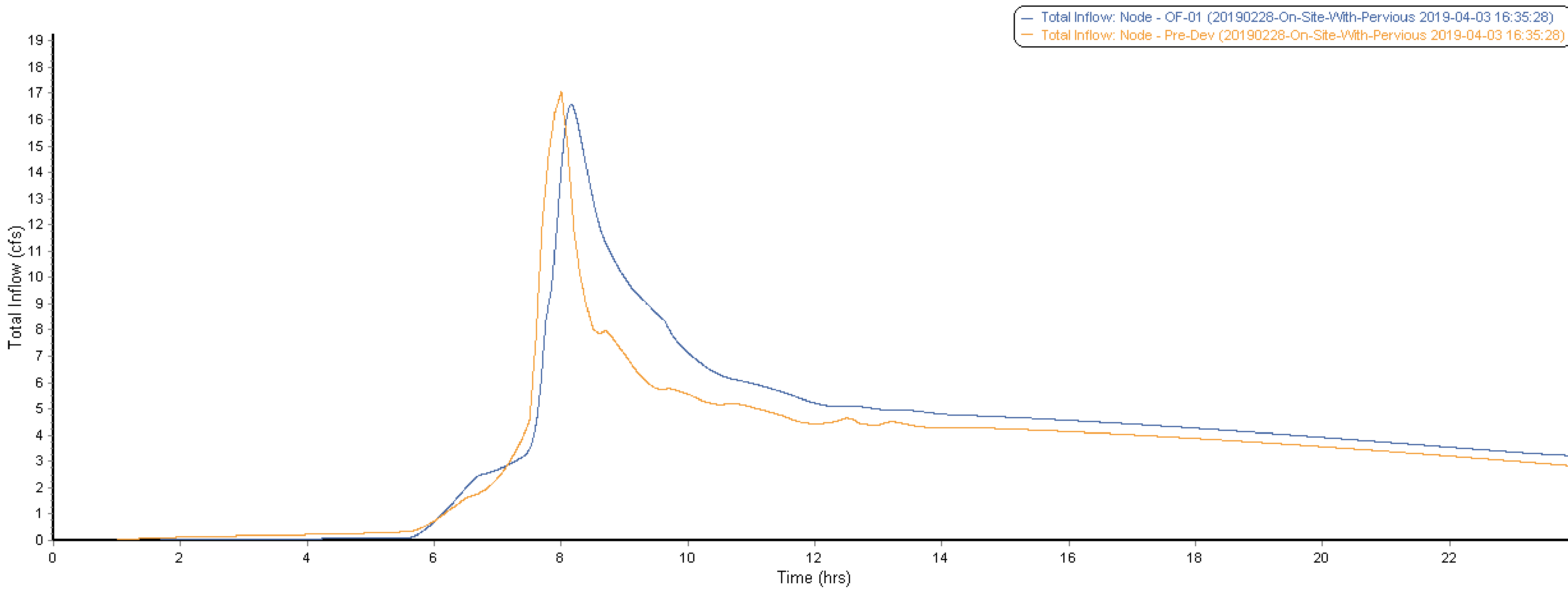
Time period
From: 11/15/2018, 12:00:00 AM
To: 11/16/2018, 12:00:10 AM

Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	OF-01	Pre-Dev
Maximum Total Inflow (cfs)	7.24	7.50
Minimum Total Inflow (cfs)	0.00	0.00
Event Mean Total Inflow (cfs)	2.20	1.83
Duration of Exceedances (hrs)	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A
Number of Exceedances	N/A	N/A
Number of Deficits	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A
Total Inflow Volume (ft³)	190162.79	157794.96
Detention Storage (ft³)	N/A	N/A

TEN-YEAR CUMULATIVE PEAK FLOWS



Total Inflow Summary Table

Time period
From: 11/15/2018, 12:00:00 AM
To: 11/16/2018, 12:00:10 AM

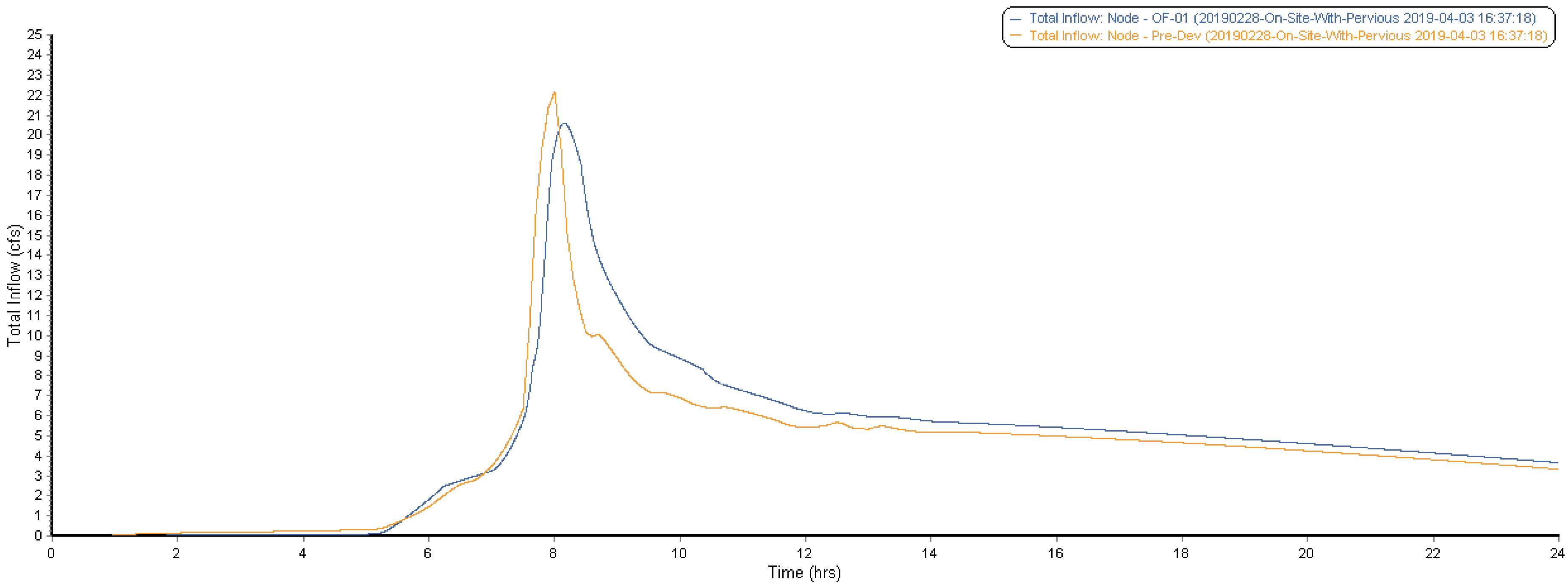
Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	OF-01	Pre-Dev
Maximum Total Inflow (cfs)	16.58	17.06
Minimum Total Inflow (cfs)	0.00	0.00
Event Mean Total Inflow (cfs)	3.84	3.40
Duration of Exceedances (hrs)	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A
Number of Exceedances	N/A	N/A
Number of Deficits	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A
Total Inflow Volume (ft³)	331729.46	293983.57
Detention Storage (ft³)	N/A	N/A

TWENTY-FIVE YEAR CUMULATIVE PEAK FLOWS

25



Total Inflow Summary Table

Time period

From: 11/15/2018, 12:00:00 AM

To: 11/16/2018, 12:00:10 AM

Thresholds

Exceedance: 0

Deficit: 0

Detention storage

Max flow: 0

Element ID	OF-01	Pre-Dev
Maximum Total Inflow (cfs)	20.62	22.17
Minimum Total Inflow (cfs)	0.00	0.00
Event Mean Total Inflow (cfs)	4.69	4.23
Duration of Exceedances (hrs)	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A
Number of Exceedances	N/A	N/A
Number of Deficits	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A
Total Inflow Volume (ft³)	405488.79	365154.47
Detention Storage (ft³)	N/A	N/A

Appendix B-2

Detention Table

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Storage Node : Extended Dry Basin

Input Data

Invert Elevation (ft) 177.1
Max (Rim) Elevation (ft) 180.5
Max (Rim) Offset (ft) 0
Initial Water Elevation (ft) 177.1
Initial Water Depth (ft) 177.1
Ponded Area (ft^2) 0.00
Evaporation Loss 0.00

Storage Area Volume

Storage Curve : VDB

Stage (ft)	Storage Area (ft^2)	Storage Volume (ft^3)
0	0	0.000
1	19500	19500
2	19500	39000
3	19500	58500

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	2	Bottom	CIRCULAR	No	1.90	0.00	0.61
2	10	Bottom	CIRCULAR	No	12.00	1.00	0.61
3	25	Bottom	CIRCULAR	No	15.00	1.65	0.61
4	Overflow	Bottom	CIRCULAR	No	18.00	3.00	0.61

Output Summary Results

25-year

Peak Inflow (cfs) 27.27
Peak Lateral Inflow (cfs) 27.27
Peak Outflow (cfs) 19.88
Peak Exfiltration Flow Rate (cfm) 0.00
Max HGL Elevation Attained (ft) 2.99
Max HGL Depth Attained (ft) 2.99
Average HGL Elevation Attained (ft) 1.55
Average HGL Depth Attained (ft) 1.55
Time of Max HGL Occurrence (days hh:mm) 0 08:10
Total Exfiltration Volume (1000-ft^3) 0.000
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0.00

Appendix B-3

Water Quality Sizing

Clean Water Services Extended Dry Basin Water Quality Calculations

Project Impervious Areas:

	Total Impervious Areas (sf)
BLAKE ROAD	400,000

Clean Water Services Manual References:

$$\text{Water Quality Volume (cu.ft.)} = \frac{0.36\text{ (in.) x Area (sq.ft.)}}{12\text{ (in./ft.)}}$$

Extended Dry Basin
a. Hydraulic Design Criteria:

1. Permanent Pool Depth: 0.4 feet
2. Permanent pool is to cover the entire bottom of the basin.
3. Minimum Water Quality Detention Volume: 1.0 x Water Quality Volume (WQV)
4. Water Quality Drawdown Time: 48 hours
5. Orifice Size:
   USE: $D = 24 * [(Q/ (C[2gH]^{0.5}) / \pi]^{0.5}$
   Where:
   D (in) = diameter of orifice
   Q(cfs) = WQV(cf) /(48*60*60)
   C = 0.62
   H(ft) = 2/3 x temporary detention height to centerline of orifice.
6. Maximum Depth of Water Quality Pool (not including Permanent Pool): 4 feet or as limited by issuing jurisdiction.

Clean Water Services Water Quality Volume Orifice Sizing Calculation for 48 Hour Drawdown

Per Clean Water Services Manual Section 4.06.3 and LIDA Handbook for Extended Dry Basin:

Orifice Size:
USE: $D = 24 * [(Q/ (C[2gH]^{0.5}) / \pi]^{0.5}$
Where:
D (in) = diameter of orifice
Q(cfs) = WQV(cf) /(48*60*60)
C = 0.62
H(ft) = 2/3 x temporary detention height to centerline of orifice

** Trial Orifice Size =	1.9	inches
**Pond Bottom Area (A) =	15,000	sf
**Pond Bottom Length (L) =	122	ft
**Pond Side Slopes X:1 (S) = {Use 0.001 for vertical}	3	

Solve for WQV = $\frac{[0.36\text{ (in) x Impervious Area (sq. ft.)}]}{12\text{ (in/ft)}}$ = 12,000

Solve for Water Quality Pond Depth given WQV (ft.) = $\frac{-A + (A^2 - [4*(0.5*S*L)*(-WQV)]^{0.5})}{2* (0.5*S*L)}$ = 0.792 = WQ DEPTH --> PLACE OTHER ORIFICES ABOVE THIS ELEVATION

Solve for Q = $\frac{\text{WQV (cf)}}{(48 \times 60 \times 60)} = \frac{12{,}000}{(48 \times 60 \times 60)}$ = 0.07

Solve for H = [2/3] x h ; where h = temporary detention height to center of orifice = 0.48

Solve for h = Water Quality Pond Depth - $\frac{[0.5\text{ x Trial Orifice Size (in)}]}{12\text{ (in/ft)}}$ = 0.792 - $\frac{0.95}{12}$ = 0.713

Given Variables C = 0.62
g = 32.174

Solve for D = $24 * [(Q/ (C[2gH]^{0.5}) / \pi]^{0.5} = 24 * [(0.22 / (0.62 [32.174*0.32]^{0.5})) / 3.1416]^{0.5}$

Orifice Diameter (in) to Drawdown the WQV in 48 Hours = 1.93 ✓

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Appendix C-1

Soil Map

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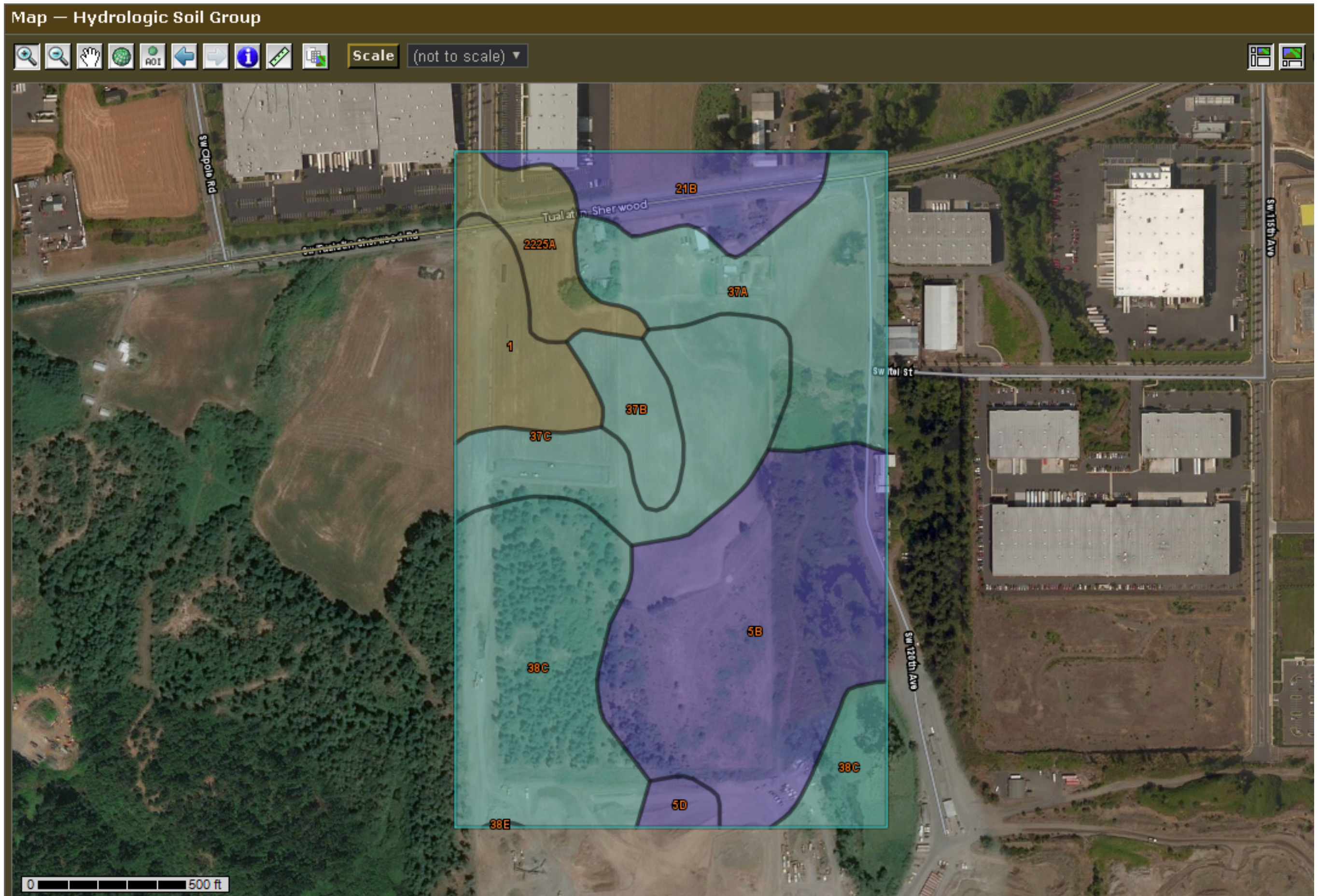
PGE IOC
NRCS SOIL MAP



Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Washington County, Oregon (OR067)

Summary by Map Unit — Washington County, Oregon (OR067)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Aloha silt loam	C/D	5.3	6.9%
5B	Briedwell stony silt loam, 0 to 7 percent slopes	B	20.3	26.5%
5D	Briedwell stony silt loam, 12 to 20 percent slopes	B	0.9	1.2%
21B	Hillsboro loam, 3 to 7 percent slopes	B	5.5	7.1%
37A	Quatama loam, 0 to 3 percent slopes	C	11.9	15.5%
37B	Quatama loam, 3 to 7 percent slopes	C	2.9	3.8%
37C	Quatama loam, 7 to 12 percent slopes	C	9.3	12.1%
38C	Saum silt loam, 7 to 12 percent slopes	C	16.5	21.5%
38E	Saum silt loam, 20 to 30 percent slopes	C	0.0	0.1%
2225A	Huberly silt loam, 0 to 3 percent slopes	C/D	4.0	5.3%
Totals for Area of Interest			76.6	100.0%

kpff

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Appendix C-2

NRCS Ch.7 Soil Group Classification

Chapter 7 Hydrologic Soil Groups

630.0700 Introduction

This chapter defines four hydrologic soil groups, or HSGs, that, along with land use, management practices, and hydrologic conditions, determine a soil's associated runoff curve number (NEH630.09). Runoff curve numbers are used to estimate direct runoff from rainfall (NEH630.10).

A map unit is a collection of areas defined and named the same in terms of their soil components or miscellaneous areas or both (NSSH 627.03). Soil scientists assign map unit components to hydrologic soil groups. Map unit components assigned to a specific hydrologic soil group have similar physical and runoff characteristics. Soils in the United States, its territories, and Puerto Rico have been assigned to hydrologic soil groups. The assigned groups can be found by consulting the Natural Resources Conservation Service's (NRCS) Field Office Technical Guide; published soil survey data bases; the NRCS Soil Data Mart Web site (*http://soildatamart.nrcs.usda.gov/*); and/or the Web Soil Survey Web site (*http://websoilsurvey.nrcs.usda.gov/*).

The NRCS State soil scientist should be contacted if a soil survey does not exist for a given area or where the soils within a watershed have not been assigned to hydrologic groups.

630.0701 Hydrologic soil groups

Soils were originally assigned to hydrologic soil groups based on measured rainfall, runoff, and infiltrometer data (Musgrave 1955). Since the initial work was done to establish these groupings, assignment of soils to hydrologic soil groups has been based on the judgment of soil scientists. Assignments are made based on comparison of the characteristics of unclassified soil profiles with profiles of soils already placed into hydrologic soil groups. Most of the groupings are based on the premise that soils found within a climatic region that are similar in depth to a restrictive layer or water table, transmission rate of water, texture, structure, and degree of swelling when saturated, will have similar runoff responses. The classes are based on the following factors:

- intake and transmission of water under the conditions of maximum yearly wetness (thoroughly wet)
- soil not frozen
- bare soil surface
- maximum swelling of expansive clays

The slope of the soil surface is not considered when assigning hydrologic soil groups.

In its simplest form, hydrologic soil group is determined by the water transmitting soil layer with the lowest saturated hydraulic conductivity and depth to any layer that is more or less water impermeable (such as a fragipan or duripan) or depth to a water table (if present). The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below it. For example, a layer having a saturated hydraulic conductivity of 9.0 micrometers per second (1.3 inches per hour) is the least transmissive layer in a soil if the layers above and below it have a saturated hydraulic conductivity of 23 micrometers per second (3.3 inches per hour).

Water impermeable soil layers are among those types of layers recorded in the component restriction table of the National Soil Information System (NASIS) database. The saturated hydraulic conductivity of an impermeable or nearly impermeable layer may range from essentially 0 micrometers per second (0 inches per hour) to 0.9 micrometers per second (0.1 inches per hour). For simplicity, either case is considered impermeable for hydrologic soil group purposes. In some cases, saturated hydraulic conductivity (a quantitatively measured characteristic) data are not always readily available or obtainable. In these situations, other soil properties such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are used to estimate water movement. Table 7–1 relates saturated hydraulic conductivity to hydrologic soil group.

The four hydrologic soil groups (HSGs) are described as:

Group A—Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group A are as follows. The saturated hydraulic conductivity of all soil layers exceeds 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer and a water table are in group A if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 10 micrometers per second (1.42 inches per hour).

Group B—Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group B are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] ranges from 10.0 micrometers per second (1.42 inches per hour) to 40.0 micrometers per second (5.67 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a water impermeable layer and a water table are in group B if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 4.0 micrometers per second (0.57 inches per hour) but is less than 10.0 micrometers per second (1.42 inches per hour).

Group C—Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

The limits on the diagnostic physical characteristics of group C are as follows. The saturated hydraulic conductivity in the least transmissive layer between the surface and 50 centimeters [20 inches] is between 1.0 micrometers per second (0.14 inches per hour) and 10.0 micrometers per second (1.42 inches per hour). The depth to any water impermeable layer is greater than 50 centimeters [20 inches]. The depth to the water table is greater than 60 centimeters [24 inches]. Soils that are deeper than 100 centimeters [40 inches] to a restriction and a water table are in group C if the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface exceeds 0.40 micrometers per second (0.06 inches per hour) but is less than 4.0 micrometers per second (0.57 inches per hour).

Group D—Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 50 centimeters [20 inches] and all soils with a water table within 60 centimeters [24 inches] of the surface are in this group, although some may have a dual classification, as described in the next section, if they can be adequately drained.

The limits on the physical diagnostic characteristics of group D are as follows. For soils with a water impermeable layer at a depth between 50 centimeters and 100 centimeters [20 and 40 inches], the saturated hydraulic conductivity in the least transmissive soil layer is less than or equal to 1.0 micrometers per second (0.14 inches per hour). For soils that are deeper than 100 centimeters [40 inches] to a restriction or water table, the saturated hydraulic conductivity of all soil layers within 100 centimeters [40 inches] of the surface is less than or equal to 0.40 micrometers per second (0.06 inches per hour).

Dual hydrologic soil groups—Certain wet soils are placed in group D based solely on the presence of a water table within 60 centimeters [24 inches] of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 60 centimeters [24 inches] below the surface in a soil where it would be higher in a natural state.

Matrix of hydrologic soil group assignment criteria—The decision matrix in table 7–1 can be used to determine a soil's hydrologic soil group. If saturated hydraulic conductivity data are available and deemed to be reliable, then these data, along with water table depth information, should be used to place the soil into the appropriate hydrologic soil group. If these data are not available, the hydrologic soil group is determined by observing the properties of the soil in the field. Factors such as texture, compaction (bulk density), strength of soil structure, clay mineralogy, and organic matter are considered in estimating the hydraulic conductivity of each layer in the soil profile. The depth and hydraulic conductivity of any water impermeable layer and the depth to any high water table are used to determine correct hydrologic soil group for the soil. The property that is most limiting to water movement generally determines the soil's hydrologic group. In anomalous situations, when adjustments to hydrologic soil group become necessary, they shall be made by the NRCS State soil scientist in consultation with the State conservation engineer.

Table 7–1 Criteria for assignment of hydrologic soil group (HSG)

Depth to water impermeable layer 1/	Depth to high water table 2/	K_{sat} of least transmissive layer in depth range	K_{sat} depth range	HSG 3/
<50 cm [<20 in]	—	—	—	D
50 to 100 cm [20 to 40 in]	<60 cm [<24 in]	>40.0 μm/s (>5.67 in/h)	0 to 60 cm [0 to 24 in]	A/D
		>10.0 to ≤40.0 μm/s (>1.42 to ≤5.67 in/h)	0 to 60 cm [0 to 24 in]	B/D
		>1.0 to ≤10.0 μm/s (>0.14 to ≤1.42 in/h)	0 to 60 cm [0 to 24 in]	C/D
		≤1.0 μm/s (≤0.14 in/h)	0 to 60 cm [0 to 24 in]	D
	≥60 cm [≥24 in]	>40.0 μm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
		>10.0 to ≤40.0 μm/s (>1.42 to ≤5.67 in/h)	0 to 50 cm [0 to 20 in]	B
		>1.0 to ≤10.0 μm/s (>0.14 to ≤1.42 in/h)	0 to 50 cm [0 to 20 in]	C
		≤1.0 μm/s (≤0.14 in/h)	0 to 50 cm [0 to 20 in]	D
>100 cm [>40 in]	<60 cm [<24 in]	>10.0 μm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A/D
		>4.0 to ≤10.0 μm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B/D
		>0.40 to ≤4.0 μm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C/D
		≤0.40 μm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D
	60 to 100 cm [24 to 40 in]	>40.0 μm/s (>5.67 in/h)	0 to 50 cm [0 to 20 in]	A
		>10.0 to ≤40.0 μm/s (>1.42 to ≤5.67 in/h)	0 to 50 cm [0 to 20 in]	B
		>1.0 to ≤10.0 μm/s (>0.14 to ≤1.42 in/h)	0 to 50 cm [0 to 20 in]	C
		≤1.0 μm/s (≤0.14 in/h)	0 to 50 cm [0 to 20 in]	D
	>100 cm [>40 in]	>10.0 μm/s (>1.42 in/h)	0 to 100 cm [0 to 40 in]	A
		>4.0 to ≤ 10.0 μm/s (>0.57 to ≤1.42 in/h)	0 to 100 cm [0 to 40 in]	B
		>0.40 to ≤4.0 μm/s (>0.06 to ≤0.57 in/h)	0 to 100 cm [0 to 40 in]	C
		≤0.40 μm/s (≤0.06 in/h)	0 to 100 cm [0 to 40 in]	D

1/ An impermeable layer has a K_{sat} less than 0.01 μm/s [0.0014 in/h] or a component restriction of fragipan; duripan; petrocalcic; orstein; petrogypsic; cemented horizon; densic material; placic; bedrock, paralithic; bedrock, lithic; bedrock, densic; or permafrost.

2/ High water table during any month during the year.

3/ Dual HSG classes are applied only for wet soils (water table less than 60 cm [24 in]). If these soils can be drained, a less restrictive HSG can be assigned, depending on the K_{sat}.

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Appendix C-3

Design Storm Distribution Chart

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DESIGN STORM DISTRIBUTION CHART

THE FOLLOWING TABLE CONTAINS THE NRCS TYPE 1A PRECIPITATION DIDTRIBUTION. THE TABLE IS FRM THE "SUB BASIN HYDROLOGIC MODLELING CRITERIA" BY KRAMER, CHIN, & MAYO INC., 1991

	PERCENT RAINFALL		RAINFALL DEPTH (INCHES)					
			2 YEAR	5 YEAR	10 YEAR	25 YEAR	50 YEAR	100 YEAR
HOUR	INCREMENTAL	CUMULATIVE	2.50	3.10	3.45	3.90	4.20	4.50
1	2.40	2.40	0.06	0.07	0.08	0.09	0.10	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.08	0.10	0.11	0.12	0.13	0.14
4	3.80	12.00	0.10	0.12	0.13	0.15	0.16	0.17
5	4.44	16.44	0.11	0.14	0.15	0.17	0.19	0.20
6	5.18	21.62	0.13	0.16	0.18	0.20	0.22	0.23
7	6.48	28.10	0.16	0.20	0.22	0.25	0.27	0.29
8	16.44	44.54	0.41	0.51	0.57	0.64	0.69	0.74
9	7.58	52.12	0.19	0.23	0.26	0.30	0.32	0.34
10	5.28	57.40	0.13	0.16	0.18	0.21	0.22	0.24
11	4.96	62.36	0.12	0.15	0.17	0.19	0.21	0.22
12	4.32	66.68	0.11	0.13	0.15	0.17	0.18	0.19
13	4.02	70.70	0.10	0.12	0.14	0.16	0.17	0.18
14	3.42	74.12	0.09	0.11	0.12	0.13	0.14	0.15
15	3.28	77.40	0.08	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.09	0.10	0.12	0.13	0.14
17	2.80	83.20	0.07	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.07	0.08	0.09	0.10	0.11
19	2.40	88.00	0.06	0.07	0.08	0.09	0.10	0.11
20	2.40	90.40	0.06	0.07	0.08	0.09	0.10	0.11
21	2.40	92.80	0.06	0.07	0.08	0.09	0.10	0.11
22	2.40	95.20	0.06	0.07	0.08	0.09	0.10	0.11
23	2.40	97.60	0.06	0.07	0.08	0.09	0.10	0.11
24	2.40	100.00	0.06	0.07	0.08	0.09	0.10	0.11

DESIGN STORM DISTRIBUTION CHART

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REVISED 12–06

Clean Water Services
Our commitment is clear.

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Appendix D-1

Geotechnical Report

GRI
9750 SW Nimbus Avenue
Beaverton, OR 97008-7172
p | 503-641-3478 f | 503-644-8034

March 7, 2019 6200 GEOTECHNICAL RPT

Dreyfuss + Blackford Architecture
3540 Folsom Boulevard
Sacramento, CA 95816

DRAFT

Attention: Gus Fischer, AIA

SUBJECT: Geotechnical Investigation and Site-Specific Seismic Hazard Evaluation
PGE Integrated Operations Center (IOC)
SW Tualatin-Sherwood Road and SW 124th Avenue
Tualatin, Oregon

As requested, GRI completed a geotechnical investigation and site-specific seismic hazard evaluation for the proposed Portland General Electric Integrated Operations Center (PGE IOC) in Tualatin, Oregon. The general location of the site is shown on the Vicinity Map, Figure 1. The purpose of our investigation was to evaluate subsurface conditions at the site and develop conclusions and recommendations to support design and construction of the project. The investigation included a review of available geologic and geotechnical information for the project area, subsurface explorations, field and laboratory testing, and an engineering analysis. This report describes the work accomplished and provides our conclusions and geotechnical recommendations for design and construction of the proposed PGE facility.

The following geotechnical report was reviewed with respect to subsurface conditions at the site:

> "Geotechnical Data Report, Tualatin-Sherwood Road & SW 124th Avenue Development, Southeast Corner of Tualatin-Sherwood Road and SW 124th Avenue, Washington County, Oregon," by Carlson Geotechnical, dated July 20, 2018, prepared for Hahn and Associates, Inc.

PROJECT DESCRIPTION

Based on our review of preliminary information provided by the design team, we understand the project will likely include the construction of two new buildings (North and South Wings), a mechanical equipment yard, and an approximately 150-ft-tall communication tower. We understand all or some of the new structures will be designed to be seismically resilient. Ancillary improvements, including an emergency helistop, paved access roads and parking areas, and an entry guard booth, are also planned for the project. The preliminary layout and configuration of the proposed improvements are shown on the Site Plan, Figure 2. The project is still in a preliminary planning phase and changes to the type, size, location, and desired seismic performance of the new structures are therefore possible. We understand the performance requirement for the proposed buildings will likely be continued functionality and uninterrupted operation (immediate occupancy) after a code-level seismic event. More specifically, the North Wing building will be a base-isolated structure and the South Wing building will be designed as an Occupancy Category IV structure (essential facility), both of which are intended to remain fully operational during and after a seismic event. Based on our discussions with the project structural engineer, KPFF, Inc. (KPFF), we understand the proposed buildings will have maximum column and wall loads on the order of 500 kips and 5 kips/ft, respectively. Estimated structural loads for the communication tower or other ancillary structures are not available at this time. Based on our review of preliminary grading plans, we understand cuts and fills of up to about 15 ft may be required to establish the access roads and parking areas, which will be a significant consideration for design and construction of the project.

We understand the project is being designed in accordance with recently adopted American Society of Civil Engineers (ASCE) document 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures" (ASCE 7-16). ASCE 7-16 is a reference standard for the 2018 International Building Code (2018 IBC). As currently planned, the 2018 IBC will serve as the basis for seismic design in the upcoming 2019 Oregon Structural Specialty Code (OSSC). For the base-isolated North Wing building, we understand a nonlinear response history analysis (RHA) will be performed using ground motions developed in accordance with Chapter 16 of ASCE 7-16. As currently planned, the Occupancy Category IV South Wing building will be designed using one of the linear-analysis procedures available in Chapter 12 of ASCE 7-16.

SITE DESCRIPTION

Surface Conditions and Topography

As shown on Figure 1, the site is located at the southeast corner of the intersection of SW 124th Avenue and SW Tualatin-Sherwood Road. The site is bounded to the north by SW Tualatin-Sherwood Road, to the east by SW 120th Avenue, to the south by an active quarry, and to the west by SW 124th Avenue. The site is approximately 1,250 ft wide in the east-west direction along SW Tualatin-Sherwood Road and up to about 1,900 ft long in the north-south direction along SW 124th Avenue. The majority of the site is currently occupied by farm fields with residential and agricultural buildings located in the northernmost portions of the site near SW Tualatin-Sherwood Road. The southern portions of the site are currently undeveloped forested areas, including dense shrubs and mature trees with large cobbles and boulders exposed at the ground surface. A preliminary topographic survey completed for the project indicates the ground surface at the site generally slopes down from the southwest to northeast, with maximum elevation changes on the order of 80 ft. Based on our review of the preliminary survey, the ground surface in the vicinity of the proposed buildings is relatively flat, at elevations ranging from about 210 to 215 ft. Unless otherwise specified, all elevations in this report reference the North American Vertical Datum of 1988 (NAVD 88).

Geology

The site is located in the northern portion of the Willamette Valley, within the Tualatin Basin. The Tualatin Basin is a northwest-southeast trending structure basin bordered by the Coast Range and Chehalem Mountains to the south and west and the Tualatin Mountains (also known as the Portland Hills) to the north and east. The site is mantled with Late Pleistocene-age lacustrine (floodplain) alluvial soils deposited by the Missoula Floods. The Missoula Floods were caused when water from the Clark Fork River in Montana became ponded behind a glacial ice dam that failed and released an estimated 500 cubic miles of water over eastern Washington, which drained to the Pacific Ocean by way of the Columbia River. The volume and velocity of the floodwaters transported boulders and scoured underlying soil and rock from the valley sides, and these sediments were deposited as the water receded. Notably, the Missoula Floods overtopped regional topographic highlands and scoured fresh and weathered rock (Wilson, 1998). In the project area, sediments deposited by the Missoula Floods primarily consist of stratified silt and clay with minor sand (O'Connor et al., 2001). These alluvial soils are underlain at relatively shallow depths by basalt of the Columbia River Basalt Group (CRBG), a thick sequence of dark-gray to black basalt lava flows of Middle Miocene age (Gannett and Caldwell, 1998). The basalt flows of the CRBG erupted from fissures and vents in northeastern Oregon, eastern Washington, and western Idaho, and eventually reached the Pacific Ocean. The CRBG forms many of the topographic highlands of the Tualatin Valley, where the basalt was scoured by the Missoula Floods. In the project area, the upper surface of the CRBG is typically decomposed to a relatively stiff residual soil, and the weathering profile in the upper portion of the basalt is highly variable.

SUBSURFACE CONDITIONS

General

Subsurface materials and conditions at the site were evaluated on January 3 and 4, 2018, with seven borings designated B-1 through B-7, 10 test pits designated TP-1 through TP-10, six cone penetration test (CPT) probes designated CPT-1 through CPT-6, and nine dynamic cone penetrometers (DCP) designated DCP-1 through DCP-9. The explorations were advanced to depths ranging from about 2 to 26 ft at the approximate locations shown on the Site Map, Figure 3. The subsurface exploration and laboratory testing programs completed for our investigation are discussed in detail in Appendix A. Logs of the explorations are provided on Figures 1A through 20A. The terms and symbols used to describe the soil and rock encountered in the explorations are defined in Tables 1A, 2A, and 3A and in the attached legend.

Soil and Rock

For the purpose of discussion, the soil and rock disclosed by the explorations have been grouped into the following categories based on their physical characteristics, geologically significant features, and engineering properties. Listed as they were encountered from the ground surface downward, the units are:

1. **SILT (Alluvium)**
2. **SILT (Residual Soil)**
3. **Silty SAND and GRAVEL (Decomposed Basalt)**
4. **BASALT (Columbia River Basalt)**

1. SILT (Alluvium). Alluvial silt was encountered at the ground surface in borings B-1, B-3, and B-5, test pits TP-1 through TP-6, and CPT probes CPT-1 through CPT-4 and extends to depths ranging from about 3.5 to 15 ft. The alluvial silt is typically brown to red-brown and has variable sand and clay content, ranging from a trace of sand to sandy and trace to some clay. Scattered roots and organics are also present in the silt. As shown on Figures 1A through 20A, the relative consistency of the alluvial silt ranges from very soft to very stiff and is typically medium stiff to stiff. The natural moisture content of the alluvium ranges from about 23 to 37%. The results of Atterberg limits determinations for samples of the alluvial silt are summarized on Figure 21A and indicate the soil typically has low to medium plasticity, with plasticity index (PI) values of about 3 to 7%. The results of a laboratory consolidation test completed on a relatively undisturbed sample of the silt are summarized on Figure 22A and indicate the soil is typically moderately to heavily overconsolidated and has a relatively low compressibility in the overconsolidated range of pressures. Test pits TP-2, TP-3, and TP-5 were terminated in the alluvium at a depth of about 5 ft.

2. SILT (Residual Soil). Silt derived from the severe weathering and decomposition of the underlying basalt was encountered at the ground surface or below the alluvium in borings B-2, B-4, and B-6, test pits TP-1, TP-

6, TP-7, TP-8, and TP-10, and CPT probe CPT-5. The residual silt is typically brown to red-brown with gray and rust mottling and has variable sand and clay content, ranging from a trace of sand to sandy and trace to some clay. The residual silt also contains gravel-sized basalt fragments and scattered roots and organics. As shown on Figures 1A through 20A, the relative consistency of the residual silt ranges from soft to stiff and is typically medium stiff to stiff. The natural moisture content of the silt ranges from about 24 to 44%. The results of Atterberg limits determinations for samples of the residual silt are summarized on Figure 21A and indicate the soil typically has a medium to high plasticity, with PI values of about 11 to 16%. Test pit TP-6 was terminated in the residual soil at a depth of about 6.5 ft.

3. Silty SAND and GRAVEL (Decomposed Basalt). Decomposed basalt consisting of silty sand and gravel was encountered at the ground surface in boring B-7 and test pit TP-9 and beneath the alluvium or residual soil in borings B-2 through B-6, test pits TP-7, TP-8, and TP-10, and CPT probes CPT-1 through CPT-5. The decomposed basalt typically extends to depths of about 2 to 7.5 ft; however, the decomposed basalt in boring B-5 extends to a depth of about 20 ft. The decomposed basalt is generally red-brown and gray with rust and brown mottling. Our experience in the project area indicates the decomposed basalt typically contains gravel- to boulder-sized fragments of predominantly decomposed basalt. As shown on Figures 1A through 20A, the relative density of the silty sand and gravel ranges from medium dense to very dense and is typically very dense. The natural moisture content of the decomposed basalt ranges from about 27 to 46%. Test pit TP-9 and CPT probes CPT-1 through CPT-5 were terminated in the decomposed basalt at depths of about 3 to 18 ft.

4. BASALT (Columbia River Basalt). Basalt of the Columbia River Basalt Group was encountered beneath the alluvial silt and residual soil in borings B-1 through B-7 and test pits TP-1, TP-4, TP-7, TP-8, and TP-10. The basalt is typically brown to gray or black, has some vesicles, and displays closely to very closely spaced fractures with secondary clay mineralization and iron oxidation. Based on Rock Quality Designation (RQD) values of about 11 to 32%, the quality of the basalt is generally very poor. Typically, the basalt is predominantly decomposed to decomposed near the upper surface of the rock and becomes moderately weathered with increasing depth. The relative rock hardness of the basalt is estimated to range from extremely soft to medium hard (R0 to R3), although harder zones may be present, particularly at greater depths. Figure 23A shows photographs of the basalt obtained from rock coring in boring B-3. Borings B-1 through B-7 and test pits TP-1, TP-4, TP-7, TP-8, and TP-10 were terminated in the basalt at depths ranging from about 3 to 26 ft.

Geophysical Survey. A geophysical survey was completed at the site to assist in evaluating the subsurface shear-wave velocity profile. The survey consisted of performing two refraction microtremor (ReMi) lines at the approximate locations shown on Figure 3 (ReMi-1 and ReMi-2). The ReMi method is based on ambient noise measurements obtained using seismic arrays to provide information on surface-wave velocity dispersion. Inversion of the dispersion curves provides a one-dimensional shear-wave velocity (Vs) model down to a depth related to the length of the array. The results of the ReMi surveys suggest the average shear-wave velocity in the upper 100 ft of the site ranges from about 2,250 to 2,400 ft/sec. Appendix C provides additional details and the results of the ReMi surveys completed at the site.

Groundwater

The borings were advanced using mud-rotary methods, which do not allow the observation of groundwater conditions during drilling. However, groundwater was encountered in test pits TP-1, TP-2, TP-3, and TP-6 at depths ranging from about 3.8 to 4.5 ft, which is likely representative of perched groundwater conditions. Based on our experience in the project area and our review of available water well logs obtained from Oregon Water Resources Department website, we anticipate the regional groundwater level at the site is located at a depth of 75 ft or more below the ground surface in the underlying basalt. However, we anticipate localized perched groundwater conditions will occur at shallower depths, as observed in the test pits, during and following periods of heavy or prolonged precipitation.

Infiltration Testing

Two encased falling-head infiltration tests, designated I-1 and I-2, were completed at the approximate locations shown on Figure 3. The infiltration tests were conducted at depths of about 3 to 5 ft in substantial conformance with the requirements for falling-head infiltration testing outlined in the September 26, 2007, Washington County document, "On-Site Stormwater Disposal System (OSDS) Design and Construction Minimum Guidelines and Requirements." To perform the tests, an approximately 5 7/8-in.-ID solid PVC pipe was firmly seated into the soil at the depth of interest and filled with water to presoak the soils for approximately 24 hours prior to testing. At the start of the test, water was added to the pipe to a height of approximately 12 in. and the change in water level was measured over time. GRI did not observe a significant drop in water levels over the course of three, 1-hour tests following saturation. In our opinion, this indicates the soils at the site are likely not conducive to on-site infiltration of stormwater.

CONCLUSIONS AND RECOMMENDATIONS

General

The explorations completed for this investigation indicate the site is mantled with alluvial and residual soils. These soils are underlain at relatively shallow depths by basalt of the CRBG, which is typically decomposed to a sand or gravel near the contact with the overlying soils. The results of this investigation and our experience with similar subsurface conditions indicate the weathering profile of the basalt and thickness of the decomposed zone can vary significantly over relatively short distances. Perched groundwater was encountered in some of the test pits at the time of excavation and we anticipate perched groundwater levels may approach the ground surface at the site during the wet winter months or following periods of prolonged or heavy precipitation.

In our opinion, the primary geotechnical considerations associated with construction of the facility include the presence of moisture-sensitive soils that are easily disturbed by construction activities, the potential for shallow, perched groundwater conditions, and the relatively shallow depth to basalt across most of the site. Foundation support for the new buildings and other structures can likely be provided by conventional spread footings or mat foundations established in firm, undisturbed native soil, rock, or granular structural fill. The following sections of this report provide our preliminary conclusions and recommendations for design and construction of the project.

Site Preparation

The ground surface within the limits of all new structures, retaining walls, walkways, pavements, or other areas to receive fill during mass grading should be stripped of vegetation, surface organics, and any loose surface soils. We anticipate stripping to a depth of about 6 in. will likely be required within the currently farmed portions of the site. In the currently forested portions of the site, we anticipate deeper stripping and grubbing will be required locally to remove tree roots and brush. Organic strippings should be disposed of off site or stockpiled on site for later use in landscaped areas. Following stripping or excavation to subgrade level, the exposed surfaces should be evaluated by a GRI representative. Proof rolling with a loaded dump truck or similar heavy equipment may be part of this evaluation. Any soft areas or areas of unsuitable material disclosed by the evaluation should be overexcavated to firm material and backfilled with structural fill following the recommendations provided in this report. During and following stripping and excavation, the subcontractor must use care to protect the subgrade from disturbance by construction equipment, particularly during wet-weather or wet-ground conditions.

The soils that mantle the site are sensitive to moisture content, and perched groundwater levels may approach the ground surface during the wet winter months. Therefore, it is our opinion earthwork can be completed most economically during the dry summer months. It has been our experience that the moisture content of the upper few feet of the soils at the site will decrease during extended periods of warm, dry weather. However, below this depth, the moisture content of the soils tends to remain relatively constant and above optimum for compaction. As a result, the contractor must use construction equipment and procedures that reduce disturbance and softening of the subgrade soils. To limit the risk of disturbing the moisture-sensitive soils, all site grading near finished subgrade elevations should be completed using track-mounted hydraulic excavators equipped with smooth-edged buckets. It may also be necessary to construct granular haul roads and work pads concurrently with the site grading and excavation to reduce the risk of subgrade disturbance. If the subgrade is disturbed during construction, soft or disturbed soils should be overexcavated to firm soil and backfilled with structural fill.

If construction occurs during wet-weather or wet-ground conditions, granular haul roads and work pads will be required to protect the underlying subgrade and provide a firm working surface for construction activities. In our experience, a minimum 12- to 18-in.-thick layer of granular fill is typically required to reduce subgrade disturbance caused by light construction equipment and limited traffic by dump trucks. Haul roads and other high-density traffic areas will typically require a minimum 18- to 24-in.-thick layer of granular fill to reduce the risk of subgrade disturbance. For thicker work pads and haul roads, it is common to use relatively large crushed rock up to 4 in. in diameter for the bottom portion of the granular layer and more finely graded rock, such as 3/4- or 1 1/2-in.-minus crushed rock, for the upper surface of the granular layer to facilitate grading and provide a more uniform working surface. The use of a geotextile fabric over the subgrade may reduce maintenance and the risk of subgrade disturbance during construction, particularly in high-density traffic areas.

As an alternative to using relatively thick granular haul roads and work pads to support construction activities and protect the subgrade, the subgrade soils can be treated with cement. The amount of cement required to effectively treat the on-site soils will depend on the moisture content and plasticity of the soil and must be evaluated at the time of construction. However, it has been our experience that treating the upper 12 to 16 in. of the subgrade soils using an admixture on the order of 6 to 8% cement and overlaying the treated section with 6 to 12 in. of granular structural fill will typically support construction equipment and provide a good, all-weather working surface.

Excavations and Site Grading

Preliminary grading plans for the project indicate cuts and fills up to about 15 ft will be required to establish final site grades for the roadway and parking areas in the southern portions of the site. The subsurface explorations completed for this project typically encountered basalt at relatively shallow depths. Considering this, we anticipate the required depth of excavations and overall site grading requirements will be a significant consideration for design and construction of the project.

In areas where rock excavation is required, we anticipate the ability to excavate the rock using conventional methods will depend on several factors, including the jointing and weathering characteristics of the rock, and to a somewhat lesser extent, the relative hardness of the rock. Our experience in the project area indicates these factors can vary significantly over relatively short distances. While it may be possible to excavate zones of highly fractured or weathered basalt by ripping with a large bulldozer and/or large hydraulic excavator equipped with a rock bucket and rock teeth or other specialty tooling, it should be anticipated that more specialized rock excavation techniques such as chipping, splitting, expansive grouting, or blasting will be necessary to remove zones of less-weathered, less-fractured rock and/or harder rock, if encountered.

In our opinion, temporary excavations at the site can generally be completed using 1H:1V (Horizontal to Vertical) side slopes in the alluvial soils, residual soils, and decomposed basalt. Flatter slopes may be necessary if significant seepage, sloughing, or running soil conditions are encountered. All permanent excavations and fill slopes in these soils should be completed using 2H:1V or flatter side slopes. Temporary and permanent excavations in the underlying rock can likely be completed using 0.5H:1V to near vertical side slopes; however, this recommendation should be reviewed during construction based on observed conditions, as flatter slopes may be required locally, particularly where the rock is highly weathered or fractured. In our opinion, the stability of the slopes will be adequate if surcharge loads due to construction traffic, vehicle parking, material laydown, etc., are not allowed in the areas within 10 ft of the top of the slopes. In this regard, we recommend placing positive measures, such as fencing or barricades, along the top of the slopes to prevent this area from being used for material storage, a queue area for construction vehicles, or worker parking. Other measures that should be considered to reduce the risk of temporary slope failure include the following: 1) use non-woven geotextile fabric or plastic sheeting to protect the exposed slopes from surface erosion during periods of heavy precipitation; 2) provide positive drainage away from the top and bottom of the excavation slopes; 3) construct and backfill embedded structures as soon as practical after completing the excavation; 4) periodically monitor the area around the top of the excavation for evidence of ground cracking; and 5) control groundwater, if encountered. It must be emphasized that following these recommendations will not guarantee that failure of the slopes will not occur; however, the recommendations are intended to reduce the risk of a major slope failure to an acceptable level. It should be realized that blocks of ground and/or localized slumps in the excavation slopes may tend to move into the excavation during the construction. In our opinion, this is most likely to occur during the initial stages of the excavation and/or when the groundwater level is the highest.

Depending on the time of year the work is completed, perched groundwater may be encountered in the excavations. Groundwater seepage, running soil conditions, and unstable excavation sidewalls or excavation subgrades, if encountered during construction, can generally be controlled by placing a blanket of clean, granular fill against the slopes. We anticipate the management of surface water and perched groundwater infiltration, if encountered in the excavations, can generally be accomplished using a network of temporary drainage ditches and sumps in conjunction with a granular working pad. Recommendations for granular working pads are provided in the Site Preparation section of this report, and relatively free-draining material such as 2- to 4-in.-minus crushed rock is generally used for this purpose. The actual required thickness of a granular working pad will depend on the conditions exposed in the excavation and the effectiveness of the contractor's groundwater management program, which should be evaluated based on observations during construction. In our opinion, the impacts of groundwater can be limited by completing the excavations during the dry summer months, when perched groundwater levels are lowest.

Structural Fill

General. All fill placed within the limits of new buildings, pavements, retaining walls, and other structures should consist of granular structural fill. We understand the on-site soils are being considered for use as general structural fill during overall site grading. In general, all structural fill should extend a minimum horizontal distance of 5 ft beyond the edge of new foundations and 1 ft beyond the limits of ancillary improvements, such as the edge of new pavements. All structural fill materials should be compacted to at least 95% of the maximum dry density and at a moisture content within about 3% of optimum as determined by ASTM International (ASTM) D698. Coarse, granular fill should be compacted until well keyed. All structural fill materials should be free of organics, construction debris, or other deleterious material. Appropriate lift thicknesses will depend on the type of structural fill being placed and the compaction equipment being used, which should be evaluated during construction based on visual observations and/or the results of nuclear field density testing. Additional information regarding specific types of fill is provided below.

Granular Fill. All fill placed within the limits of new structures, pavements, and retaining walls should consist of imported granular structural fill. In our opinion, relatively clean sand, sandy gravel, or crushed rock with a maximum size of 2 in. and less than about 5% passing the No. 200 sieve (washed analysis) would be suitable for use as granular structural fill. Appropriate lift thicknesses will depend on the type of compaction equipment used. For example, if hand-operated vibratory plates are used, lift thicknesses should be limited to about 6 in. If smooth-drum, vibratory rollers are used, lift thicknesses of about 12 in. are appropriate. If excavator-mounted vibratory plates are used, lift thicknesses up to 2 ft may be acceptable. Particular care should be taken when placing an initial lift of granular structural fill over a silt subgrade, particularly during wet-weather or wet-ground conditions. In our experience, using a thickened lift for the first layer of granular fill will limit the risk of subgrade disturbance and provide more uniform support for subsequent fill placement, which should be evaluated during construction.

Fine-Grained Fill. We understand use of the on-site soils for structural fill is being considered during overall site grading. These soils will only be suitable for use as structural fill if they are relatively free of organics and placed near optimum moisture content during extended periods of dry weather. Based on our previous experience, significant air-drying and moisture-conditioning of the on-site soils will generally be required to achieve suitable placement as structural fill. This is typically accomplished by plowing, disking, or tilling thin lifts of soil over relatively large areas to achieve a relatively uniform moisture content that is near optimum for compaction. Drying rates will depend on weather-related factors, including wind, temperature, and relative humidity. Fine-grained fill should be placed in about 8- to 12-in.-thick lifts and compacted using segmented-pad rollers. If fine-grained fill soils are compacted at a moisture content that is significantly higher than recommended, the specified densities cannot be achieved, and the fill material will be relatively weak and compressible.

Foundation Support

Preliminary information provided by KPFF, the project structural engineer, indicates the proposed buildings will have maximum column and wall loads on the order of 500 kips and 5 kips/ft, respectively. Anticipated structural loads for the communication tower or other ancillary improvements are not available at this time. In our opinion, the proposed structural loads can be supported on conventional spread footings or mat foundations. Depending on the final configuration of the new buildings and other structures, we anticipate new foundations at the site may be established in the near-surface soils and the underlying rock. We recommend using a maximum allowable bearing pressure of 3,000 psf for the design of spread footings established in native soils at relatively shallow depths below existing site grades. Footings with a significant embedment depth relative to existing site grades can likely be designed using a higher allowable bearing pressure, which can be evaluated on a case-by-case basis as the project design advances. For footings established in relatively hard basalt, we recommend using a maximum allowable bearing pressure of 10,000 psf. Recommended allowable bearing pressures for mat foundation design, if required, can be provided when more detailed design information is available. These values apply to the total of dead load plus permanently and/or frequently applied live loads and can be increased by one-third for the total of all loads: dead, live, and wind or seismic. We estimate the total static settlement of spread footings designed and constructed in accordance with the recommendations provided in this report will be less than about 1 in. for footings established in soil and ½ in. for footings established in rock. Differential static settlements between adjacent, comparably loaded footings with similar subgrade conditions should be less than half the total settlement.

Horizontal shear forces can be resisted partially or completely by frictional forces developed between the base of spread footings and the underlying soil or rock. The total shearing resistance beneath the base of the footing can be computed as the normal force, i.e., the sum of all vertical forces (dead load plus real live load) multiplied by the coefficient of friction between the soil or rock and the base of the footing. We recommend using an ultimate value of 0.35 and 0.50 for the coefficient of friction for footings cast on undisturbed soil or rock, respectively. If additional lateral resistance is required, passive earth pressures against embedded footings can be computed on the basis of an equivalent fluid having a unit weight of 250 pcf, assuming the footings are backfilled with granular structural fill. In areas where the footings are established in basalt and are constructed with a limited backfill width, passive earth pressures can be estimated using an equivalent fluid having a unit weight of 500 pcf. These design passive earth pressures assume the ground surface does not slope downward away from the footings and were reduced from ultimate values to limit lateral deformations.

We recommend establishing all spread footings (i.e., bottom of the footing) at a minimum depth of 2 ft below the lowest adjacent finished grade. The footing width should not be less than 18 in. for continuous footings and 24 in. for isolated column footings. All footing excavations in soil should be completed using an excavator equipped with a smooth-edged bucket, and the subgrade in the base of the excavations should be evaluated by a GRI representative. For footing excavations in rock, it should be anticipated that some removal of loose and/or disturbed rock using hand tools or other methods will be required. Soft, loose, or otherwise unsuitable material encountered at foundation subgrade level should be overexcavated and backfilled with granular structural fill. During wet-weather or wet-ground conditions, footings established in soils should have a minimum 4-in.-thick layer of ¾-in.-minus crushed rock placed in the bottom of excavations as soon as practical to limit the risk of disturbance from construction activities.

Subdrainage and Floor Support

Perched groundwater levels during the wet winter months may rise to near the existing ground surface at the site. Due to sloping ground conditions at the site, this will be a particularly important consideration for the design of any embedded structures. We recommend any embedded or partially embedded structures be designed to withstand hydrostatic pressures imposed by groundwater, or, alternatively, provided with subdrainage systems to reduce hydrostatic pressures and the risk of groundwater entering through embedded walls and floor slabs. Typical recommendations for subdrainage are provided on Figure 4 and include perimeter wall drainage behind embedded walls and underslab drainage beneath concrete floor slabs. All groundwater collected by the subdrainage system should be drained by gravity or pumped from sumps. If the water is pumped, an emergency power supply should be provided to prevent flooding due to a power loss. Water collected in the outside perimeter wall drain should be hard-piped to a sump or drain and should not be allowed beneath the building floor slabs. In our opinion, GRI should be contacted to review the design of any subdrainage systems for the project.

Drain rock placed beneath concrete floor slabs will limit the potential for capillary rise of water beneath the slabs and provide more uniform floor support. In areas where the proposed buildings are established near existing site grades, installation of a perimeter foundation drain around the building will also reduce the risk of perched groundwater entering the drain rock beneath the slab. In areas where the finished floor elevation will be established near or above adjacent site grades and exterior finish grades, a minimum 8-in.-thick layer of drain rock should be placed beneath floor slabs. Similarly, floor slabs for embedded structures should be underlain by a minimum 12-in.-thick layer of drain rock equipped with perforated drain pipes following the recommendations shown on Figure 4. As discussed in the Site Preparation section of this report, a thicker rock section will likely be required in areas where construction equipment will operate. The drain rock placed beneath floor slabs should consist of angular rock with a maximum size of up to 1.5 in. and less than about 2% passing the No. 200 sieve (washed analysis) and should be placed in one lift and compacted until well-keyed. To evaluate isolated point loading on the floor slabs, in our opinion it is appropriate to assume a coefficient of subgrade reaction, k, of about 200 pci to characterize the subgrade support with a minimum 8 in. of compacted drain rock beneath the slabs. To improve workability, the drain rock may be capped with 2 in. of ¾-in.-minus crushed rock. In areas where floor coverings will be installed or moisture-sensitive materials stored, it is also appropriate to install a vapor-retarding membrane in accordance with the manufacturer's recommendations.

Lateral Earth Pressures

Design lateral earth pressures for embedded building and retaining walls depend on the drainage condition provided behind the wall and the ability of the wall to yield. The two possible conditions regarding the drainage condition behind the wall are: 1) backfill that is fully drained and therefore does not induce hydrostatic loading on the wall; and 2) backfill that is not fully drained and therefore may induce hydrostatic pressures on the wall. The two possible conditions regarding the ability of the wall to yield are: 1) a wall that is laterally supported at its base and top and therefore is unable to yield; and 2) a conventional cantilevered retaining wall that yields by tilting about its base. Assuming the wall backfill will be horizontal and fully drained, yielding and non-yielding walls can be designed on the basis of a hydrostatic pressure using an equivalent fluid unit weight of 35 and 50 pcf, respectively.

Additional lateral pressures due to surcharge loadings in the backfill area can be estimated using the guidelines provided on Figure 5. At a minimum, we recommend using a uniform vertical surcharge pressure of 250 psf to account for construction equipment operating over the backfill for embedded walls. To evaluate the potential increase in design lateral earth pressures due to seismic loading, we reviewed recently developed recommendations provided in California Department of Transportation Report CA13-2170

(Agusti and Sitar, 2013). Based on our review of the report, we recommend evaluating temporary seismic loading based on a hydrostatic pressure using an equivalent fluid unit weight of about 10 and 20 pcf, respectively, for yielding and non-yielding walls retaining horizontal backfill. This seismic force is in addition to the static lateral earth pressure acting on the wall. The temporary construction surcharge does not need to be included in the seismic load case. Resistance to lateral and vertical driving forces can be evaluated following the recommendations provided in the Foundation Support section of this report.

The foregoing lateral earth pressure criteria assume the embedded walls will be fully drained and backfilled with granular structural fill following the recommendations provided in this report. Heavy compactors and large pieces of construction equipment should not be allowed to operate within a minimum distance of 5 ft from the walls to avoid the buildup of excessive lateral pressures. Compaction close to the walls should be accomplished using hand-operated vibratory-plate compactors. To provide adequate drainage, we recommend placing a minimum 2-ft-wide, vertical drainage layer against the back of the walls during backfilling. This drainage layer should consist of open-graded crushed rock (drain rock) with not more than about 2% passing the No. 200 sieve (washed analysis) and should be installed following the perimeter wall drain recommendations shown on Figure 4. If the general wall backfill behind the drainage layer is significantly finer-grained material, such as sand or sandy gravel, we recommend placing a non-woven geotextile between the drainage layer and the general wall backfill. Non-woven geotextile such as Mirafi 140N (or similar) would be suitable for this purpose.

Utilities

As currently planned, several new utilities will be installed to service the proposed facility. All utility excavations should be properly sloped or shored to conform to applicable local, state, or federal regulations. The method of excavation and design of trench support are the responsibility of the contractor and are subject to applicable local, state, and federal safety regulations, including the current Oregon Occupational Safety and Health Administration (OSHA) excavation and trench safety standards. The means, methods, and sequencing of construction operations and site safety are also the responsibility of the contractor. The information provided below is for the use of our client and should not be interpreted to suggest we are assuming responsibility for the contractor's actions or site safety.

Depending on the required depth of the new utilities, relatively hard rock could be encountered in utility trench excavations completed at the site. We also anticipate excavations for new utilities could encounter cobbles or boulders. In our opinion, the potential for encountering rock, cobbles, or boulders in utility trench excavations will be an important consideration for construction of the project. Additional discussion regarding rock excavation is provided in the Excavations and Site Grading section of this report.

Depending on the time of year construction will occur, groundwater seepage could be encountered in utility trench excavations, which could create the potential for running soil conditions and unstable trench sidewalls. Groundwater seepage, running soil conditions, and unstable trench sidewalls, if encountered, may require dewatering of the excavation and temporary support of the trench sidewalls. Some overexcavation of the trench bottom may also be necessary to permit the installation of stabilization/drainage material if wet-ground conditions are encountered, particularly in silty soils. To provide a relatively firm working base and facilitate groundwater management by pumping from sumps within the excavations, a drainage/stabilization layer consisting of a 12- to 24-in. thickness of open-graded crushed rock up to 4 in. in diameter and having less than about 2% passing the No. 200 sieve (washed analysis) may be appropriate.

However, the need for and requirements of a base stabilization layer should be evaluated by a GRI representative during construction based on actual conditions.

All utility trench excavations within the limits of new structures, pavements, and other improved areas should be backfilled with granular structural fill following the recommendations provided in this report. The use of excavator-mounted vibratory-plate compactors (hoe packs) is typically most efficient for placing utility trench backfill. Lift thicknesses should be evaluated on the basis of field density tests; however, particular care should be taken when operating hoe packs to prevent damage to newly placed utilities. Flooding or jetting the backfilled trenches with water to achieve the recommended compaction should not be permitted.

Pavement Design

Based on our review of preliminary site plans, we understand significant portions of the site will be surfaced with paved access roadways and parking areas. Specific design traffic loading information for the roadways and parking areas is not currently available. However, you indicated the roadways and parking areas will subjected primarily to automobile and occasional heavy-truck or emergency-vehicle traffic. For similar projects and soil subgrade conditions, it has been our experience that 3 in. of asphalt concrete (AC) over 8 in. of crushed-rock base (CRB) course is suitable for support of automobile traffic and parking areas. The pavement section should consist of at least 4 in. of AC over 12 in. of CRB in areas that will be subjected to occasional heavy-truck traffic or emergency vehicles.

The pavement sections provided above should be considered minimum thicknesses and should be reviewed when more specific design traffic information is available, particularly in areas where heavy-truck or emergency-vehicle traffic is anticipated. It should be assumed that some maintenance will be required over the life of the pavement (typically 15 to 20 years). The sections assume pavement construction will be accomplished during the dry season. If wet-weather pavement construction is considered, it will likely be necessary to increase the thickness of CRB to support construction equipment and protect the subgrade from disturbance. The sections provided above are not intended to support extensive construction traffic, such as dump trucks and concrete trucks. Pavements subjected to construction traffic may require repair or reconstruction.

Properly installed drainage is an essential aspect of pavement design and performance. We recommend all paved areas be provided with positive drainage to remove surface water and water within the CRB. This will be particularly important in cut sections or at low points within the paved areas, such as loading docks and catch basins. Effective methods to prevent saturation of the CRB include providing weep holes in the sidewalls of catch basins, subdrains in conjunction with utility excavations, and separate trench drain systems. To provide quality materials and construction practices, we recommend all paving conform to applicable Oregon Department of Transportation standards. Prior to placing the CRB, all pavement subgrade should be proof rolled with a loaded dump truck or similar heavy equipment. Any areas of soft or otherwise unsuitable subgrade identified during the proof rolling should be overexcavated to firm subgrade and backfilled with granular structural fill following the recommendations provided in this report.

Seismic Considerations

We understand the project is being designed in accordance with ASCE 7-16, which is also a reference standard for the 2018 IBC. The 2018 IBC will serve as the basis for seismic design in the upcoming 2019 OSSC. The ASCE methodology uses two spectral response parameters, S_S and S_1, corresponding to periods of about 0.2 and 1.0 sec to develop the Risk-Targeted Maximum Considered Earthquake (MCE_R) response spectrum for Site Class B/C, or bedrock conditions. The S_S and S_1 parameters for the site located at the approximate latitude and longitude coordinates of 45.3672° N and 122.8034° W are 0.83 and 0.39 g, respectively. To establish the ground-surface MCE_R spectrum, these bedrock spectral parameters are adjusted for site class using the short- and long-period site coefficients, F_a and F_v, in accordance with Section 11.4.4 of ASCE 7-16. The design-level response spectrum is calculated as two-thirds of the ground-surface MCE_R spectrum.

Based on the results of the explorations completed for this project, the soil profile at the site is generally representative of Site Class C conditions. As part of our investigation, GRI completed a site-response analysis for the project, the results of which were used to develop recommended ground-surface response spectra for design. Additional details regarding the site-response analysis and development of the recommended response spectra are provided in Appendix B. Our recommended MCE_R and design response spectral values for design of the project are summarized in Table 1, below. These spectral values can be used in seismic design of the buildings using the modal response spectrum analysis (MRSA) and RHA procedures. The design acceleration parameters, S_{DS} and S_{D1}, for use with the equivalent lateral-force procedure are derived in accordance with the guidelines provided in Section 21.4 of ASCE 7-16. These design spectral values corresponding to 0.2- and 1-sec periods are 0.54 and 0.31 g, respectively.

Table 1: RECOMMENDED MCE_R AND DESIGN RESPONSE SPECTRAL VALUES, 5% DAMPING

Period, sec	MCE_R- Response Spectral Values, g	Design Response Spectral Values, g
0.01	0.49	0.33
0.05	0.75	0.50
0.10	1.23	0.82
0.20	0.91	0.61
0.28	0.80	0.53
0.50	0.80	0.53
0.58	0.80	0.53
0.80	0.58	0.39
1.00	0.47	0.31
1.50	0.31	0.21
2.00	0.23	0.15
2.50	0.19	0.13
3.00	0.16	0.11
3.50	0.13	0.09
4.00	0.12	0.08
5.00	0.09	0.06
6.00	0.08	0.05

In our opinion, the risk of significant seismically induced soil-strength loss or liquefaction at the site during a design-level earthquake is low. In our opinion, the potential for fault rupture or displacement at the site is low unless occurring on a previously unknown or unmapped fault. Additional discussion regarding local crustal faults is provided in Appendix B. In our opinion, the risk of seismically induced slope displacement at the site is very low. The risk of tsunami or seiche at the site is absent.

Nonlinear Response History Analysis

We understand the project structural engineers will use a numerical modeling program to analyze the soil-structure interactions for the base-isolated North Wing building. ASCE 7-16 provides recommendations for the development of ground motions (i.e., selection and scaling of ground motions appropriate to the MCE_R hazard level) for seismically isolated structures in Chapters 16 and 17. The time histories were selected for the base-isolated building from events consistent with the magnitudes, fault distances, soil conditions, and source mechanisms of the earthquakes that dominate the seismic hazard at the project site. The time histories were selected from a large dataset of crustal and subduction-zone earthquakes since these sources are the primary contributors to the potential seismicity of the site. The ground-motion modifications were completed by employing amplitude scaling since the method preserves the frequency characteristics of the original ground motion. ASCE 7-16 requires the average of the maximum-direction spectra from all horizontal component pairs generally matches or exceeds the MCE_R target spectrum over the period range of interest. The period range of interest for scaling corresponds to the vibration periods that significantly contribute to the building's lateral dynamic response. Based on discussions with the structural design team, KPFF, the base-isolated building is expected to have an effective fundamental period that ranges between 2.0 and 3.5 sec. In accordance with Chapter 17 of ASCE 7-16, the maximum-direction spectra constructed from each pair of ground motions were scaled in a period range of $0.75T_M$ to $1.25T_M$, where T_M is the effective fundamental period of the building under MCE_R loading. Appendix D provides a detailed discussion of the selection and scaling of time histories for RHA of the base-isolated North Wing building. The selected and scaled ground-motion records are summarized in Table 1D.

DESIGN REVIEW AND CONSTRUCTION SERVICES

We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GRI should be retained to review all geotechnical-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. To observe compliance with the intent of our recommendations, design concepts, and the plans and specifications, we are of the opinion that all construction operations dealing with earthwork and foundations should be observed by a GRI representative. Our construction-phase services will allow for timely design changes if site conditions are encountered that are different from those described in this report. If we do not have the opportunity to confirm our interpretations, assumptions, and analyses during construction, we cannot be responsible for the application of our recommendations to subsurface conditions that are different from those described in this report.

LIMITATIONS

This preliminary report has been prepared to aid the architects and engineers in the design of this project. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects of the project relevant to earthwork and design and construction of foundations and floor support. In the event that any changes in the design and location of the new structures as outlined in this report are planned, we should be given the opportunity to review the changes and to modify or reaffirm the conclusions and recommendations of this report in writing.

The conclusions and recommendations submitted in this report are based on data obtained from the explorations completed at the approximate locations shown on Figure 3 and other sources of information discussed in this report. It is acknowledged that variations in soil conditions may exist over short distances, and actual conditions encountered at the site may differ from the assumptions made in this report. The nature and extent of variation may not become evident until construction. If, during construction, subsurface conditions differ from those described in this report, we should be advised at once so that we can observe and review these conditions and reconsider our recommendations, where necessary.

Please contact the undersigned if you have any questions regarding this report.

Submitted for GRI,

Michael W. Reed, PE, GE	Tadesse Meskele, PhD, PE	John K. (Jack) Gordon, PE
Principal	Project Engineer	Senior Engineer

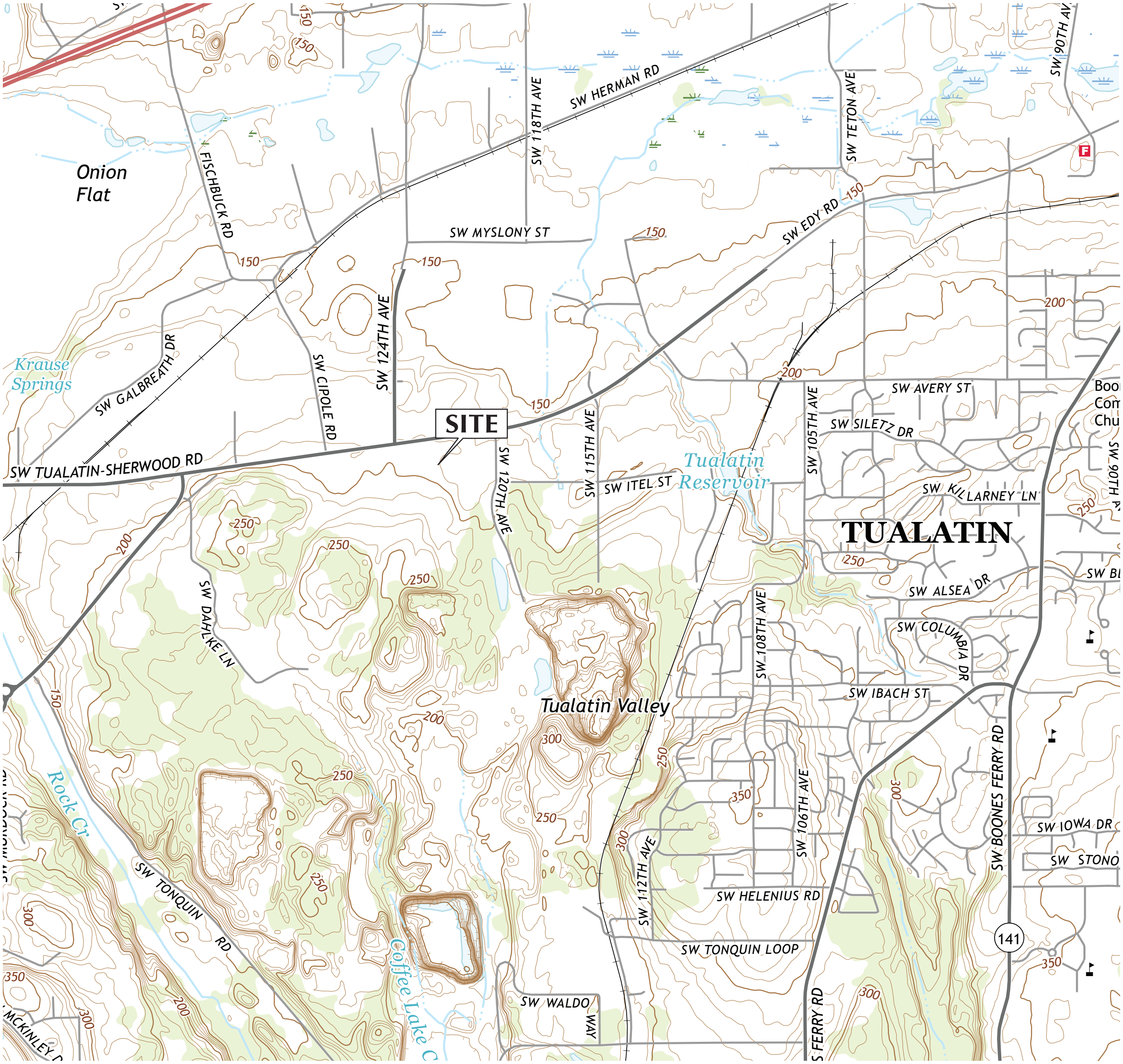
This document has been submitted electronically.

References

Agusti, G. C., and Sitar, N., August 14, 2013, Seismic Earth Pressures on Retaining Structures with Cohesive Backfills, Report No. CA13-2170, prepared in Cooperation with the State of California Department of Transportation.

O'Connor, J. E., Sarna-Wojcicki, A., Wozniak, K. C., and Polette, D. J., 2001, Origin, extent and thickness of Quaternary geologic units in the Willamette Valley, Oregon: U.S. Geological Survey, Professional Paper 1620, scale 1:250,000.

Wilson, D. C., 1998, Post-middle Miocene geologic evolution of the Tualatin basin, Oregon: Oregon Geology, vol. 60, no. 5.



USGS TOPOGRAPHIC MAP
BEAVERTON & SHERWOOD, OREG. (2017)

North

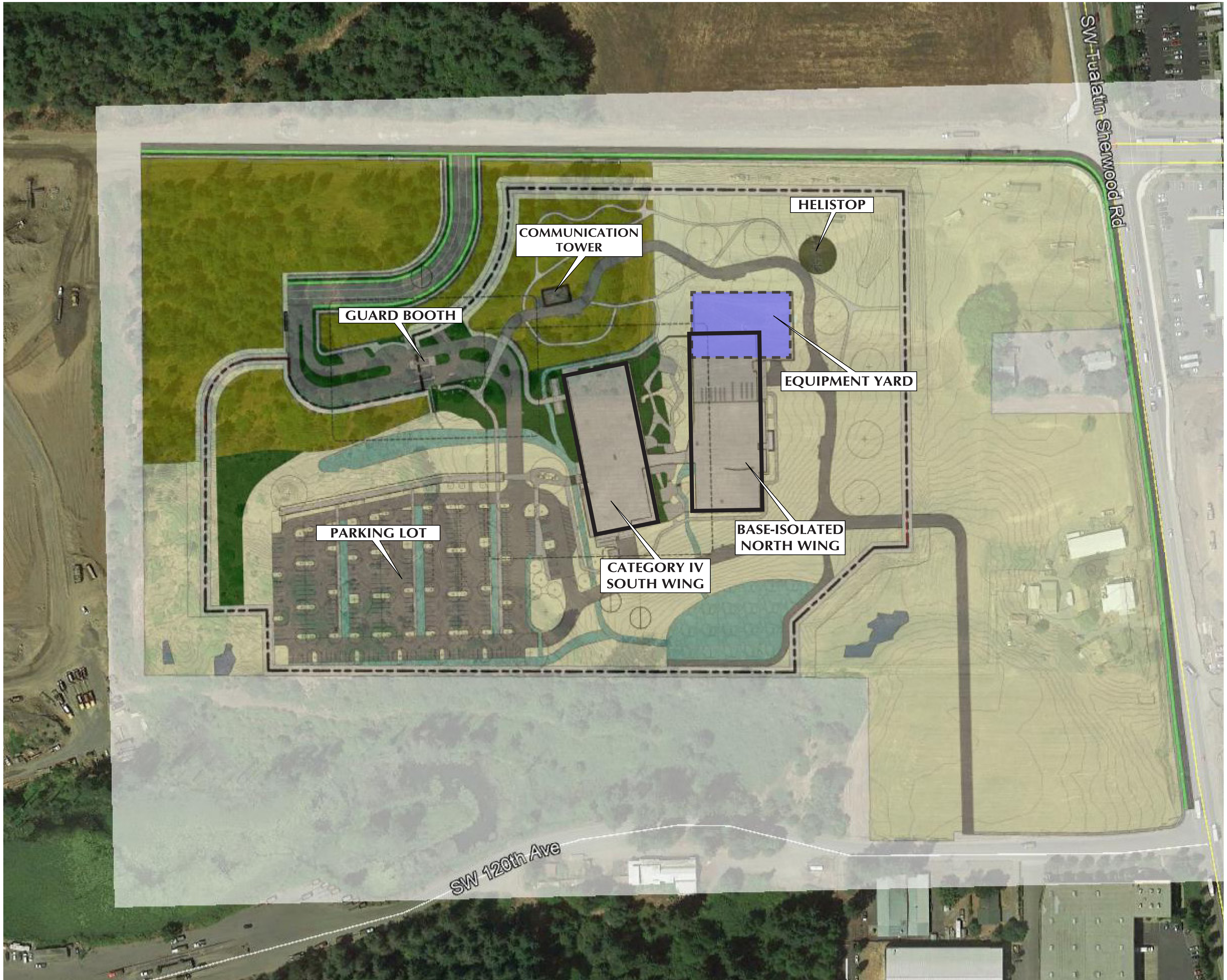
0 1/2 1 MILE

GRI

DREYFESS & BLACKFORD ARCHITECTURE
PGE IOC

VICINITY MAP

FEB. 2019 JOB NO. 6200 FIG. 1



*NOTE: LOCATIONS OF IMPROVEMENTS ARE APPROXIMATE. SITE PLAN CREATED USING PDF IMAGE OVERLAY.

SITE PLAN FROM FILE BY DREYFESS & BLACKFORD ARCHITECTURE, 2018

GRI

DREYFESS & BLACKFORD ARCHITECTURE
PGE IOC

SITE PLAN

FEB. 2019 | JOB NO. 6200 | FIG. 2

BORING COMPLETED BY GRI (JANUARY 3-4, 2019)

TEST PIT COMPLETED BY GRI (JANUARY 4, 2019)

CONE PENETRATION TEST COMPLETED BY GRI (JANUARY 3, 2019)

INFILTRATION TEST COMPLETED BY GRI (JANUARY 3-4, 2019)

DYNAMIC CONE PENETRATION TEST COMPLETED BY GRI (JANUARY 3, 2019)

TEST PIT AND DYNAMIC CONE PENETRATION TEST COMPLETED BY GRI (JANUARY 3-4, 2019)

SHEAR WAVE REFRACTION MICROMETER (ReMi) ARRAYS

[8.0] ESTIMATED DEPTH TO BASALT, FT (NE = NOT ENCOUNTERED)

SITE PLAN FROM FILE BY GOOGLE EARTH PRO, 2018

North

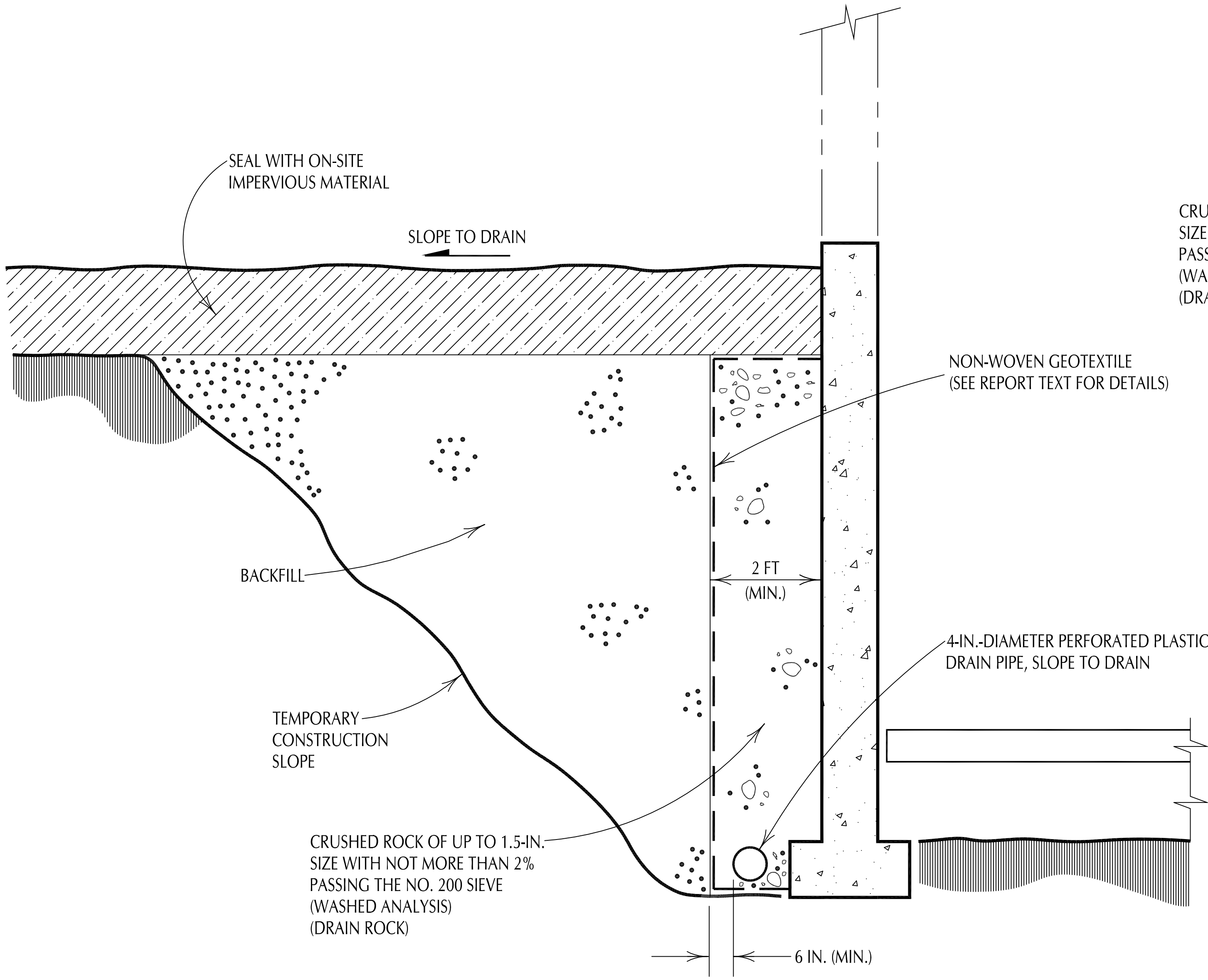
0 180 360 FT

GRI

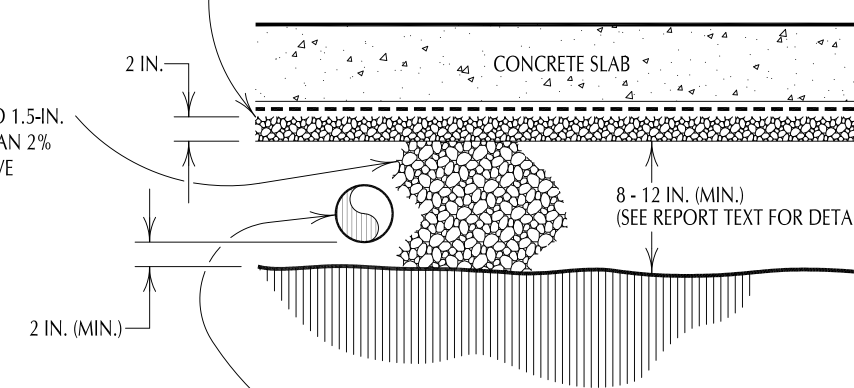
DREYFESS & BLACKFORD ARCHITECTURE
PGE IOC

SITE MAP

FEB. 2019 JOB NO. 6200 FIG. 3



PERIMETER WALL DRAINAGE



UNDERSLAB DRAINAGE

NOTES:

1) A VAPOR-RETARDING MEMBRANE SYSTEM IS RECOMMENDED FOR MOISTURE-SENSITIVE AREAS.

2) DETAILS REGARDING INSTALLATION OF THE SYSTEM SHOULD BE REVIEWED BY THE DESIGN TEAM.

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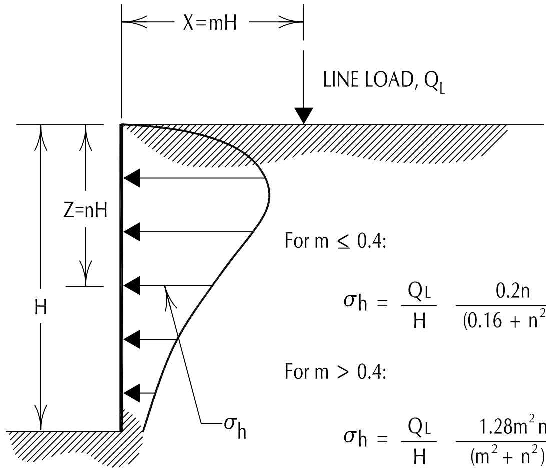
TYPICAL SUBDRAINAGE DETAILS



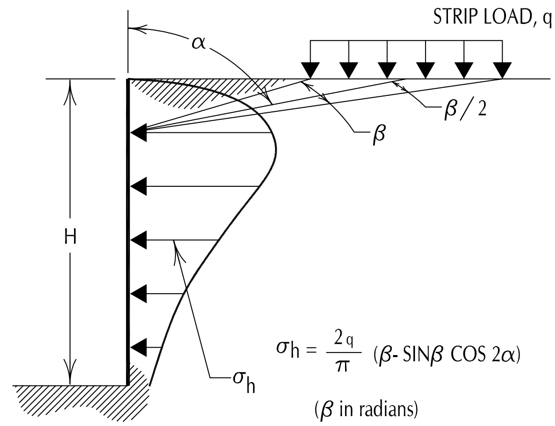
For m ≤ 0.4:

$$\sigma_h = \frac{Q_L}{H} \frac{0.2n}{(0.16 + n^2)^2}$$

For m > 0.4:

$$\sigma_h = \frac{Q_L}{H} \frac{1.28m^2 n}{(m^2 + n^2)^2}$$

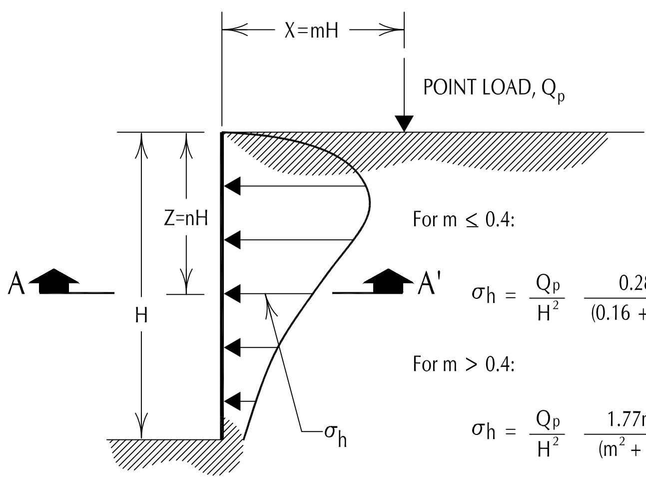
LINE LOAD PARALLEL TO WALL



$$\sigma_h = \frac{2q}{\pi} (\beta - \sin\beta \cos 2\alpha)$$

(β in radians)

STRIP LOAD PARALLEL TO WALL

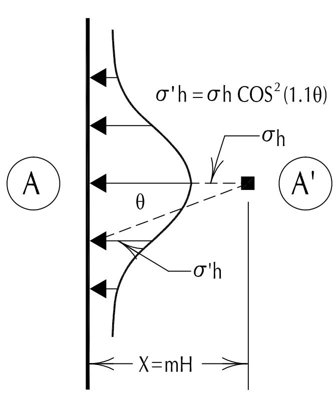


For m ≤ 0.4:

$$\sigma_h = \frac{Q_p}{H^2} \frac{0.28n^2}{(0.16 + n^2)^3}$$

For m > 0.4:

$$\sigma_h = \frac{Q_p}{H^2} \frac{1.77m^2 n^2}{(m^2 + n^2)^3}$$



DISTRIBUTION OF HORIZONTAL PRESSURES

VERTICAL POINT LOAD

NOTES:

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

GRI

DREYFESS & BLACKFORD ARCHITECTURE
PGE IOC

SURCHARGE-INDUCED LATERAL PRESSURE

FEB. 2019 | JOB NO. 6200 | FIG. 5

APPENDIX A

Subsurface Explorations and Laboratory Testing

APPENDIX A

SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

SUBSURFACE EXPLORATIONS

Subsurface materials and conditions at the site were evaluated on January 3 and 4, 2019, with seven borings designated B-1 through B-7, 10 test pits designated TP-1 through TP-10, six cone penetration test (CPT) probes designated CPT-1 through CPT-6, and nine dynamic cone penetrometers (DCP) designated DCP-1 through DCP-9. In addition, a geophysical survey consisted of two refraction microtremor lines, ReMi 1 and ReMi 2, were completed at the site to assist in developing the shear-wave velocity profile. Two open-hole, falling head infiltration tests, I-1 and I-2, were completed. The approximate locations of the explorations completed for this project are shown on the Site Map, Figure 3. A GRI representative directed the subsurface exploration program and maintained a log of the materials and conditions disclosed during the course of the work. Details of the subsurface exploration program are provided in the following sections.

Borings

The borings were advanced to depths of about 7.6 to 26 ft using a CME 55 HT track-mounted drill rig provided and operated by Western States Soil Conservation, Inc., of Hubbard, Oregon. The drilling was completed using mud-rotary drilling methods and the rock coring was completed using wireline drilling techniques and an HQ diamond core bit attached to a split-core barrel. Disturbed and undisturbed samples were obtained from the borings at frequent intervals of depth. Relatively undisturbed soil samples were obtained using standard, 3-in.-outside-diameter (O.D.), thin-walled Shelby tubes. Disturbed soil samples were obtained using a standard split-spoon sampler. At the time of sampling, the Standard Penetration Test (SPT) was conducted. This test consists of driving a standard split-spoon sampler into the soil or rock a distance of 18 in. using a 140-lb hammer dropped 30 in. The number of blows required to drive the sampler the last 12 in. is known as the Standard Penetration Resistance, or SPT N-value. SPT N-values provide a measure of the relative density of granular soils and the relative consistency of cohesive soils. All soil samples obtained from the borings were returned to our laboratory for further classification and physical testing.

Logs of the borings are provided on Figures 1A through 7A. Each log provides a descriptive summary of the various types of materials encountered in the boring and notes the depths at which the materials and/or characteristics of the materials change. To the right of the descriptive summary, the numbers and types of samples taken during the drilling operation are indicated. Farther to the right, SPT N-values are shown graphically, along with the natural moisture contents, unit weights, Torvane shear-strength values, Atterberg limits, and percentage of material passing the No. 200 sieve. The terms and symbols used to describe the soil and rock encountered in the borings are defined in Tables 1A and 2A and on the attached legend.

Test Pits

The test pits were advanced to depths ranging from about 3 and 6.5 ft using a John Deere 35C track-mounted excavator owned and operated by Dan J. Fischer Excavating, Inc., of Forest Grove, Oregon. Logs of the test pits are provided on Figures 8A through 12A. The terms and symbols used to describe the soil and rock encountered in the test pits are defined in Tables 1A and 2A and on the attached legend.

Cone Penetration Test (CPT) Probes

The CPT probes were advanced to refusal at depths ranging from about 2 to 20 ft using a truck-mounted rig provided and operated by Oregon Geotechnical Explorations, Inc., of Keizer, Oregon, who also provided interpretation of the data obtained during the CPT explorations. During the CPT, a steel cone is forced vertically into the soil at a constant rate of penetration. The force required to cause penetration at a constant rate can be related to the bearing capacity of the soil immediately surrounding the point of the penetrometer cone. This force is measured and recorded every 2 in. In addition to the cone measurements, measurements are obtained of the magnitude of force required to force a friction sleeve, attached above the cone, through the soil. The force required to move the friction sleeve can be related to the undrained shear strength of silt and clay soils. The dimensionless ratio of sleeve friction to point bearing capacity provides an indicator of the type of soil penetrated. The cone penetration resistance and sleeve friction values can be used to evaluate geotechnical engineering parameters including shear strength, consolidation stress history, and compressibility. In addition, a piezometer fitted between the cone and the sleeve measures changes in water pressures as the probe is advanced and can also be used to approximate the static groundwater level. An accelerometer is also fitted at the end of the probe. The accelerometer is used to measure the arrival times of shear waves produced at the ground surface as the exploration is advanced. Using these measurements, the shear-wave velocity of the soils penetrated can be estimated. The shear-wave velocities characterize the soils for the purpose of seismic studies. The shear-wave measurements were made at 3.28-ft (1-m) increments during the advancement of CPT probes CPT-3, CPT-4, and CPT-6. It should be noted that CPT probe CPT-6 was completed in the borehole for boring B-5, which was filled with bentonite chips following completion of the boring. This CPT probe was completed to obtain shear-wave velocity measurements for the surrounding soil profile and additional information obtained from the CPT probe does not represent actual soil conditions.

Logs of the CPT probes are provided on Figures 13A through 20A. Each log presents a graphical summary of the tip resistance, local (sleeve) friction, friction ratio, pore pressure, and shear-wave velocity measurements. The estimated types of soil encountered within the probe are shown graphically along the right side of the figure. The terms used to describe the materials encountered in the CPT probes are defined in Table 3A.

Dynamic Cone Penetrometer (DCP)

Nine dynamic cone penetration tests, designated DCP-1 through DCP-9, were advanced to a depth about 3 ft below the ground surface using a Kessler DCP manufactured by KSE Testing Equipment. The DCP tests were completed in accordance with ASTM International (ASTM) D6951 by driving a ⁵⁄₈-in.-diameter steel rod with a cone tip into the soil using a 17.6-lb sliding hammer dropped a fixed height of 22.6 in. The number of blows required to drive the probe approximately 5 cm (2 in.) was recorded to depths ranging from 687 to 951 mm (2.3 to 3.1 ft). The DCP blow counts were used to estimate a California bearing ratio (CBR) value for the soil subgrade. The average CBR values obtained from the DCP probes were observed to range from about 2 to 5.

Geophysical Survey

The geophysical survey consisted of performing two refraction microtremor (ReMi) lines at the approximate locations shown on Figure 3 (ReMi-1 and ReMi-2). The ReMi method is based on ambient noise measurements that are obtained using seismic arrays to provide information on surface-wave velocity dispersion. Inversion of the dispersion curves provides a one-dimensional shear-wave velocity (Vs) model down to a depth related to the length of the array. The results of the ReMi surveys suggest the average shear-wave velocity in the upper 100 ft of the site ranges from about 2,250 to 2,400 ft/sec. Appendix C provides additional details and the results of the ReMi surveys completed at the site.

Infiltration Testing

Two open-hole, falling head infiltration tests, designated I-1 and I-2, were conducted in substantial conformance with the requirements for falling-head infiltration testing outlined in the September 26, 2007, Washington County document titled On-Site Stormwater Disposal System (OSDS) Design and Construction Minimum Guidelines and Requirements. The tests were completed in open holes made with a hollow-stem auger of the drill rig. The depth of the holes was approximately 5 and 3 ft for infiltration tests I-1 and I-2, respectively. The soil at the depth tested consisted of brown silt with a trace of clay and fine-grained sand. Groundwater was not encountered in the holes at the time of testing. Each hole was filled with water to about 12 in. above the bottom of the hole and allowed to soak for approximately 24 hours. After the soaking period, the testing was started with a 12-in. depth of water and initially measured at 20- to 30-minute intervals, gradually increasing to greater intervals during the course of the tests due to the slow rate of infiltration observed. Measurements of the water levels were made for approximately 6 hours. The infiltration testing resulted in no significant drop in the water level for both infiltration tests I-1 and I-2.

LABORATORY TESTING

General

Soil and rock samples obtained from the borings and test pies were returned to our laboratory, where the physical characteristics of the samples were noted and the field classifications modified where necessary. At the time of classification, the natural moisture content of each sample was determined. The laboratory testing program also included Atterberg limits determinations, washed-sieve analyses, undisturbed unit weight determinations, Torvane shear strength measurements, and one-dimensional consolidation testing. A summary of the laboratory test results is provided on Table 4A. The following paragraphs describe the laboratory testing program in more detail.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM D2216. The results are shown on Figures 1A through 12A and are summarized in Table 4A.

Washed-Sieve Analyses

Washed-sieve analyses was performed for selected soil samples to determine the percentage of material passing the No. 200 sieve. The test result assists in material classification. The test is performed by taking a sample of known dry weight and washing it over a No. 200 sieve. The material retained on the sieve is oven-dried and weighed. The percentage of material that passed the No. 200 sieve is then calculated. The test results are shown on Figures 1A through 12A and are summarized in Table 4A.

Torvane Shear Strength

The approximate undrained shear strength of select soil samples was estimated in the sides of the test pits using a Torvane shear device. The Torvane is a hand-held apparatus with vanes that are inserted into the soil. The torque required to fail the soil in shear around the vanes is measured using a calibrated spring. The results of the Torvane shear-strength measurements are summarized on Figures 8A through 12A.

Atterberg Limits

Atterberg limits determinations were completed on select soils samples obtained from the borings in substantial conformance with ASTM D4318. The test data is provided on the Plasticity Chart, Figure 21A, and is summarized in Table 4A.

One-Dimensional Consolidation

One-dimensional consolidation tests were performed in conformance with ASTM D2435 on relatively undisturbed soils sample extruded from the Shelby tubes. This test provides data on the compressibility and stress history of the soils. The test results are summarized on Figure 22A in the form of a curve showing percent strain versus applied effective stress. The initial moisture content and unit weight of the sample is provided on the figure.

Table 1A

GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values), blows per ft
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values), blows per ft	Torvane or Undrained Shear Strength, tsf
Very Soft	0 – 2	less than 0.125
Soft	2 – 4	0.125 – 0.25
Medium Stiff	4 – 8	0.25 – 0.50
Stiff	8 – 15	0.50 – 1.0
Very Stiff	15 – 30	1.0 – 2.0
Hard	over 30	over 2.0

Grain-Size Classification

Boulders:
- >12 in.

Cobbles:
- 3 – 12 in.

Gravel:
- ¼ – ¾ in. (fine)
- ¾ – 3 in. (coarse)

Sand:
- No. 200 – No. 40 sieve (fine)
- No. 40 – No. 10 sieve (medium)
- No. 10 – No. 4 sieve (coarse)

Silt/Clay:
- pass No. 200 sieve

Modifier for Subclassification

Adjective	Primary Constituent SAND or GRAVEL	Primary Constituent SILT or CLAY
	Percentage of Other Material (by weight)	
trace:	5 – 15 (sand, gravel)	5 – 15 (sand, gravel)
some:	15 – 30 (sand, gravel)	15 – 30 (sand, gravel)
sandy, gravelly:	30 – 50 (sand, gravel)	30 – 50 (sand, gravel)
trace:	<5 (silt, clay)	*Relationship of clay and silt determined by plasticity index test*
some:	5 – 12 (silt, clay)	
silty, clayey:	12 – 50 (silt, clay)	

Table 2A

GUIDELINES FOR CLASSIFICATION OF ROCK

Relative Rock Weathering Scale

Term	Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 in. into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Relative Rock Hardness Scale

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	$<$ 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocket knife and scratched with fingernail.	100 – 1,000 psi
Soft	R2	Can be peeled by a pocket knife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1,000 – 4,000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4,000 – 8,000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8,000 – 16,000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	$>$ 16,000 psi

RQD and Rock Quality

Relation of RQD and Rock Quality		Terminology for Planar Surface		
RQD (Rock Quality Designation), %	Description of Rock Quality	Bedding	Joints and Fractures	Spacing
0 – 25	Very Poor	Laminated	Very Close	$<$ 2 in.
25 – 50	Poor	Thin	Close	2 in. – 12 in.
50 – 75	Fair	Medium	Moderately Close	12 in. – 36 in.
75 – 90	Good	Thick	Wide	36 in. – 10 ft
90 – 100	Excellent	Massive	Very Wide	$>$ 10 ft

Table 3A

CONE PENETRATION TEST (CPT) CORRELATIONS

Cohesive Soils

Cone Tip Resistance, tsf	Consistency
<5	Very Soft
5 to 15	Soft to Medium Stiff
15 to 30	Stiff
30 to 60	Very Stiff
>60	Hard

Cohesionless Soils

Cone Tip Resistance, tsf	Relative Density
<20	Very Loose
20 to 40	Loose
40 to 120	Medium
120 to 200	Dense
>200	Very Dense

Reference

Kulhawy, F. H., and Mayne, P. W., 1990, Manual on Estimating Soil Properties for Foundation Design, Electric Power Research Institute, EL-6800.

Table 4A

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-1	S-1	0.0	--	23	--	--	--	75	SILT
	S-2	2.5	--	35	--	--	--	68	Sandy SILT
	S-3	5.0	--	33	--	--	--	--	Sandy SILT
	S-4	6.5	--	34	--	--	--	--	Sandy SILT
B-2	S-1	0.0	--	28	--	--	--	54	Sandy SILT
B-3	S-1	0.0	--	26	--	--	--	65	Sandy SILT
	S-2	2.5	--	34	--	--	--	--	Sandy SILT
B-4	S-1	0.0	--	32	--	42	11	68	Sandy SILT
B-5	S-1	0.0	--	27	--	32	7	73	SILT
	S-2	2.5	--	37	--	--	--	--	SILT
	S-3	5.0	--	34	--	--	--	63	Sandy SILT
B-6	S-1	0.0	--	27	--	42	16	86	SILT
	S-2	2.5	--	28	--	--	--	30	Silty SAND
B-7	S-1	0.0	--	27	--	--	--	16	Silty SAND
TP-1	S-1	1.0	--	26	--	29	3	60	Sandy SILT
	S-2	2.0	--	29	--	--	--	--	Sandy SILT
	S-3	3.5	--	37	--	--	--	62	Sandy SILT
TP-2	S-1	1.0	--	25	--	--	--	--	SILT
	S-2	2.5	--	34	--	--	--	--	SILT
	S-3	4.5	--	32	--	--	--	--	SILT
TP-3	S-1	1.0	--	29	--	--	--	76	SILT
	S-2	2.5	--	33	--	--	--	--	SILT
	S-3	4.5	--	30	--	--	--	--	SILT
TP-4	S-1	1.0	--	25	--	30	7	79	SILT
	S-2	2.0	--	33	--	--	--	--	SILT
TP-5	S-1	1.5	--	26	--	--	--	--	SILT
	S-2	3.5	--	28	--	--	--	--	SILT
	S-3	4.5	--	32	--	--	--	--	SILT
TP-6	S-1	1.0	--	23	--	--	--	--	SILT
	S-2	2.0	--	31	--	--	--	--	SILT
	S-3	6.0	--	44	--	--	--	--	Sandy SILT
TP-7	S-1	1.0	--	27	--	--	--	68	Sandy SILT
TP-8	S-1	1.0	--	24	--	--	--	--	SILT
TP-10	S-1	1.0	--	46	--	--	--	--	Silty GRAVEL

BORING AND TEST PIT LOG LEGEND

SOIL SYMBOLS

Symbol	Typical Description
	LANDSCAPE MATERIALS
	FILL
	GRAVEL; clean to some silt, clay, and sand
	Sandy GRAVEL; clean to some silt and clay
	Silty GRAVEL; up to some clay and sand
	Clayey GRAVEL; up to some silt and sand
	SAND; clean to some silt, clay, and gravel
	Gravelly SAND; clean to some silt and clay
	Silty SAND; up to some clay and gravel
	Clayey SAND; up to some silt and gravel
	SILT; up to some clay, sand, and gravel
	Gravelly SILT; up to some clay and sand
	Sandy SILT; up to some clay and gravel
	Clayey SILT; up to some sand and gravel
	CLAY; up to some silt, sand, and gravel
	Gravelly CLAY; up to some silt and sand
	Sandy CLAY; up to some silt and gravel
	Silty CLAY; up to some sand and gravel
	PEAT

BEDROCK SYMBOLS

Symbol	Typical Description
	BASALT
	MUDSTONE
	SILTSTONE
	SANDSTONE

SURFACE MATERIAL SYMBOLS

Symbol	Typical Description
	Asphalt concrete PAVEMENT
	Portland cement concrete PAVEMENT
	Crushed rock BASE COURSE

SAMPLER SYMBOLS

Symbol	Sampler Description
	2.0-in. O.D. split-spoon sampler and Standard Penetration Test with recovery (ASTM D1586)
	Shelby tube sampler with recovery (ASTM D1587)
	3.0-in. O.D. split-spoon sampler with recovery (ASTM D3550)
	Grab Sample
	Rock core sample interval
	Sonic core sample interval
	Geoprobe sample interval

INSTALLATION SYMBOLS

Symbol	Symbol Description
	Flush-mount monument set in concrete
	Concrete, well casing shown where applicable
	Bentonite seal, well casing shown where applicable
	Filter pack, machine-slotted well casing shown where applicable
	Grout, vibrating-wire transducer cable shown where applicable
P	Vibrating-wire pressure transducer
	1-in.-diameter solid PVC
	1-in.-diameter hand-slotted PVC
	Grout, inclinometer casing shown where applicable

FIELD MEASUREMENTS

Symbol	Typical Description
	Groundwater level during drilling and date measured
	Groundwater level after drilling and date measured
	Rock core recovery (%)
	Rock quality designation (RQD, %)

BORING B-1

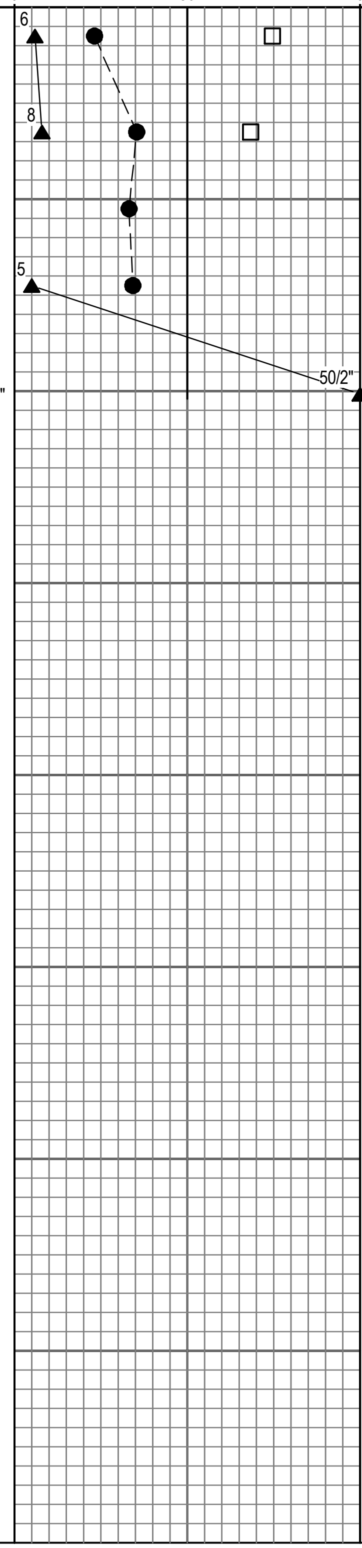
Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0	SILT, some fine-grained sand, trace clay, brown, medium stiff, contains roots and organics (Alluvium)		S-1	2 2 4	
	---sandy, medium stiff to stiff, fine- to medium-grained sand, roots and organics absent below 2.5 ft		S-2	2 4 4	
5			S-3		
	---medium stiff at 6.5 ft		S-4	2 2 3	
	BASALT, gray, moderately weathered to predominantly decomposed, extremely soft to medium hard (R0 to R3) (Columbia River Basalt)	8.0			Driller notes hard drilling below 8 ft
10	(1/4/2019)	10.2	S-5	50/2"	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

Legend: ▲ BLOWS PER FOOT; ● MOISTURE CONTENT, %; □ FINES CONTENT, %; LIQUID LIMIT, %; PLASTIC LIMIT, %

Scale: 0 50 100



Scale: 0 0.5 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/4/19	**GPS Coordinates:** 45.368° N -122.80506° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

GRI

FEB. 2019 JOB NO. 6200 FIG. 1A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	BLOWS PER FOOT / MOISTURE CONTENT, % / FINES CONTENT, % / LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS
		Surface Elevation: Not Available							
		Sandy SILT, trace clay, red-brown mottled gray, soft, fine-grained sand, contains roots, organics, and gravel-sized fragments of predominantly decomposed basalt, grass at ground surface (Residual Soil)	2.0		S-1		1 1 2	3	
5		Silty SAND, trace to some clay and subangular gravel, gray mottled rust and brown to light brown mottled black and rust, very dense, fine to coarse grained (Decomposed Basalt)	7.5		S-2		44 50/2"	44-50/2"	Driller notes hard drilling below 2 ft
					S-3		39 50/4"	39-50/4"	
		BASALT, some vesicles, gray, predominantly decomposed, very soft to medium hard (R1 to R3), closely jointed (Columbia River Basalt) (1/4/2019)	7.6		S-4		50/1"	50/1"	
10									
15									
20									
25									
30									
35									
40									

0 – 0.5 – 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/4/19	**GPS Coordinates:** 45.36743° N -122.803276° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

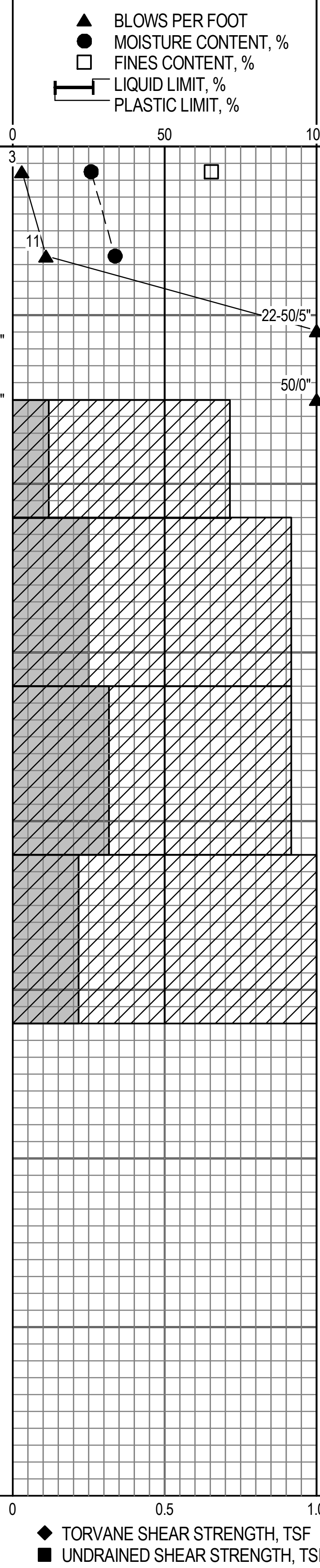
GRI

BORING B-2

BORING B-3

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE / BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0–4.0	Sandy SILT, trace clay, red-brown, soft, fine-grained sand, contains roots (Alluvium) ---stiff, fine- to medium-grained sand, roots absent below 2.5 ft	4.0	S-1 S-2	0, 1, 2 3, 4, 7	
4.0–7.5	Silty SAND, some subangular gravel, trace clay, gray mottled rust and black, very dense, fine to coarse grained (Decomposed Basalt)	7.5	S-3	22, 50/5"	Driller notes hard drilling below 4 ft
7.5–26.0	BASALT, some vesicles, gray, slightly weathered to predominantly decomposed, variable weathering with depth, extremely soft to medium hard (R0 to R3), closely to very closely fractured, secondary clay mineralization in vesicles, iron oxidation and clay mineralization in fractures (Columbia River Basalt) ---dark gray to light brown below 11 ft	26.0	S-4 Run 1 Run 2 Run 3 Run 4	50/0"	
26.0	(1/3/2019)				

Surface Elevation: Not Available

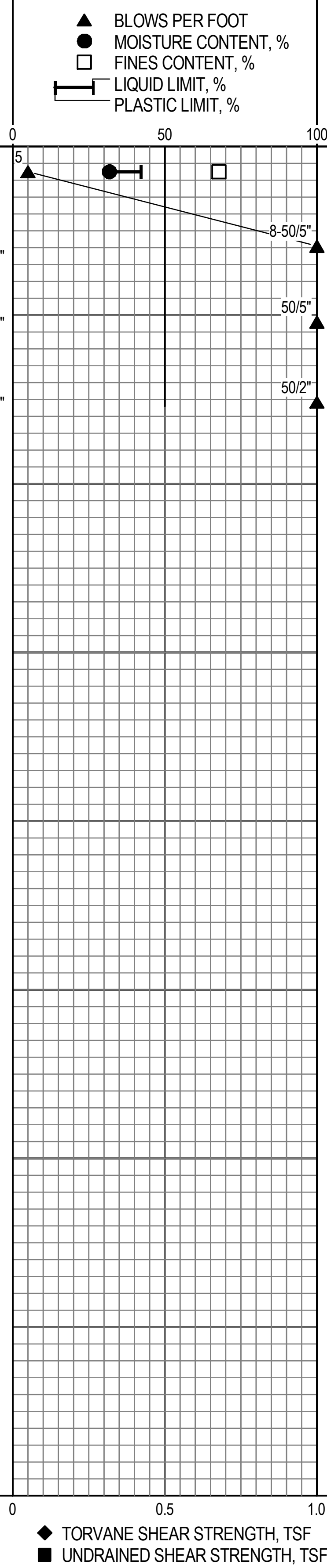


Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/3/19	**GPS Coordinates:** 45.36752° N -122.8042° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

GRI

FEB. 2019 JOB NO. 6200 FIG. 3A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
		Sandy SILT, trace clay, brown to gray, medium stiff, fine-grained sand, contains roots and subangular gravel (Residual Soil)			S-1		1 2 3	
		Silty SAND, trace to some clay and subangular gravel, gray mottled rust and brown, very dense, fine to coarse grained (Decomposed Basalt)	2.5		S-2		8 50/5"	
5					S-3		50/5"	
		BASALT, some vesicles, gray, slightly weathered to predominantly decomposed, very soft to medium hard (R1 to R3), secondary clay mineralization (Columbia River Basalt)	7.5 7.7		S-4		50/2"	
10		(1/3/2019)						



Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

GRI BORING LOG (GPS) - NO ELEV GRI DATA TEMPLATE.GDT 1/31/19

Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/3/19	**GPS Coordinates:** 45.36688° N -122.80307° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

GRI

BORING B-4

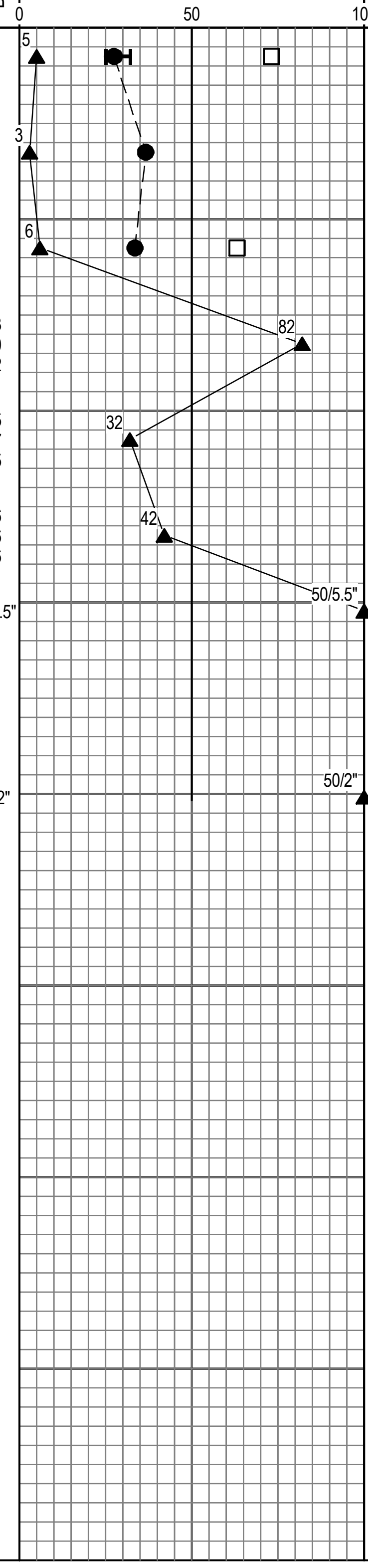
FEB. 2019 JOB NO. 6200 FIG. 4A

BORING B-5

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
	Surface Elevation: Not Available				
0	SILT, some fine- to coarse-grained sand to sandy, trace clay, brown to red-brown, medium stiff, contains roots and organics, grass at ground surface (Alluvium)		S-1	1, 2, 3	
	---soft at 2.5 ft		S-2	2, 1, 2	
5	---sandy, trace subangular gravel below 5 ft		S-3	2, 3, 3	
	Silty SAND, some clay, trace subangular gravel, gray mottled rust, black, and yellow, very dense, fine to coarse grained (Decomposed Basalt)	7.0	S-4	23, 40, 42	Driller notes hard drilling below 7 ft
10	---some gravel, dense below 10 ft		S-5	15, 17, 15	
			S-6	16, 16, 26	
15	---brown mottled rust and gray, very dense below 15 ft		S-7	50/5.5"	
20	BASALT, some vesicles, gray to brown, moderately weathered to predominantly decomposed, very soft to medium hard (R1 to R3), very closely fractured (Columbia River Basalt)	20.0 20.2	S-8	50/2"	
	(1/3/2019)				

Other column headings: GRAPHIC LOG, INSTALLATION, SAMPLE TYPE. Depth axis: 5, 10, 15, 20, 25, 30, 35, 40.

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %
□ FINES CONTENT, %
LIQUID LIMIT, %
PLASTIC LIMIT, %



◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/3/19	**GPS Coordinates:** 45.36676° N -122.80379° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

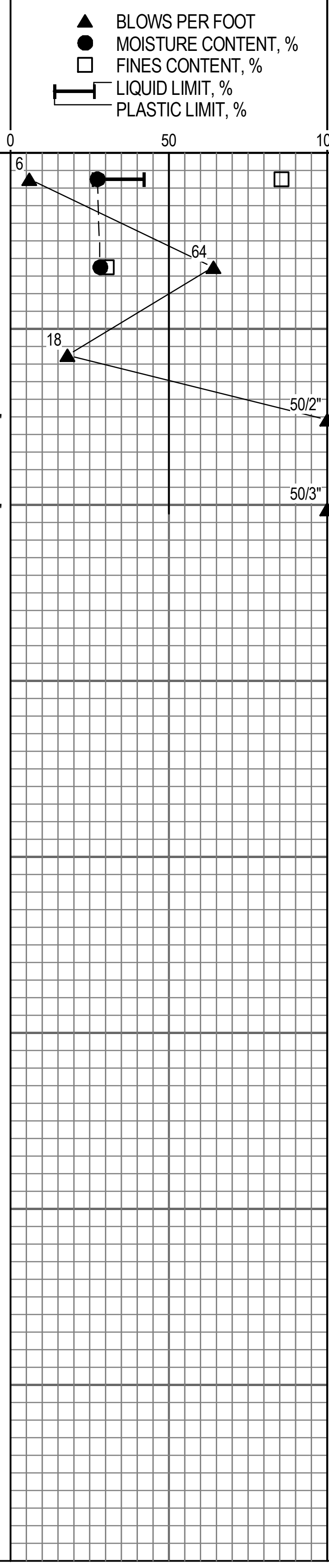
GRI

BORING B-5

BORING B-6

Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0–2.5	SILT, some clay, trace to some fine- to coarse-grained sand, red-brown, medium stiff, contains roots and organics, grass at ground surface (Residual Soil)	2.5	S-1	2, 3, 3	
2.5–7.5	Silty SAND, some subangular gravel, trace clay, gray mottled rust and brown, very dense, fine to coarse grained (Decomposed Basalt) ---some clay, medium dense below 5 ft	7.5	S-2 S-3	7, 36, 28 9, 10, 8	Driller notes possible boulder at 2.5 ft
7.5–10.3	BASALT, some vesicles, gray, moderately weathered to predominantly decomposed, very soft to medium hard (R1 to R3), very closely fractured (Columbia River Basalt) (1/4/2019)	10.3	S-4 S-5	50/2" 50/3"	



Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.	
Date Started: 1/4/19	**GPS Coordinates:** 45.36583° N -122.80257° W (WGS 84)	
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76	
Note: See Legend for Explanation of Symbols		

GRI

BORING B-6

FEB. 2019 JOB NO. 6200 FIG. 6A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL Surface Elevation: Not Available	DEPTH, FT	INSTALLATION	SAMPLE NO.	SAMPLE TYPE	BLOW COUNT	COMMENTS AND ADDITIONAL TESTS
0–2.0		Silty SAND, brown to red-brown, very dense, fine to coarse grained, contains gravel, cobbles, and boulders, grass and visible boulders at ground surface (Decomposed Basalt)	2.0		S-1		20 30	SPT testing of S-1 ended due to large deflection of sampler after driving approximately 10 in. Driller notes cobbles and boulders to a depth of 2.5 ft
2.0–8.0		BASALT, gray, moderately weathered to predominantly decomposed, extremely soft to medium hard (R0 to R3) (Columbia River Basalt)	8.0		S-2		50/1"	
					S-3		50/1"	
					S-4		50/0"	
					S-5		50/0"	
		(1/4/2019)						

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

▲ BLOWS PER FOOT
● MOISTURE CONTENT, %
□ FINES CONTENT, %
LIQUID LIMIT, %
PLASTIC LIMIT, %

Scale: 0, 50, 100 (plotted values: 50/1", 50/1", 50/0", 50/0")

Scale: 0, 0.5, 1.0

◆ TORVANE SHEAR STRENGTH, TSF
■ UNDRAINED SHEAR STRENGTH, TSF

Logged By: N. Utevsky	**Drilled by:** Western States Soil Conservation, Inc.
Date Started: 1/4/19	**GPS Coordinates:** 45.36506° N -122.80399° W (WGS 84)
Drilling Method: Mud Rotary **Equipment:** CME 55 HT Track-Mounted Drill Rig **Hole Diameter:** 5 in.	**Hammer Type:** Auto Hammer **Weight:** 140 lb **Drop:** 30 in. **Energy Ratio:** 0.76
Note: See Legend for Explanation of Symbols	

GRI

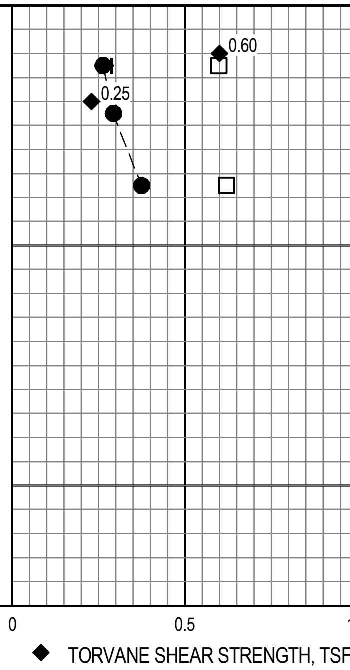
BORING B-7

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % ├─┤ LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-1

Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	COMMENTS AND ADDITIONAL TESTS
	Sandy SILT, some clay, brown, stiff, fine-grained sand, contains scattered roots, 8-in.-thick heavily rooted zone at ground surface (Alluvium) ---soft to medium stiff below 2 ft		S-1 S-2	
	Sandy SILT, some clay, brown mottled rust, medium stiff, fine- to medium-grained sand (Residual Soil)	3.5	S-3	
5	BASALT, highly vesicular, gray, slightly weathered to moderately weathered, soft to medium hard (R2 to R3) (Columbia River Basalt)	4.8 5.3	S-4	▽4.6 ft (1/4/2019)
	(1/4/2019)			
10				

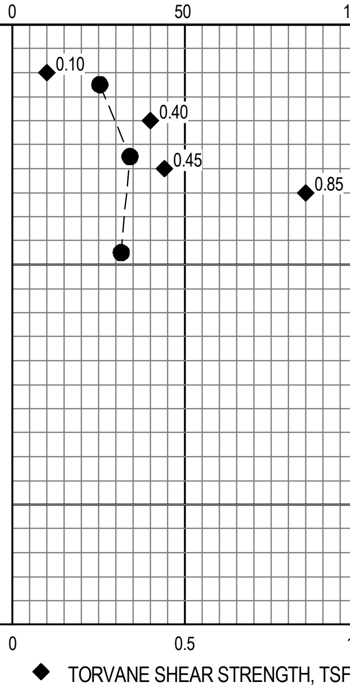


Logged By: B. Cook	**Excavated by:** Dan J. Fischer Excavating, Inc.	**Equipment:** John Deere 35C Track-Mounted Excavator	
Date Started: 1/4/19	**GPS Coordinates:** 45.3682° N -122.8016° W (WGS 84)	**Note:** See Legend for Explanation of Symbols	

TP-2

Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	COMMENTS AND ADDITIONAL TESTS
	SILT, some clay and fine- to coarse-grained sand, brown, very soft to soft, contains scattered roots, 8-in.-thick heavily rooted zone at ground surface (Alluvium) ---medium stiff below 2 ft ---trace clay, brown mottled light brown and rust below 2.5 ft ---some clay and sand, light brown mottled rust, stiff below 3.5 ft		S-1 S-2 S-3	Charred wood debris observed at a depth of approximately 1 ft ▽3.8 ft (1/4/2019)
5	(1/4/2019)	5.0		
10				



Logged By: B. Cook	**Excavated by:** Dan J. Fischer Excavating, Inc.	**Equipment:** John Deere 35C Track-Mounted Excavator
Date Started: 1/4/19	**GPS Coordinates:** 45.368° N -122.8028° W (WGS 84)	**Note:** See Legend for Explanation of Symbols

GRI TP LOG (GPS) - 2 PP - NO ELEV GRI DATA TEMPLATE.GDT 1/31/19

GRI

TEST PITS

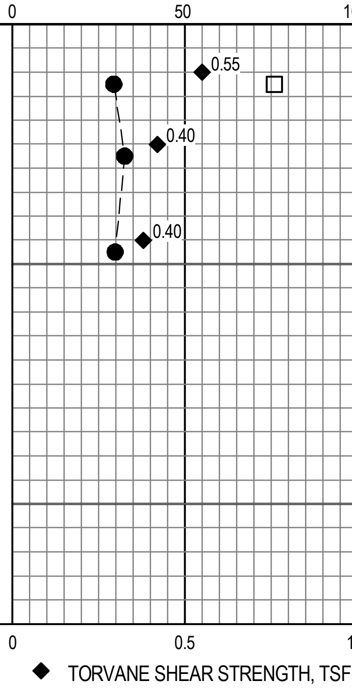
FEB. 2019 JOB NO. 6200 FIG. 8A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % / □ FINES CONTENT, % / LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-3

Surface Elevation: Not Available

Depth, ft	Classification of Material	Depth, ft	Sample No.	Comments and Additional Tests
	SILT, trace to some fine- to medium-grained sand, trace clay, red-brown mottled rust, stiff (Alluvium)		S-1	Ground surface stripped of organics prior to excavation
	---soft to medium stiff below 2.5 ft		S-2	
5		5.0	S-3	▽4.0 ft (1/4/2019)
	(1/4/2019)			
10				

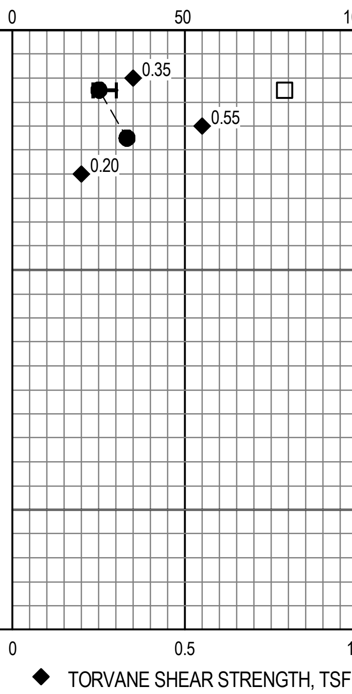


Logged By: B. Cook	**Excavated by:** Dan J. Fischer Excavating, Inc.	**Equipment:** John Deere 35C Track-Mounted Excavator
Date Started: 1/4/19	**GPS Coordinates:** 45.3679° N -122.8049° W (WGS 84)	**Note:** See Legend for Explanation of Symbols

TP-4

Surface Elevation: Not Available

Depth, ft	Classification of Material	Depth, ft	Sample No.	Comments and Additional Tests
	SILT, some clay, trace to some fine-grained sand, brown mottled rust, medium stiff, contains scattered roots, 8-in.-thick heavily rooted zone at ground surface (Alluvium)		S-1	
	---stiff at 2 ft		S-2	
	---soft at 3 ft	3.5		
	BASALT, gray with rust and black staining, slightly weathered, soft to medium hard (R2 to R3), closely jointed (Columbia River Basalt)	4.0	S-3	Equipment refusal at a depth of approximately 4 ft
5	(1/4/2019)			
	Groundwater not encountered			
10				



Logged By: B. Cook	**Excavated by:** Dan J. Fischer Excavating, Inc.	**Equipment:** John Deere 35C Track-Mounted Excavator
Date Started: 1/4/19	**GPS Coordinates:** 45.367° N -122.8025° W (WGS 84)	**Note:** See Legend for Explanation of Symbols

GRI TP LOG (GPS) - 2 PP - NO ELEV GRI DATA TEMPLATE.GDT 1/31/19

GRI

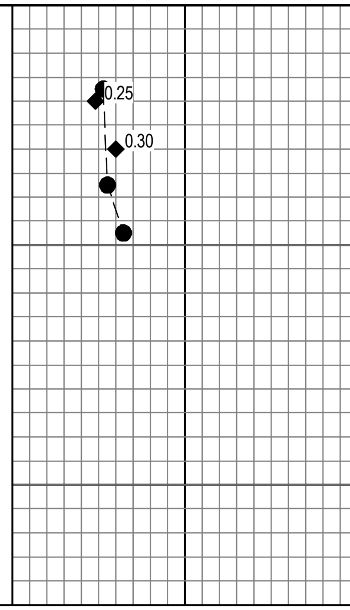
TEST PITS

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % / □ FINES CONTENT, % / LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

TP-5

Surface Elevation: Not Available

Depth, ft	Classification of Material	Depth, ft	Sample No.
0–5.0	SILT, some clay, trace to some fine- to coarse-grained sand, brown mottled rust, soft to medium stiff, 4-in.-thick heavily rooted zone at ground surface (Alluvium)	5.0	S-1, S-2, S-3
	(1/4/2019) Groundwater not encountered		



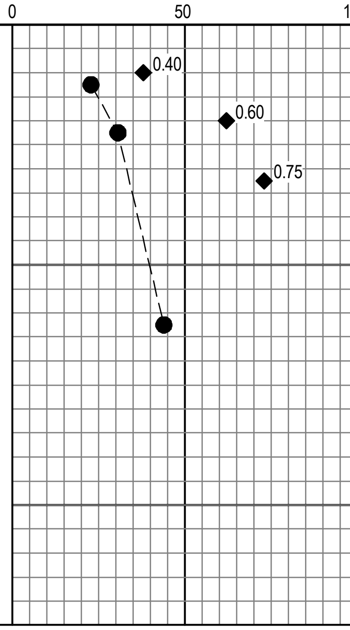
0 – 0.5 – 1.0
◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** John Deere 35C Track-Mounted Excavator
Date Started: 1/4/19 **GPS Coordinates:** 45.367° N -122.8049° W (WGS 84) **Note:** See Legend for Explanation of Symbols

TP-6

Surface Elevation: Not Available

Depth, ft	Classification of Material	Depth, ft	Sample No.
0–5.5	SILT, some fine- to coarse-grained sand, trace clay, light gray mottled rust, medium stiff, contains scattered roots, 8-in.-thick heavily rooted zone at ground surface (Alluvium) ---some clay, brown mottled rust, stiff below 1.8 ft	5.5	S-1, S-2
5.5–6.5	Sandy SILT, some clay, trace angular gravel, brown mottled rust and gray, stiff, fine- to coarse-grained sand (Residual Soil) (1/4/2019)	6.5	S-3



Comments: ∇ 4.0 ft (1/4/2019)

0 – 0.5 – 1.0
◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** John Deere 35C Track-Mounted Excavator
Date Started: 1/4/19 **GPS Coordinates:** 45.3664° N -122.8029° W (WGS 84) **Note:** See Legend for Explanation of Symbols

GRI

TEST PITS

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO. / SAMPLE TYPE	● MOISTURE CONTENT, % / □ FINES CONTENT, % / LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

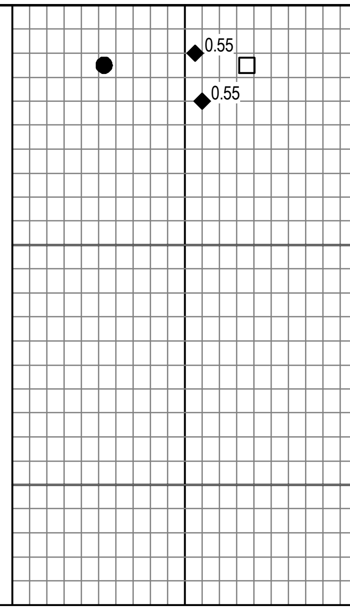
TP-7

Surface Elevation: Not Available

Classification of Material	Depth, ft	Sample No.	Comments and Additional Tests
Sandy SILT, trace clay, red-brown, medium stiff to stiff, fine- to coarse-grained sand, 4-in.-thick heavily rooted zone at ground surface (Residual Soil)	2.5	S-1	
Silty GRAVEL, some fine- to coarse-grained sand, red-brown, medium dense, angular (Decomposed Basalt)	4.0	S-2	
BASALT, brown to gray, moderately weathered, soft to medium hard (R2 to R3) (Columbia River Basalt)	5.0	S-3	Boulders up to 14 in. diameter observed at a depth of approximately 4 ft

(1/4/2019)

Groundwater not encountered



0 – 0.5 – 1.0
◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** John Deere 35C Track-Mounted Excavator

Date Started: 1/4/19 **GPS Coordinates:** 45.3665° N -122.805° W (WGS 84) **Note:** See Legend for Explanation of Symbols

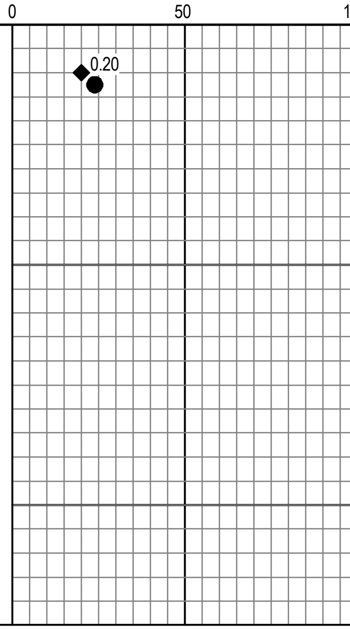
TP-8

Surface Elevation: Not Available

Classification of Material	Depth, ft	Sample No.	Comments and Additional Tests
SILT, some clay and fine- to coarse-grained sand, red-brown, soft, contains scattered roots and gravel-sized basalt fragments, 6-in.-thick heavily rooted zone at ground surface (Residual Soil)	1.5	S-1	
Silty GRAVEL, some fine- to coarse-grained sand, red-brown, medium dense, angular (Decomposed Basalt)	2.5	S-2	
BASALT, gray, rust, brown, and black, slightly weathered, soft to medium hard (R2 to R3), closely jointed (Columbia River Basalt)	3.0	S-3	Equipment refusal at a depth of approximately 3 ft

(1/4/2019)

Groundwater not encountered



0 – 0.5 – 1.0
◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook **Excavated by:** Dan J. Fischer Excavating, Inc. **Equipment:** John Deere 35C Track-Mounted Excavator

Date Started: 1/4/19 **GPS Coordinates:** 45.3659° N -122.8041° W (WGS 84) **Note:** See Legend for Explanation of Symbols

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % ├─┤ LIQUID LIMIT, % / PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS

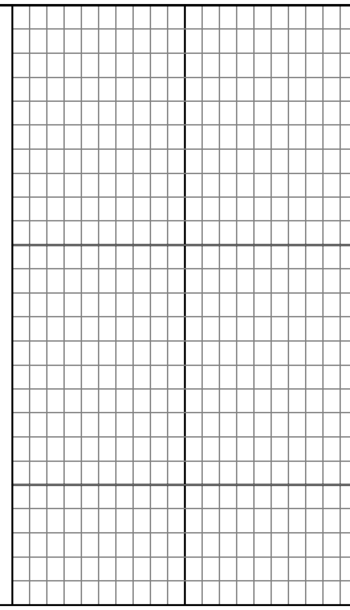
TP-9

Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	COMMENTS AND ADDITIONAL TESTS
0–3.0	Silty GRAVEL, COBBLES, and BOULDERS, some fine- to coarse-grained sand, trace clay, medium dense, subangular to angular (Decomposed Basalt)	3.0	S-1, S-2	⊠	Boulders up to 36 in. diameter visible at ground surface. Sample S-1 consists of gravel and matrix

(1/4/2019)

Excavation terminated at 3 ft due to sidewall sloughing
Groundwater not encountered



◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook | **Excavated by:** Dan J. Fischer Excavating, Inc. | **Equipment:** John Deere 35C Track-Mounted Excavator

Date Started: 1/4/19 | **GPS Coordinates:** 45.3654° N -122.8024° W (WGS 84) | **Note:** See Legend for Explanation of Symbols

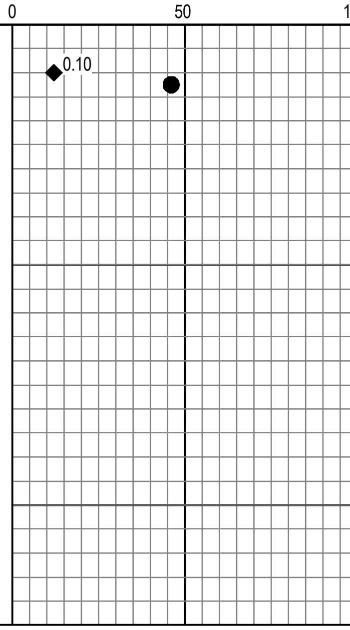
TP-10

Surface Elevation: Not Available

DEPTH, FT	CLASSIFICATION OF MATERIAL	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	COMMENTS AND ADDITIONAL TESTS
0–1.0	SILT, some fine- to coarse-grained sand, trace clay, red-brown, very soft to soft, contains scattered roots, 10-in.-thick heavily rooted zone at ground surface (Residual Soil)	1.0	S-1	⊠	3-in.-thick layer of charred wood debris observed at approximately 1 ft
1.0–2.5	Silty GRAVEL, some fine- to coarse-grained sand, red-brown, medium dense, angular (Decomposed Basalt)	2.5	S-2	⊠	Boulders up to 18 in. diameter observed at a depth of approximately 2 ft
2.5–3.5	BASALT, gray, rust, black, and brown, slightly weathered to moderately weathered, soft to medium hard (R2 to R3) (Columbia River Basalt)	3.5	S-3	⊠	Equipment refusal at a depth of approximately 3.5 ft

(1/4/2019)

Groundwater not encountered



◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook | **Excavated by:** Dan J. Fischer Excavating, Inc. | **Equipment:** John Deere 35C Track-Mounted Excavator

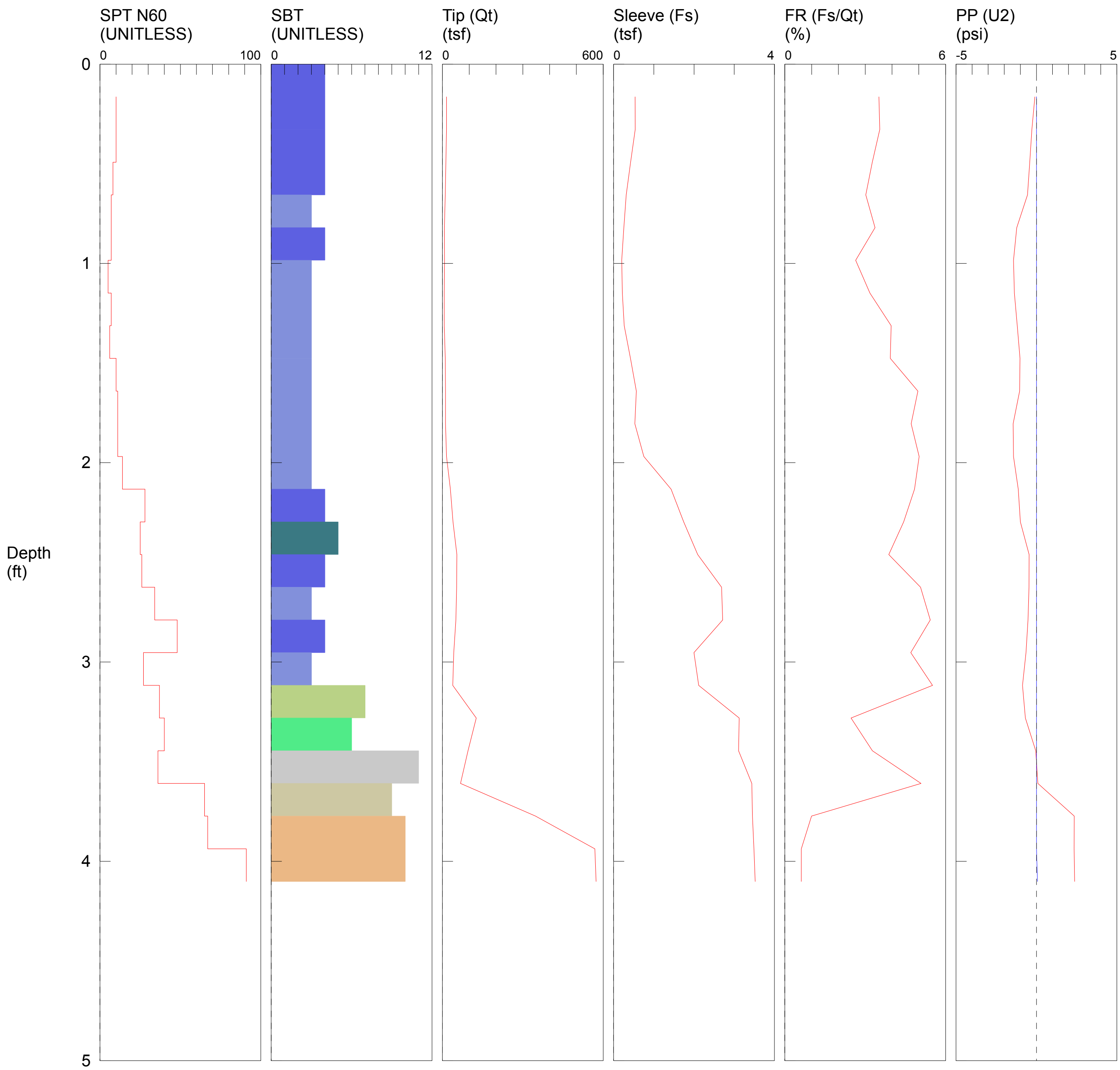
Date Started: 1/4/19 | **GPS Coordinates:** 45.3656° N -122.8049° W (WGS 84) | **Note:** See Legend for Explanation of Symbols

GRI TP LOG (GPS) - 2 PP - NO ELEV GRI DATA TEMPLATE.GDT 1/31/19

GRI

TEST PITS

FEB. 2019 JOB NO. 6200 FIG. 12A



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

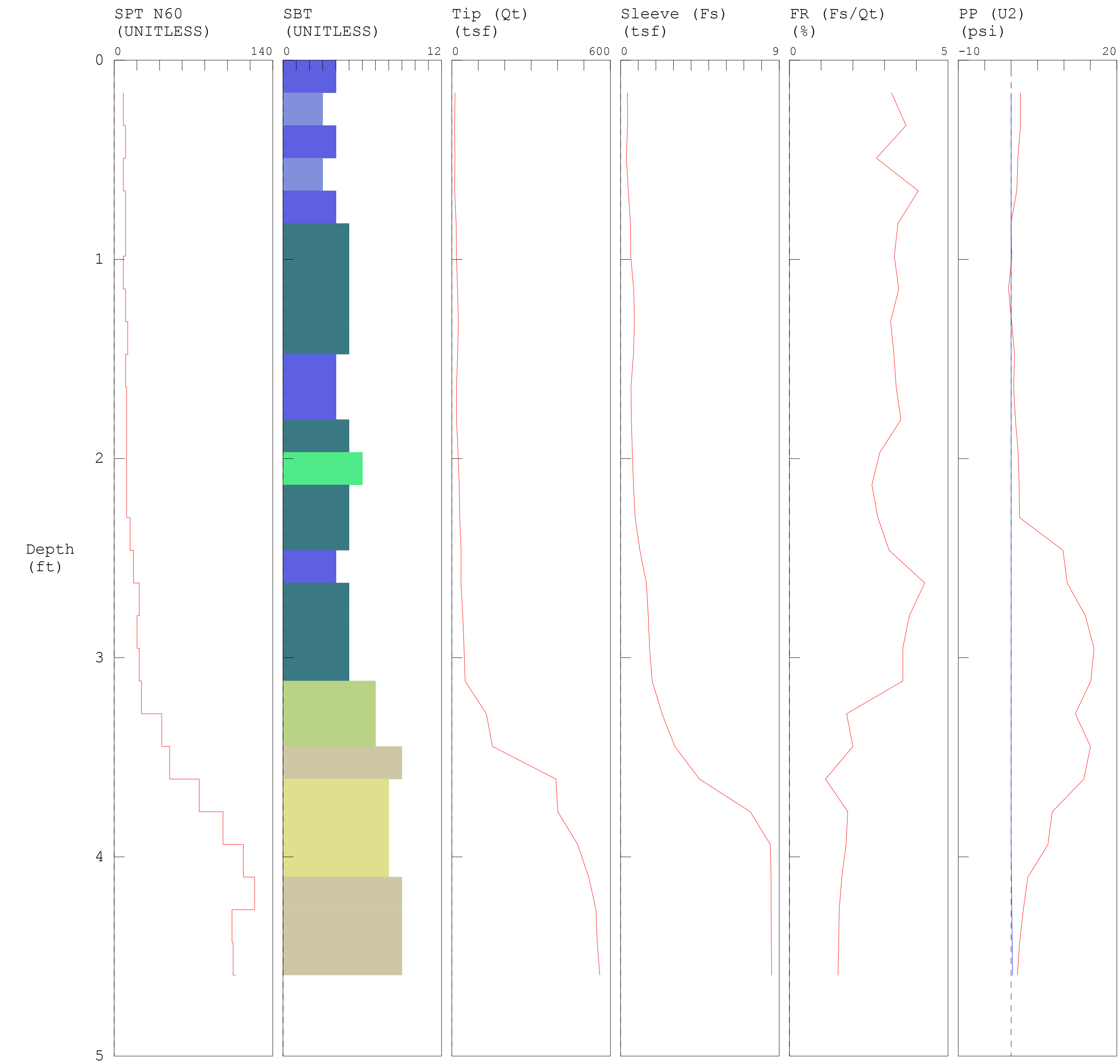
*SBT/SPT CORRELATION: UBC-1983

GRI

Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-1

FEB. 2019 JOB NO. 6200 FIG. 13A



1	sensitive fine grained	4	silty clay to clay	7	silty sand to sandy sil
2	organic material	5	clayey silt to silty cl	8	sand to silty sand
3	clay	6	sandy silt to clayey si	9	sand
10	gravelly sand to sand	11	very stiff fine grained (*)	12	sand to clayey sand (*)

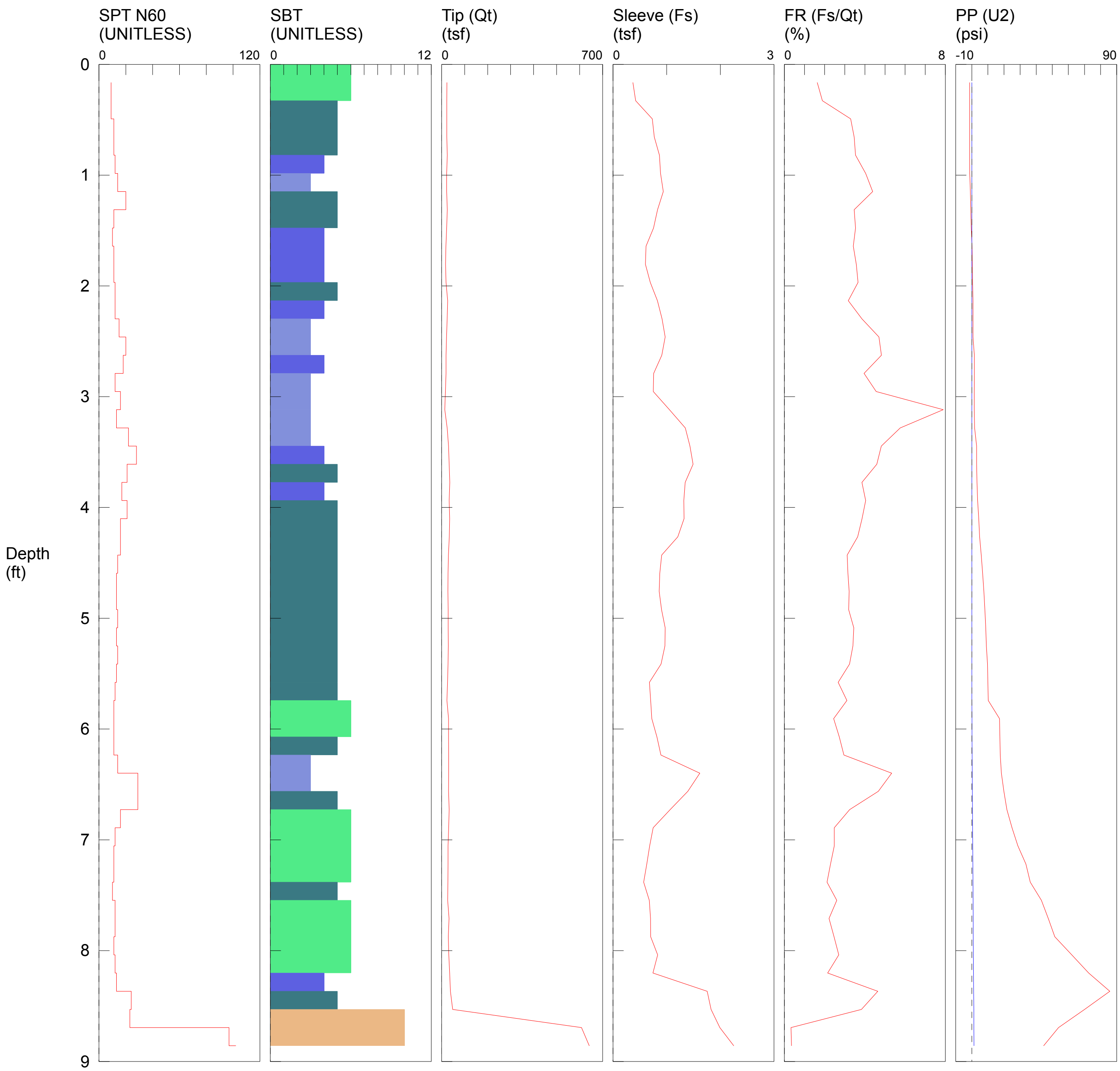
*SBT/SPT CORRELATION: UBC-1983

GRI

Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-2

FEB. 2019 JOB NO. 6200 FIG. 14A



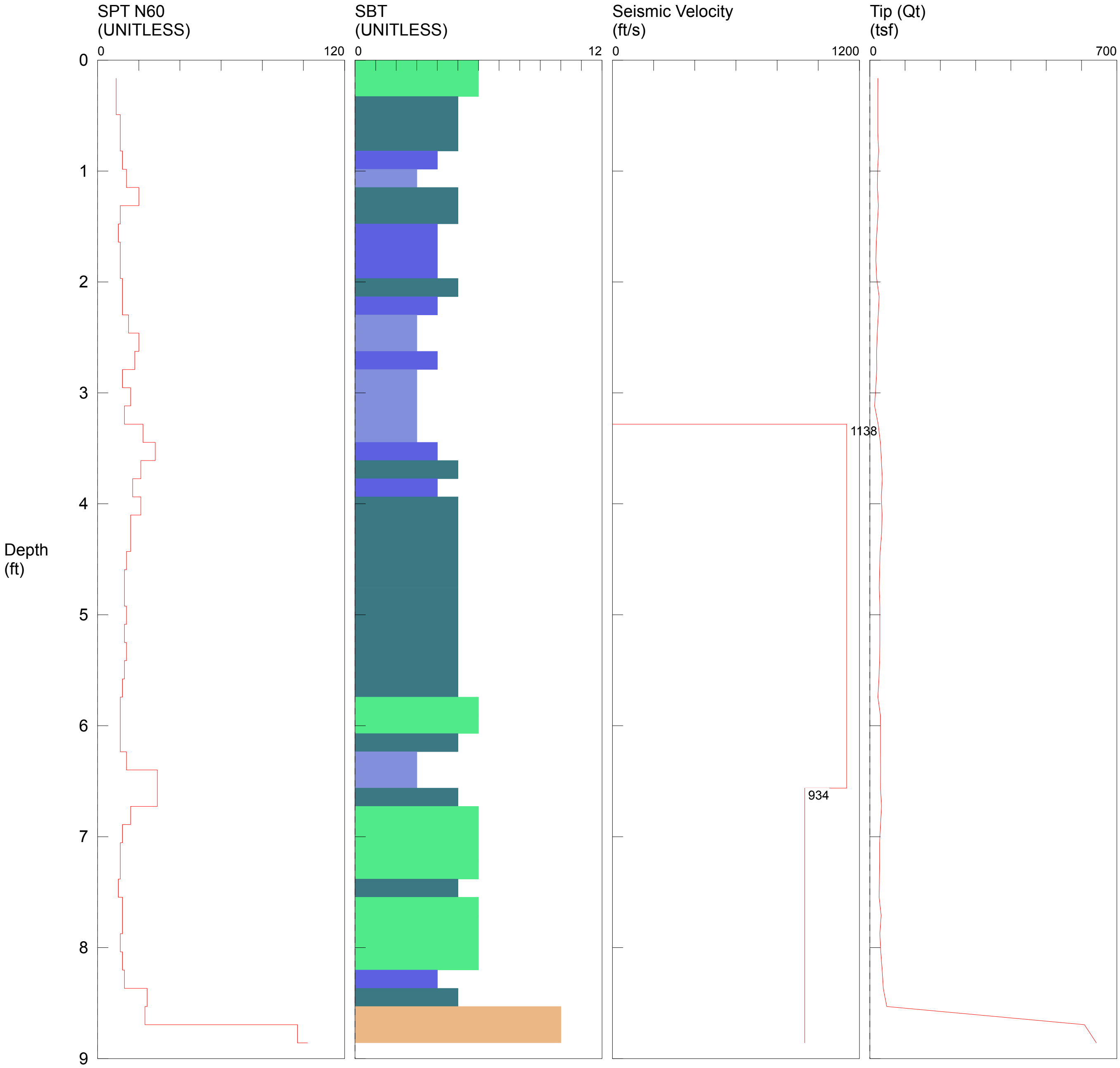
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-3



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

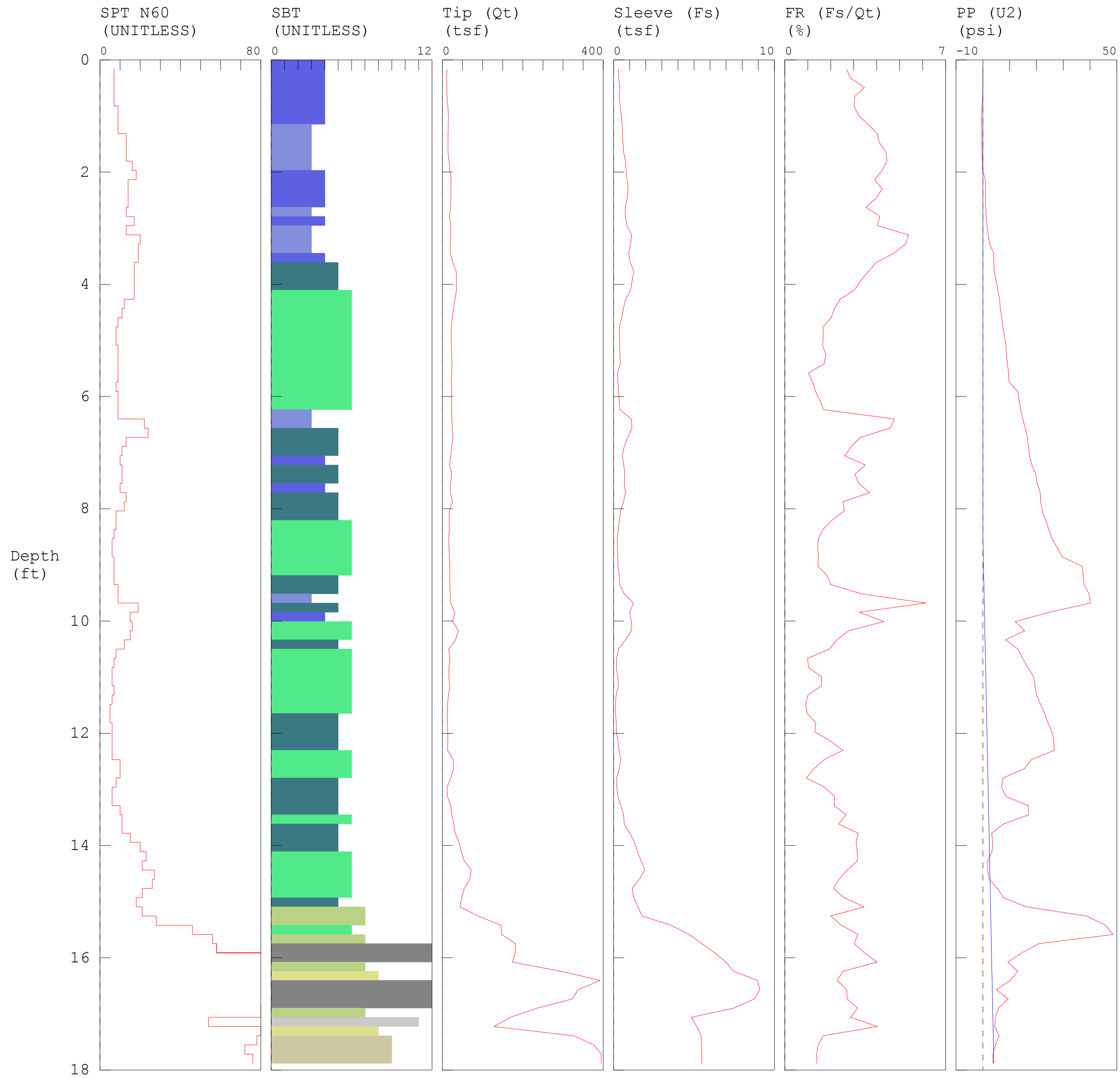
Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-3

(SEISMIC VELOCITY PROFILE)

FEB. 2019 JOB NO. 6200 FIG. 16A



1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt
2 organic material	5 clayey silt to silty clay	8 sand to silty sand
3 clay	6 sandy silt to clayey silt	9 sand
10 gravelly sand to sand	11 very stiff fine grained (*)	12 sand to clayey sand (*)

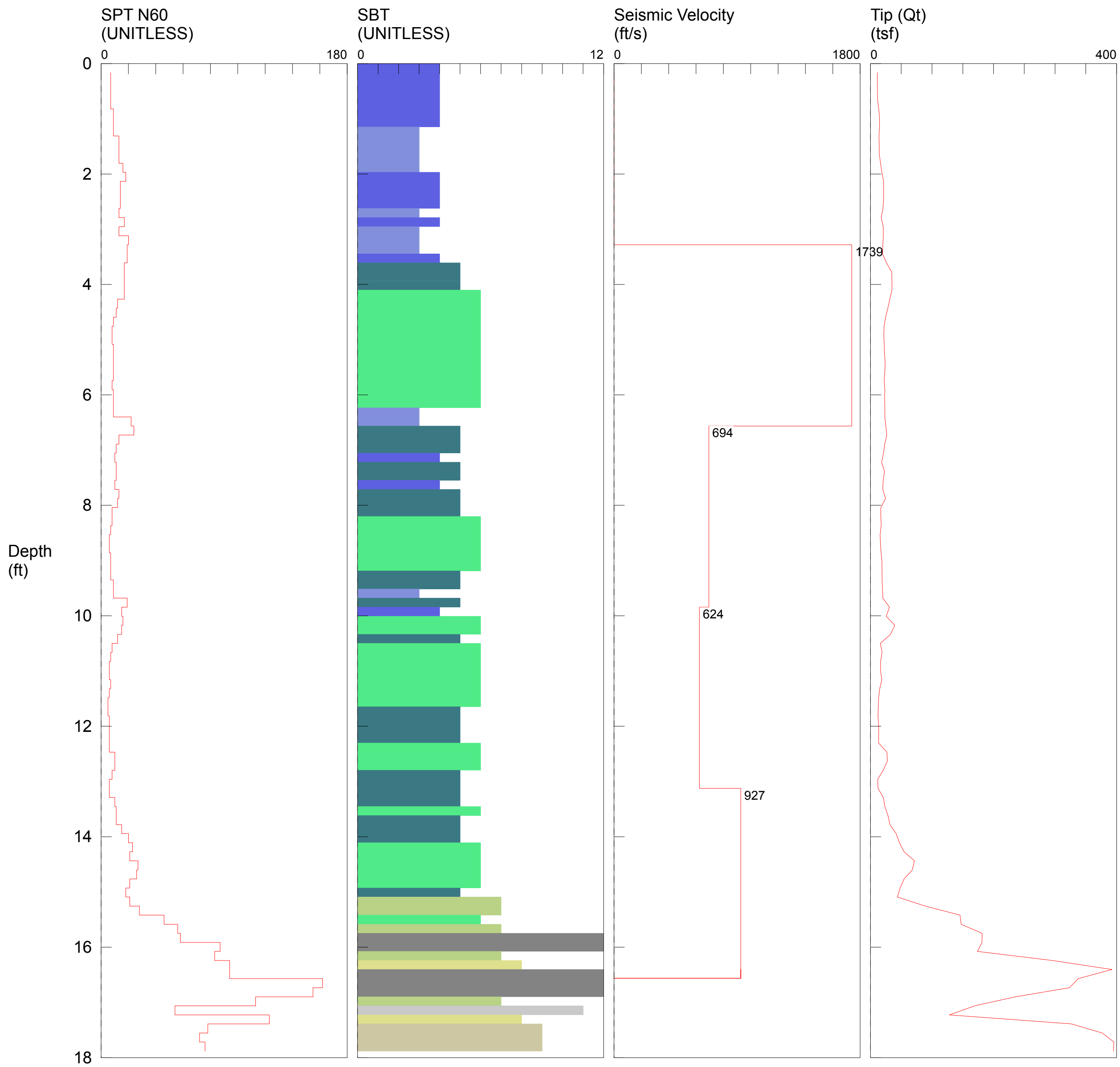
*SBT/SPT CORRELATION: UBC-1983

GRI

Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-4

FEB. 2019 JOB NO. 6200 FIG. 17A



1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*SBT/SPT CORRELATION: UBC-1983

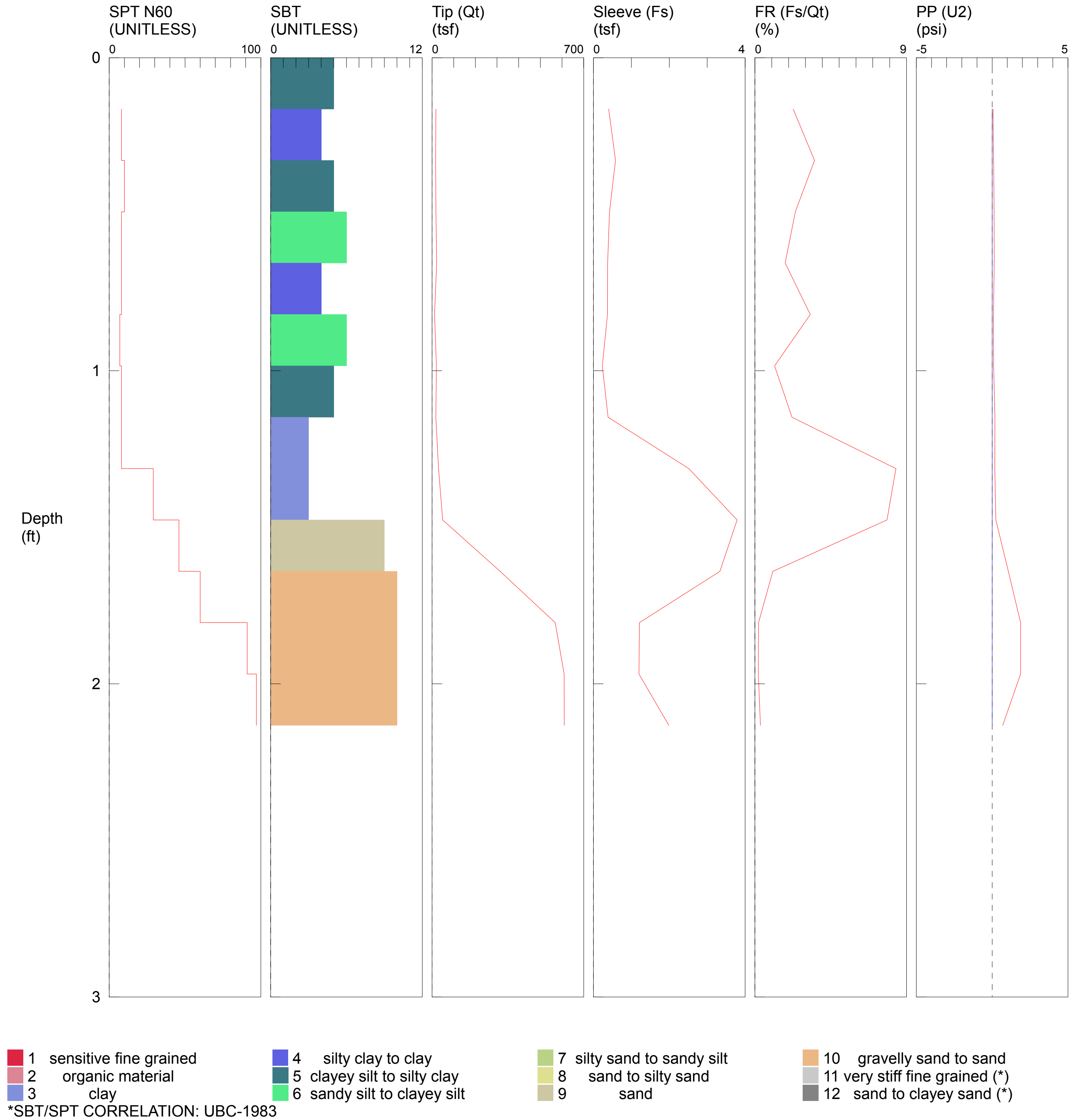
Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

GRI

CONE PENETRATION TEST CPT-4

(SEISMIC VELOCITY PROFILE)

FEB. 2019 JOB NO. 6200 FIG. 18A

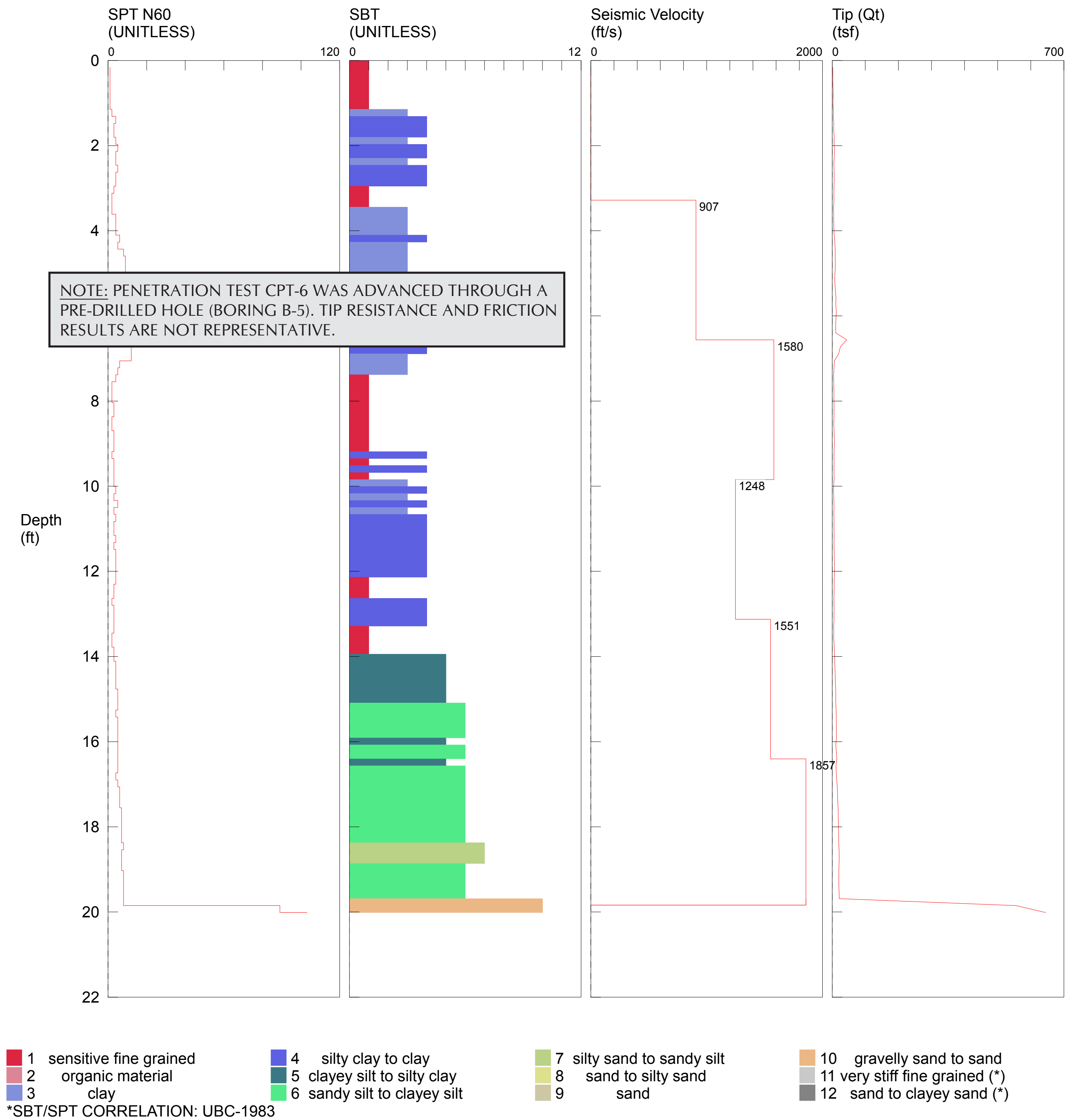


GRI

Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

CONE PENETRATION TEST CPT-5

FEB. 2019 JOB NO. 6200 FIG. 19A



Observed By: N. Utevsky	**Advanced By:** Oregon Geotechnical Explorations, Inc.
Date Started: 01/03/19	**Ground Surface Elevation:** Not Available
Coordinates: Not Available	

GRI

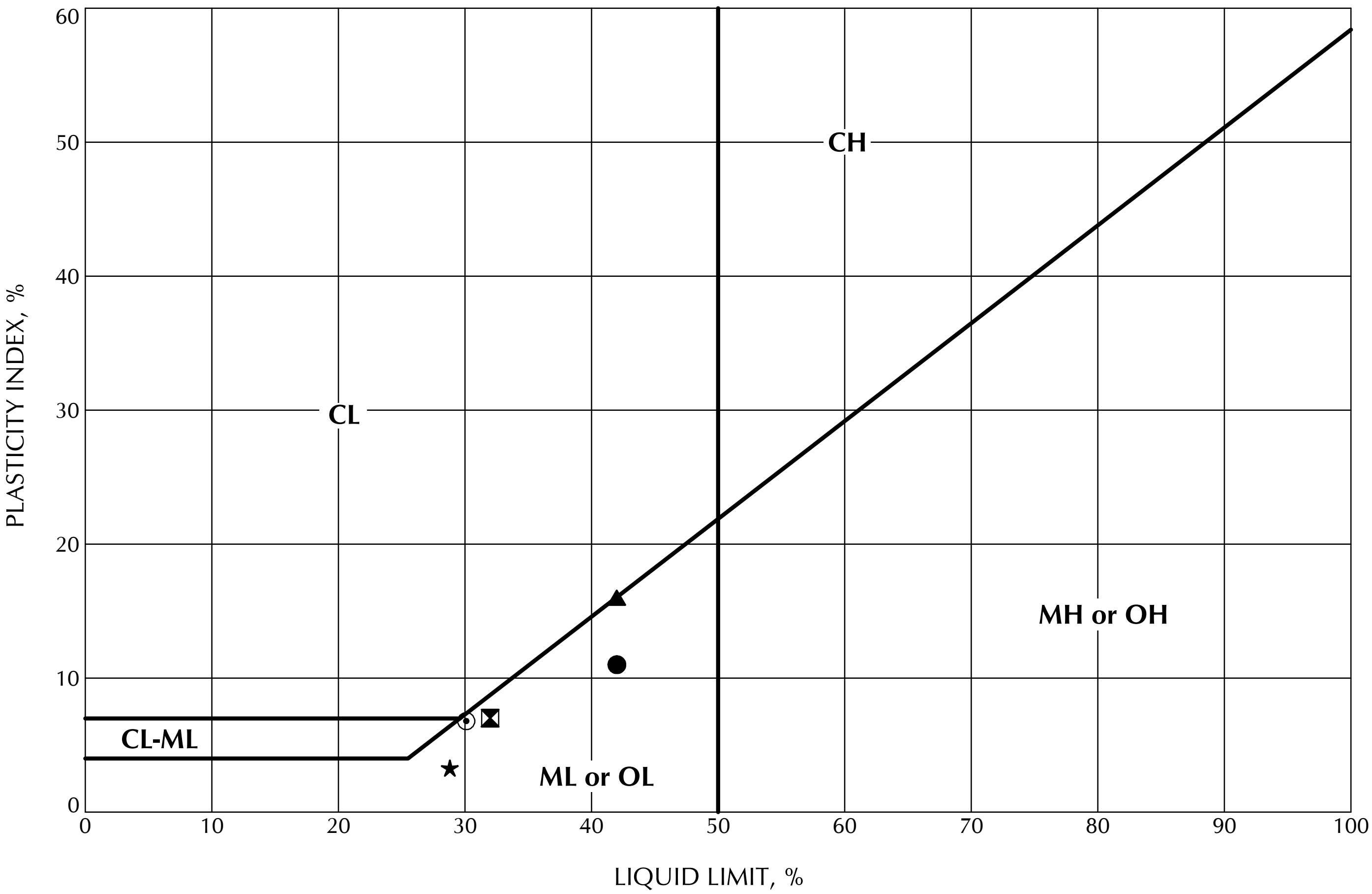
CONE PENETRATION TEST CPT-6

(SEISMIC VELOCITY PROFILE)

FEB. 2019 JOB NO. 6200 FIG. 20A

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
ML	INORGANIC CLAYEY SILTS TO VERY FINE SANDS OF SLIGHT PLASTICITY
CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY

GROUP SYMBOL	UNIFIED SOIL CLASSIFICATION FINE-GRAINED SOIL GROUPS
OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
MH	INORGANIC SILTS AND CLAYEY SILT
CH	INORGANIC CLAYS OF HIGH PLASTICITY



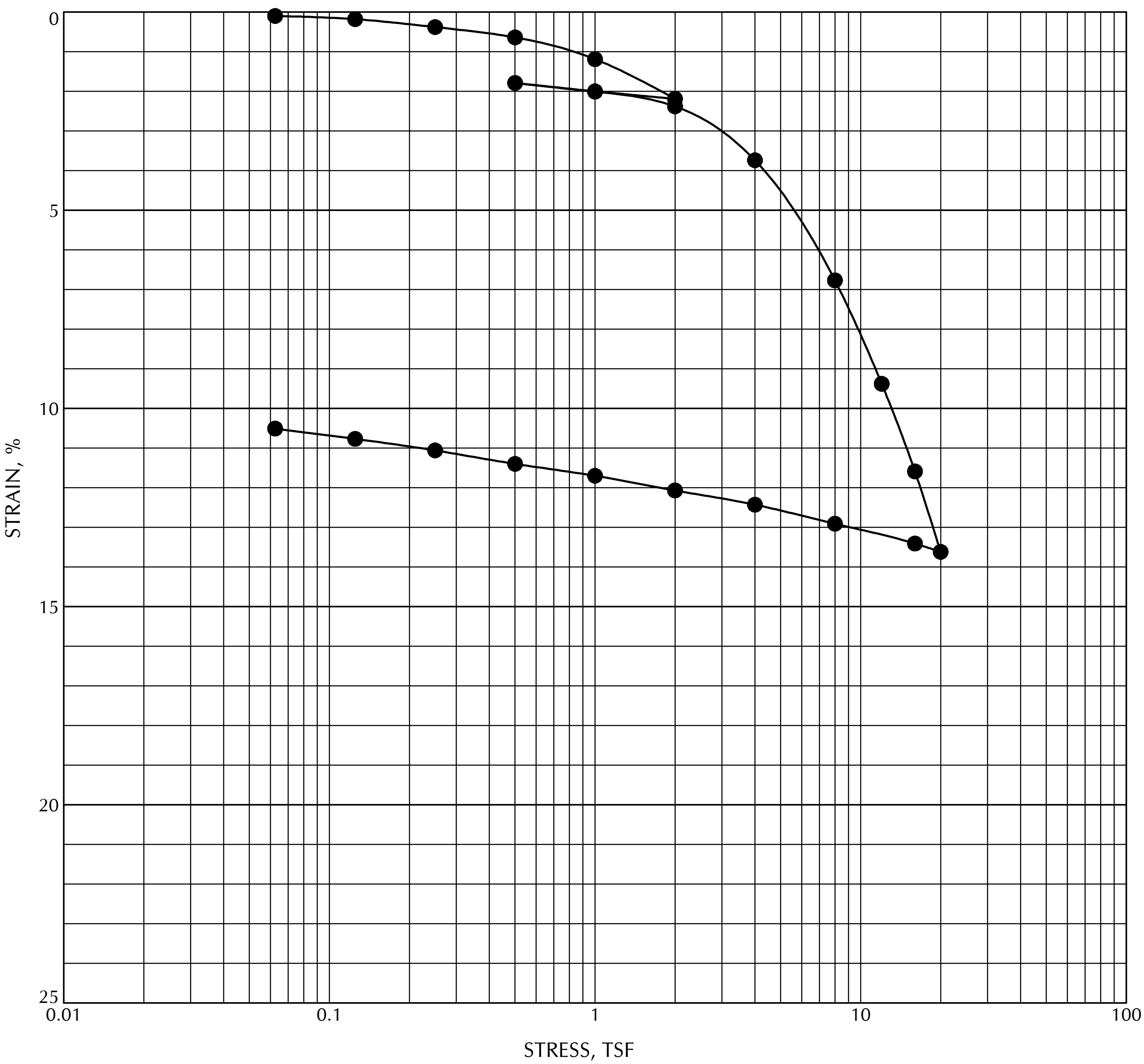
	Location	Sample	Depth, ft	Classification	LL	PL	PI	MC, %
●	B-4	S-1	0.0	Sandy SILT, trace clay, brown to gray, fine-grained sand (Residual Soil)	42	31	11	32
⧗	B-5	S-1	0.0	SILT, some fine- to coarse-grained sand to sandy, trace clay, brown to red-brown (Alluvium)	32	25	7	27
▲	B-6	S-1	0.0	SILT, some clay, trace to some fine- to coarse-grained sand, red-brown (Residual Soil)	42	26	16	27
★	TP-1	S-1	1.0	Sandy SILT, some clay, brown, stiff, fine-grained sand (Alluvium)	29	26	3	26
⊙	TP-4	S-1	1.0	SILT, some clay, trace to some fine-grained sand, brown mottled rust (Alluvium)	30	23	7	25

GRI

PLASTICITY CHART

FEB. 2019 JOB NO. 6200 FIG. 21A

ATTERBERG-PLASTICITY 5 PER PAGE GRI DATA TEMPLATE.GDT 1/25/19



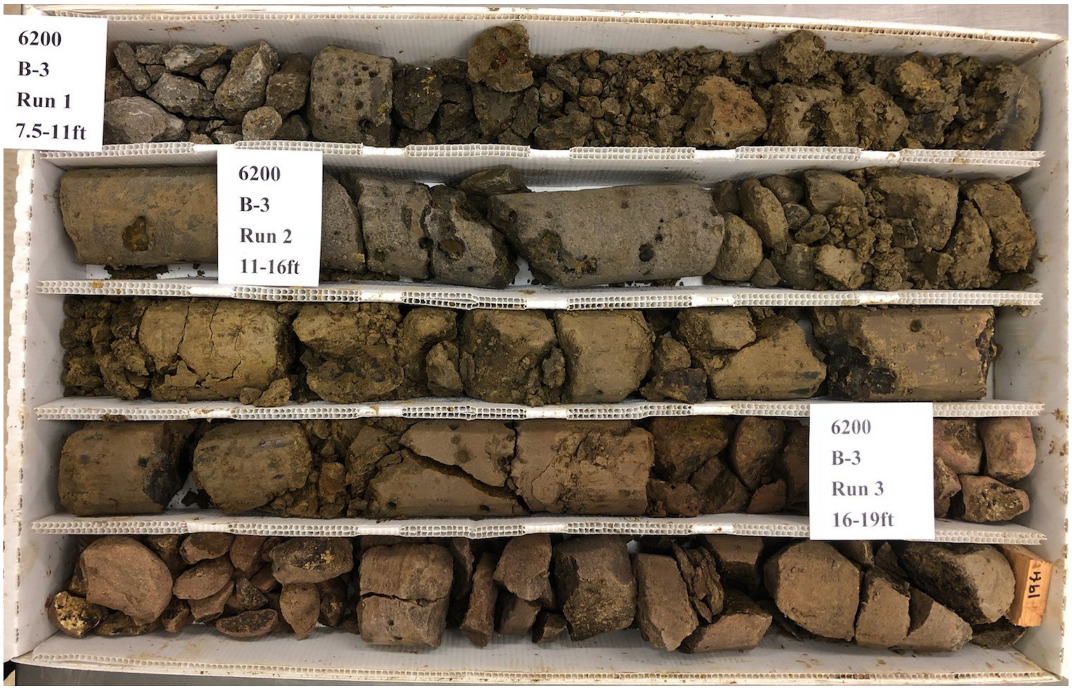
	Location	Sample	Depth, ft	Classification	Initial γ_d, pcf	Initial MC, %
●	B-1	S-3	5.25	Sandy SILT, brown, medium stiff to stiff, fine-grained sand (Alluvium)	87	34

GRI

CONSOLIDATION TEST

FEB. 2019 JOB NO. 6200 FIG. 22A

CONSOL STRAIN GRI-0 TO 25-1 PER PAGE GRI DATA TEMPLATE.GDT 1/25/19



BORING B-3 CORE RUNS 1 THROUGH 3

BORING B-3 CORE RUNS 4 THROUGH 5

GRI

ROCK CORE PHOTOGRAPHS

APPENDIX B

Site-Specific Seismic Hazard Evaluation and Site-Response Analysis

APPENDIX B

SITE-SPECIFIC SEISMIC HAZARD EVALUATION AND SITE-RESPONSE ANALYSIS

GRI completed a site-specific seismic hazard evaluation and site-response analysis for the proposed Portland General Electric Integrated Operations Center (PGE IOC) located in Tualatin, Oregon. The purpose of our work was to evaluate the potential seismic hazards associated with regional and local seismicity and complete site-response modeling for the project. We understand the project will be designed in accordance with recently adopted American Society of Civil Engineers (ASCE) standard 7-16, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures" (ASCE 7-16), which is also a reference standard for the 2018 International Building Code (2018 IBC). The 2018 IBC will serve as the basis for the upcoming 2019 Oregon Structural Specialty Code (2019 OSSC). Like its predecessor, ASCE 7-16 requires evaluation of seismic hazards based on the Risk-Targeted Maximum Considered Earthquake (MCE_R), which is defined in Chapter 21 of ASCE 7-16 as the response spectrum expected to achieve a 1% probability of building collapse within a 50-year period.

Our site-specific seismic evaluation was based on the potential for regional and local seismic activity, as described in the existing scientific literature, and the subsurface conditions at the site, as disclosed by the subsurface explorations completed for this project. Specifically, our work included the following tasks:

1) A review of available literature, including published papers, maps, open-file reports, seismic histories and catalogs, and other sources of information regarding the tectonic setting, regional and local geology, and historical seismic activity that might have a significant effect on the site.

2) Compilation, examination, and evaluation of existing subsurface data gathered at the site, including classification and laboratory analyses of soil samples and shear-wave velocity (V_S) measurements. This information was used to prepare a generalized subsurface profile for the site.

3) Identification of potential seismic sources appropriate for the site and characterization of those sources in terms of magnitude, distance, and acceleration response spectra.

4) Engineering analyses based on the generalized subsurface profile and generalized design earthquakes resulting in conclusions and recommendations concerning:

    a) specific seismic events and characteristic earthquakes that might have a significant effect on the project site;

    b) the potential for seismic-energy amplification at the site; and

    c) site-specific acceleration-response spectra for design of structures at the site.

This appendix describes the work accomplished and summarizes our conclusions and recommendations.

SEISMIC AND GEOLOGIC SETTING

On a regional scale, the site is located approximately 90 km inland from the down-dip edge of the seismogenic extent of the Cascadia Subduction Zone (CSZ), an active convergent-plate boundary along which remnants of the Farallon Plate (the Gorda, Juan de Fuca, and Explorer plates) are being subducted beneath the western edge of the North American continent. The subduction zone is a broad, eastward-dipping zone of contact between the upper portion of the subducting slabs of the Gorda, Juan de Fuca, and Explorer plates and the overriding North American plate, as shown on the Tectonic Setting Summary, Figure 1B.

On a local scale, the site is located within the Tualatin Basin, west of Portland, a well-defined, northwest-southeast-trending, pull-apart subbasin of the Willamette Valley (Wilson, 1998). The Tualatin Basin is bordered by the Coast Range and Chehalem Mountains to the south and west and the Tualatin Mountains (also known as the Portland Hills) to the north and east. The site is mantled by alluvial and residual soils underlain at relatively shallow depths by Columbia River Basalt. The local geology in the general project area is shown on the Local Geologic Map, Figure 2B.

Within the basin, a poorly defined, scattered network of relatively short, northwest-trending faults have been mapped (Madin, 1990). The Tualatin Mountains were uplifted by a series of northwesterly oriented faults related to compressional, right-lateral tectonics that control the region. The distribution of nearby quaternary faults included in the U.S. Geological Survey (USGS) database is shown on the Local Fault Map, Figure 3B. Information regarding the continuity and potential activity of these faults is lacking due largely to the scale at which geologic mapping in the area has been conducted. Other faults may be present within the basin, but clear stratigraphic and/or geophysical evidence regarding their location and extent is not presently available.

SEISMICITY

General

Because of the proximity of the site to the CSZ and its location within the Tualatin Basin, three seismic sources contribute to the potential for damaging earthquake motions at the site. Two of these sources are associated with tectonic activity related to the CSZ (i.e., subduction-zone events related to sudden slip between the upper surface of the Juan de Fuca plate and the lower surface of the North American plate and subcrustal (intraslab) events related to deformation and volume changes within the deeper portion of the subducted Juan de Fuca plate); the third is associated with movement on relatively shallow faults within and adjacent to the Portland Basin. Each of these sources is considered capable of producing damaging earthquakes in the Pacific Northwest; however, there are no historical records of significant subcrustal (intraslab) earthquakes in northwest Oregon and southwest Washington. Wong (2005) hypothesizes that due to subduction-zone geometry, geophysical conditions, and local geology, southwest Washington and northwest Oregon may not be subject to intraslab earthquakes. Considering this, based on historical records and our review of the USGS deaggregations, the two primary types of seismic sources at the site are the CSZ and local crustal faults.

Cascadia Subduction Zone (CSZ)

Written Japanese tsunami records suggest a great CSZ earthquake occurred in January 1700 (Atwater et al., 2015). Geological studies suggest great megathrust earthquakes have occurred repeatedly in the past 7,000 years (Atwater et al., 1995; Clague, 1997; Goldfinger et al., 2003; and Kelsey et al., 2005), and geodetic studies (Hyndman and Wang, 1995; Savage et al., 2000) indicate rate of strain accumulation consistent with the assumption the CSZ is locked beneath offshore northern California, Oregon, Washington, and southern British Columbia (Fluck et al., 1997; Wang et al., 2001). Numerous geological and geophysical studies suggest the CSZ may be segmented (Hughes and Carr, 1980; Weaver and Michaelson, 1985; Guffanti and Weaver, 1988; Goldfinger, 1994; Kelsey and Bockheim, 1994; Mitchell et al., 1994; Personius, 1995; Nelson and Personius, 1996; Witter, 1999; Goldfinger et al., 2017), but the most recent studies suggest for the last great earthquake in 1700, most of the subduction zone ruptured in a single magnitude (M_W) 9 earthquake (Satake et al., 1996; Atwater and Hemphill-Haley, 1997; Clague et al., 2000). Published estimates of the probable maximum size of subduction-zone events range from M_W 8.3 to greater than M_W 9. Numerous detailed studies of coastal subsidence, tsunamis, and turbidites yield a wide range of recurrence intervals, but the most complete records (>4,000 years) indicate intervals of about 350 to 600 years between great earthquakes on the CSZ (Adams, 1990; Atwater and Hemphill-Haley, 1997; Witter, 1999; Clague et al., 2000; Kelsey et al., 2002; Kelsey et al., 2005; Witter et al., 2003). Tsunami inundation in buried marshes along the Washington and Oregon coasts and stratigraphic evidence from the Cascadia margin support these recurrence intervals (Kelsey et al., 2005; Goldfinger et al., 2003). Goldfinger et al. (2003, 2012, and 2017) evaluated turbidite evidence for 20 earthquakes that ruptured the entire CSZ over the past 10,000 years and about 20 M_W 8 earthquakes that only ruptured along the southern portion of the CSZ and developed a model for recurrence of CSZ M_W 8 to M_W 9 earthquakes.

The USGS probabilistic analysis assumes four potential locations (three alternative down-dip edge options and one up-dip edge option) for the eastern edge of the earthquake-rupture zone for the CSZ, as shown on Figure 4B. As discussed in Petersen et al. (2014), the 2014 USGS mapping effort represents the 2014 CSZ source model with the full CSZ ruptures and moment magnitudes from M_W 8.6 to M_W 9.3 supplemented by partial ruptures with smaller magnitudes (M_W 8.0 to M_W 9.1). The partial ruptures were accounted for using a segmented model and an unsegmented model. The magnitude-frequency distribution showing the contributions to the earthquake rates from each of the models and how the rates vary along the fault are presented on Figure 5B. In general, the earthquake rates along the CSZ are dominated by the full-characteristic CSZ ruptures (i.e., from Northern California to Southern British Columbia), with one event in 526 years (M_W 8.6 to M_W 9.3 earthquakes likely occur more often than the smaller, segmented ruptures).

Local Crustal Event

Sudden crustal movements along relatively shallow, local faults in the project area, although rare, have been responsible for local crustal earthquakes. The precise relationship between specific earthquakes and individual faults is not well understood since few of the faults in the area are expressed at the ground surface and the foci of the observed earthquakes have not been located with precision. The history of local seismic activity is commonly used as a basis for determining the size and frequency to be expected of local crustal events. Although the historical record of local earthquakes is relatively short (the earliest reported seismic event in the area occurred in 1920), it can serve as a guide for estimating the potential for seismic activity in the area.

The locations of and general information regarding Quaternary faults (i.e., those that have experienced movement during the last 2.6 million years and are considered potentially active) are available through the USGS Earthquake Hazards Program. The USGS Quaternary Fault and Fold Database shows the Portland Hills fault as one of the seismic sources significantly contributing to the seismicity of the site. The Portland Hills fault is a northwest-striking, reverse-oblique fault located approximately 14.5 km east of the site that dips to the southwest beneath the eastern base of the Portland Hills. The length of the Portland Hills fault is approximately 40 to 60 km and has a characteristic earthquake magnitude of M_W 7.0. Additionally, there are about five more faults within 25 km of the site that potentially contribute to the seismicity: the Bolton fault at about 10 km, Newberg fault at about 13 km, Helvetia fault at about 19 km, Mount Angel fault at about 23.5 km, and Grant Butte fault at about 24 km.

PROBABILISTIC AND DETERMINISTIC SEISMIC HAZARD ANALYSIS

A Probabilistic Seismic Hazard Analysis (PSHA) estimates the seismic hazard at a specific location using a statistical evaluation of the potential earthquake sources in consideration and implicitly incorporates uncertainties in fault parameters, such as location and geometry, slip rate and activity, probable magnitude, and potential ground motions. The potential variations in input parameters are considered with different assumptions and assigned relative weighting in a logic-tree format. The output from a PSHA includes a seismic-hazard curve showing the variation of a selected ground-motion parameter, such as peak ground acceleration (PGA), as a function of the annual frequency of exceedance (i.e., reciprocal of the average return period). The USGS provides probabilistic seismic-hazard maps for various probabilities of exceedance or hazard levels (i.e., specified probabilities of being exceeded over a given time period), which are updated about every 6 years. The results of a PSHA for a given hazard level are commonly referred to as a Uniform Hazard Spectrum (UHS) because all spectral ordinates have a uniform probability of exceedance in a given period of time.

The site-specific PSHA was derived based on the 2014 USGS Probabilistic National Seismic Hazard Maps (NSHMs), which were partially released in 2014 (i.e., deaggregations were available only for PGA, 0.2-, 1.0-, and 2.0-sec spectral periods and Site Class B/C boundary conditions) and recently updated to include an expanded set of spectral periods and other site classes (Shumway et al., 2018). The current 2014 NSHMs incorporate four new ground-motion models from the NGA-West2 project for shallow crustal earthquakes. Similarly, interface and intraslab earthquakes on the CSZ are characterized with new ground-motion models. Table 1B summarizes the ground-motion prediction equations (GMPEs) and applied weighting used in the updated 2014 USGS NSHMs.

Table 1B: GROUND-MOTION MODELS AND WEIGHTS USED IN THE 2014 USGS NSHMs FOR THE PACIFIC NORTHWEST

Earthquake Source Mechanism	GMPEs	Weight
Crustal	Abrahamson et al. (2014)	0.25
	Boore et al. (2014)	0.25
	Campbell and Bozorgnia (2014)	0.25
	Chiou and Youngs (2014)	0.25
Subduction Intraslab	Zhao et al. (2006)	0.50
	BC Hydro (Abrahamson et al., 2016)	0.50
Subduction Interface	Atkinson and Macias (2009)	0.33
	Zhao et al. (2006)	0.33
	BC Hydro (Abrahamson et al., 2016)	0.34

The site-specific PSHA obtained from 2014 NSHMs (Shumway et al., 2018) consisted of the full PSHA values (i.e., PGA, 0.1, 0.2, 0.3, 0.5, 0.75, 1.0, 2.0, 3.0, 4.0, and 5.0 sec) associated with a 2,475-year (2% in 50 year) return period for Site Class B/C boundary conditions (i.e., $V_S = 2{,}500$ ft/sec). Table 2B summarizes the site-specific UHS values (2% in 50 years) obtained for the project site. These PSHA values represent the "geomean" spectral response accelerations.

Table 2B: 2014 USGS 2,475-YEAR UHS SPECTRAL VALUES (B/C BOUNDARY CONDITION)

Spectral Acceleration, g	
Period, sec	**2,475-Year Return Period**
PGA	0.42
0.10	0.89
0.20	0.92
0.30	0.76
0.50	0.55
0.75	0.42
1.00	0.33
2.00	0.19
3.00	0.12
4.00	0.09
5.00	0.07

A Deterministic Seismic Hazard Analysis (DSHA) was completed concurrently with the PSHA to evaluate the ground motions in accordance with Section 21.2.2 of ASCE 7-16. The deterministic ground motions are defined at the 84th-percentile level. The DSHA was completed by estimating bedrock motions for likely active earthquake sources at the site. Review of the 2014 USGS Quaternary Fault Database indicates the primary seismic sources for the site are a magnitude M_W 9.0 CSZ earthquake with a source-to-site distance of approximately 90 km and a magnitude M_W 7.0 local crustal earthquake associated with the Portland Hills fault with a source-to-site distance of approximately 14.5 km. The anticipated magnitudes and source-to-site distances from the USGS database, GMPEs, and weighting consistent with the development of the 2014 USGS PSHA, outlined previously, were used to develop the bedrock spectra for the CSZ and Portland Hills fault. The specific GMPEs and corresponding weighting selected for the CSZ and crustal events are presented above in Table 1B. The spectral accelerations estimated using the GMPEs represent the geometric mean of two orthogonal horizontal directions. The resulting deterministic CSZ and crustal response spectra for Site Class B/C boundary conditions are shown on Figure 6B. The spectral values from the site-specific, 84th-percentile deterministic spectra were compared with the code-based deterministic lower-limit spectrum to define the deterministic spectrum. The deterministic spectrum is defined as the larger of the 84th-percentile spectral values and the code-based lower limit. As shown on Figure 6B, the code-based deterministic lower limit spectrum was observed to be higher than all the site-specific 84th-percentile deterministic spectra at all periods. Therefore, the deterministic spectrum is defined by the code-based deterministic lower-limit spectrum.

Finally, the controlling target bedrock spectrum for design is defined as the lower of the probabilistic and deterministic response spectra. Figure 7B shows a comparison of the probabilistic and deterministic spectra and indicates the probabilistic spectral values are lower than the deterministic values at all periods. Therefore, the probabilistic spectrum defines the controlling target bedrock spectrum at the site.

SITE-RESPONSE ANALYSIS

General

The effect of a specific seismic event on the site is related to the type and thickness of the soil column being modeled and the type and quantity of seismic energy delivered by the earthquake at the base of the soil column. Dynamic site-response modeling consisted of three components: 1) selection of the target response spectrum at the base of the soil column; 2) numerical modeling to analyze the site-specific behavior of the soils using horizontal ground-motion acceleration time histories scaled to the approximate level of the target response spectrum over the periods of interest; and 3) calculation of the surface-to-base response spectra (i.e., ratio of the surface response spectra values to the input motion response spectra values) at each spectral period to develop a recommended ground-surface response spectrum.

Site-response analysis was completed to evaluate the site-specific influence of subsurface conditions on the resulting ground-surface response spectra in accordance with Chapter 21 of ASCE 7-16. The following sections discuss the steps in additional detail.

Development of Target Spectra

The site-response analysis requires developing target spectra at the base of the soil column (hereafter referred to as "target bedrock spectra") prior to selecting and scaling the input earthquake-acceleration time histories. The target spectra were developed for the soil column in accordance with the requirements of ASCE 7-16, which defines the controlling target spectrum as the lower of the probabilistic and the deterministic spectra discussed in previous sections. Therefore, the target bedrock spectrum was defined by the probabilistic spectrum.

As discussed previously, deaggregation of probabilistic ground motions for the site indicate the CSZ and crustal sources are the primary contributors to the potential seismicity of the site. In general, the local crustal sources control the seismic hazard at shorter time-period ranges, while the CSZ sources control the hazard at longer periods. To more appropriately characterize the contribution of each primary source, site-specific target bedrock spectra were developed for both CSZ and local crustal sources. The individual target spectra were developed using the same GMPEs and corresponding weights discussed previously. Figure 8B shows a comparison of the 2014 NSHMs PSHA values and the individual CSZ and crustal target bedrock spectra developed for this analysis.

Ground Motion Selection and Scaling

For the site-response analyses, a suite of seven recorded horizontal ground-motion acceleration time histories were selected from earthquakes having magnitudes, frequency contents, and spectral shapes consistent with those that control the target spectra. Ground-motion records from crustal and subduction-zone earthquakes were used for the site-response modeling and scaled to the target spectra discussed above. The selected time histories used for the site-response modeling are summarized in Table 3B.

Table 3B: SUMMARY OF GROUND-MOTION RECORDS SELECTED FOR SITE-RESPONSE MODELING

No.	Earthquake/Year	Mag, Mw	Station Name	Record Used	Record Source	Unscaled PGA, g	Sampling Frequency, Hz	Record Length, sec
1	Tohoku /2011[1]	9.0	Yaita	TCG005NS	KNET	0.26	100	300
2	Tohoku /2011[1]	9.0	Shimodate	IBR008NS	KNET	0.27	100	300
3	Maule /2010[1]	8.8	Santiago La Florida	SlaFloridaEW	UCS	0.13	200	208
4	Maule /2010[1]	8.8	PuentaAlto	PuentaAltoNS	UCS	0.27	100	147
5	Niigata /2004[2]	6.6	NIGH11	Niigata_NIGH11EW	PEER	0.6	200	180
6	Loma Prieta/1989[2]	6.9	Gilroy – Gavilan Coll.	Lomap_Gil067	PEER	0.37	200	40
7	San Simeon/2003[2]	6.5	Templeton	Sansimeo_360	PEER	0.49	200	101

Notes:

1. Subduction-Zone Interface Earthquake.
2. Shallow Crustal Earthquake.

Following selection of the time histories, the input bedrock motions were linearly modified using amplitude scaling so the mean response spectra of the recordings reasonably matched the crustal and CSZ base target spectra. The amplitude-scaling process involves selecting a single scaling factor for each time history and multiplying the entire acceleration time history by this factor so its response spectrum approximates the input target spectra. Figures 9B and 10B show comparisons of the amplitude-scaled motions and the target spectra for CSZ and crustal motions. Time histories were scaled to reasonably approximate the target spectra at the fundamental period of the site. From the selected time histories summarized in Table 3B, the 2011 Tohoku and 2010 Maule records were matched to the CSZ target spectrum and the 2004 Niigata,1989 Loma Prieta, and 2003 San Simeon records were matched to the crustal target spectrum.

Modeling Method

The site-response analysis was performed using one-dimensional, non-linear, total-stress, site-response modeling in DEEPSOIL (Hashash et al., 2016), a program developed by the University of Illinois. The program employs time-domain site-response analysis capable of incorporating the non-linear hysteretic soil behavior observed during cyclic loading and unloading. The program computes the dynamic response of a layered soil profile to vertically propagating shear waves using a built-in total-stress or effective-stress analysis option. The program uses the pressure-dependent, modified, hyperbolic constitutive model initially developed by Kondner and Zelasko (1963) (Modified Kondner and Zelasko (MKZ) model) and the General Quadratic/Hyperbolic (GQ/H) strength-controlled constitutive model recently introduced by Groholski et al. (2015). The GQ/H model allows the shear strength at failure to be defined while still providing the flexibility to represent the small-strain soil behavior. Therefore, the GQ/H material model was utilized since it provides a better approximation of modulus reduction and damping and higher levels of shear strain approaching the ultimate shear strength while still maintaining small-strain nonlinearity.

The GQ/H parameters are generally obtained by fitting the hyperbolic model to published empirical modulus reduction and damping curves, such as EPRI (1993), Vucetic and Dobry (1991), and Darendeli (2001). The conventional approach for defining unloading-reloading criteria and behavior under general cyclic-loading conditions (hysteretic damping) is based on the Masing criteria (Masing, 1926) and extended Masing criteria (Pyke, 1979; Vucetic, 1990). An exact match of the target modulus reduction and damping curves is not concurrently possible using the Masing or extended Masing rules (i.e., one has to match the target modulus reduction curve as accurately as possible and accept the misfit of damping or optimize the fit of both simultaneously). Phillips and Hashash (2009) developed an alternative non-Masing model by introducing a reduction factor that effectively alters the Masing rules and allows for both modulus reduction and damping curves to be fitted simultaneously.

In general, DEEPSOIL allows the user to create a discretized soil profile and input a variety of soil-modeling parameters derived from field and laboratory testing and established correlations in the geotechnical literature. A suite of scaled earthquake records is input into the program and propagated up through the soil column to the ground surface. From the modeled ground-surface response for a particular soil profile, a Spectral Acceleration Ratio (SAR) can be determined for each earthquake record as the ratio of ground surface to input target or bedrock spectral acceleration at selected periods.

Input Soil Parameters

A generalized subsurface profile was developed for the existing site conditions based on the subsurface explorations and laboratory testing programs completed for the project. The thickness and material properties of the site's soils were characterized based on the results of the subsurface explorations and laboratory testing programs, which included drilled borings, cone penetration test (CPT) probes, and V_S profiles. The V_S profile for the site was developed based on the seismic CPT probes and Refraction Microtremor (ReMi) arrays (Earth Dynamics, 2019) completed at the project site. The ReMi method is a non-invasive, seismic surface-wave technique that uses ambient noise and surface waves to generate a detailed vertical V_S profile. It is also very useful for stratigraphic delineation in complex geologic environments. Details of the ReMi V_S testing conducted at the site are attached in Appendix C. Figure 11B presents the results of the CPT and ReMi V_S surveys. The V_S measurements extend to a depth of about 20 ft below the existing ground surface. The figure also presents the recommended V_S profile for the site, which was used in the site-response analysis.

The dynamic properties of each soil layer were estimated using published relationships and local experience. The total-stress analyses were completed using the family of shear-modulus reduction and damping-ratio curves developed by Darendeli (2001). Darendeli (2001) provides a functional form of modulus reduction and damping curves for coarse- and fine-grained soils as a function of soil properties (such as the plasticity index, the in-situ overburden stress, and the overconsolidation ratio). The half-space boundary condition at the base of the soil column was represented by a visco-elastic boundary with a unit weight of 130 pcf and a V_S of 2,500 ft/sec.

SITE RESPONSE RESULTS

Ground Surface Response Spectra

Using the scaled ground-motion records listed in the preceding tables and the generalized soil profile, pseudo acceleration response spectra were developed using Total Stress Analyses (TSA) site-response analysis. The ground-surface response spectra for individual earthquake motions were developed at 5% of critical damping. The resulting response spectra were compared with the input target spectra at the base of the soil column to quantify amplification and/or attenuation through the soil column at the site. In general, the ground-surface response spectra are defined as the base-target response spectrum multiplied by the SAR estimated from the site-response modeling. Therefore, the ground-surface response spectra were developed for both the crustal and subduction-zone ground motions. ASCE 7-16 defines ground motions as the spectral response acceleration in the maximum direction of ground motions represented by a 5%-damped acceleration response spectrum expected to achieve a 1% probability of collapse within a 50-year period (i.e., MCE_R). Therefore, the ground-surface MCE_R spectra were obtained by applying directivity factors and risk coefficients to the ground-surface response acceleration values. The directivity factors adjust the spectral values from geometric mean to direction of maximum horizontal response and the risk coefficients incorporate the uniform collapse risk objective of 1% in a 50-year time period. Per Section 21.2 of ASCE 7-16, the geometric-mean ground motions are converted to the corresponding direction of maximum horizontal response values by applying 1.1 for periods less than or equal to 0.2 sec, 1.3 for a period of 1.0 sec, and 1.5 for periods greater than or equal to 5.0 sec. For spectral periods between these periods, the directivity factor was estimated using linear interpolation. The risk coefficients obtained from USGS maps indicate the short- and long-period risk coefficients C_{RS} and C_{R1} at the site are approximately 0.884 and 0.865, respectively. For spectral periods between 0.2 and 1.0 sec, the risk coefficients were estimated using linear interpolation. The resulting mean ground-surface MCE_R spectra are summarized on Figure 12B for crustal and subduction-zone records. These response spectra represent the mean ground-surface response of the crustal and subduction-zone records at 5% damping derived based on the suite of spectrum-compatible time histories previously discussed. The figure shows peak spectral values for both crustal and subduction-zone ground motions at a period of about 0.1 sec. The mean crustal spectral values are observed to be higher than the mean CSZ spectral values at periods less than about 0.75 sec. At periods greater than 0.75 sec, the mean crustal spectral values are observed to be lower than the mean CSZ spectral values. The weighted average spectrum (hereafter referred to as the "site-specific response spectrum") was developed from the mean crustal and CSZ spectra based on the relative contribution of local crustal and CSZ sources at each period.

Code-Based Spectra Comparisons and Recommended Design Spectra

Typically, the recommended response spectra for structural design can be developed by comparing the site-specific spectra based on site-response modeling with the code-based spectra based on site class and generic site-amplification factors. At the project site, the site is designated Site Class C based on the V_S profile for the upper 100 ft developed from the seismic CPT probes and ReMi measurements. ASCE 7-16 requires the site-specific spectral accelerations at the ground surface not be less than 80% of the spectral values determined for Site Class C.

Comparisons of the site-specific ground-surface spectrum (i.e., weighted average of mean crustal and CSZ) and the code-based ground-surface spectra are shown on Figure 13B. The code-based Site Class C spectrum was derived based on the 0.2- and 1.0-sec spectral-acceleration values (S_S and S_1) at the bedrock and corresponding site coefficients, F_a and F_v, in accordance with Chapter 21 of ASCE 7-16. The 0.2- and 1.0-sec spectral values (S_S and S_1) for the site at bedrock are 0.83 and 0.39, respectively. The short- and long-period site coefficients, F_a and F_v, are 1.2 and 1.5, respectively. The site-specific response spectrum (i.e., weighted average of mean crustal and CSZ) obtained from site-response modeling was generally observed to be higher than the code-based 80% Site Class C spectra at periods less than about 0.25 sec. At periods greater than about 0.25 sec, the site-specific response spectra were observed to fall below 80% of Site Class C values. Therefore, the recommended MCE_R spectrum was developed by enveloping the site-specific spectral values at short periods (i.e., periods less than 0.25 sec) and the code-based 80% Site Class C spectral values for periods greater than 0.25 sec. The design-level response spectrum is calculated as two-thirds of the MCE_R spectrum. Table 5B summarizes the MCE_R and design response spectral values. Figure 13B shows the recommended MCE_R ground-surface spectral values developed for the modal response spectrum analysis (MRSA) procedure and nonlinear response history analysis (RHA) in accordance with ASCE 7-16.

Table 5B: RECOMMENDED MCE_R AND DESIGN RESPONSE SPECTRAL VALUES, 5% DAMPING

Period, sec	MCE_R- Response Spectral Values, g	Design Response Spectral Values, g
0.01	0.49	0.33
0.05	0.75	0.50
0.10	1.23	0.82
0.20	0.91	0.61
0.28	0.80	0.53
0.50	0.80	0.53
0.58	0.80	0.53
0.80	0.58	0.39
1.00	0.47	0.31
1.50	0.31	0.21
2.00	0.23	0.15
2.50	0.19	0.13
3.00	0.16	0.11
3.50	0.13	0.09
4.00	0.12	0.08
5.00	0.09	0.06
6.00	0.08	0.05

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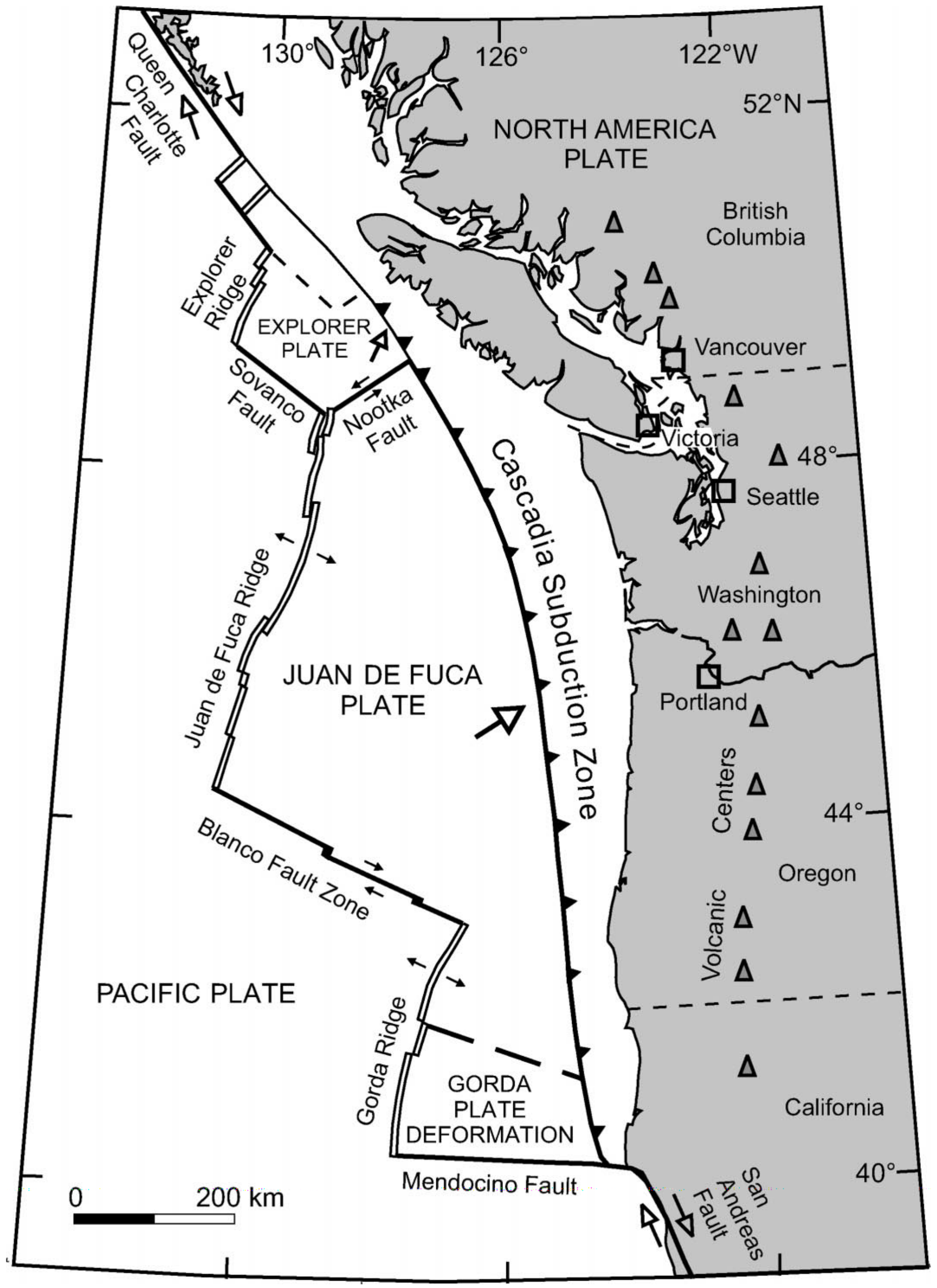
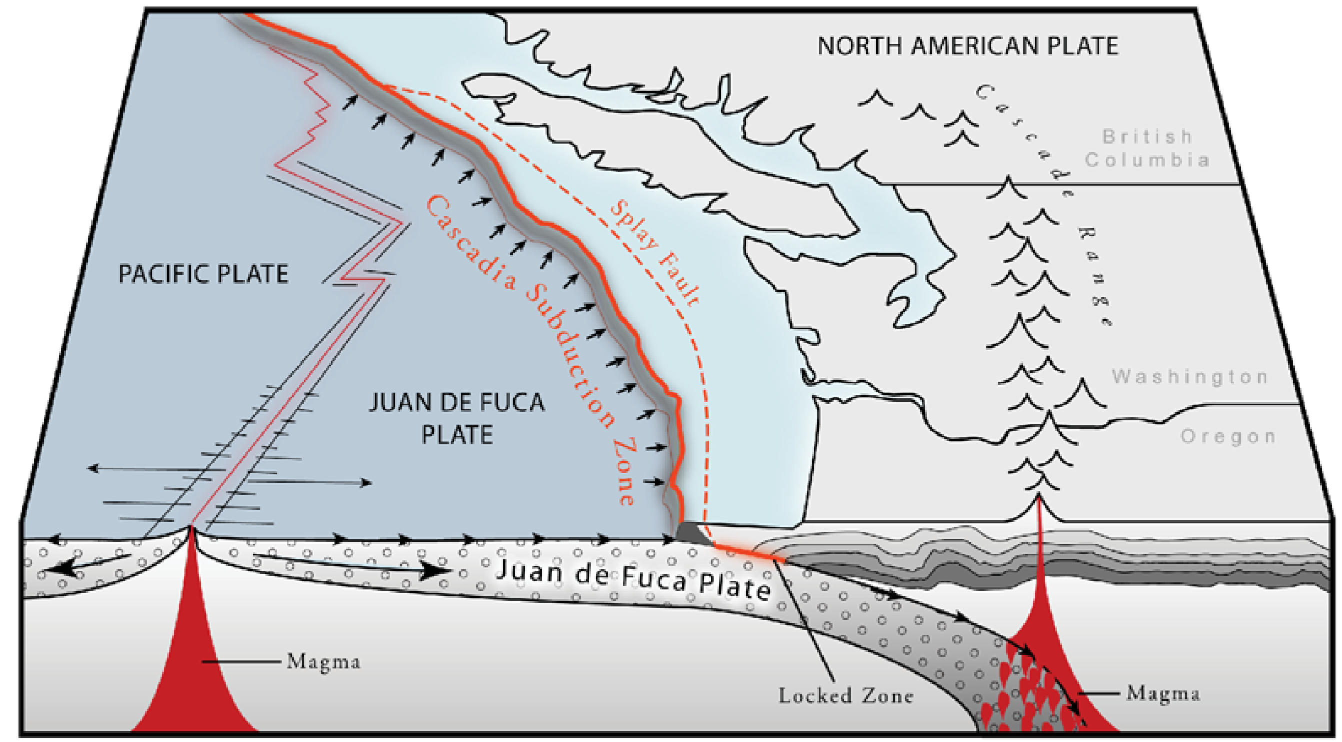


A) TECTONIC MAP OF PACIFIC NORTHWEST, SHOWING ORIENTATION AND EXTENT OF CASCADIA SUBDUCTION ZONE (MODIFIED FROM DRAGERT AND OTHERS, 1994)

Cascadia Subduction Zone Setting

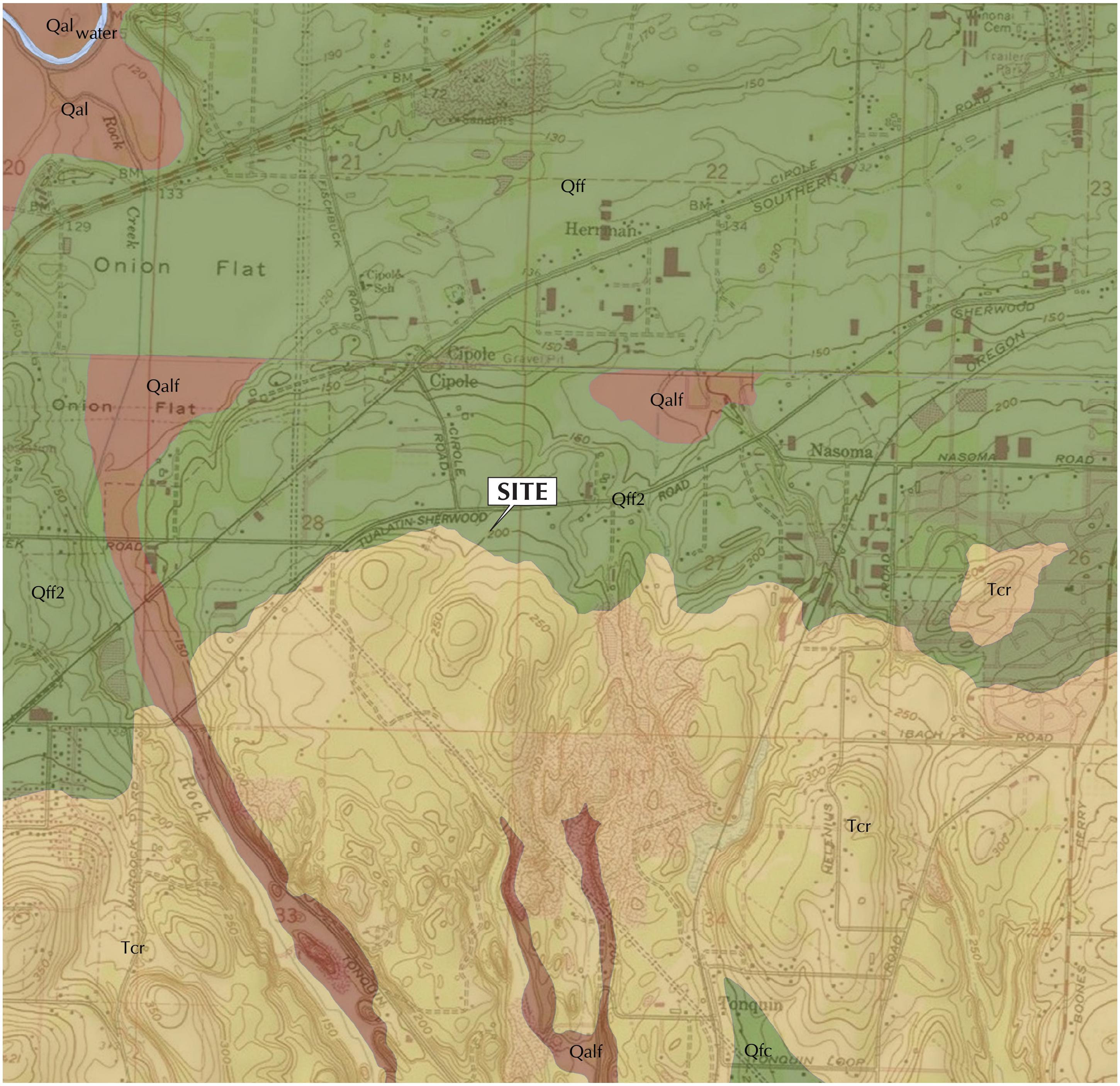


CASCADIA SUBDUCTION ZONE SETTING, TSUNAMI INUNDATION MAPS, OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRY, 2013

GRI

TECTONIC SETTING SUMMARY

FEB. 2019 JOB NO. 6200 FIG. 1B



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GEOLOGIC FORMATIONS

- ALLUVIAL DEPOSITS, Qal, Qalf
- COLUMBIA RIVER BASALT GROUP, Tcr
- MISSOULA FLOOD DEPOSITS, Qfc, Qff, Qff2

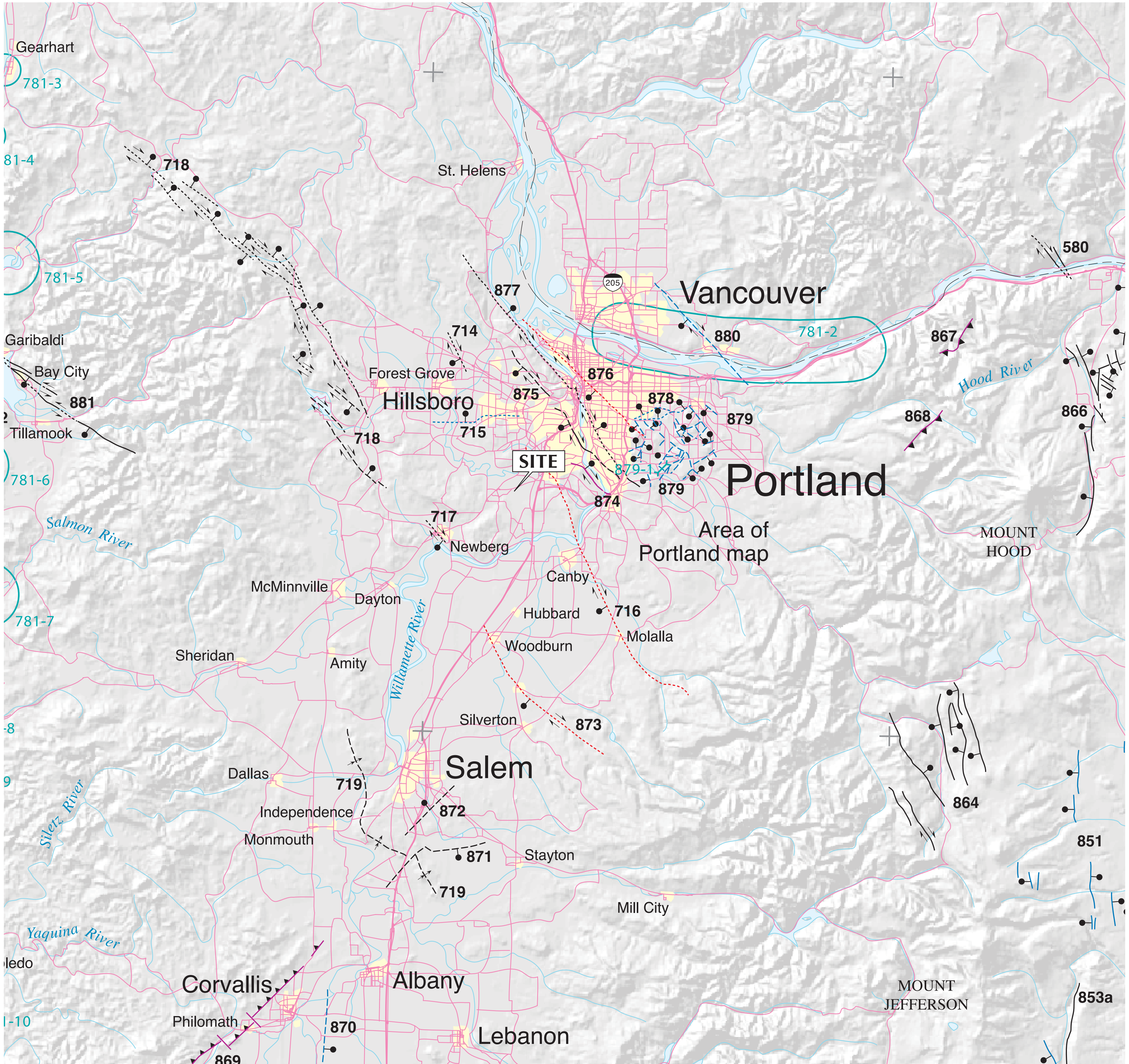
North

0 2,000 4,000 FT

GRI

LOCAL GEOLOGIC MAP

FEB. 2019 JOB NO. 6200 FIG. 2B



MAP EXPLANATION

TIME OF MOST RECENT SURFACE RUPTURE

- Holocene (<10,000 years) or post last glaciation (<15,000 years; 15 ka); no historic ruptures in Oregon to date
- Late Quaternary (<130,000; post penultimate glaciation)
- Late and middle Quaternary (<750,000 years; 750 ka)
- Quaternary, undifferentiated (<1,600,000 years; <1.6 Ma)
- Class B structure (age or origin uncertain)

SLIP RATE

- >5 mm/year
- 1.0-5.0 mm/year
- 0.2-1.0 mm/year
- <0.2 mm/year

TRACE

- Mostly continuous at map scale
- Mostly discontinuous at map scale
- Inferred or concealed

STRUCTURE TYPE AND RELATED FEATURES

- Normal or high-angle reverse fault
- Strike-slip fault
- Thrust fault
- Anticlinal fold
- Synclinal fold
- Monoclinal fold
- Plunge direction of fold
- Fault section marker

DETAILED STUDY SITES

- 731-2 Trench site
- 781-2 Subduction zone study site

CULTURAL AND GEOGRAPHIC FEATURES

- Divided highway
- Primary or secondary road
- Permanent river or stream
- Intermittent river or stream
- Permanent or intermittent lake

FAULT NUMBER	NAME OF STRUCTURE
714	HELVETIA FAULT
715	BEAVERTON FAULT
716	CANBY-MOLALLA FAULT
717	NEWBERG FAULT
718	GALES CREEK FAULT ZONE
719	SALEM-EOLA HILLS HOMOCLINE
864	CLACKAMAS RIVER FAULT ZONE
867	EAGLE CREEK THRUST FAULT
868	BULL RUN THRUST FAULT
872	WALDO HILLS FAULT
873	MOUNT ANGEL FAULT
874	BOLTON FAULT
875	OATFIELD FAULT
876	EAST BANK FAULT
877	PORTLAND HILLS FAULT
878	GRANT BUTTE FAULT
879	DAMASCUS-TICKLE CREEK FAULT ZONE
880	LACAMAS LAKE FAULT
881	TILLAMOOK BAY FAULT ZONE

FROM: PERSONIUS, S.F., AND OTHERS, 2003, MAP OF QUATERNARY FAULTS AND FOLDS IN OREGON, USGS OPEN FILE REPORT OFR-03-095.

North

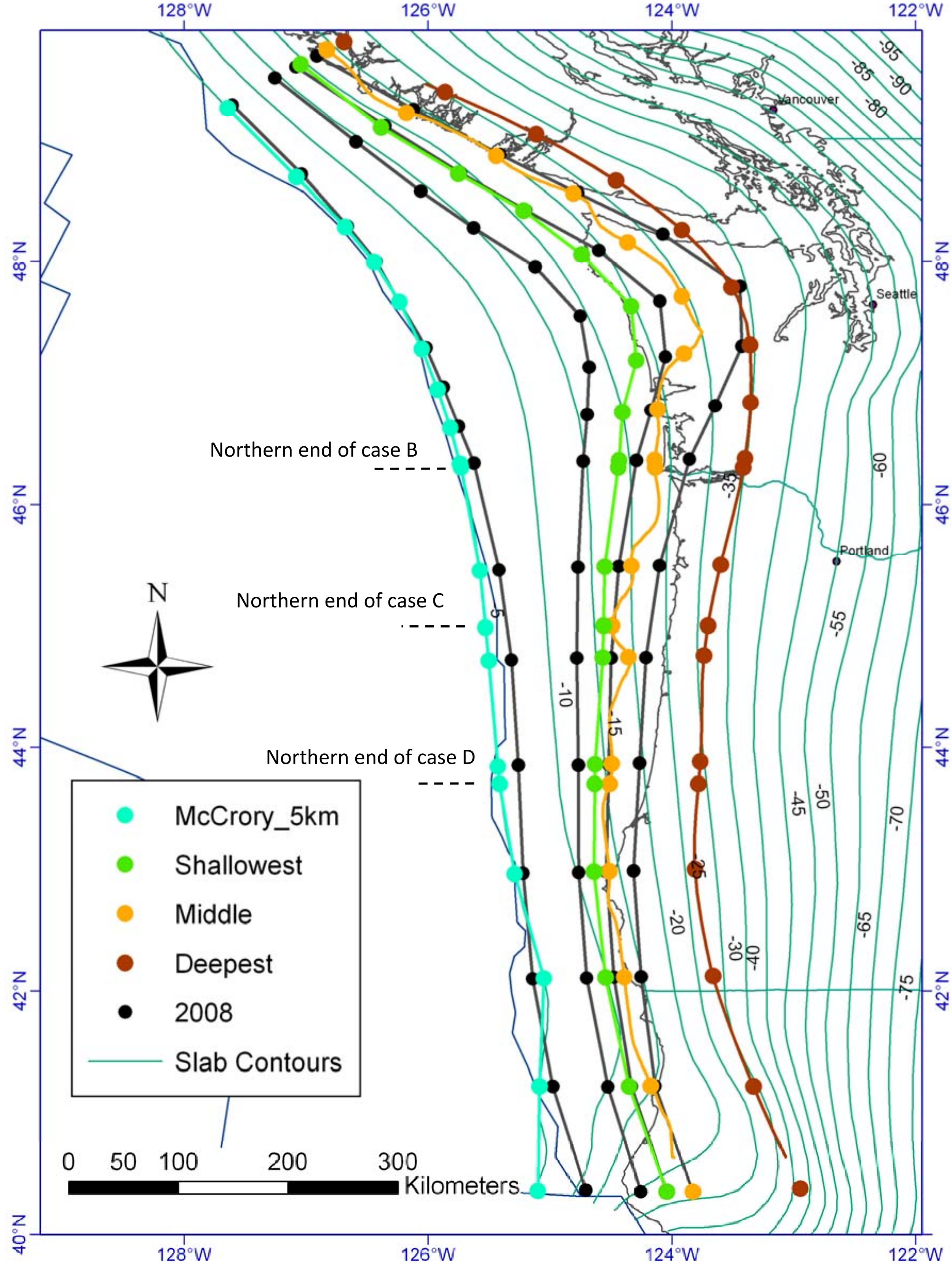
0 10 20 MILES

0 20 40 KILOMETERS

GRI

LOCAL FAULT MAP

FEB. 2019 JOB NO. 6200 FIG. 3B

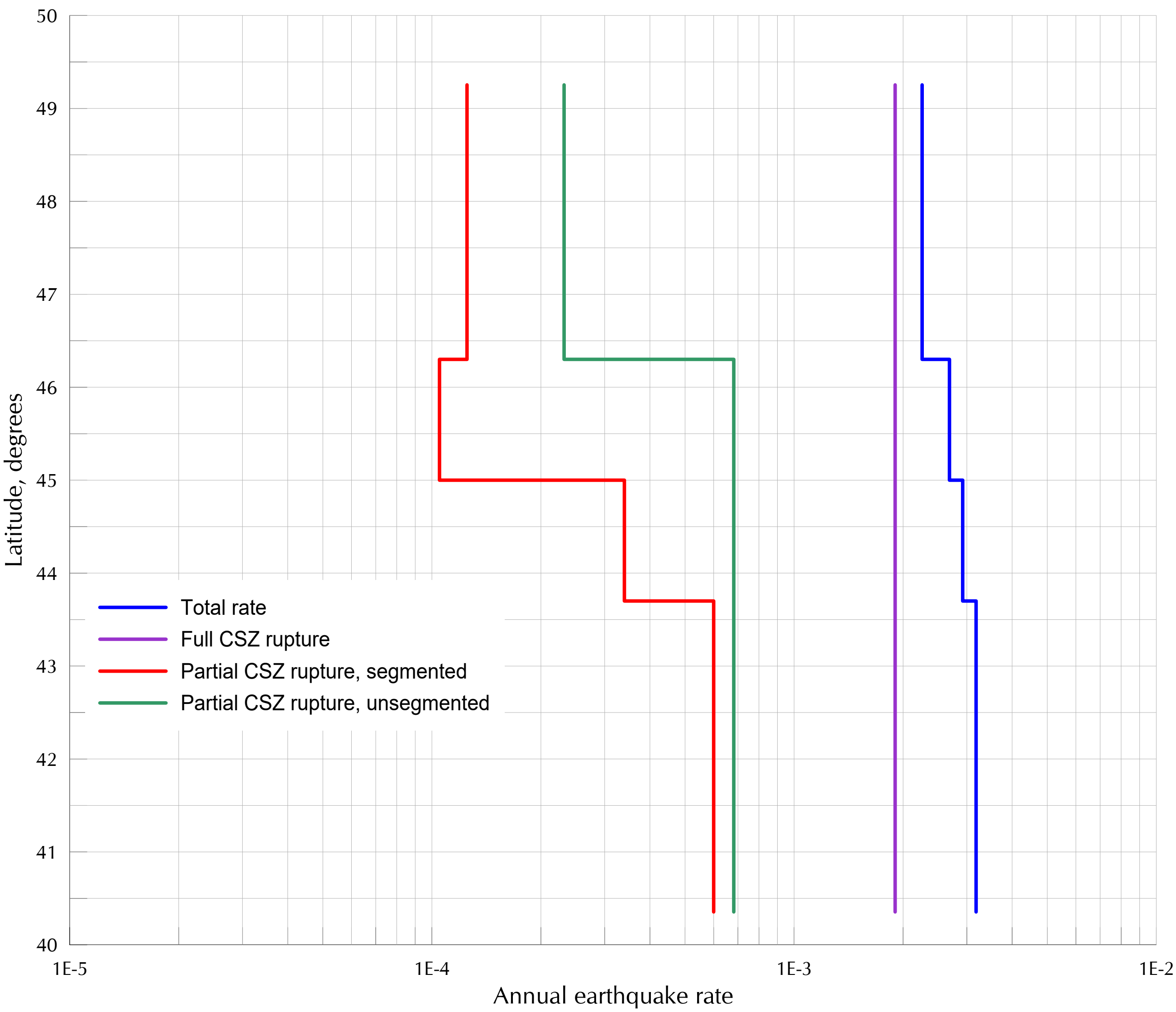


REFERENCE:
CHEN, RO, FRANKED, A., AND PETERSON, M., 2014, IMPLEMENTATION OF THE CASCADIA SUBDUCTION ZONE SOURCE MODELS FOR THE 2014 UPDATE OF THE NATIONAL SEISMIC HAZARD MAPS, PERSONAL COMMUNICATION.

GRI

ASSUMED RUPTURE LOCATIONS
(CASCADIA SUBDUCTION ZONE)

FEB. 2019 JOB NO. 6200 FIG. 4B

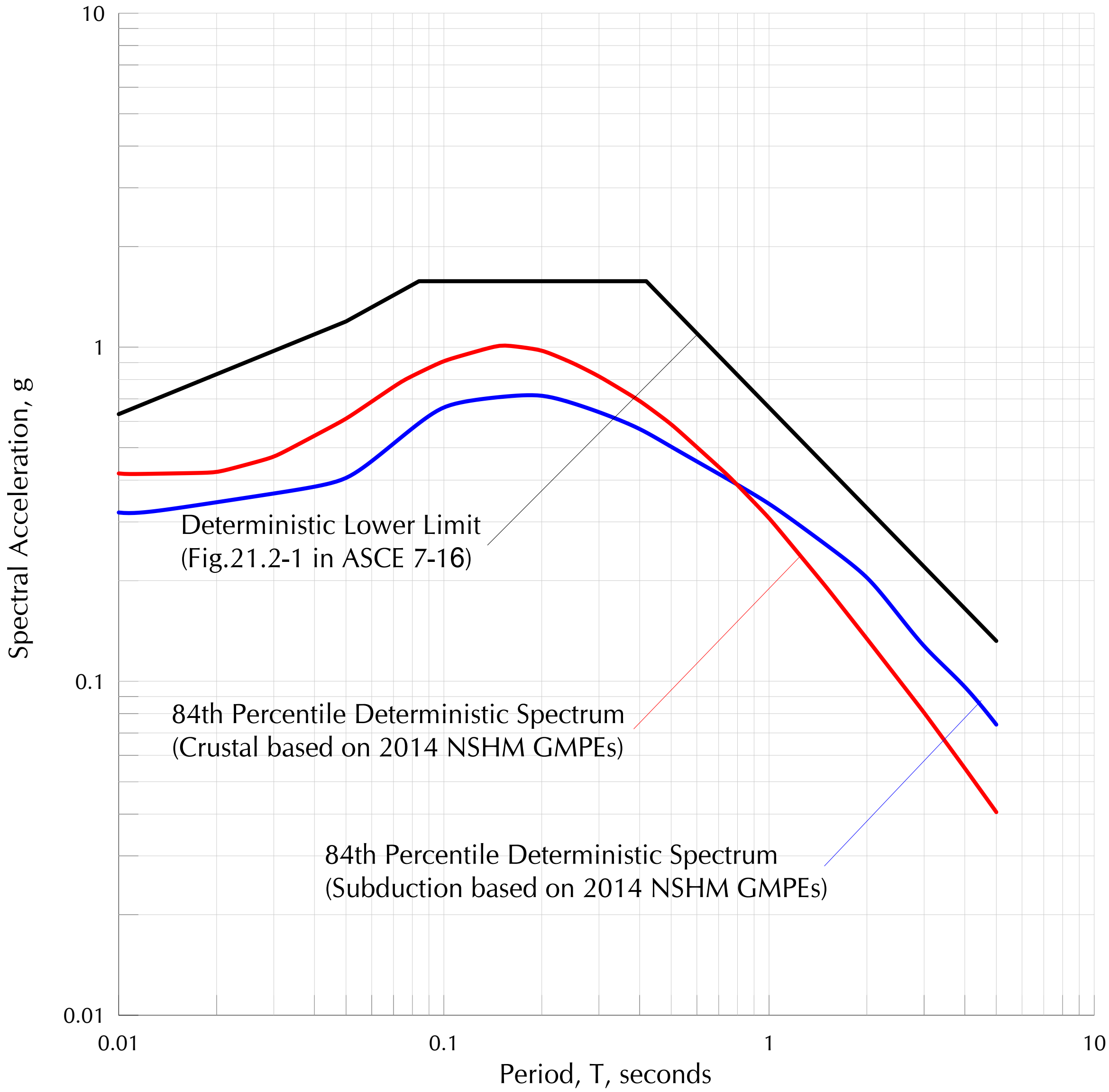


REFERENCE:
CHEN, RO, FRANKED, A., AND PETERSON, M., 2014, IMPLEMENTATION OF THE CASCADIA SUBDUCTION ZONE SOURCE MODELS FOR THE 2014 UPDATE OF THE NATIONAL SEISMIC HAZARD MAPS, PERSONAL COMMUNICATION.

GRI

VARIATION OF EARTHQUAKE RATES
CASCADIA SUBDUCTION ZONE (CSZ)

FEB. 2019 JOB NO. 6200 FIG. 5B



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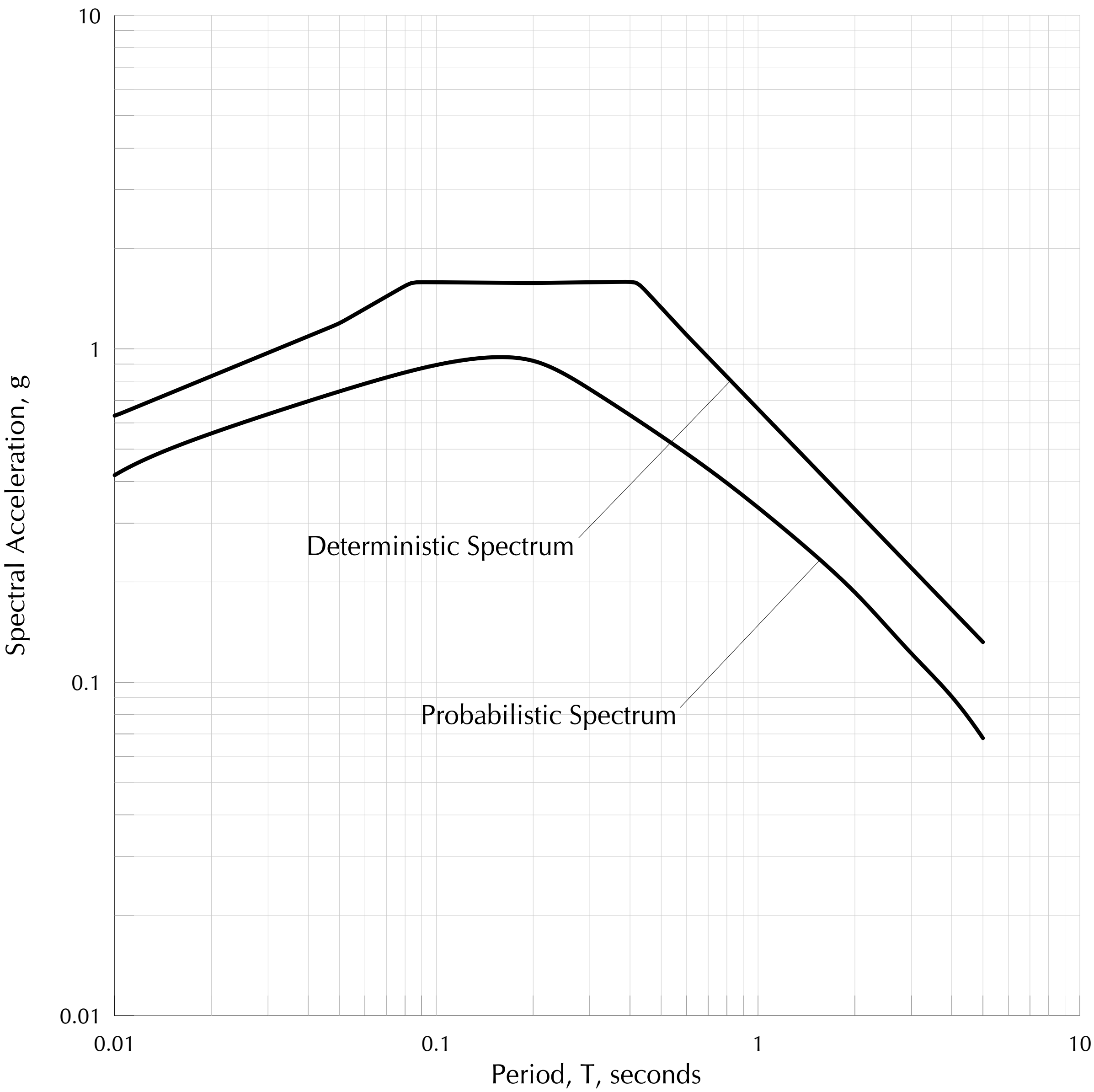
DETERMINISTIC SPECTRA COMPARISON FOR B/C

BOUNDARY CONDITION

(5% DAMPING)

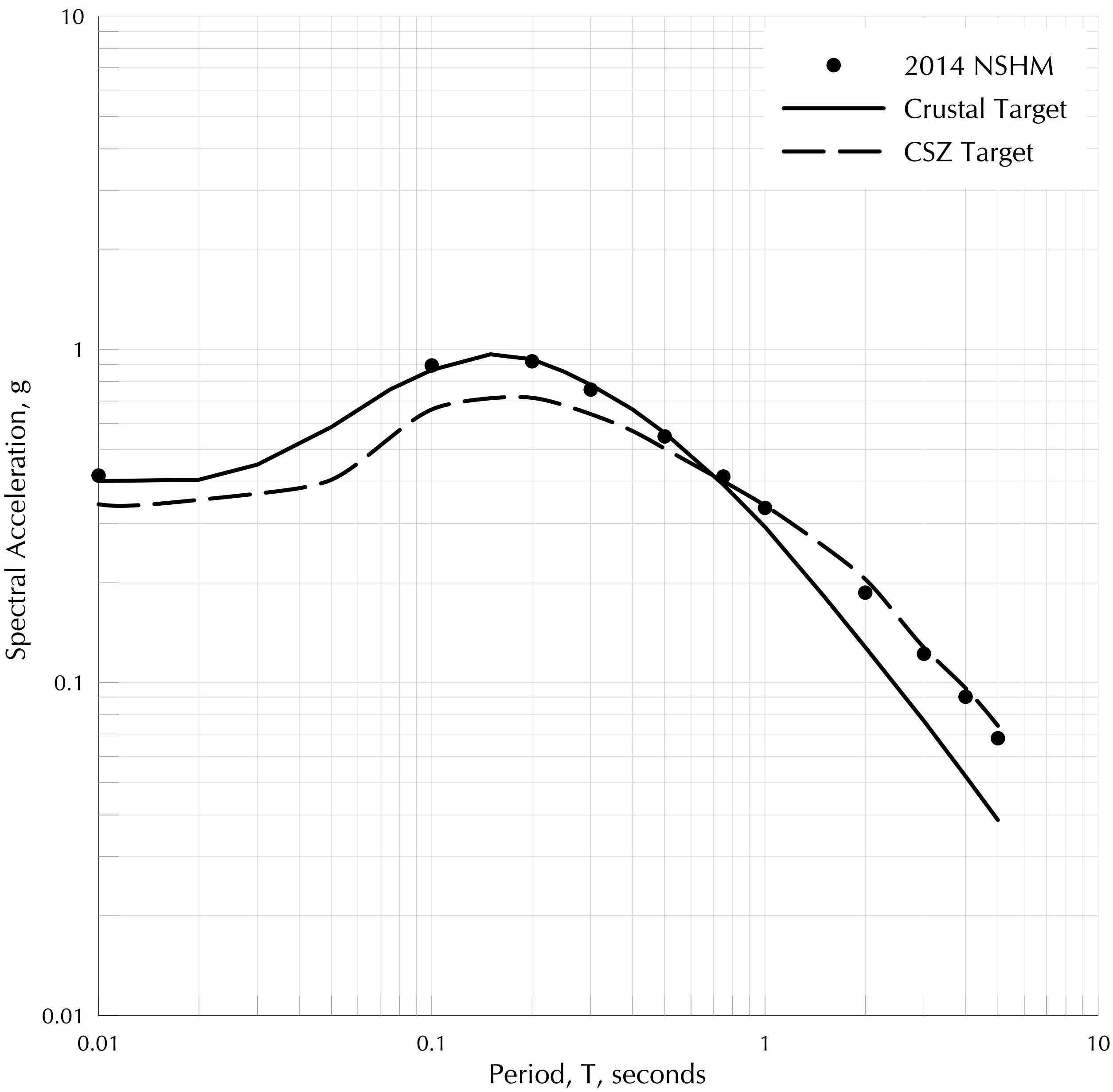
FEB. 2019 | JOB NO. 6200 | FIG. 6B



GRI

DETERMINISTIC AND PROBABILISTIC SPECTRA
COMPARISON FOR B/C BOUNDARY CONDITION
(5% DAMPING)

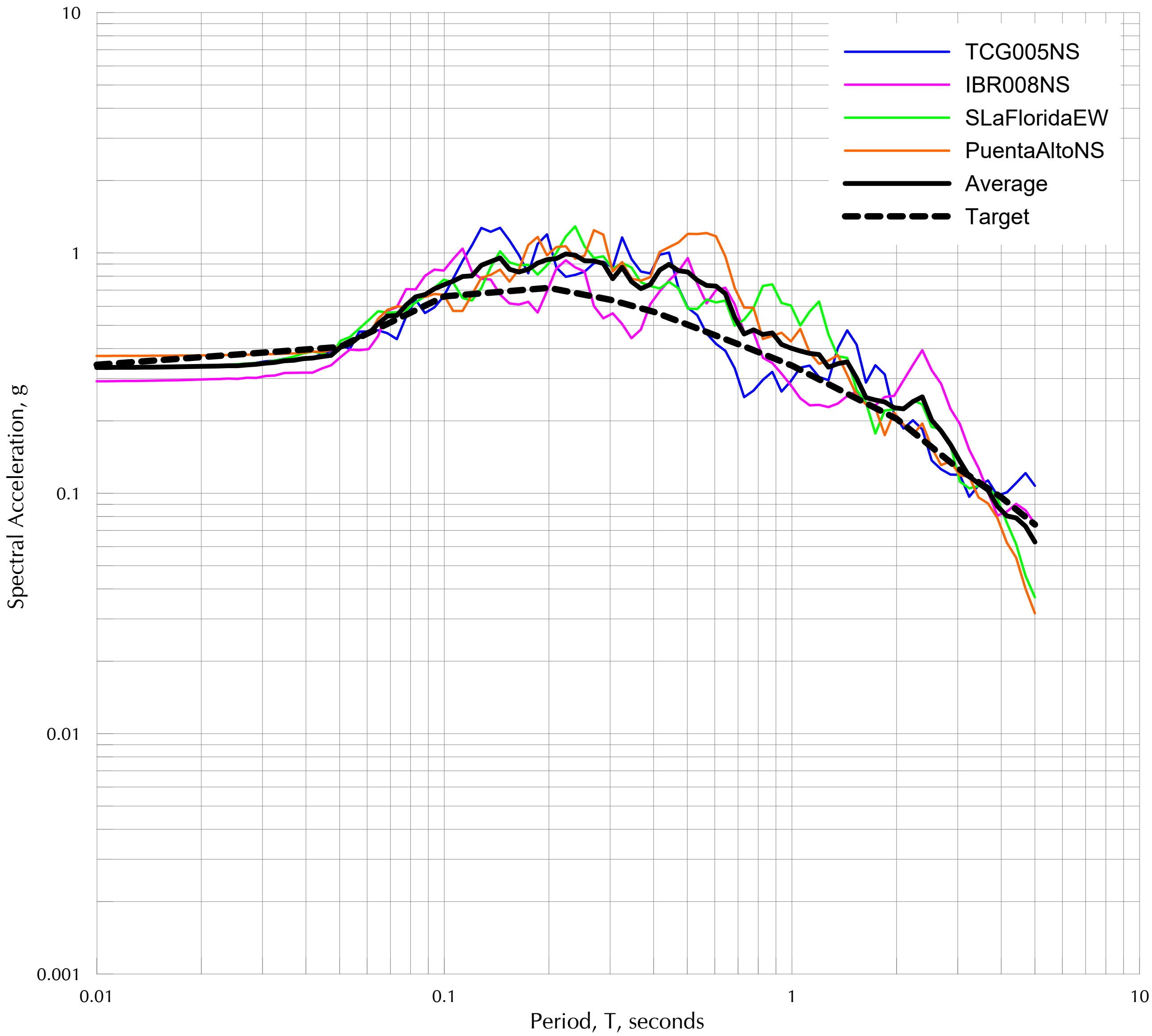
FEB. 2019 JOB NO. 6200 FIG. 7B



GRI

TARGET SPECTRA
B/C BOUNDARY CONDITION
(5% DAMPING)

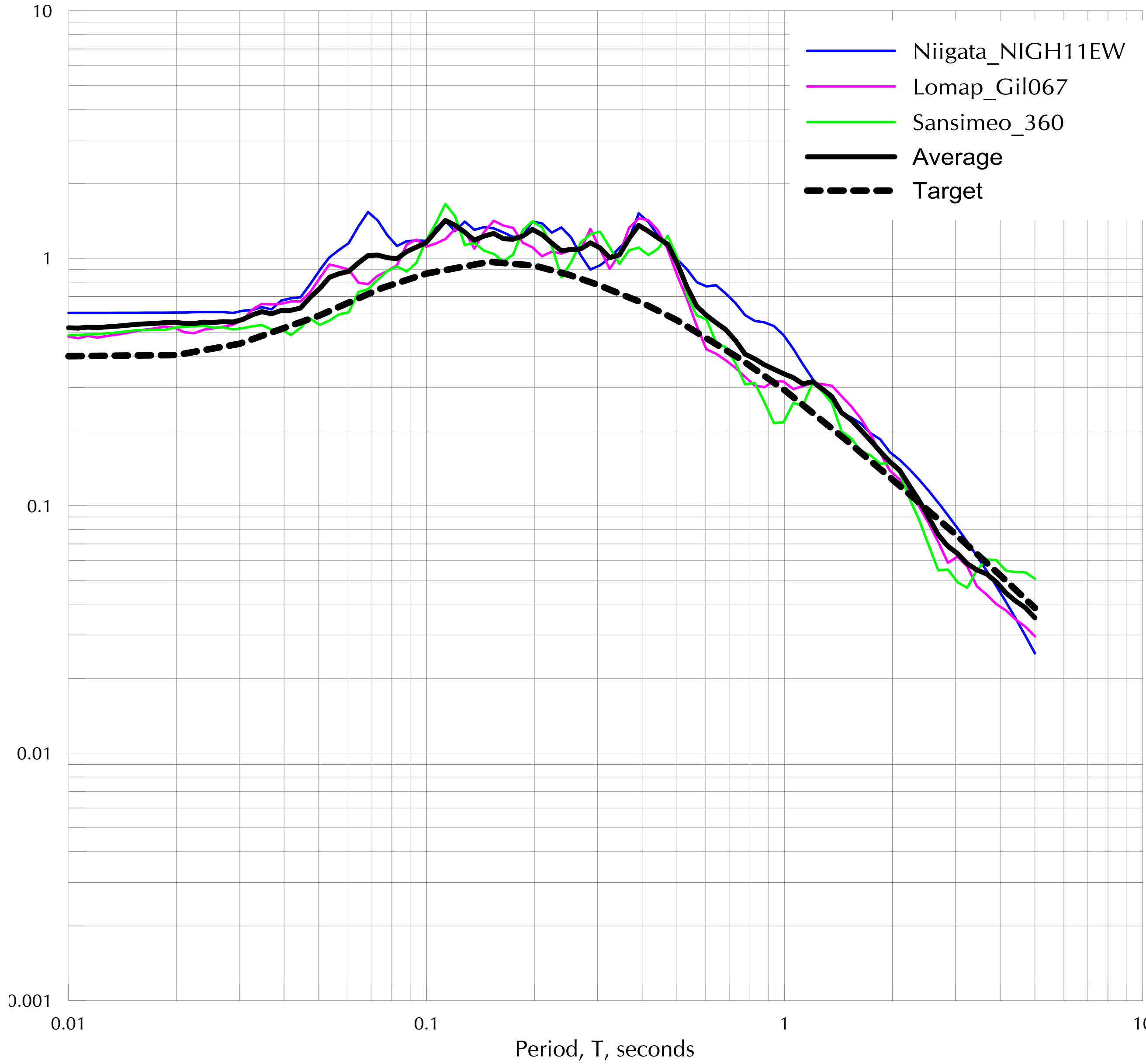
FEB. 2019 JOB NO. 6200 FIG. 8B



GRI

AMPLITUDE-SCALED CSZ MOTIONS
AND TARGET SPECTRA COMPARISON
(5% DAMPING)

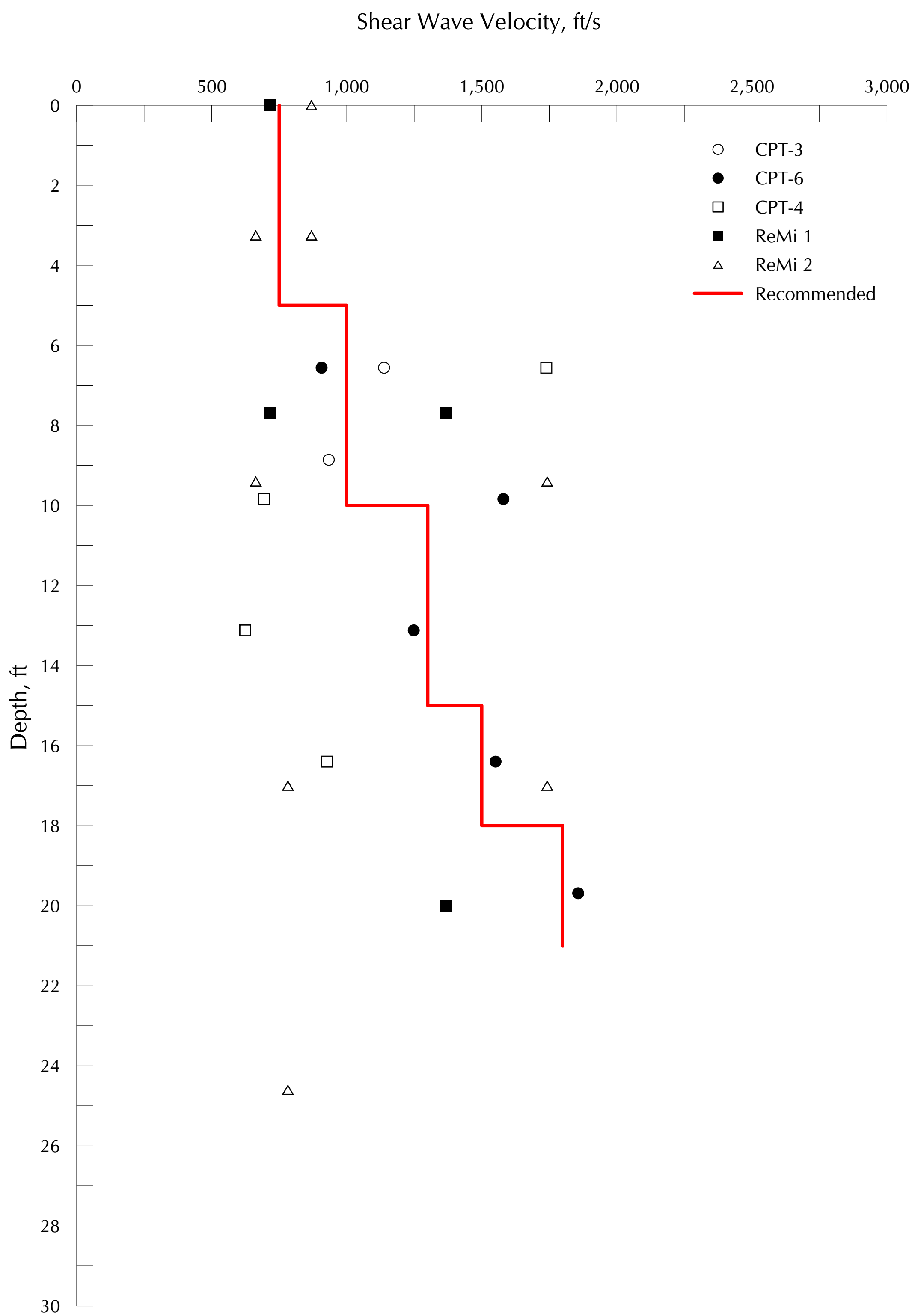
FEB. 2019 JOB NO. 6200 FIG. 9B



GRI

AMPLITUDE-SCALED CRUSTAL MOTIONS
AND TARGET SPECTRA COMPARISON
(5% DAMPING)

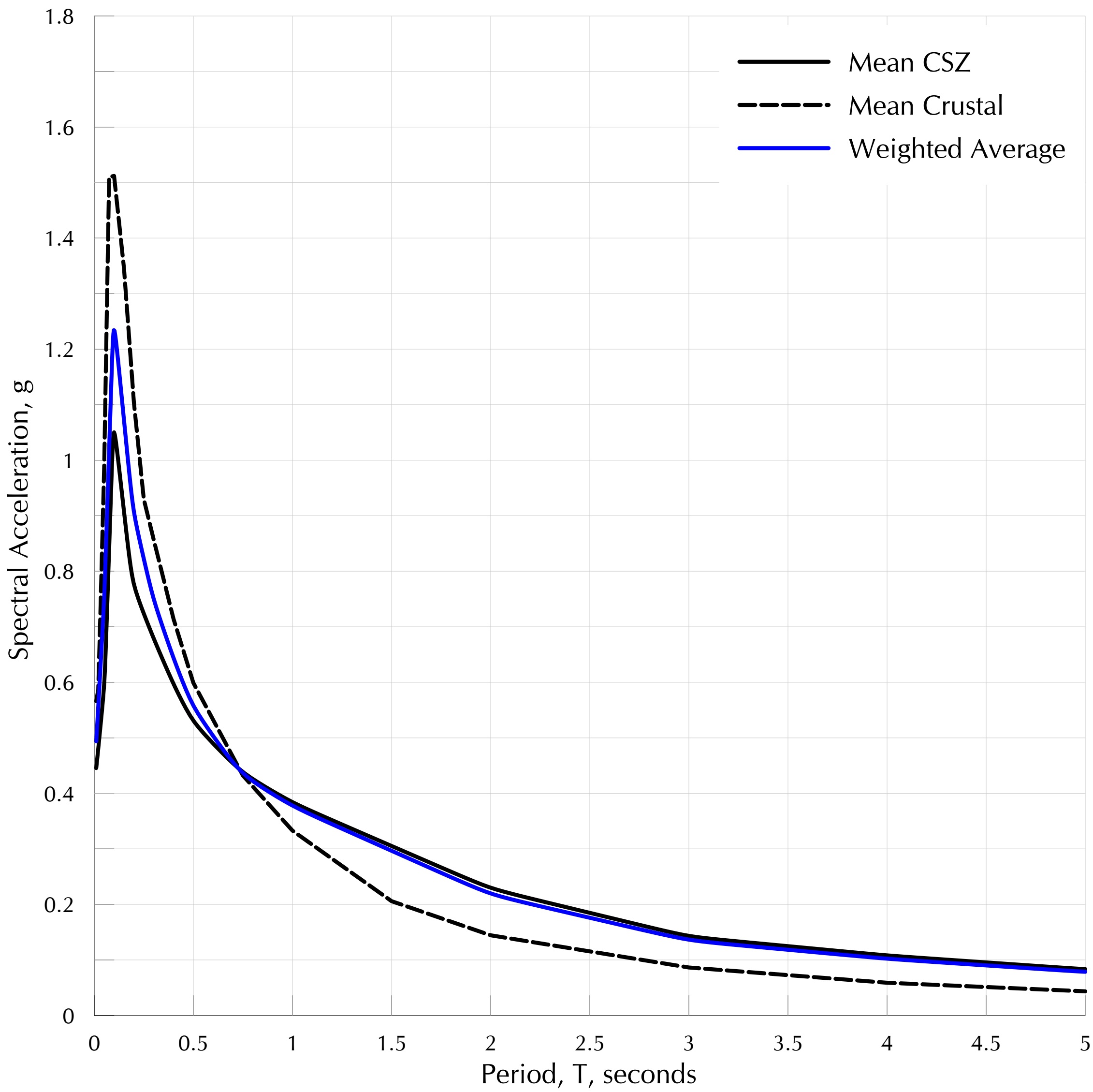
FEB. 2019 JOB NO. 6200 FIG. 10B



GRI

SHEAR WAVE VELOCITY PROFILES
AT PROJECT SITE

FEB. 2019 JOB NO. 6200 FIG. 11B



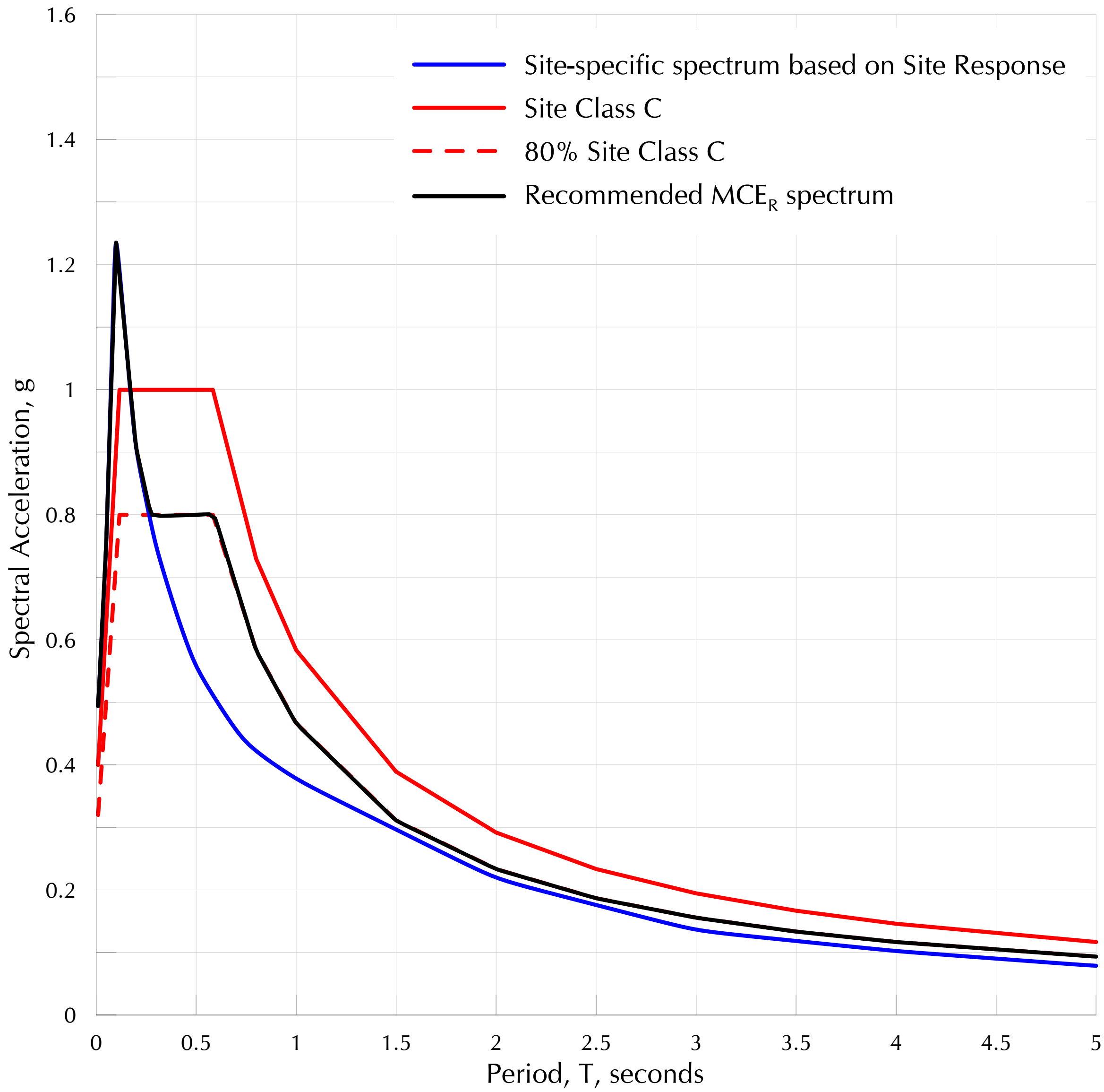
GRI

MEAN GROUND SURFACE

MCE_R SPECTRA COMPARISON

(5% DAMPING)

FEB. 2019 JOB NO. 6200 FIG. 12B



GRI

RECOMMENDED MCE$_R$ FOR MRSA & RHA
(5% DAMPING)

FEB. 2019 JOB NO. 6200 FIG. 13B

APPENDIX C

Geophysical Exploration Report, January 14, 2019, Earth Dynamics LLC

Report on Shear Wave Refraction Microtremor Analysis (ReMi)
PGE IOC
Sherwood, Oregon

Report Date: January 14, 2019

Prepared for:

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Prepared by:

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Project No. 18216

1.0 INTRODUCTION

This report presents the results of shear wave seismic explorations at the PGE IOC site near SW 124th and Tualatin-Sherwood Road in Sherwood, Oregon. The work was requested and authorized by Mr. Jack Gordon of GRI. The field work was completed by Mr. Daniel Lauer on December 28, 2018. This report describes the methodology and results of the investigation.

2.0 SCOPE OF WORK

The primary purpose of this study is to determine the subsurface shear wave velocity at the site. These data are needed to help determine the seismic response of the site to earthquake loading. The exploration consisted of two twenty-four channel refraction microtremor (ReMi) arrays. The total length of each ReMi array is 345 feet.

3.0 METHOD

The ReMi technique provides a simplified characterization of relatively large volumes of the subsurface. The method can be used to estimate one-dimensional shear wave velocity profiles and provide site-specific soil classification data as described in ASCE/SEI 7-10 (2013). In a ReMi survey, geophones are deployed at designated intervals along a linear array. The resolution and depth of investigation depends upon the cut-off frequency and spacing of the geophones and the total array length. The depth of investigation is approximately one-third of the geophone array length.

For this project, data were acquired for two ReMi arrays. Each ReMi Array consists of twenty-four 4.5 Hz geophones spaced fifteen feet apart. The geophones were installed using spikes in firm soil. More than twenty 30-second long seismic records of ambient seismic noise were recorded. Data were also acquired when vehicles, and people were moving on and near the site.

The theoretical basis of the ReMi method is the same as Spectral Analysis of Surface Waves (SASW) and Multi-channel Analysis of Surface Waves (MASW) as first described to the earthquake engineering community by Nazarian and Stokoe (1984). However, ReMi does not require a frequency controlled source and the field equipment is much more compact and economical. A complete description of the theoretical basis for ReMi is described by Louie (2001). In ReMi analysis all interpretation is done in the frequency domain, and the method assumes that the most energetic arrivals recorded are Rayleigh waves. By applying a time-domain velocity analysis, Rayleigh waves can be separated from body waves, air waves, and other coherent noise. Transforming the time-domain velocity results into the frequency domain allows combination of many arrivals over a long time period, and yields easy recognition of dispersive surface waves.

Data reduction is completed in two steps. First, the time versus amplitude seismic records are transformed into spectral energy shear wave frequency versus shear wave velocity (or slowness). The data are graphically presented in what is commonly termed a p-f plot. The interpreter determines a dispersion curve from the p-f plot by selecting the lower bound of the spectral energy shear wave velocity versus frequency trend. The second phase of the analysis consists of fitting the measured dispersion curve with a theoretical dispersion curve that is based upon a model of multiple layers with various shear wave velocities. The model velocities and layer thicknesses are adjusted until a 'best fit' to the measured data is obtained. This type of interpretation does not provide a unique model. Interpreter experience and knowledge of the existing geology is important to provide a realistic solution. The data are presented as one-dimensional velocity profiles that represent the average shear wave velocities of the subsurface layers over the length of the geophone array.

4.0 RESULTS

The approximate locations of the ReMi arrays are shown in Figure 1. The results of ReMi analyses for ReMi 1 and ReMi 2 are summarized in Figures 2 and 3 respectively. Figures 2 and 3 contain the p-f plot, the dispersion curve and the derived velocity versus depth model that best fits the geology of the site and the dispersion curve for the array.

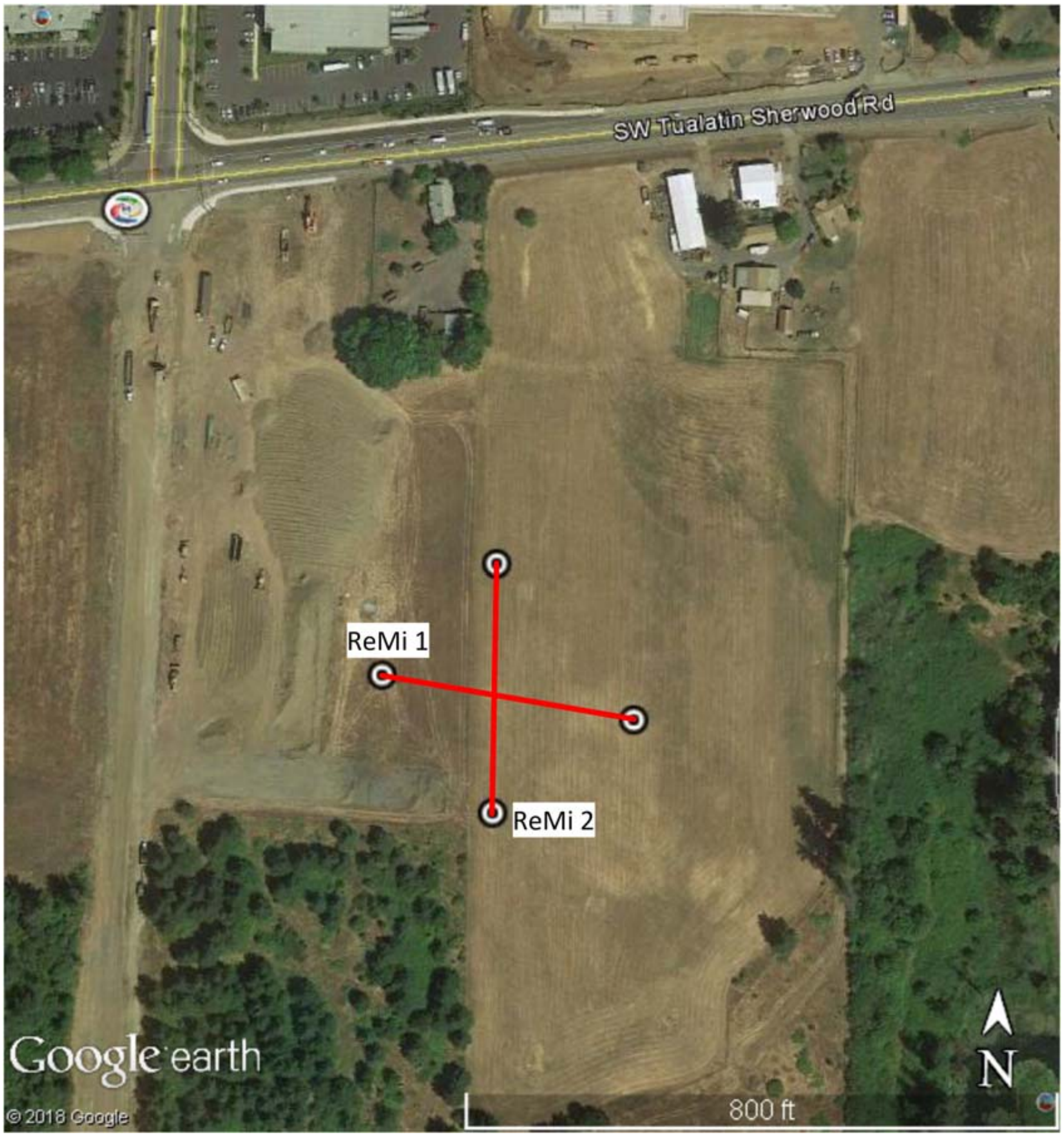


Figure 1. Site layout showing location of ReMi arrays.

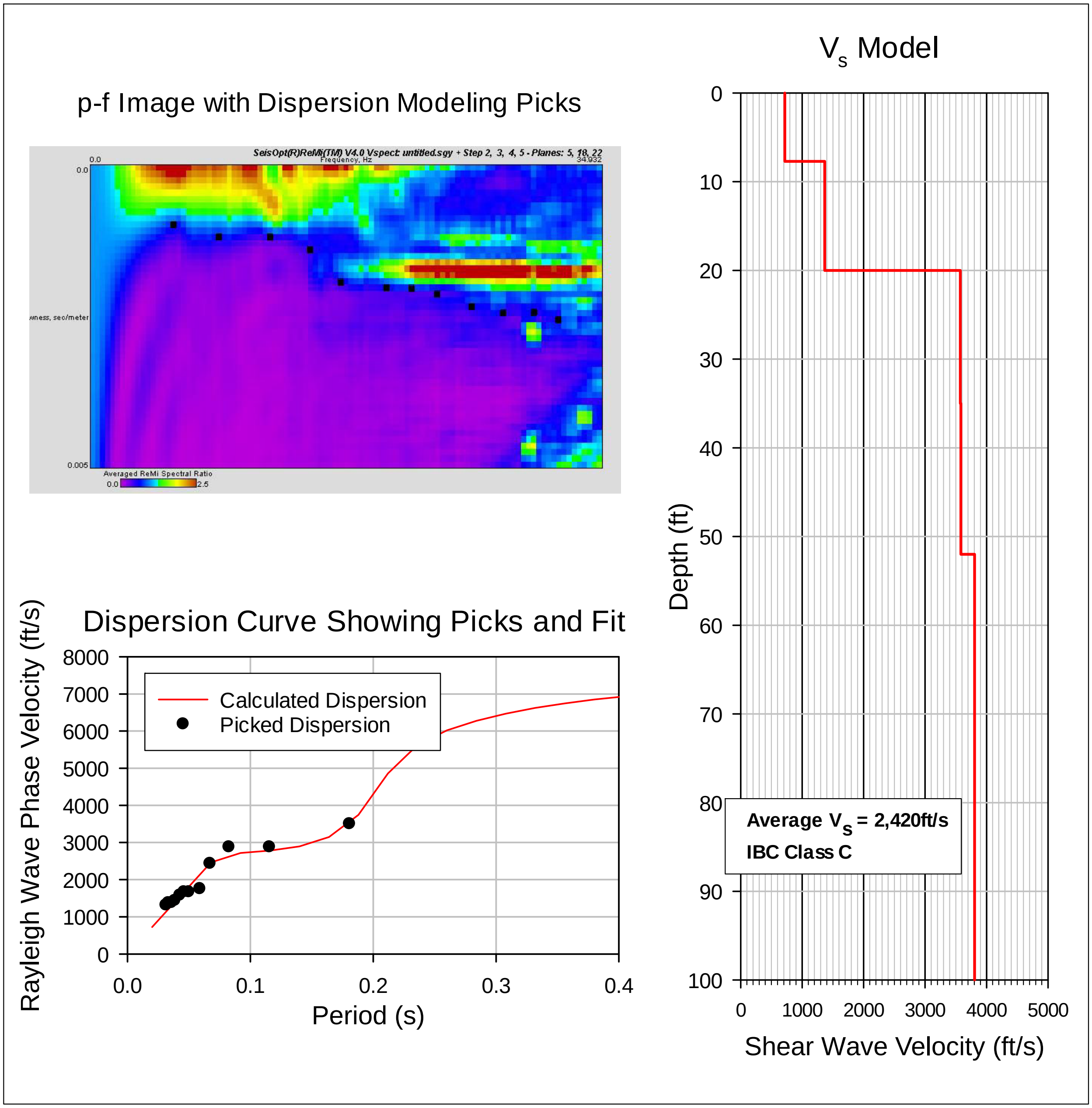


Figure 2. ReMi 1 Data.

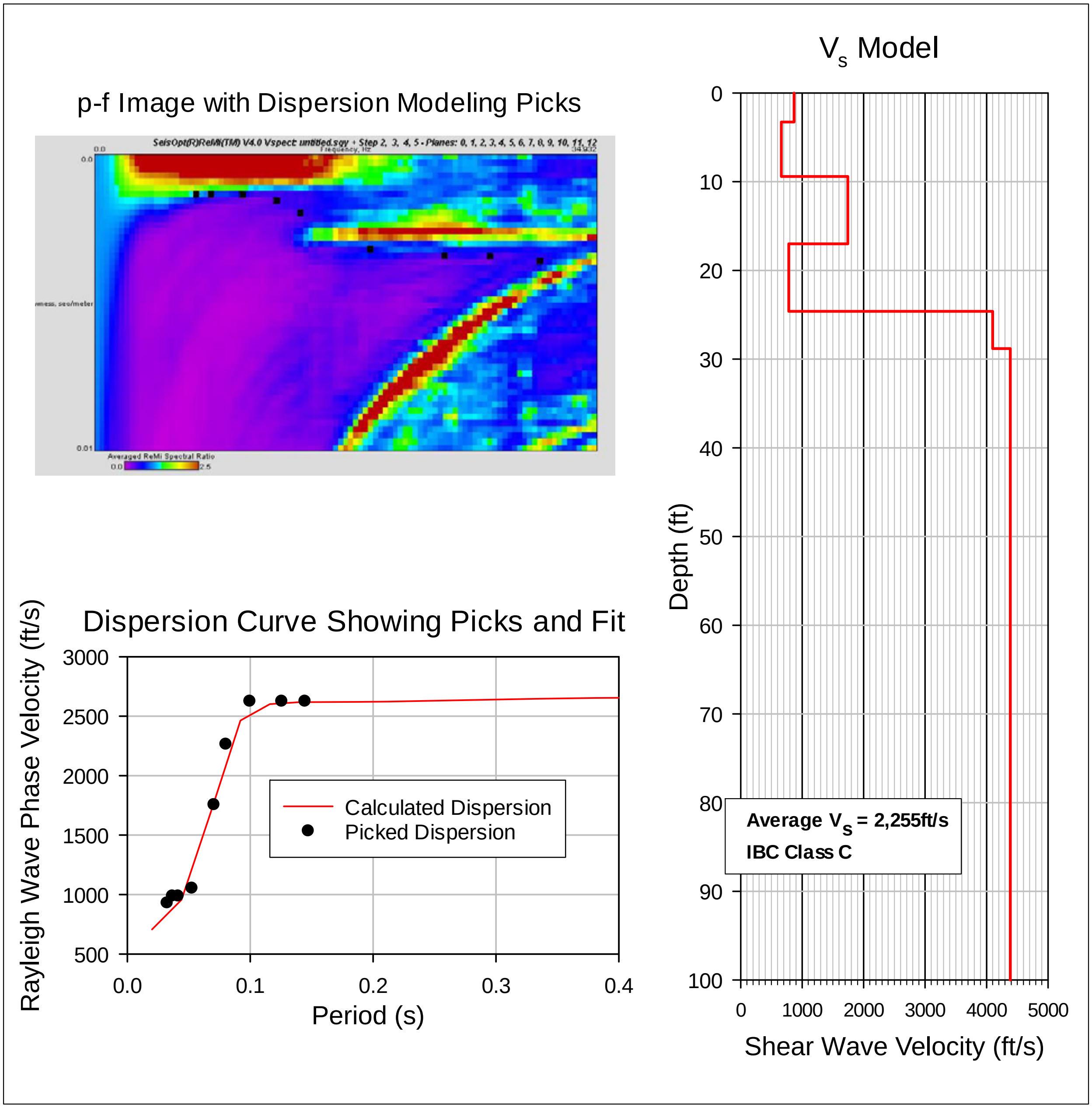


Figure 3. ReMi 2 Data.

5.0 DISCUSSION

The dispersion curve data quality for the ReMi arrays appears to be moderate. Logs from borings completed at the site indicate that the geology consists of Sandy Silt overlying Basalt. The depth to the top of Weathered Basalt appears be approximately eight feet below the ground surface (bgs) across the site. The modelled ReMi profiles both have an increase in shear wave velocity at approximately 8 feet bgs. Both models show an additional increase in shear wave velocity at a depth of approximately 20 feet bgs. The modelled average Vs(100) for the ReMi 1 is 2,420 ft/s. The modelled average Vs(100) for the ReMi 2 is 2,255 ft/s. The $V_s(100)$ value is calculated using Equation 1.

$$Vs(100) = \frac{100}{Sum\left(\frac{d}{Vs}\right)} \qquad \text{Equation 1}$$

Where:
d = the interval depth
Vs = the velocity of the interval

ASCE/SEI 7-10 (2013) defines five site classes based upon the average shear-wave velocity of the soil to a depth of 100 feet. The ASCE classification is summarized in Table 1. The classifications in Table 1 are incorporated into the International Building Code (IBC 2012) Earthquake shaking is expected to be stronger where shear-wave velocity is lower. The $V_s(100)$ corresponds to the upper bound of the IBC seismic design classification "C". The fit error between the picked and calculated dispersion curve for ReMi 1 is approximately ±185 ft/s. The fit error between the picked and calculated dispersion curve for ReMi 2 is approximately ±70 ft/s. Therefore, an IBC Classification "B" is within the model error for ReMi 1.

It should be noted that the "rule of thumb" for the ReMi technique is that the penetration depth of the survey is approximately one third of the total array length. The total array length for this survey is 345 feet. Therefore, the data should be reliable to approximately 100 feet below the ground surface.

Table 1. Summary of ASCE soil classification.

Class	Average S-wave Velocity (ft/sec)	Description
A	> 5,000	Hard rock
B	2,500 – 5,000	Rock
C	1,200 – 2,500	Very dense soil and soft rock
D	600 – 1,200	Stiff soil
E	<600	Soil

6.0 <u>LIMITATIONS</u>

The geophysical methods used in this study involve the inversion of measured data. Theoretically, the inversion process yields an infinite number of models which will fit the data. Further, many geologic materials have the same seismic velocity. We have presented models and interpretations which we believe to be the best fit given the geology and known conditions at the site. However, no warranty is made or intended by this report or by oral or written presentation of this work. Earth Dynamics accepts no responsibility for damages as a result of decisions made or actions taken based upon this report.

7.0 REFERENCES

ASCE/SEI 7-10 (2013), Minimum Design Loads for Buildings and other Structures, American Society of Civil Engineers, Structural Engineering Institute, Reston, VA.

Louie, J.N. (2001). "Faster, better: shear-wave velocity to 100 meters depth from refraction microtremor arrays", Bull. Seism. Soc. Am., 91, 347-364.

Nazarian, S., and Stokoe II, K.H., (1984), "In situ shear-wave velocities from spectral analysis of surface waves", Proceedings for the World Conference on Earthquake Engineering Vol. 8, San Francisco, Calif., July 21-28, v.3, 31-38.

IBC (2012) 2012 International Building Code , International Code Council, Washington D.C.

RESPECTFULLY SUBMITTED
EARTH DYNAMICS LLC

Daniel Lauer
Partner - Senior Geophysicist

APPENDIX D

Selecting and Scaling Ground Motions for Nonlinear Response History Analysis (RHA)

APPENDIX D

SELECTING AND SCALING GROUND MOTIONS FOR NONLINEAR RESPONSE HISTORY ANALYSIS (RHA)

GENERAL

GRI completed ground-motion development for nonlinear response history analysis (RHA) of the proposed Portland General Electric Integrated Operations Center (PGE IOC) in Tualatin, Oregon. The purpose of our study was to develop time histories for the nonlinear analysis of the base-isolated North Wing building; non-linear response history analyses are becoming more prevalent in practice in the framework of performance-based design, particularly for tall buildings, buildings with damping devices, and/or buildings with base-isolation systems. Nonlinear RHA requires selection and scaling of ground motions appropriate to the Risk-Targeted Maximum Considered Earthquake (MCE_R) hazard level. We understand selection and scaling of the appropriate time histories will be completed in accordance with Chapter 16 of the recently adopted American Society of Civil Engineers (ASCE) standard, namely the 2016 ASCE 7-16 document titled "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," which is also a reference standard for the upcoming 2019 Oregon Structural Specialty Code (2019 OSSC). The nonlinear RHA is implemented to capture the dynamic interaction of the superstructure and base-isolation system using site-specific ground motions. The MCE_R target spectrum was developed based on the site-specific ground-motion hazard analysis and site-response modeling completed at the project site (see Appendix B for details).

GROUND MOTION SELECTION

Selection and scaling of ground-motion records are integral to the successful application of nonlinear analysis. The main goal of ground-motion selection and scaling is to produce acceleration histories consistent with the ground-shaking hazard anticipated for the proposed structure at the project site. The ground-motion records should be selected from events of magnitudes, fault distances, soil conditions, and source mechanisms consistent with the earthquakes that dominate the seismic hazard at the project site. The seismic-hazard study for the site indicates the Cascadia Subduction Zone (CSZ) and crustal sources are the primary contributors to the potential seismicity of the site. Therefore, ground-motion records were selected from a large dataset of crustal and subduction-zone earthquakes. The seed (input) ground motions were obtained from the PEER-NGA-West2, COSMOS, and Kiban-Kyoshin databases.

The selection of the recorded ground motions is typically performed in two steps, as generally discussed in the commentary section of Chapter 16 of ASCE 7-16. The initial screening involves preselection of relatively liberal ranges of ground motions based on their source mechanisms, magnitudes, time-averaged shear-wave velocities to 30 m ($V_{S}30$) values, ranges of useable frequencies, and site-to-source distances. The final step involves selecting ground motions that provide good matches to a target spectrum since the shape of the response spectrum is considered the primary criteria when selecting ground motions. In accordance with Section 16.2.2 of ASCE 7-16, the use of a suite of 11 ground motions is recommended for nonlinear RHA to achieve a more-reliable estimate of structural response. Each set of ground motions typically comprises a pair of orthogonal horizontal components. For near-fault sites where directivity effects are considered significant, the selected ground motions are required to include a number of pulse-like ground motions consistent with the hazard contribution. A near-fault site is defined in Section 11.4.1of ASCE 7-16 as a site within 15 km of the surface projection of a known active fault capable of producing moment magnitude (M_W) 7.0 or larger events.

Based on our review of the project-specific Probabilistic Seismic Hazard Analysis (PSHA) performed and discussed in Appendix B, the hazard at the site is largely controlled by the CSZ and various shallow crustal faults, including regional, gridded seismicity. Of the shallow crustal sources, the controlling deterministic event is the Portland Hills fault (represents approximately 6% of the hazard at the site), which is located approximately 14.5 km from the project site and therefore is one of the seismic sources significantly contributing to the probabilistic seismicity of the site. The Portland Hills fault is a northwest-striking, reverse-oblique fault with a characteristic M_W of 7.0. The ground motions considered for time-history analyses were obtained from the PEER local crustal ground-motion database and are generally consistent in magnitude, fault distance, and mechanism with the Portland Hills fault. The selected crustal ground motions consist of pairs of horizontal components for the 1992 Cape Mendocino, 1994 Northridge, 1999 Chi-Chi, 2007 Chuetsu-oki, and 2008 Iwate records. Because of the proximity of the site to the CSZ, the other seismic source that controls the seismicity at the site is a CSZ event with a potential to produce earthquakes of M_W 8.0 to 9.0. Therefore, ground motions were selected from subduction events with magnitudes between 8.0 and 9.0, including two of the most-recent, large, subduction-zone earthquakes (i.e., 2010 Maule and 2011 Tohoku). In addition, subduction-zone motions were selected from the 2003 Hokkaido and 1985 Michoacan earthquakes. A summary of the selected time histories for RHA is provided in Table 1D. The time histories include five pairs of crustal motions and six pairs of subduction-zone motions.

Table 1D: SUMMARY OF GROUND MOTION RECORDS SELECTED FOR RESPONSE HISTORY ANALYSES

No.	Earthquake/Year	Mag. Mw	Station Name	Record Source	Record ID	Rrup (km)	Vs30 (m/sec)	Sampling Frequency, Hz	Scaling Factor
1	Tohoku/2011	9.0	Taiwa	KNET	MYG009EW MYG009NS	183	537	100	1.00
2	Tohoku/2011	9.0	Ukita	KNET	TKY026EW TKY026NS	374	N/A	100	1.50
3	Tohoku/2011	9.0	Sawara	KNET	CHB004EW CHB004NS	316	>325	100	1.40
4	Hokkaido/2003	8.3	Nukabira	KNET	HKD093EW HKD093NS	171	>340	100	2.90
5	Maule/2010	8.8	Talca	UCS	TalcaEW TalcaNS	113	598	200	1.10
6	Michoacan/1985	8.1	La Union	UNR	LaUnionEW LaUnionNS	84	N/A	200	2.00
7	Cape Mendocino/1992	7.0	Loleta Fire Station	PEER	CAPEMEND_LFS270 CAPEMEND_LFS360	26	515	200	1.20
8	*Northridge/1994	6.7	Sunland - Mt Gleason Ave	PEER	NORTHR_GLE170 NORTHR_GLE260	13	402	100	2.75
9	Chi-Chi/1999	7.6	CHY046	PEER	CHICHI_CHY046E CHICHI_CHY046N	24	442	200	1.50
10	Chuetsu-oki/2007	6.8	Matsushiro Tokamachi	PEER	CHUETSU_65006EW CHUETSU_65006NS	25	640	100	2.60
11	Iwate/2008	6.9	Yuzawa	PEER	IWATE_44BC1EW IWATE_44BC1NS	25.6	655	100	1.95

GROUND MOTION MODIFICATION

Nonlinear RHA is generally performed at the MCE_R ground-motion level. Therefore, the selected ground motions were scaled to match the previously developed MCE_R target spectrum (see Appendix B for details) over the period range that dominates the structure's dynamic response. ASCE 7-16 requires ground motions for seismically isolated structures designed in accordance with Chapter 17 to be scaled in a period range of $0.75T_M$ to $1.25T_M$, where T_M is the effective fundamental period of the building under MCE_R loading. ASCE 7-16 Chapter 16 further stipulates the lower bound on the period range of interest captures at least 90% mass participation. Based on discussions with the structural design team, T_Ms of the base-isolated system are expected to be approximately 2.0 and 3.5 sec under upper- and lower-bound isolation-system properties, respectively. Therefore, the period range utilized for ground-motion scaling is between 1.5 and 4.5 sec.

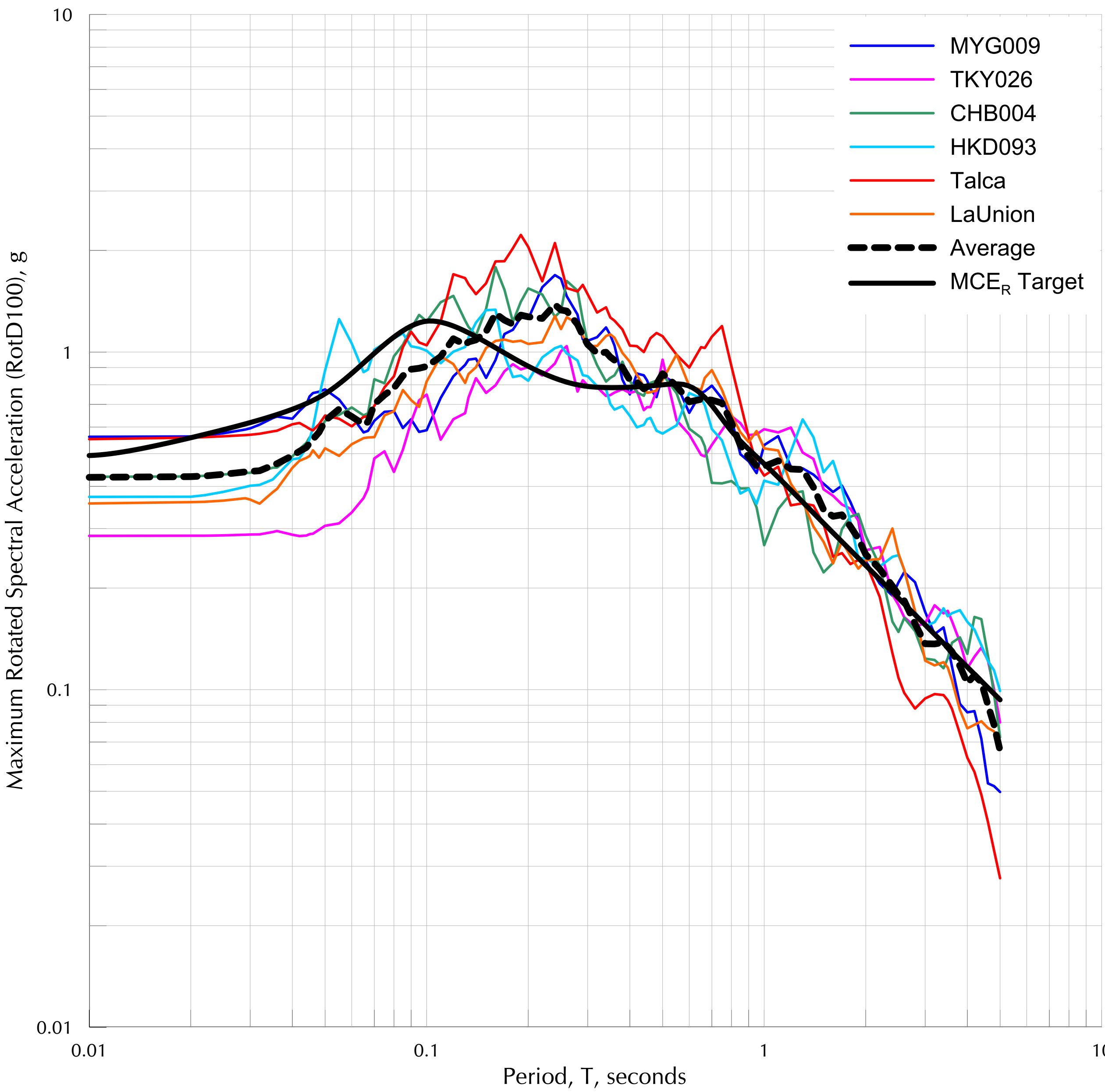
In ASCE 7-16, the MCE_R target spectrum is defined to be a maximum direction spectrum. Therefore, when the ground motions are scaled to the MCE_R target spectrum, the maximum direction spectral acceleration spectrum is scaled to match the MCE_R target spectrum over the period range of interest. The maximum spectral acceleration ($Sa_{RotD100}$) represents the maximum value of response spectra over all orientations at each period (Boore et al., 2006; Boore, 2010). Boore (2010) presents an efficient approach to compute the maximum spectral acceleration ($Sa_{RotD100}$) by a linear combination of the two-dimensional (2D) horizontal ground motions. This approach was adopted for the project. The ground-motion modifications were completed by employing amplitude scaling since the method preserves the frequency characteristics of the original ground motion. The amplitude-scaling process involves selecting a single scaling factor for each time history and multiplying the entire acceleration time history by this factor, so its response spectrum approximates the MCE_R target spectrum over the period range of interest. In general, ASCE 7-16 recommends each of the ground-motion time histories be scaled with an identical scale factor applied to both horizontal components such that the average of the maximum-direction spectra from all ground motions generally matches the MCE_R target response spectrum at any period within the period range of interest. Moreover, the code necessitates the average of the maximum-direction spectra from all the ground motions not fall below 90% of the MCE_R target response spectrum over the period range of interest. Therefore, the previously selected ground motions were modified in accordance with the requirements of ASCE 7-16, and the scaling factors are summarized in Table 1D. The scaling factors were limited to a range of 0.25 to 4.00. Figures 1D and 2D show comparisons of the amplitude-scaled maximum-direction spectra ($Sa_{RotD100}$) subduction-zone and crustal records, respectively. The time histories (acceleration, velocity, and displacement), spectral plots (pseudo-acceleration, pseudo-velocity, and displacement), and Arias-intensity plots for each of the scaled ground-motion records are provided on Figures 3D through 24D. The draft amplitude-scaled time histories have been provided digitally to the structural design team. Due to variations in the records, we recommend using all 11 pairs of ground motions for nonlinear RHA to capture the variability in frequency content and significant duration of the individual record pairs.

References

American Society of Civil Engineers, 2016, ASCE 7-16, Minimum design loads and associated criteria for buildings and other structures, ASCE, Reston, Virginia.

Boore, D. M., Watson-Lamprey, J., and Abrahamson, N.A., 2006, Orientation-independent measures of ground motion: Bulletin of the Seismological Society of America, v. 96, no. 4A, pp. 1502–1511.

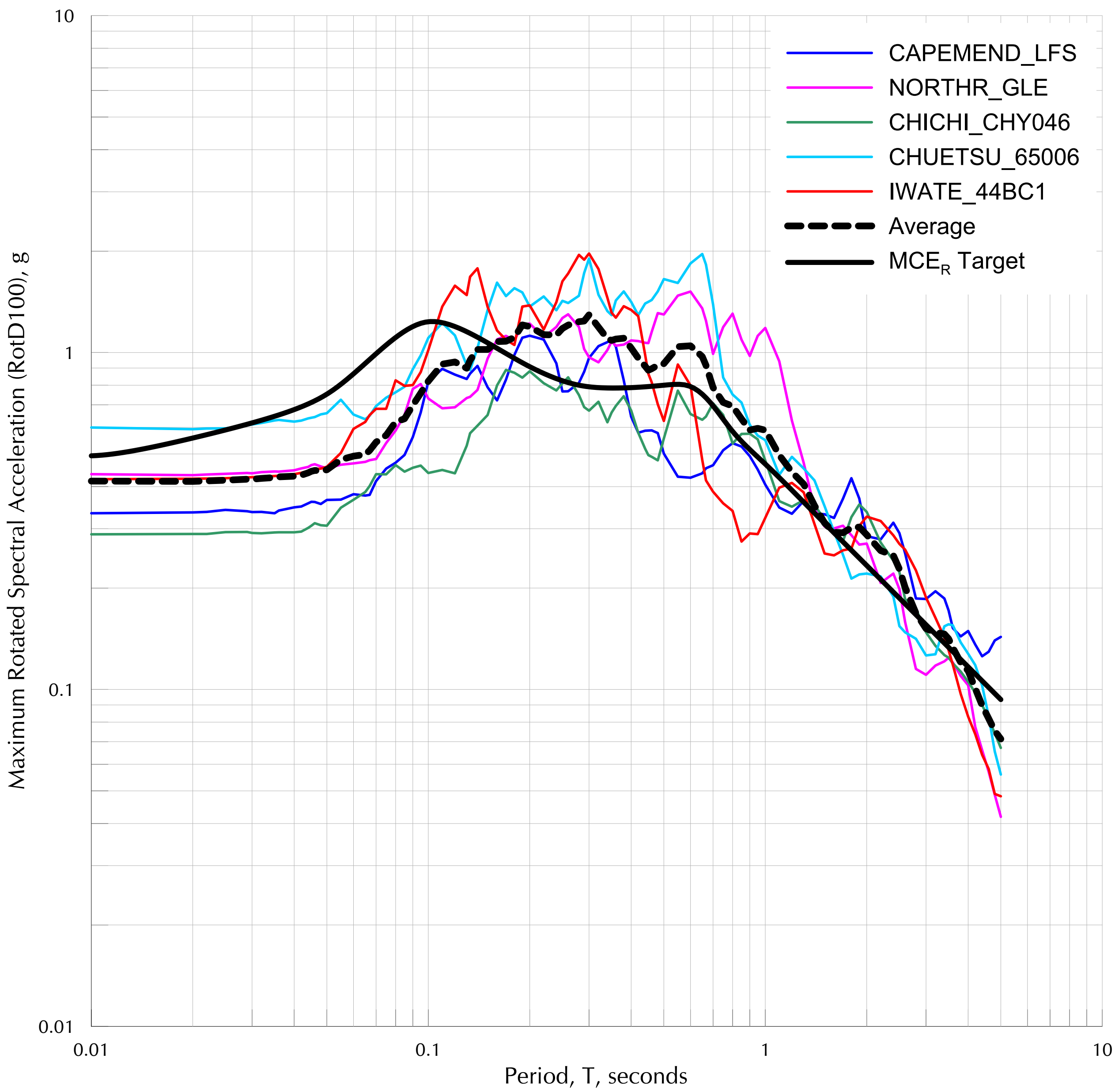
Boore, D. M., 2010, Orientation-independent, nongeometric-mean measures of seismic intensity from two horizontal components of motion: Bulletin of the Seismological Society of America, v. 100, no. 4, pp. 1830–1835.



GRI

COMPARISON AMPLITUDE-SCALED RotD100 CSZ
RECORDS AND THE MCE$_R$ TARGET SPECTRA
(5% DAMPING)

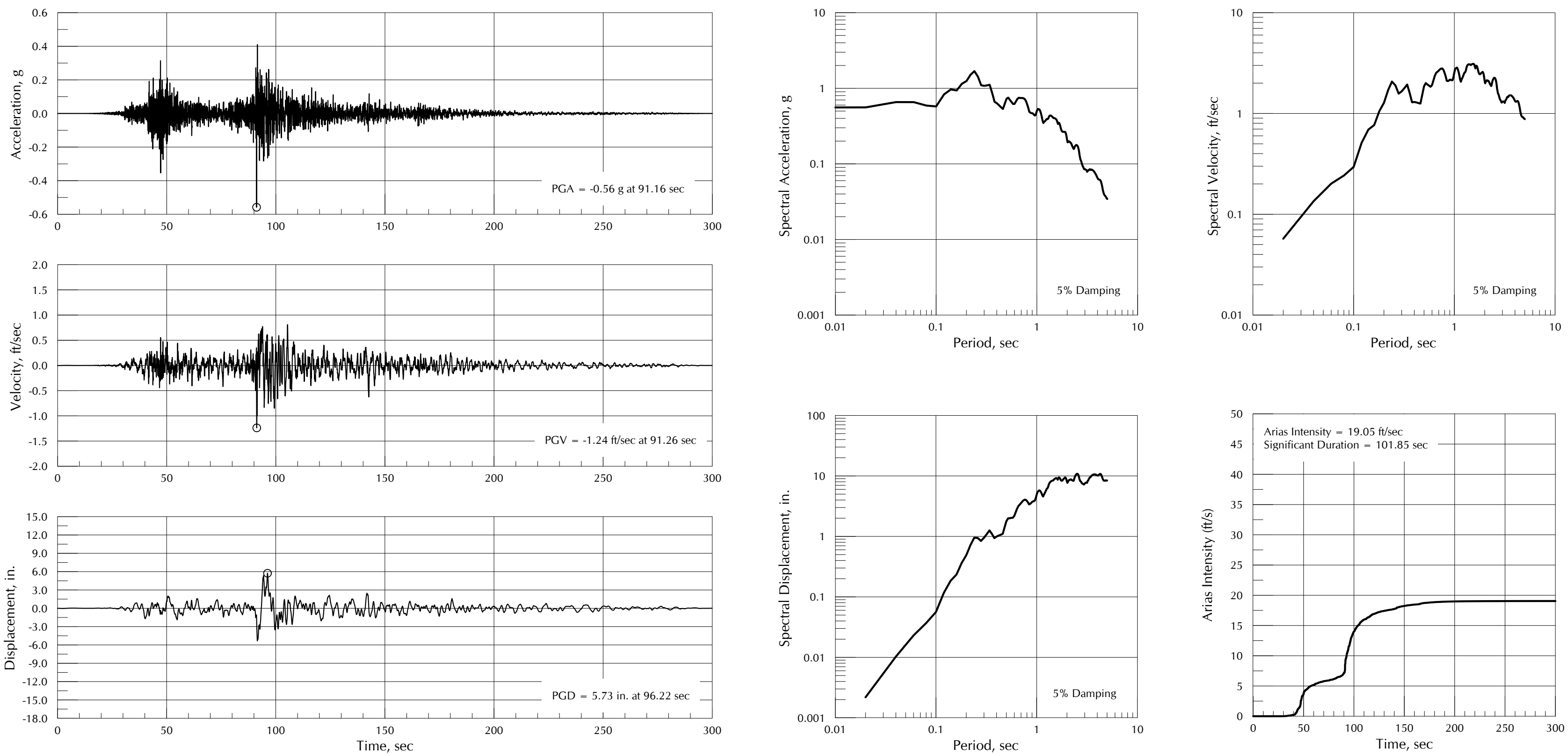
MAR. 2019 | JOB NO. 6200 | FIG. 1D



GRI

COMPARISON OF THE AMPLITUDE-SCALED RotD100
CRUSTAL RECORDS & MCER TARGET SPECTRA
(5% DAMPING)

MAR. 2019 | JOB NO. 6200 | FIG. 2D

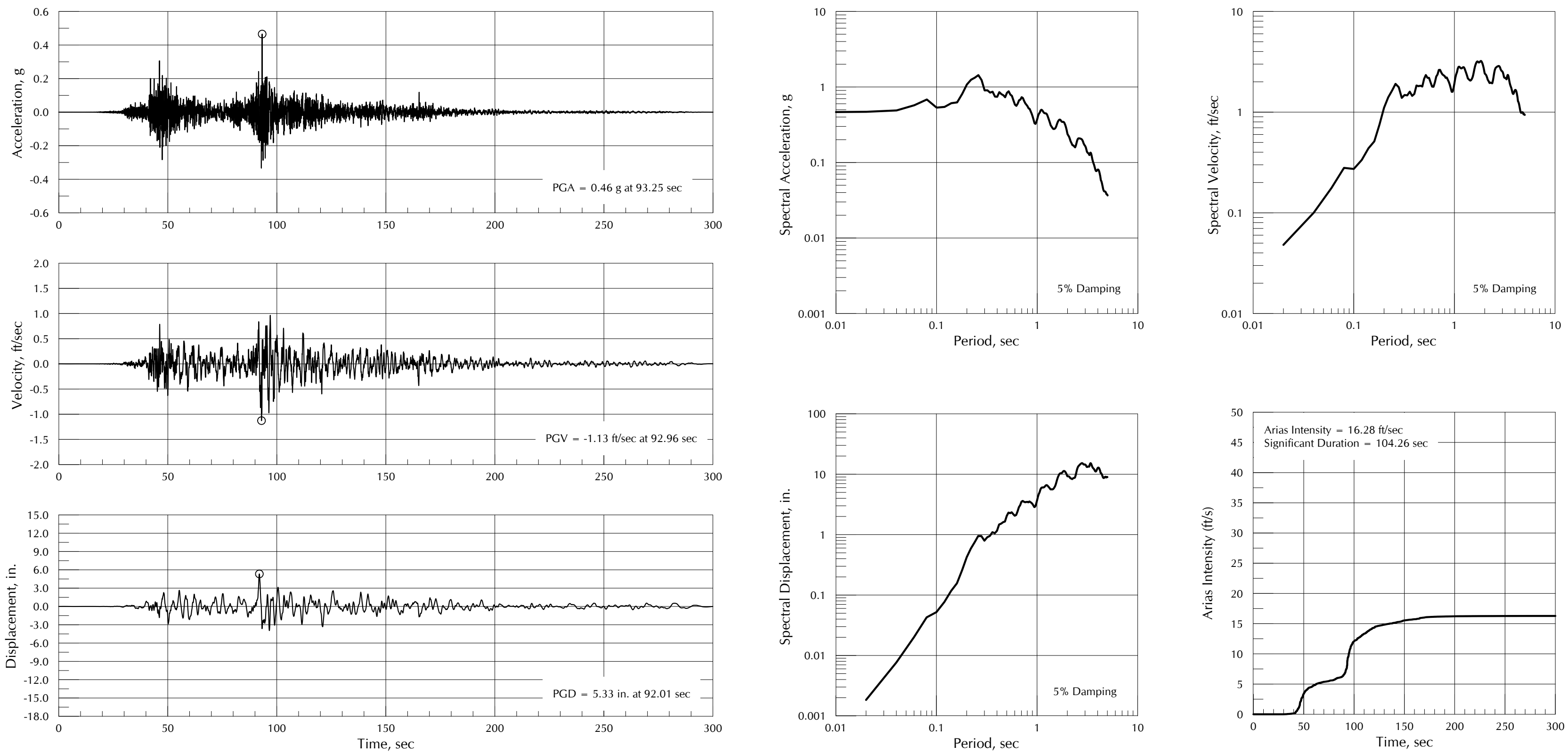


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
MYG009 EW GROUND MOTION
(TOHOKU 2011)

MAR. 2019 JOB NO. 6200 FIG. 3D

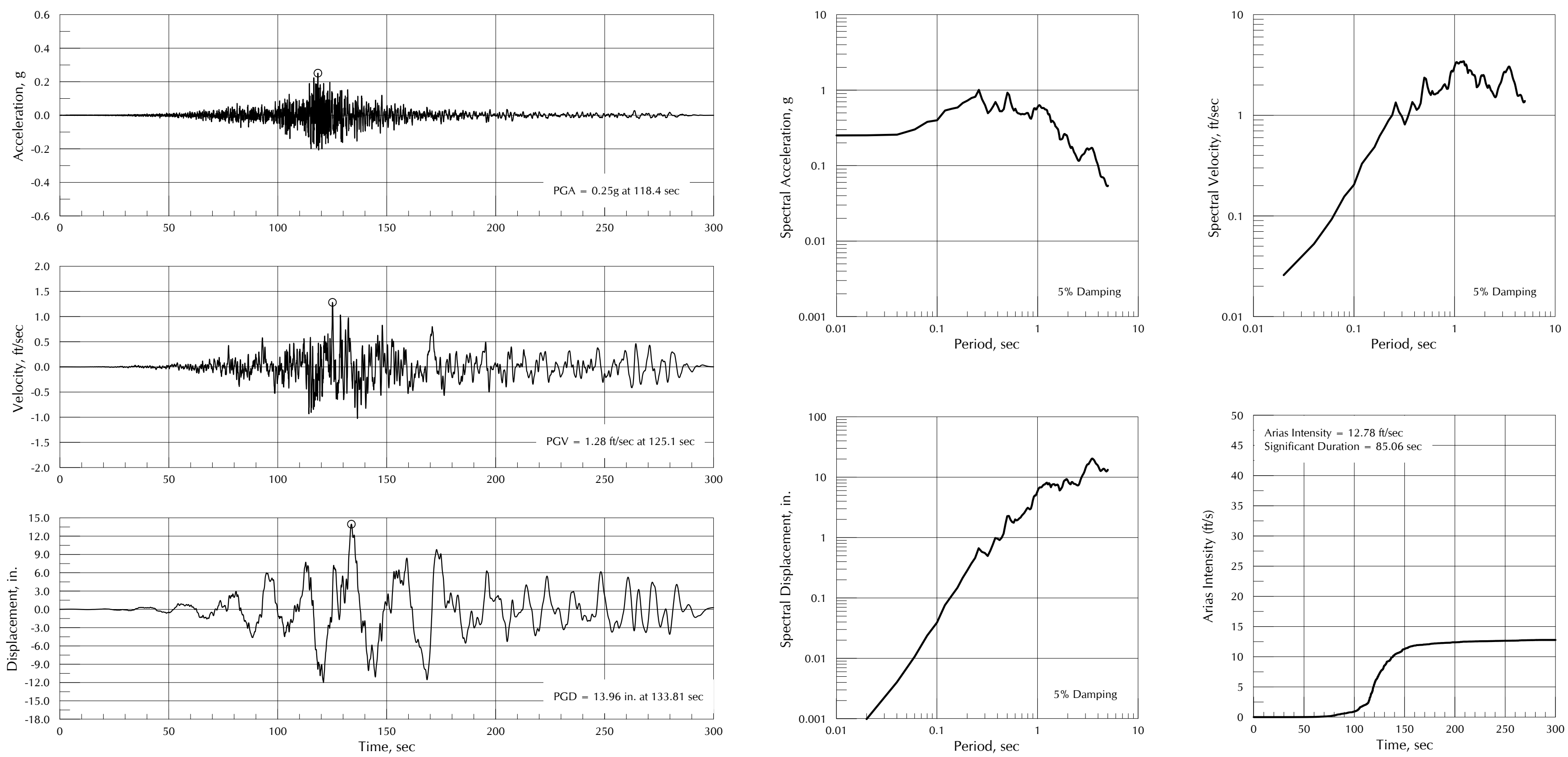


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
MYG009 NS GROUND MOTION
(TOHOKU 2011)

MAR. 2019 JOB NO. 6200 FIG. 4D

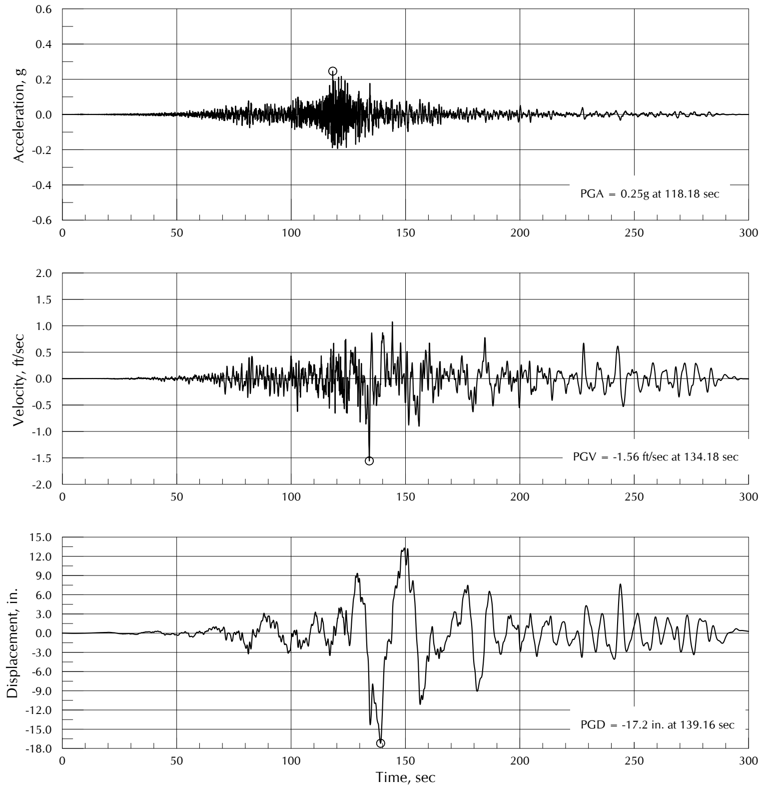


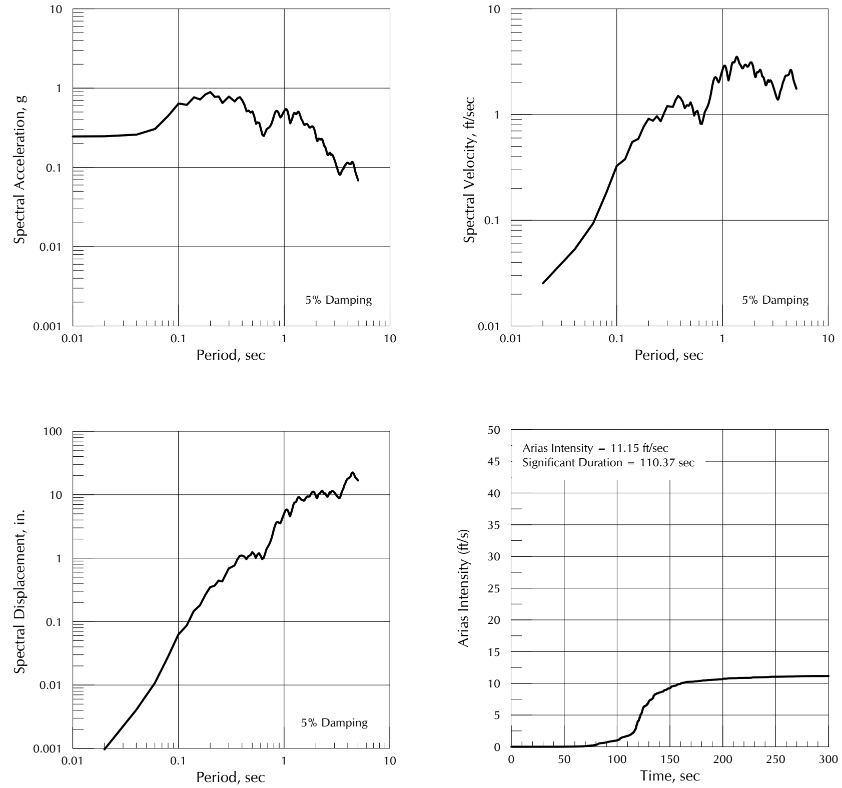
The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
TKY026 EW GROUND MOTION
(TOHOKU 2011)

MAR. 2019 | JOB NO. 6200 | FIG. 5D



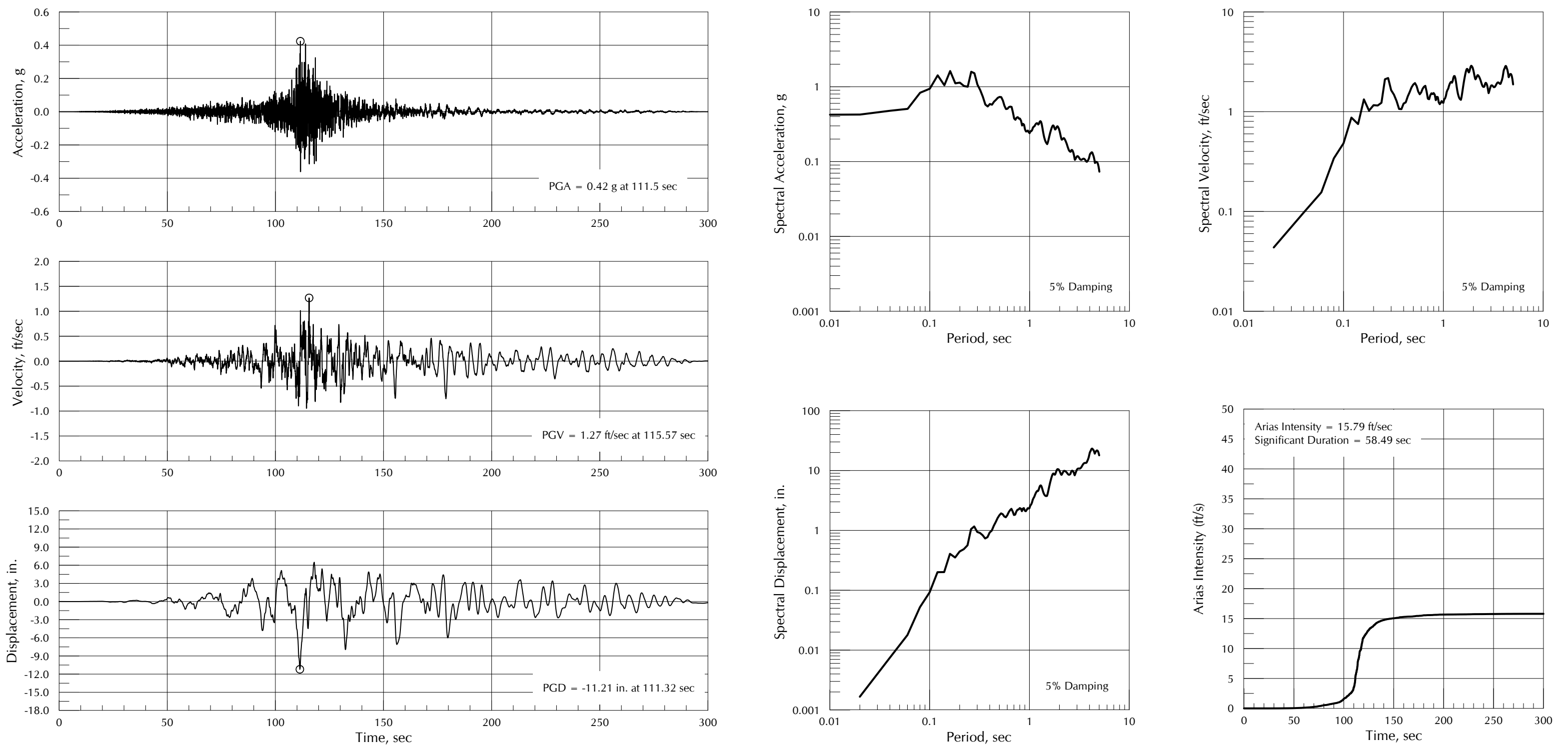


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
TKY026 NS GROUND MOTION
(TOHOKU 2011)

MAR. 2019 | JOB NO. 6200 | FIG. 6D

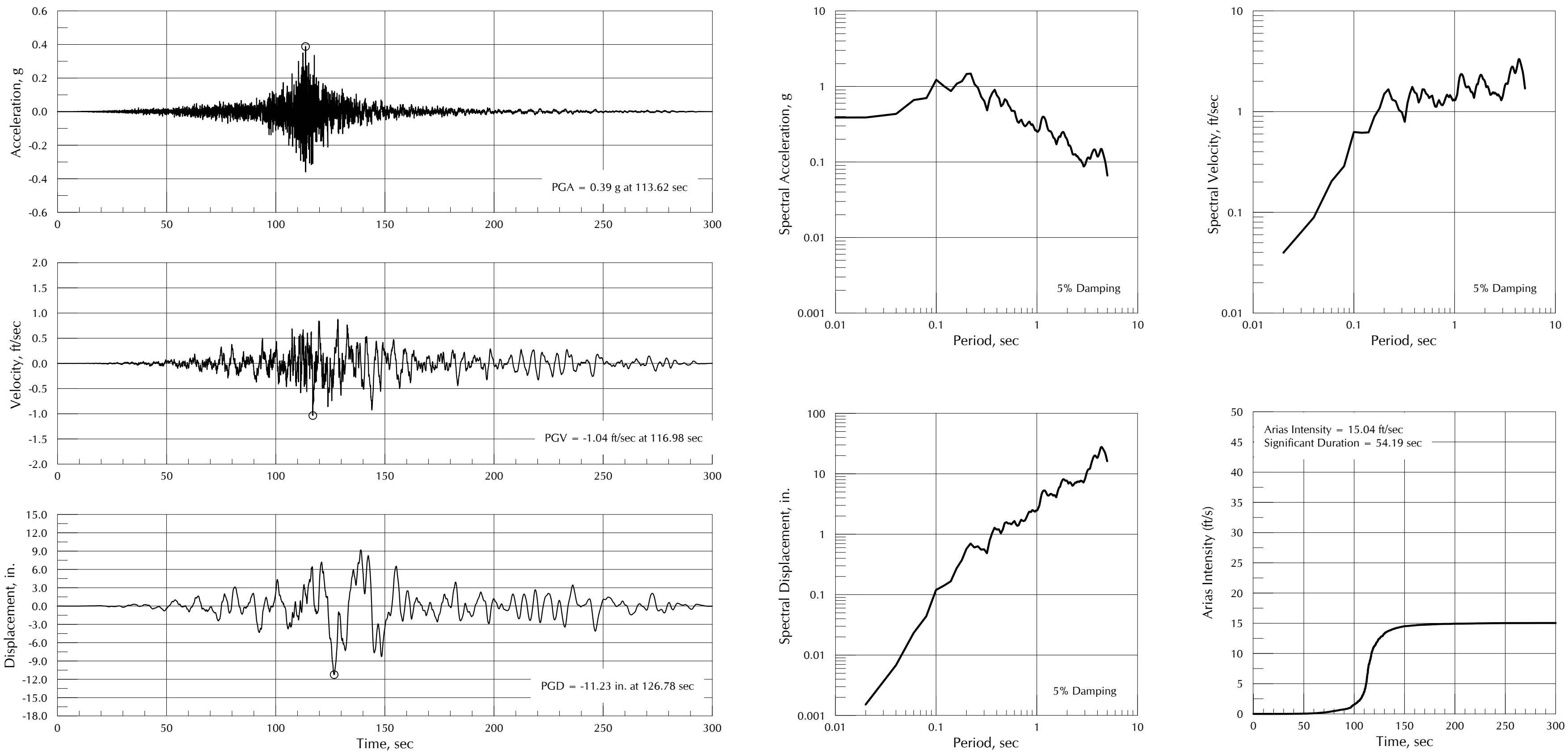


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
CHB004 EW GROUND MOTION
(TOHOKU 2011)

MAR. 2019 | JOB NO. 6200 | FIG. 7D

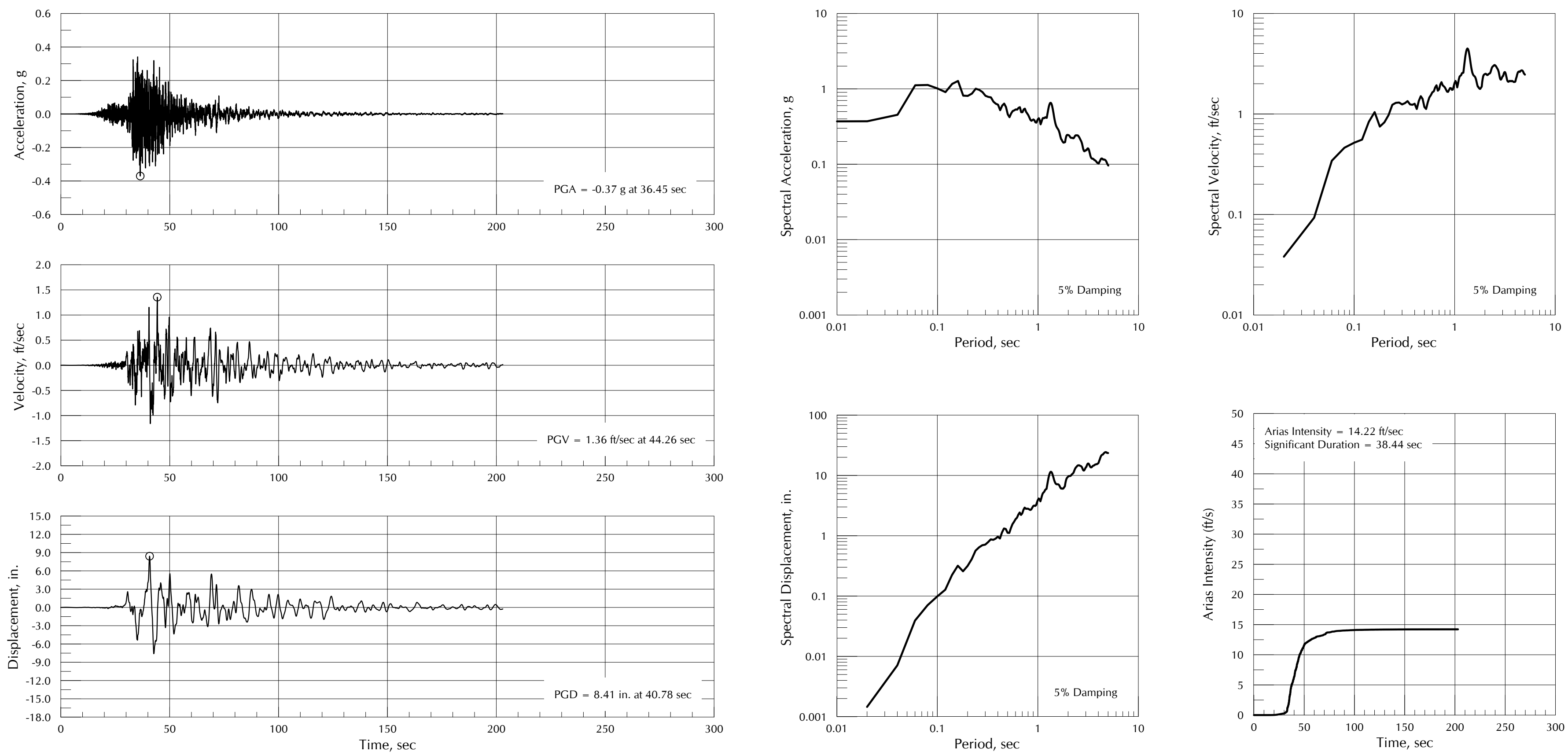


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
CHB004 NS GROUND MOTION
(TOHOKU 2011)

MAR. 2019 | JOB NO. 6200 | FIG. 8D

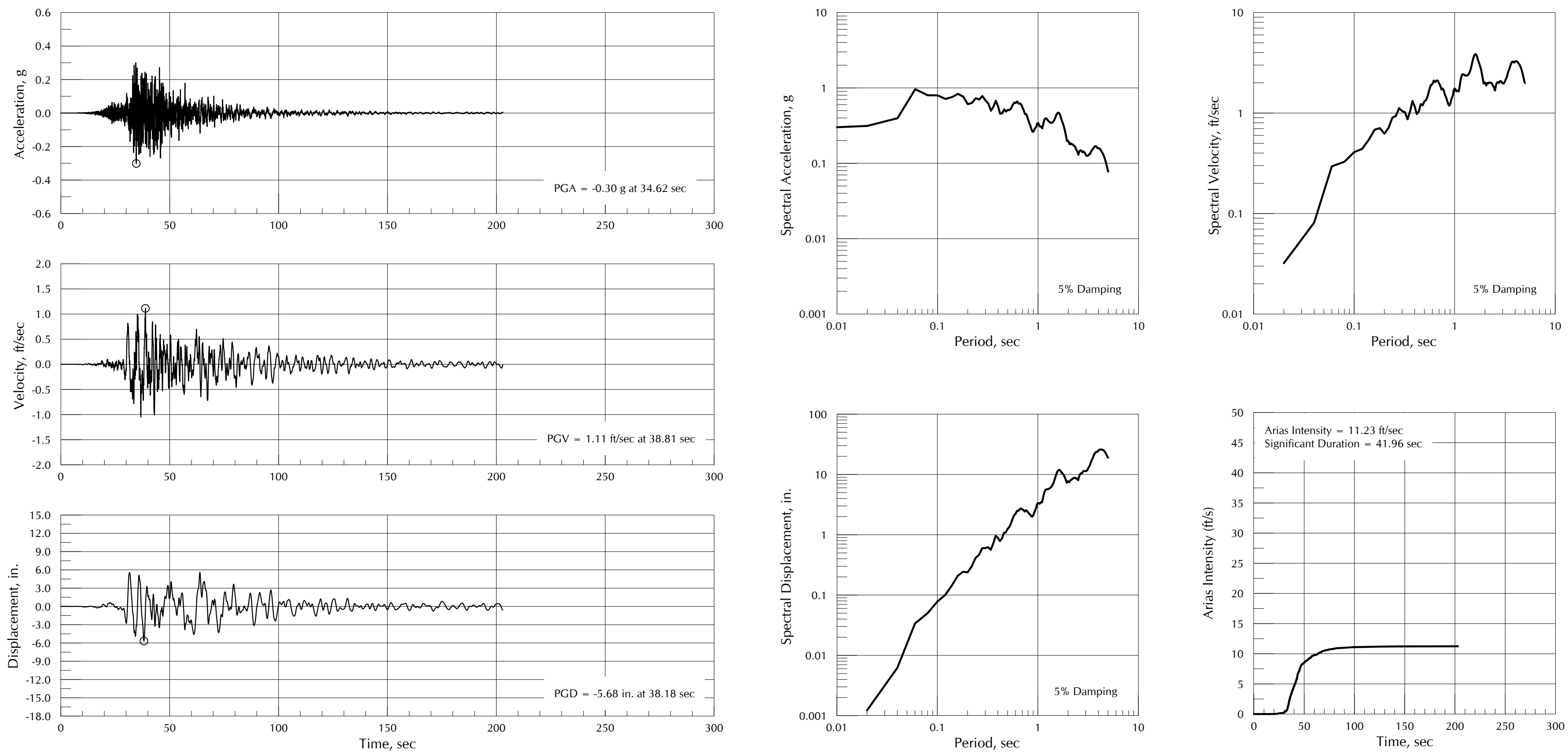


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
HKD093 EW GROUND MOTION
(TOHOKU 2011)

MAR. 2019 JOB NO. 6200 FIG. 9D

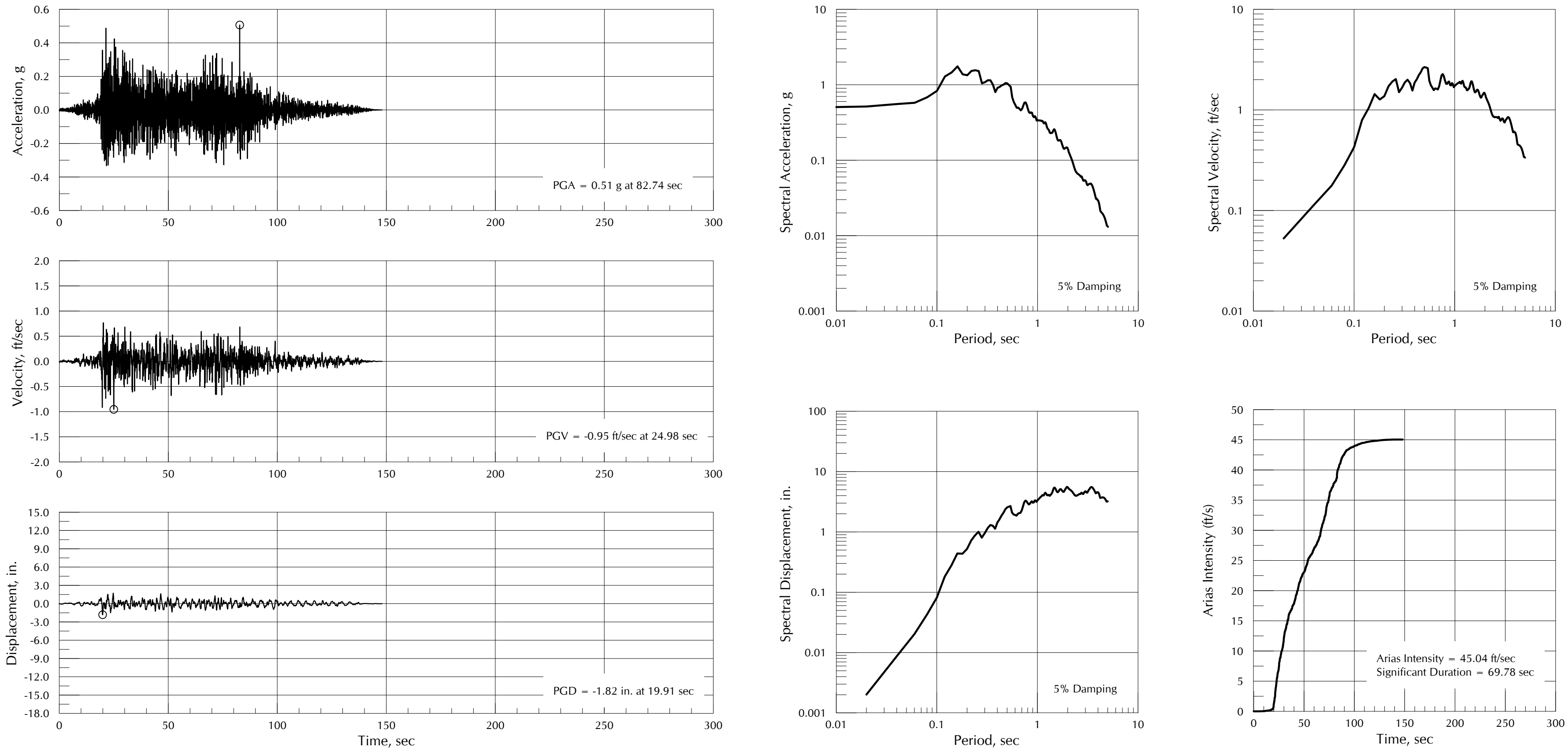


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
HKD093 NS GROUND MOTION
(TOHOKU 2011)

MAR. 2019 | JOB NO. 6200 | FIG. 10D

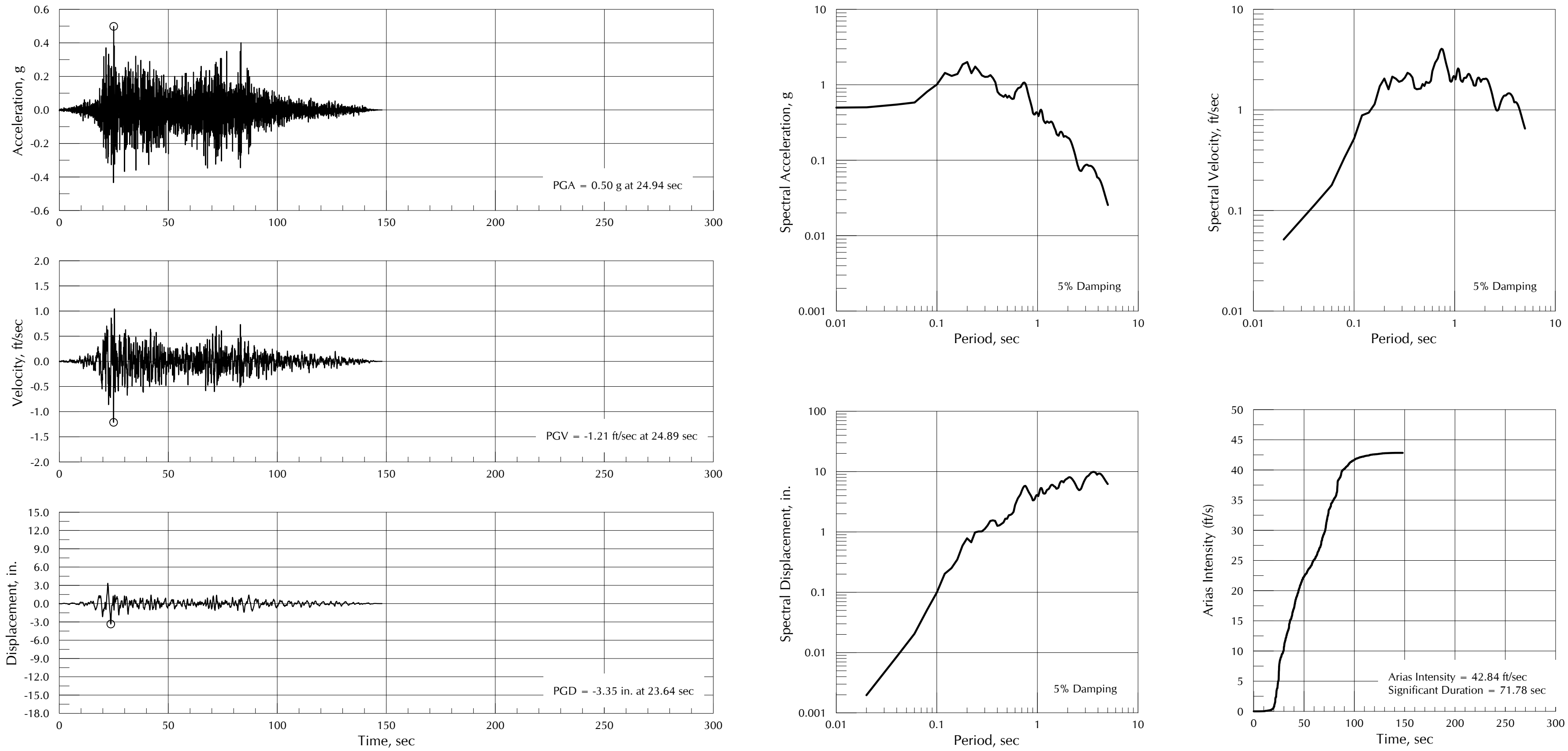


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
TALCA EW GROUND MOTION
(MAULE 2010)

MAR. 2019 | JOB NO. 6200 | FIG. 11D

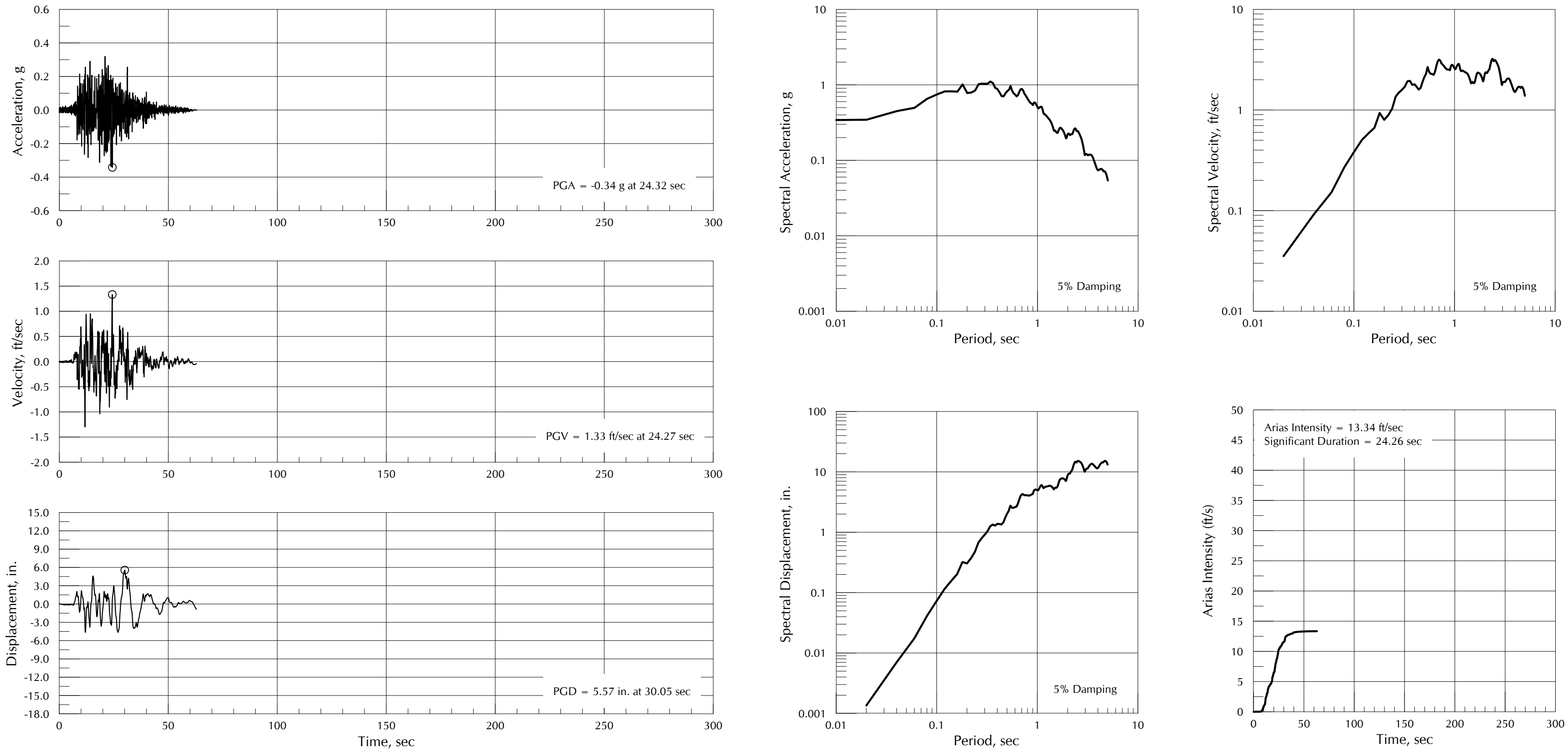


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
TALCA NS GROUND MOTION
(MAULE 2010)

MAR. 2019 | JOB NO. 6200 | FIG. 12D

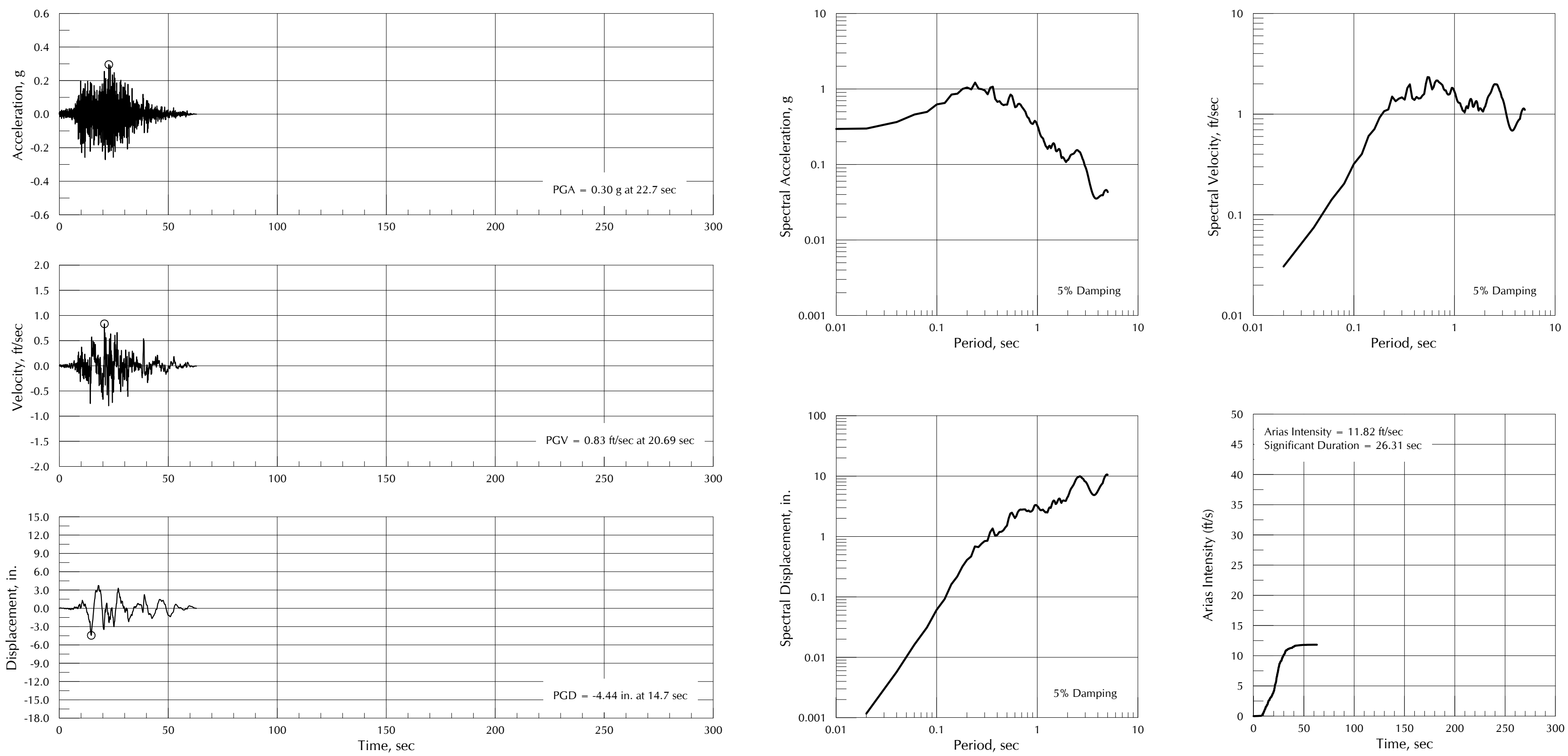


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
LA UNION EW GROUND MOTION
(MICHOACAN 1985)

MAR. 2019 | JOB NO. 6200 | FIG. 13D

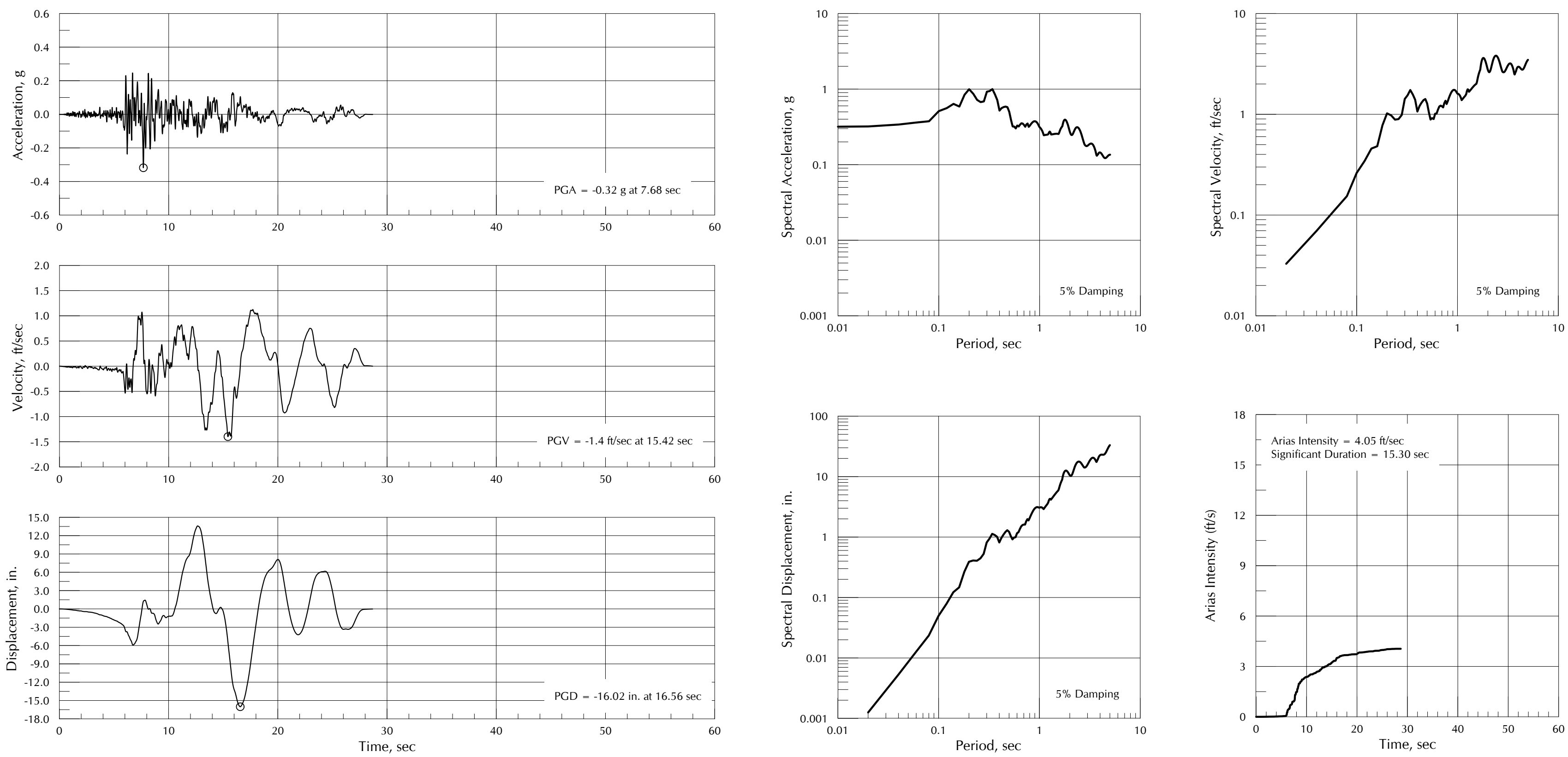


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
LA UNION NS GROUND MOTION
(MICHOACAN 1985)

MAR. 2019 JOB NO. 6200 FIG. 14D

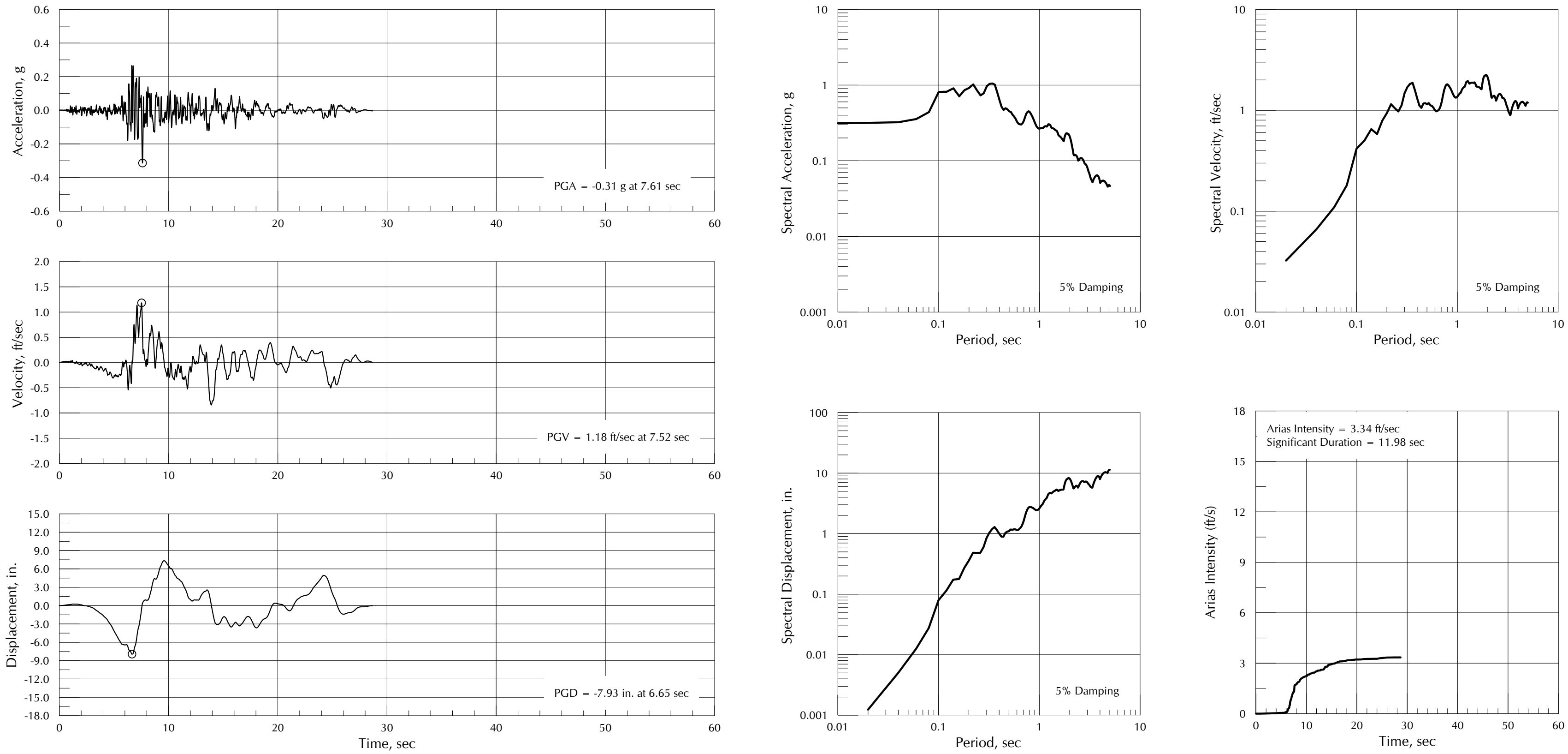


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
LOLETA FIRE STATION 270 GROUND MOTION
(CAPE MENDOCINO 1992)

MAR. 2019 JOB NO. 6200 FIG. 15D

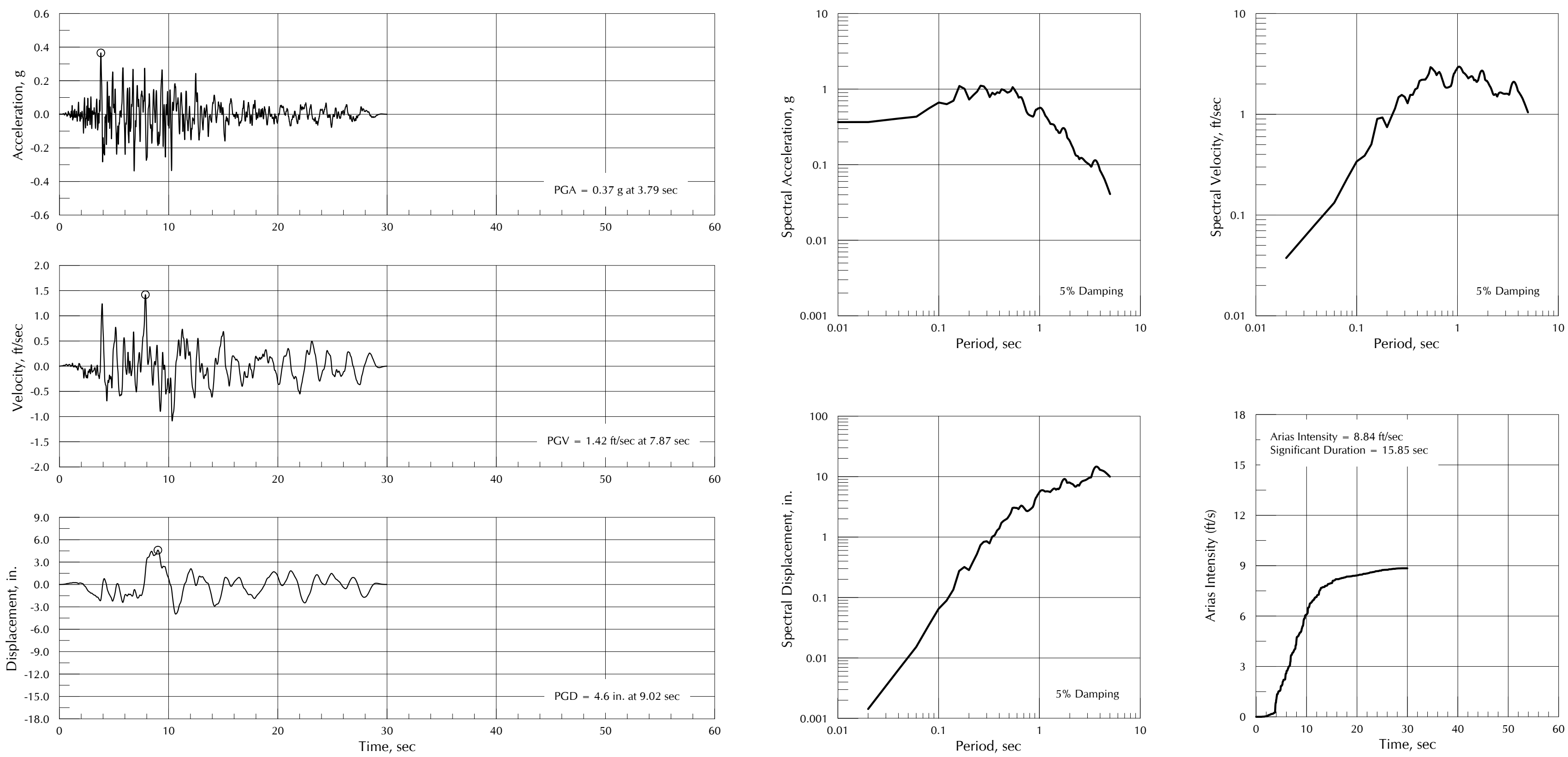


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
LOLETA FIRE STATION 360 GROUND MOTION
(CAPE MENDOCINO 1992)

MAR. 2019 | JOB NO. 6200 | FIG. 16D

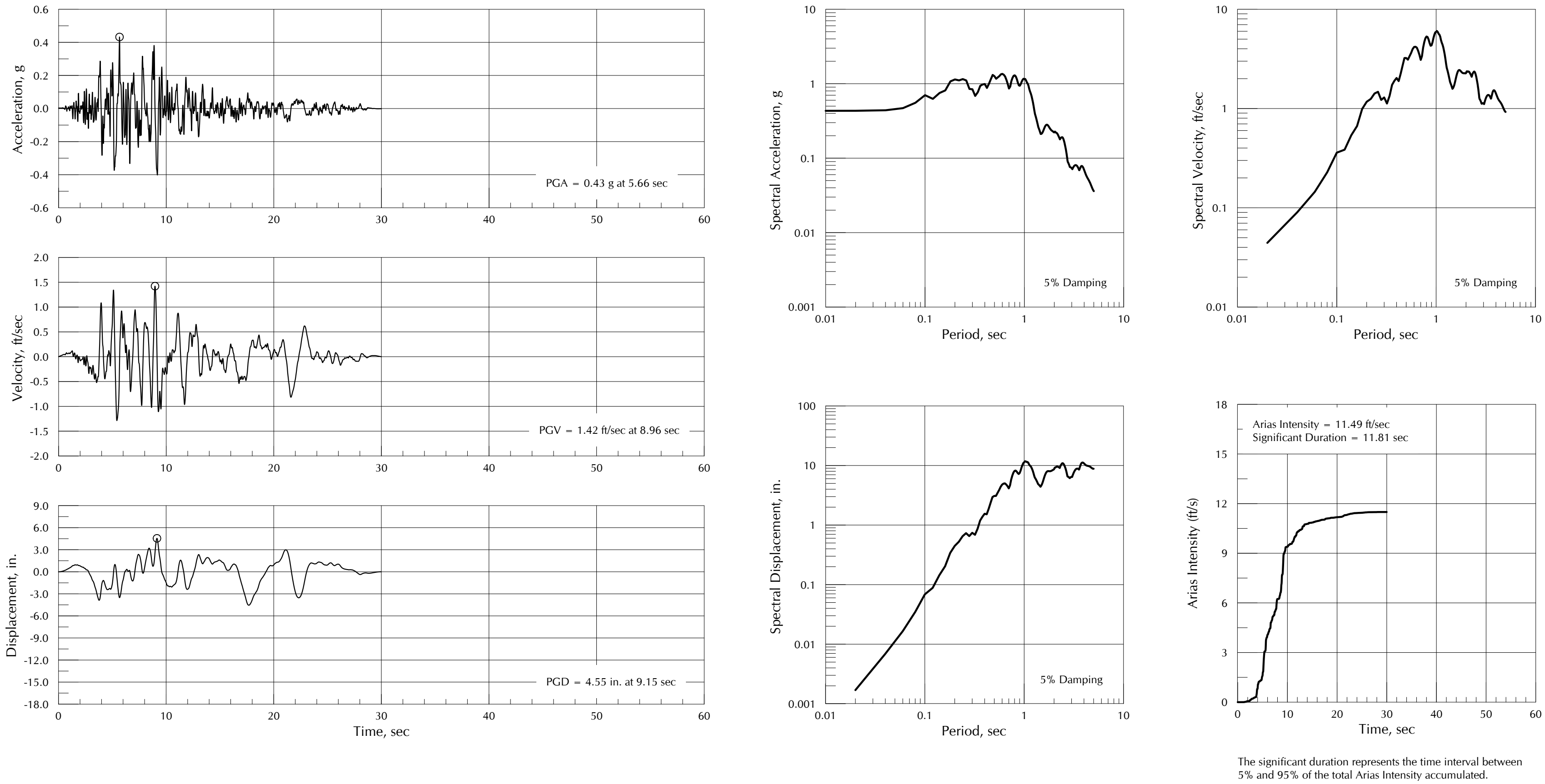


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
SUNLAND - MT GLEASON AVE 170 GROUND MOTION
(NORTHRIDGE 1994)

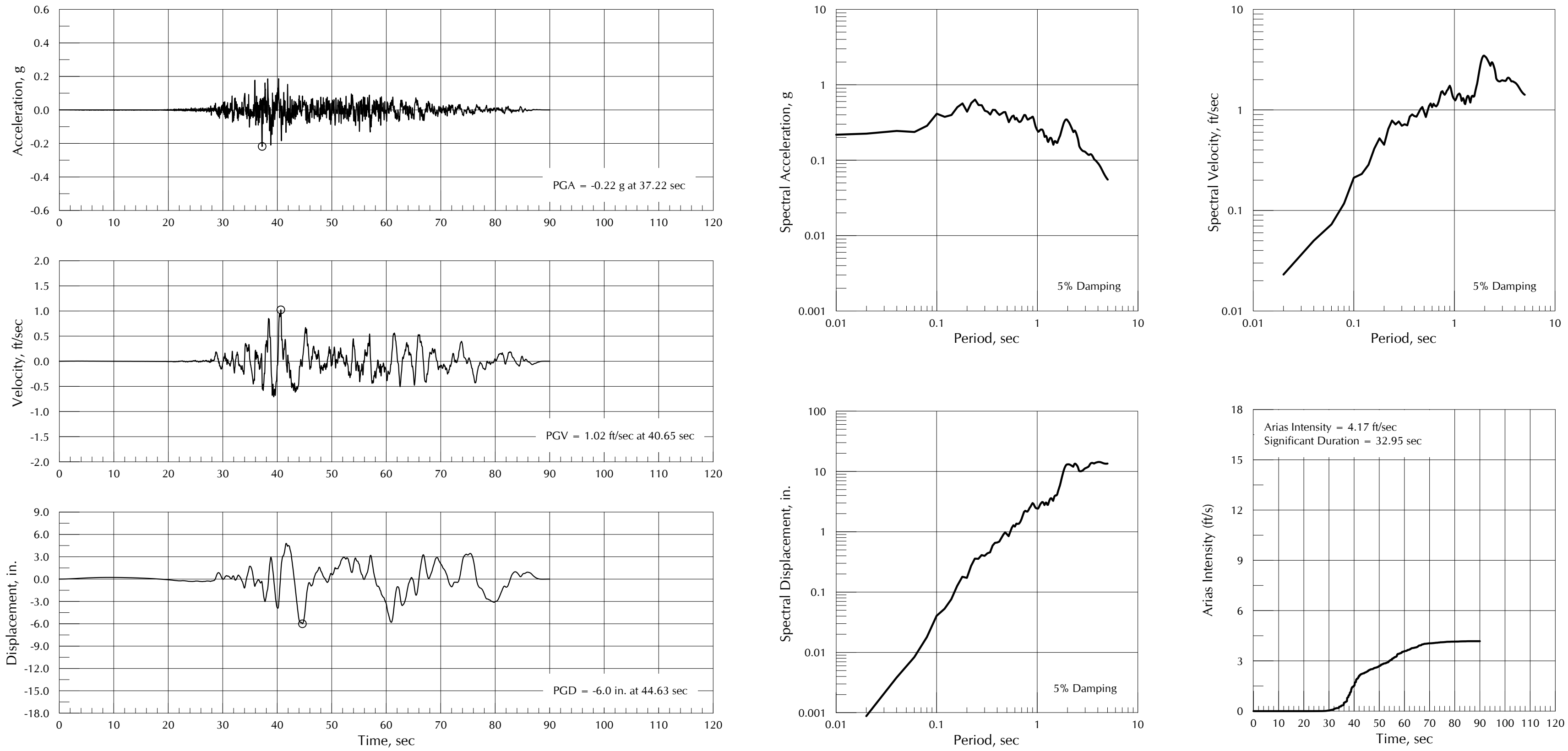
MAR. 2019 | JOB NO. 6200 | FIG. 17D



GRI

SCALED TIME HISTORIES
SUNLAND - MT GLEASON AVE 260 GROUND MOTION
(NORTHRIDGE 1994)

MAR. 2019 JOB NO. 6200 FIG. 18D

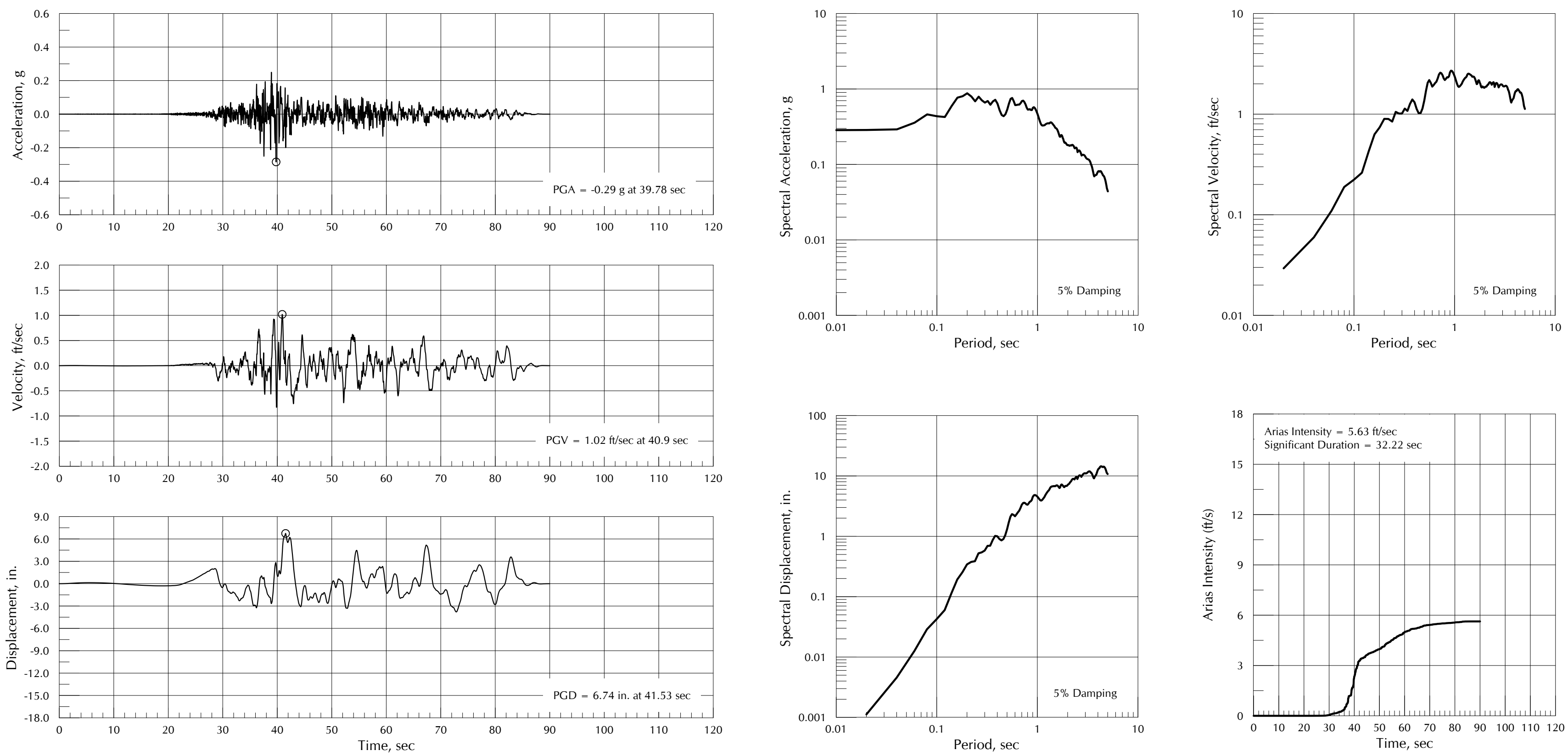


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
CHY046 E GROUND MOTION
(CHI-CHI 1999)

MAR. 2019 | JOB NO. 6200 | FIG. 19D

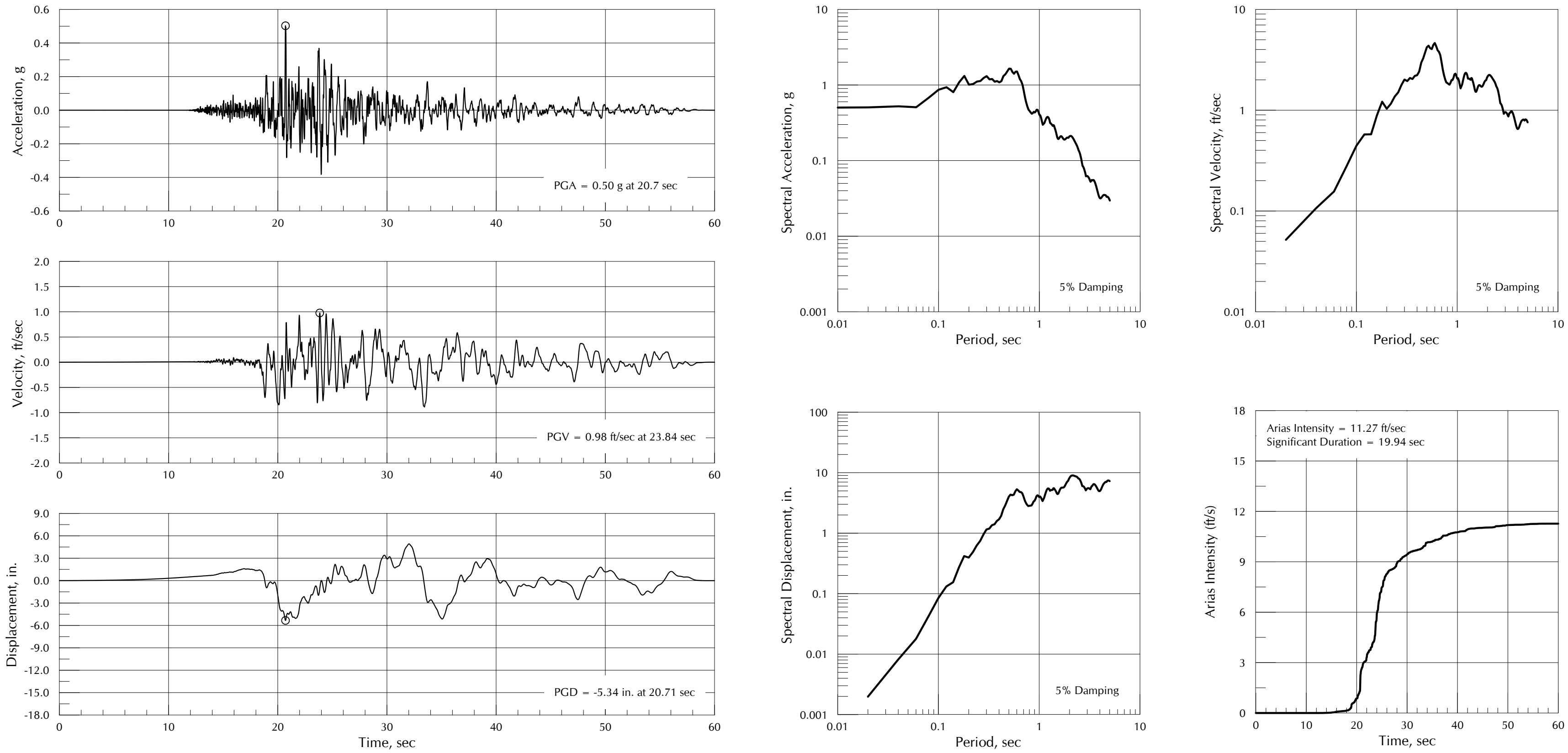


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
CHY046 N GROUND MOTION
(CHI-CHI 1999)

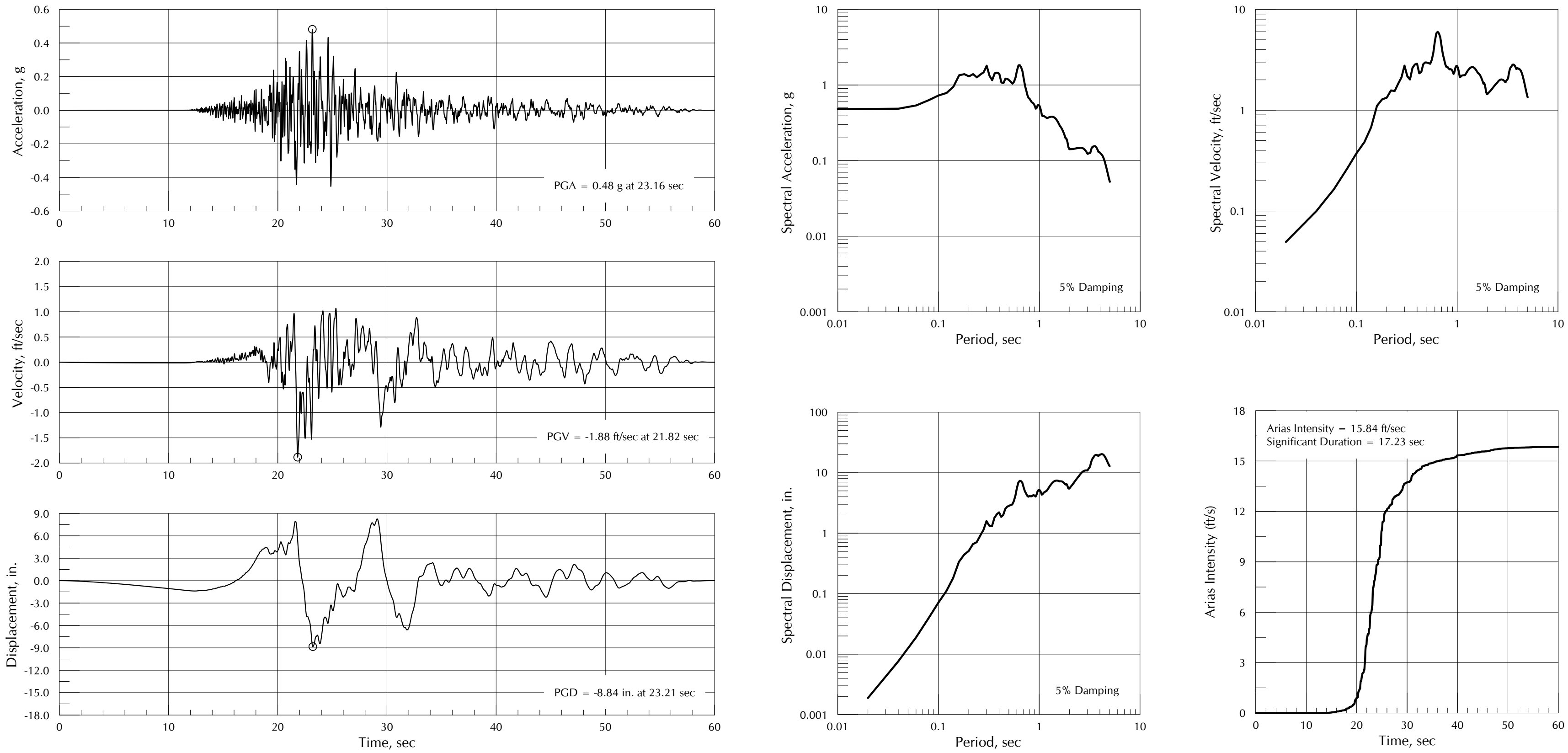
MAR. 2019 | JOB NO. 6200 | FIG. 20D



The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
MATSUSHIRO TOKAMACHI EW GROUND MOTION
(CHUETSU-OKI 2007)

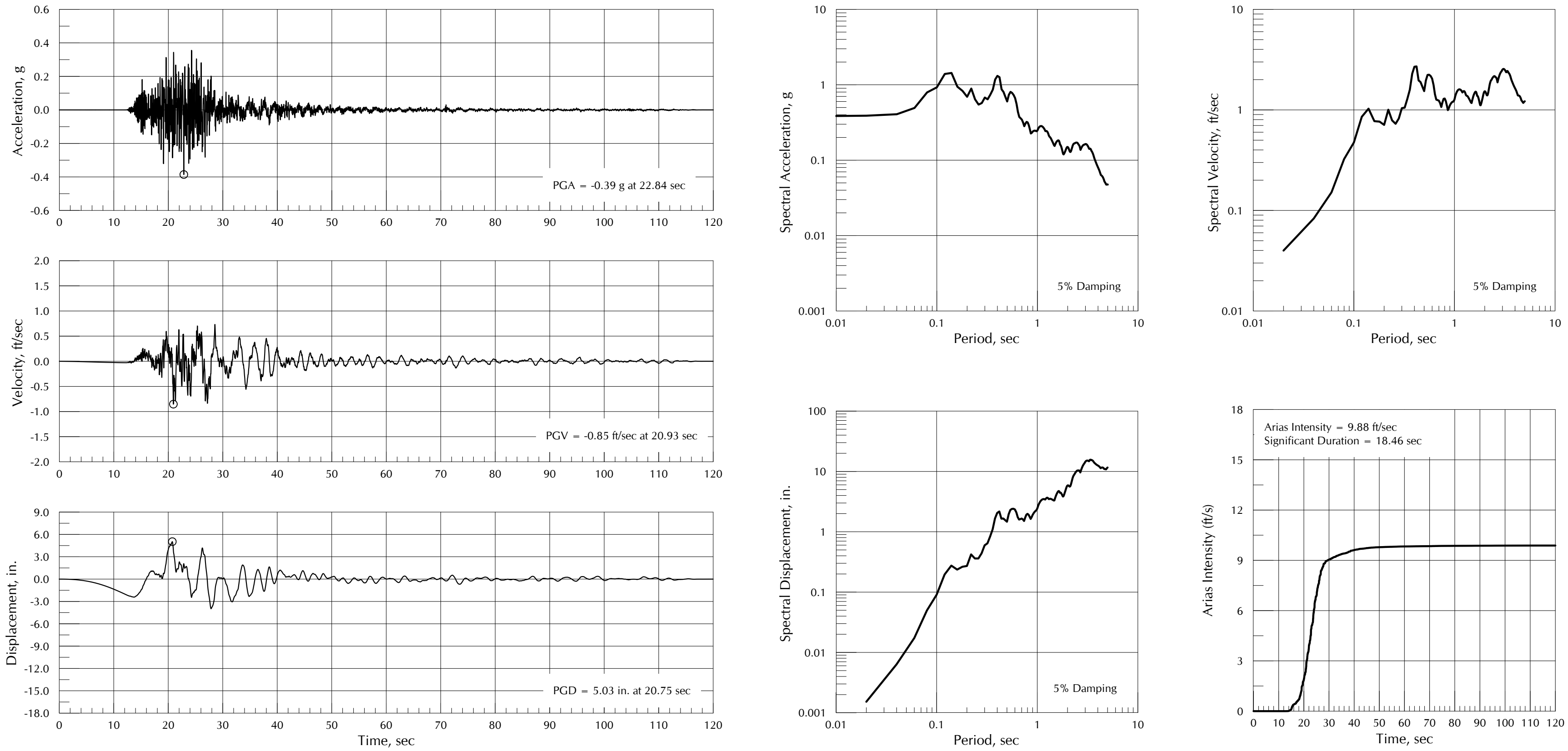


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
MATSUSHIRO TOKAMACHI NS GROUND MOTION
(CHUETSU-OKI 2007)

MAR. 2019 | JOB NO. 6200 | FIG. 22D

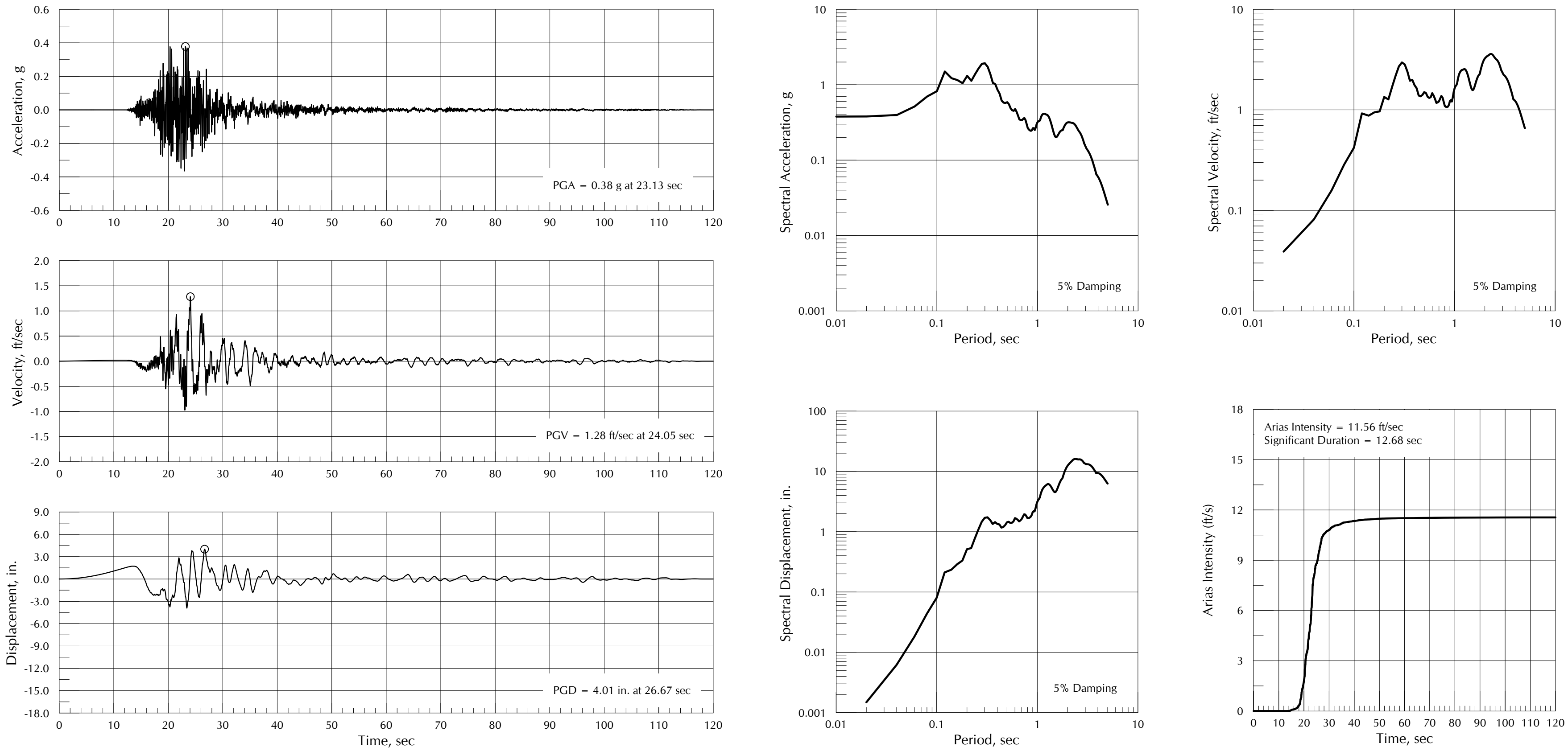


The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
YUZAWA EW GROUND MOTION
(IWATE 2008)

MAR. 2019 JOB NO. 6200 FIG. 23D



The significant duration represents the time interval between 5% and 95% of the total Arias Intensity accumulated.

GRI

SCALED TIME HISTORIES
YUZAWA NS GROUND MOTION
(IWATE 2008)

MAR. 2019 | JOB NO. 6200 | FIG. 24D

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