WCE

Whipple Consulting Engineers, Inc.

WCE No. 2013-1166

August 20, 2018

City of Spokane Valley
11707 E Sprague Ave, Suite 106
Spokane Valley, WA 99206

RECEIVED
AUG 20 2018
CITY OF SPOKANE VALLEY

Attn: Mr. Henry Allen, P.E.

Re: Painted Hills Flood Control Development Narrative

Dear Henry:

This letter is provided as a description of the flood control plan associated with grading and site improvements that would be completed in conjunction with a future mixed-use development on approximately 99.5-acres of a former golf course property located at 4403 S Dishman-Mica Road. It is intended as an update to previous flood control narrative descriptions provided to the City by Whipple Consulting Engineers dated July 23, 2015, October 13,2016, and July 6, 2017.

Since the date of the last narrative provided to the City, the applicant has modified the proposed site design in order to obtain a Conditional Letter of Map Revision – Fill (CLOMR-F) from the Federal Emergency Management Agency (FEMA). This design update to obtain a CLOMR-F approval represents a change in the FEMA re-map effort for the project, which was formerly designed to revise the FEMA mapping through a Conditional Letter of Map Revision (CLOMR) process resulting from levee improvements and levee certifications. This change to a CLOMR-F was implemented due to concerns raised by the City at a meeting held on November 9th. 2017 wherein long-term levy maintenance was questioned by City staff. A call between FEMA representatives, WCE, WEST, and City staff occurred on January 18, 2018.

The project site is located within the area identified as Storage Area 1 (SA1) in the effective FEMA Flood Insurance Study (FIS). SA 1 is designated as a compensatory storage area. Within a compensatory storage area loss of flood storage capacity due to placement of fill must be mitigated with an equivalent compensatory volume of storage or through a reduction in flows such that the net condition causes no adverse impact to the base flood or floodway elevations within the storage area. In addition, loss of infiltration capacity due to placement of fill or impervious surfaces must be mitigated in such a way that the decrease in infiltration capacity will cause no adverse impact to the base flood or floodway elevations within the storage area. The overall purpose of the "compensatory" requirement is to ensure that development activities do not cause an adverse impact on flood elevations within the storage area, or downstream of the development (e.g. increasing downstream flows due to reduced infiltration capacity within the storage area). With the current plan to pursue a CLOMR-F, the applicant is proposing to control and manage floodwaters and address compensatory storage requirements on the site through a combination of on-site fill, enhanced conveyance facilities (culverts) and infiltration galleries. Chester Creek main channel with the exception of a small extension of the culvert at Thorpe Road due to widening will remain unchanged.

The intent of the Painted Hills PRD flood control design is to mimic the flood control project that Spokane County did on the Chester Creek mainstem, when the Kokomo area was taken out of the flood plain, by digging two deep borrow pits just West of Dishman-Mica Road and South of 28th Avenue.

This narrative restates and clarifies background information regarding the FEMA mapping for the site and further describes the current proposed plan.

MAPPED FLOODPLAIN CONDITIONS

History of Site Flood Analysis

A hydrologic and hydraulic analysis for Chester Creek Basin was completed by Michael Baker Jr., Inc. and approved by Spokane County in a letter to the Federal Emergency Management Agency dated August 6, 1990. There are no long-term gage records for Chester Creek. The limited gage measurements on Chester Creek were collected near the Dishman-Mica Road crossing of Chester Creek for December 1994 through March 1995 and November 1995 through February 1996 when no significant flood events occurred. In February 2006, the hydraulic analysis for Chester Creek was revised by WEST Consultants, Inc. under a FEMA contract. The analysis established updated flood magnitude-frequency estimates for the watercourse. A steady flow hydraulic model has been developed for Chester Creek. [1]

The reports concluded that spring floods in the upper Spokane River basin are due to snowmelt runoff from high elevation watersheds. Such floods are of less significance on Chester Creek because of the lower elevation of the water shed limit and the size of the snowpack. Spring runoff occurs about a month earlier with the more gradual rates than on the Spokane River. Nearly all maximum annual flood peaks on Chester Creek occur during the winter. Warm winds and rain can melt the snow rapidly. When winter rain causes snowmelt on partially frozen soil conditions, short-duration, intense runoff generates a flood peak during winter storms. During the more extreme events, Chester Creek runs over its banks filling localized depressions in the flood zone. [1]

The duration of flooding is generally between 100 hours and 1000 hours, or between four days and forty days with smaller events occurring with greater frequency than large events. [1]
Channel geometry for Chester Creek was developed from surveys conducted in March 2003. Overbank geometry was developed from topography developed by TerraPoint (2003). Flood plain boundaries for Chester Creek and the Unnamed Tributary to Chester Creek were delineated using 2-foot contour interval maps developed by TerraPoint from LiDAR data. [1]

A watershed plan for Chester Creek was previously designed with management recommendations for drainage, flooding, water quality, and riparian habitat. As a result, flood control improvements have been implemented along Chester Creek. The improvements to the area began at the Painted Hills Golf Course. In 1998, a project to install new culverts and extensive dredging of the channel between Thorpe Road and Schafer Road was implemented. Two large volume borrow pits were constructed downstream. Each pit was designed for the retention and infiltration of Chester Creek floodwaters up to a 25-year event. One borrow pit for the unnamed Tributary to Chester Creek was constructed just north of E 40th Avenue and the other borrow pit for Chester Creek just West of Dishman Mica and South of 28th Avenue.

Before the storage areas #1 (compensatory area) and #6 (triangle pond) are to be modified (see Site Element Plan), it is important to understand where they are within the Chester Creek Basin, and what floodwaters they receive. Within the Chester Creek Basin, the storage areas are generally located in the northeast corner of the basin along the edge of the valley floor. Specifically, north of Thorpe Road and along Madison Road (Storage Area 1) and to the northeast of 40th Avenue (Storage Area 6).

The flood condition flows, as identified by WEST Consultants, are separated into three parts in relation to the three directions of flow that enters into the Painted Hills Development: the main flow (Golf Course Overflow Reach) across Thorpe Road, the secondary (Unnamed Tributary) flow from Highway 27, and the secondary flow across Madison Road. The project is proposing to redirect the anticipated flows of the identified flood events for storage area #1 (main flow and Madison secondary flow) to a discharge point at the north end of the development and for storage area #6 (Unnamed Tributary) to an existing offsite discharge point to the east of the development.

Storage Area #1 (compensatory area) is a large storage area that encompasses the majority of the former Painted Hills Golf Course as well as areas to the east of Madison Road. There is no outflow route for this storage area so it is classified as compensatory storage and is allowed to infiltrate through the native soils and into the Spokane Valley Rathdrum Prairie Aquifer. The soils below the storage area include the Spokane Valley Rathdrum Prairie Aquifer as its base followed by layers of course sands that are topped by soils of an alluvial fan or an area of natural deposit from Chester Creek, before the creek was channelized.

The floodwaters that enter Storage Area #1 are identified on the July 6, 2010 FIRM Map as the Chester Creek Golf Course Overflow. The Chester Creek Golf Course Overflow originates at a point to the south of Thorpe Road where there was at one time a breach in the man-made channel of Chester Creek. The breach was reportedly from a lack of maintenance and the overgrowth of vegetation in the main channel that blocked the main channel during a storm event. This flow of floodwater enters the storage area from the south at a low point in Thorpe Road through three 15" culverts and, if flow is larger, by overtopping Thorpe Road.

Storage Area #6 (triangle pond) is a smaller storage area that is located east of 40th Avenue primarily within a 30-foot-deep gravel pit that was excavated during the early development years of Spokane Valley. Spokane County obtained a drainage easement over the pit in 1983 for storm drainage (flood flow) purposes. The overflow route of storage area #6 is along the south side of 40th Avenue and flows into Storage Area #1 via culverts under Madison Road. The soils below the storage area include the Spokane Valley Rathdrum Prairie Aquifer as its base followed by layers of course sands and gravels that were further exposed by the gravel pit excavation.

The Main Flow Across Thorpe Road

Concept Design and Process

For the concept design the 100-year event was used to size facilities. When reviewing the Geotechnical Evaluations, Phase I (December 31, 2013 – Revised August 29, 2016) and Phase II (July 23, 2015) it was evident that there are "valley gravels" or well-draining soils that lead directly to the Spokane Valley Rathdrum Prairie Aquifer under the poor draining soils that cover the site. Therefore, we concluded that if we conducted flood waters into these well-draining soils the flood waters may be treated and discharged. Through extensive review, analysis and confirmation from geotechnical evaluations, it was determined that gravel galleries at the north end of the proposed development represented the optimal location for floodwater infiltration due to the fact that the groundwater depth in this location is much deeper than other locations on the site. See Supplemental Geotechnical Evaluation by IPEC dated April 19, 2016.

Proposed Design

See Site Element Plan in the attachments.

100 Year Flood Event

There is currently a shallow channel to the South of Thorpe Road that conveys the flood water flow from the breach North to Thorpe Road. This 100-year flood event, known as the Golf Course overflow Reach has a peak flow rate of 64 cfs, at the crossing of Thorpe Road, based on the existing FEMA FIS. Since the levee on the east side of Chester Creek immediately downstream of Thorpe Road is not certified to protect against the 100-year flood, a peak flow of 91 cfs will be used as the design flow at Thorpe Road instead of the 64 cfs in the effective FIS. The larger 91 cfs flow is more conservative and simulates additional flow that could be contributed to the Golf Course Overflow Reach from the main channel of Chester Creek in the event of a failure of the non-certified levee (without-levee scenario). This provides a conservative design flow which accounts for a potential levee breach or additional overflows that could occur due to the continued mainstream Chester Creek Channel issues, primarily a lack of upstream channel maintenance, which could result in additional overflows. In addition to the overflow from Chester Creek the hillside above Madison Road has a peak design inflow of 15 cfs through the four operational 18" culverts of Madison Road. Therefore, the total peak 100-yr event flow rate used for conveyance and infiltration design for Storage Area #1 is 106 cfs.

System Summary

On the south side of Thorpe Road, the waters from a 100-year without-levee flood event, the 91 cfs peak flow rate, is proposed to enter a box culvert on the south side of Thorpe Road. The box culvert has a capacity of 216 cfs. From the box culvert the floodwater enters an open channel to a sloped headwall that holds two 48" concrete pipes. Each pipe has a capacity of 77 cfs for a total capacity of 154 cfs. The two 48" pipes extend north from the headwall along Madison Road, with manholes strategically placed to connect to the existing 18" culverts in Madison Road. This connection allows the design flow rate of 15 cfs from the Madison hills to be added to the 91 cfs, for a total design flow rate of 106 cfs. The two 48" pipes end at a vertical headwall where the floodwater splashes out onto a concrete pad and flows across a level spreader into a sloped biofiltration swale. The biofiltration swale cross section has a capacity of 269 cfs. Within the biofiltration swale the suspended solids are stripped out by the tall grasses. At the end of the biofiltration swale is a settling pond that allows the floodwater to settle and rise 1 foot in elevation before flowing over a 20-foot-wide rock weir into the infiltration pond that is 2 feet below the elevation of the rock weir. Within the infiltration pond the floodwater can begin to infiltrate through the pond bottom. When the floodwater in the infiltration pond rises 1 foot in elevation the floodwater will crest over the rim of the 48 drywells and fall into the infiltration trench where the floodwater will then infiltrate into the native soils and enter the Spokane Valley-Rathdrum aquifer. The infiltration trenches have a design capacity of 162 cfs. As demonstrated the flood control system has the capacity to handle the peak 100-yr event without-levee flood design flow rate of 106 cfs with a Factor of Safety of 1.53+/-. The following are descriptions of each design element in more detail.

Box Culvert/Open Channel

The Golf Course Overflow Reach flows coming from the upstream flow split on Chester Creek is anticipated to approach Thorpe Road as it currently does at the low point in the Thorpe Road profile where there are currently three 15" culverts within the natural drainage way of the Golf Course Overflow Reach. The flow will then enter into a 30-foot-wide by 3-foot-high box culvert under Thorpe Road, replacing the 3 existing culverts. The roadside ditches along Thorpe Road will be regraded to ensure positive flow toward the box culvert. Given the topography of the area, aside from shallow puddles caused by upstream localized depressions, all stormwater will enter into the proposed box culvert. The flow will exit on the north side of Thorpe Road and enter into a concrete open channel with a concrete bottom and vertical concrete walls and then flow to the sloped headwall of the two 48" Pipes.

Pipe Mainline

At the terminus of the open channel the flow will enter into a two-pipe, parallel, buried pipe system with WSDOT Type II catch basins along the East side of Madison Road. Once inside, the two 48" concrete pipes the flood flow will continue to the north end of the project with an outfall into a bio-filtration swale. Each WSDOT Type II catch basin will have a sump for the settling of particles in low flow conditions. These particles or silt can then be vactored out of the manholes as part of the routine maintenance, prior to reaching the bio-filtration swale.

Bio-filtration Swale (Channel)/Settling Pond

The bio-filtration channel receives the flood water upon discharge from the two 48" concrete pipes. The filtration will be planted with tall dryland grasses. The flow of the floodwater overland through the tall grass provides an initial phase of silt and solid removal before the floodwater flows into a settling pond where additional silt will settle before cresting over a 1' rock weir with 8" minus rock compacted in place.

Bio-infiltration pond

The crested flood water from the settling pond then flows into an open surface bio-infiltration pond. Within the infiltration pond the suspended particles will continue to decelerate and settle downward to the pond bottom while the clear surface water crests over the rim of the drywells that leads into a gravel gallery system only when the floor dictates. Assuming that the infiltration pond discharges at the rate of $1.6x10^{-4}$cfs/sf the pond bottom in a non-frozen ground event would discharge ($61,000x1.6x10^{-4}$) 9.76 cfs directly to the underlying soils, and not enter the drywells. Therefore, a flow represented by 9.76 cfs is generally consistent with a pre-project flow over Thorpe Road of 0.25' or 3 inches, which has been experienced once during the preparation of this project and documented on February 17, 2017. The gravel gallery system is for the ultimate disposal into the aquifer, its final destination. See Bio-infiltration worksheet in the attachments.

Gravel Gallery System

Once floodwater flows exceed bottom infill rates it will rise to a depth of one foot and enter the discharge drywells which will evenly distribute the floodwater through gravel galleries by either flowing through the drywell barrels or distributing through the interconnected 12" perforated pipes and galleries along the pond's entire length.

The gravel gallery system is based upon a system of 10-foot wide by 10-foot deep infiltration trenches with 3 trenches at 340 feet, a trench at 330 feet, and a trench at 100 feet. the trenches are lined with geo-fabric per WSDOT Std. Spec. 9-33.2(1) and filled with gravel drywell material in conformance with WSDOT Std. Spec. 9-03.12(5). Within the top 3 feet of the infiltration trench runs a 12" perforated pipe at a 0% slope that connects the trench drywells within each trench segment. As treated floodwater crests over the rims of the drywells, the floodwater fills from the bottom up, and equalizes throughout the trench. Once filled the gallery is at its maximum design infiltration rate of 162.64 cfs (see gravel gallery worksheet in the attachments). For analysis the 100-year storm has a peak flow rate of 91 cfs, plus the 15 cfs from the Madison Hills for a total design peak flow rate of 106 cfs. So, with a design outflow rate over 1.5 times greater than the design inflow rate the system will adequately discharge the 100-year flood. This is a conservative measure of protection.

Infiltration Rate

A full-scale drywell test was performed at the north end of the site. Based on this test we used the design flow rate of 1.8×10^{-3} cfs/sf for design of the gravel galleries in the open space area north of the proposed Cottages residential area. See attached IPEC Geotechnical Report dated June 28, 2016.

Maintenance of the pipe, bioswale, road and gravel gallery system is a semi-annual inspection of the gallery through the system drywells looking for a build-up of sediment and debris, and if needed, the removal of the sediment and debris by a vactor truck.

Secondary Protection

As a secondary measure of protection, a detention facility is proposed at the south end of the project in the park area. A 176,181-sf area located in the park area has been lowered 3 feet +/- from the existing ground surface. This area will be covered with grass turf and will function as park open space, with gentle 3:1 side slopes for easy access. If for whatever reason an emergency situation exceeds the capacity of the pipe headwall or if the 48" concrete pipe inlets are blocked by debris, floodwater is intended to crest over the open channel wall and flow into the park as a temporary containment measure. The detention facility has an outlet located in the NE Corner. The outlet is a catch basin with a rim elevation placed 1 foot above the bottom of the park. The catch basin has an 18" pipe that connects into the western 48" concrete Pipe that runs along Madison Road. Below the rim of the catch basin the detention facility has a holding capacity of 178,699 cf or 4.10-acre feet, at a final grade of 5 ft depth the detention facility has an ultimate holding capacity of 943,866 cf or 21.67-acre feet. While the detention facility is not the ultimate disposal point for flood water the detention facility provides a secondary containment that will detain the floodwater and drain flood water back into the flood control system without risking a flood of the subdivision streets.

Project Site Fill and Flood Protection Measures

The project site is protected from the main channel of Chester Creek by the existing levee type fill of property along the existing Chester Creek channel and along Dishman-Mica Road. As was originally proposed and noted the project was going to be a levy type flood control project. However, it has since been modified to strictly a fill project where all future building pads will be placed 1.0 feet above the Base Flood Elevation (BFE). The new fill elevation is proposed to be placed 1 foot or more above the Chester Creek Base Flood Elevation (BFE) and then be graded out to the existing elevation toward Madison Road. Regardless of the grade back, all building pads will be placed above the BFE and certified to FEMA during the development. Therefore, it is incumbent upon the reader to understand that the grading plan of the project site will be to raise the surface. So that all residential building pads will be at least 1.0 foot above the BFE and will therefore always be out of the floodplain, even if the discharge measures experience some catastrophic failure of infiltration during a flood event.

Design Elements

	Box Culvert	Open Channel	Pipes	Bioswale	Settling Pond	Rock Weir	Pond	Drywell	Infil. Trench
Width/Area	28'	28'	48"	6'	7,172 sf	2'	61,004 sf	48"	10
Length	45'	18'	*2,629'	334'	-	20'	-	-	*1,450
Slope	0.5%	1.0%	0.26%	1.0%	0.0%	0.0%	0.0%	-	0.0%
Depth	3'	6'	-	6'	6'	5'	7'	18'	10'
Elev: in/btm	2007.58	2007.36	2007.18	2000.04	1996.80	1997.80	1995.80	1996.80	1978.8
Elev: Out	2007.36	2007.18	2000.24	1996.80	-	-	-	-	-

*Indicates a total

The Secondary Flow Across Madison Road:

The flow across Madison Road is divided into 5 basins from the heights above and to the east of Madison Road that correspond to the 5 culverts that are placed under Madison Road. The most northerly culvert does not have an outlet on the west side of Madison Road. Therefore, the floodwater that should enter this culvert goes to the south to the culvert at Sta 30+42. The floodwaters on the east side of Madison Rd distribute along the east side of Madison and appear to be separated into the four culverts that cross Madison Road at Stations (S to N) 13+22, 20+44, 24+41 and 30+42. As the development proposes to widen Madison Road on the west side, the 4 culverts will be replaced and extended. Since the proposed inverts of the extended culverts will fall below the proposed grade of the roadside swales, the culverts will connect into the East 48" pipe.

The storm water along the west side of Madison Road will be collected in roadside swales where it will receive treatment. The swales will have catch basins with the rim set 6" above the swale bottom. Any excess treated flow that does not infiltrate and exceeds a 6" depth will enter the catch basins. The catch basins will be connected to the East 48" mainline pipe.

West Consultants provided the following 100-year storm flows for each culvert during the 100-year storm. We are using these flows to size and design floodwater facilities.

STA.	100 Year Storm Flow (cfs)
13+22	4
20+44	1
24+41	1
30+42	2
38+98	7
Total	**15**

Any floodwater generated west of the triangle pond along E 40th Avenue flows to the west. Then at Madison Road it flows south between the road and the easterly hillside. These flows will be intercepted with the replacement culverts installed at Stations 13+22 through 30+42 that are connected at manholes into the east 48" pipe.

The Secondary Flow From Highway 27 (Spokane County)

Proposed Design

The existing and documented 16 cfs flood flow from Highway 27 (Unnamed Tributary) is currently conveyed via a 36" culvert (limiting factor) that empties into a ditch that flows West across the Gustin property (Parcel No. 45344.9108). The stormwater flows through the ditch and into the existing County borrow pit within the triangular parcel located northeast of E 40th Avenue (Parcel No. 45343.9052). The existing ditch has been maintained over the years by the property owner (Gustin) to ensure that whatever floodwater comes out of the culvert under Highway 27 will be conveyed to the existing borrow pit. With this or a separate project the ditch will be replaced with a 36" pipe that extends from Highway 27 to the proposed infiltration (triangle) pond bottom in barrow pit. With the pipe there is no potential for floodwater to flow in the natural drainage way to the West. The existing pond is anticipated to be regraded with 18 drywells being installed.

Design Elements:

Proposed Pond 17,060 sf @ El: 1990.00; 35,812 sf @ El. 1995.00; 84,416 sf @ El. 2000.00
Drywell spacing 30', total drywell outflow 18.0 cfs, negates pond bottom, frozen ground flow
Maintenance Access Road: 6" gravel, max grade 10%, min. radius 35'
Fenced with gate

Infiltration Pond

WCE proposes to improve the outflow of the (triangle pond) borrow pit by regrading and expanding the lowest bottom area of the borrow pit and installing 18 double depth drywells into the bottom of the internal pond. The drywells will provide outflow during a frozen ground condition. Each double depth drywell will provide a design outflow of 1.0 cfs for a total of 18 cfs per the recommendations in the Geotechnical Evaluation by IPEC dated October 14, 2014.

If you have any questions or comments in regard to this letter please feel free to contact us at (509) 893-2617.

Sincerely,
WHIPPLE CONSULTING ENGINEERS, INC.

TODD R. WHIPPLE
STATE OF WASHINGTON
25462
REGISTERED
PROFESSIONAL ENGINEER

8/20/18

Todd R. Whipple, PE

TRW/bng

Encl: Attachments

CC: File

ATTACHEMENTS

Bibliography
Site Element Plan (Sheet C1.3)
100 Year Flood Event Flows
- Thorpe Road Crossing
- Madison Hills Flow to Culverts
- Gustin Pipe Flow to Culverts

System Capacity
- Box Culvert
- Madison Pipe
- Bioswale Trapezoidal Channel

Storage and Discharge
- Pond Summary Worksheet
- Gravel Gallery Worksheet – North

Bio-filtration Channel Worksheet
Geotechnical Reports

BIBLIOGRAPHY

1) Dawes, Larry. August 30, 2016. Biological Evaluation, Buffer Averaging, and Habitat Management Plan for the Painted Hills PRD. Biology Soil & Water, Inc., Spokane Valley, WA. 12-13.

PAINTED HILLS PRD

BIOLOGICAL EVALUATION, BUFFER AVERAGING, AND HABITAT MANAGEMENT PLAN

Spokane County Tax Parcels #45336.9191 and 44041.9144

July 20, 2015 (Revised August 30, 2016)

Biology

Soil &

Water, Inc.

BIOLOGICAL EVALUATION, BUFFER AVERAGING, AND HABITAT MANAGEMENT PLAN

for the

PAINTED HILLS PRD

Spokane County Tax Parcels #45336.9191 and 44041.9144
July 20, 2015 (Revised August 30, 2016)

Retained by

NAI Black
Contact Person: Bryan Walker
107 S. Howard St., #500
Spokane, WA 99201
509.622.3593 (m)
509.623.1000 (o)
bwalker@naiblack.com

Investigated by

Biology Soil & Water, Inc.
Contact Person: Larry Dawes, Principal Biologist
3102 N. Girard Road
Spokane Valley, WA 99212-1529
Phone 509-327-2684
Email: bswinc@icehouse.net

BIOLOGICAL EVALUATION, BUFFER AVERAGING, AND HABITAT MANAGEMENT PLAN
for the
PAINTED HILLS PRD
Spokane County Tax Parcels #45336.9191 and 44041.9144
July 20, 2015 (Revised August 30, 2016)

1.0: Introduction

Biology Soil & Water, Inc. (BSW) was retained by Black Realty to complete a Biological Evaluation (BE) and Habitat Management Plan (HMP) for the proposed Painted Hills Planned Residential Development (PRD) located in the City of Spokane Valley, WA. South Dishman Mica Road defines the west boundary of the site, E. Thorpe Road defines the south boundary of the property, S. Madison Road defines the East boundary, and developed private property defines the north property boundary (Figures 1-3).

The Painted Hills Golf Course formerly occupied this location. The former club house is being renovated to expand the existing restaurant and the remainder of the site will become residential development and open space. The subject property is comprised of seven separate tax parcels including a 91.25 acre parcel where 580 residential units are proposed, and an 8+ acre parcel on the south end of the site that will be designated as a wildlife travel corridor. The Action Area was defined as a half mile radius of the 93+ acre Project Area so the site investigation would characterize adjacent areas where listed species could inhabit or be impacted by the project. This assessment addresses all Critical Areas and listed Priority Habitat and Species including Threatened, Endangered, Proposed, and Candidate Species in the Project Area.

The USFWS and NMFS species lists were accessed on their websites on 4/21/2015 and updated August 29, 2016. No NMFS species are listed for the vicinity. The USF&W list indicated the potential presence of the species and critical habitat(s) shown in Table 1 (and in Appendix 1).

Table 1. USFWS listed species and critical habitats potentially present in the vicinity of

Species	**ESU/DPS**	**Federal Status**	**Designated Critical Habitat**
Bull trout *Salvelinus confluentus*	Columbia River DPS	*Threatened*	*Yes*
Water howellia, *Howellia aquatilis*		*Threatened*	*No*
Spalding's silene, *Silene spaldingii*		*Threatened*	*No*
Canada Lynx, *Lynx canadensis*		*Threatened*	*No*
Yellow-billed cuckoo, Coccyzus americanus,		*Threatened*	*No*

The undersigned investigated the Project and Action Areas on March 1, March 29, and April 19, 2015. The conclusions of this plan are based on an evaluation of habitat and species data for Spokane County compiled by State and Federal jurisdictions, an evaluation of construction plans and specifications for the project, a literature review, and field investigations by the author of this report. The project will have no effect on Bull Trout or proposed Bull Trout Critical Habitat. The project will not result in the destruction or adverse modification of potential, designated or proposed Critical Habitat or Essential Fish Habitat for any fish species. The project will have no effect on the threatened species Water howellia, Spalding's silene, Canada lynx, or the Yellow-billed cuckoo. There will be no significant adverse effect on any listed Species of Concern. The site plan includes an 8+ acre wildlife travel corridor for deer and elk and over 30 acres of open space.

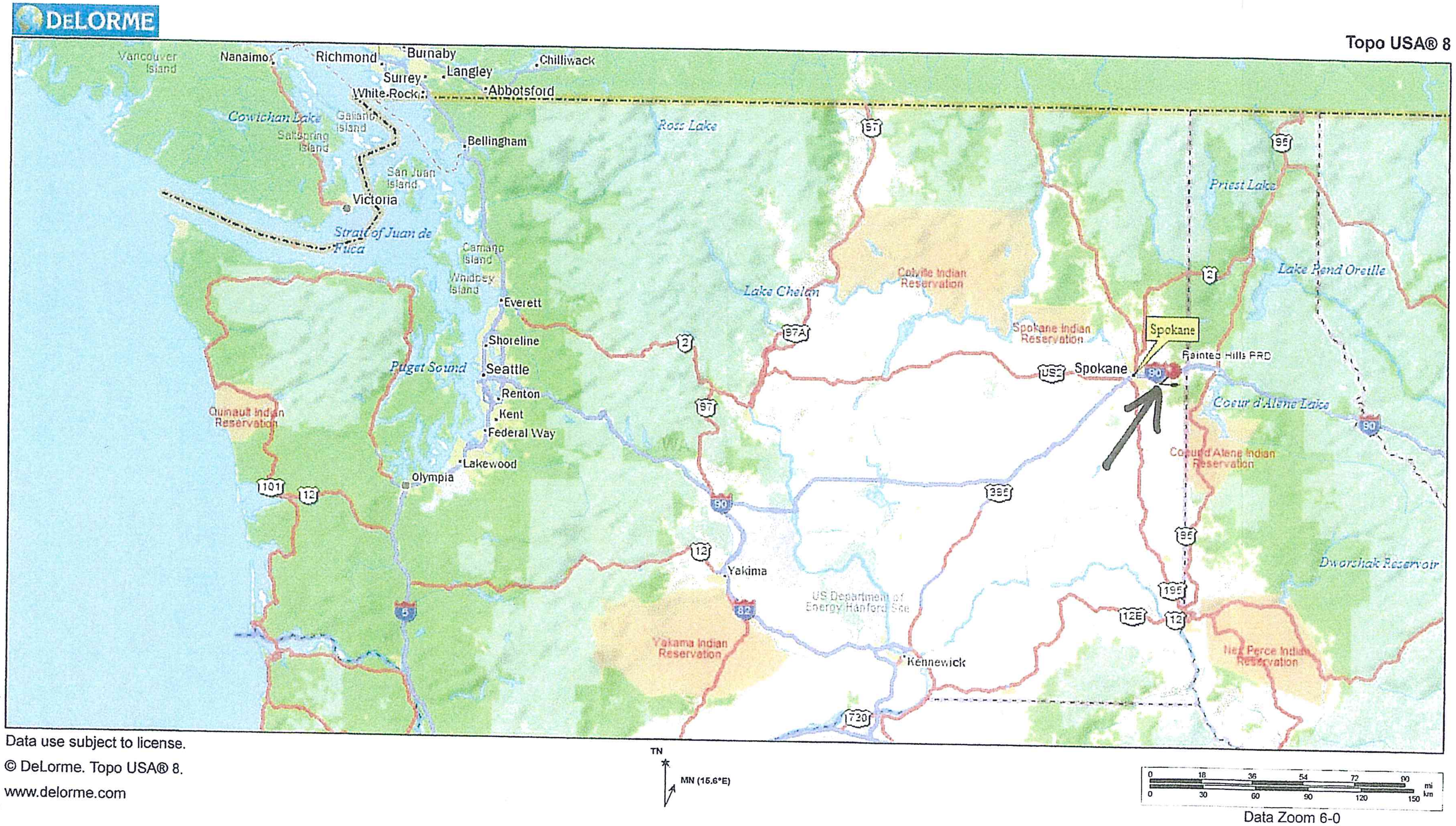
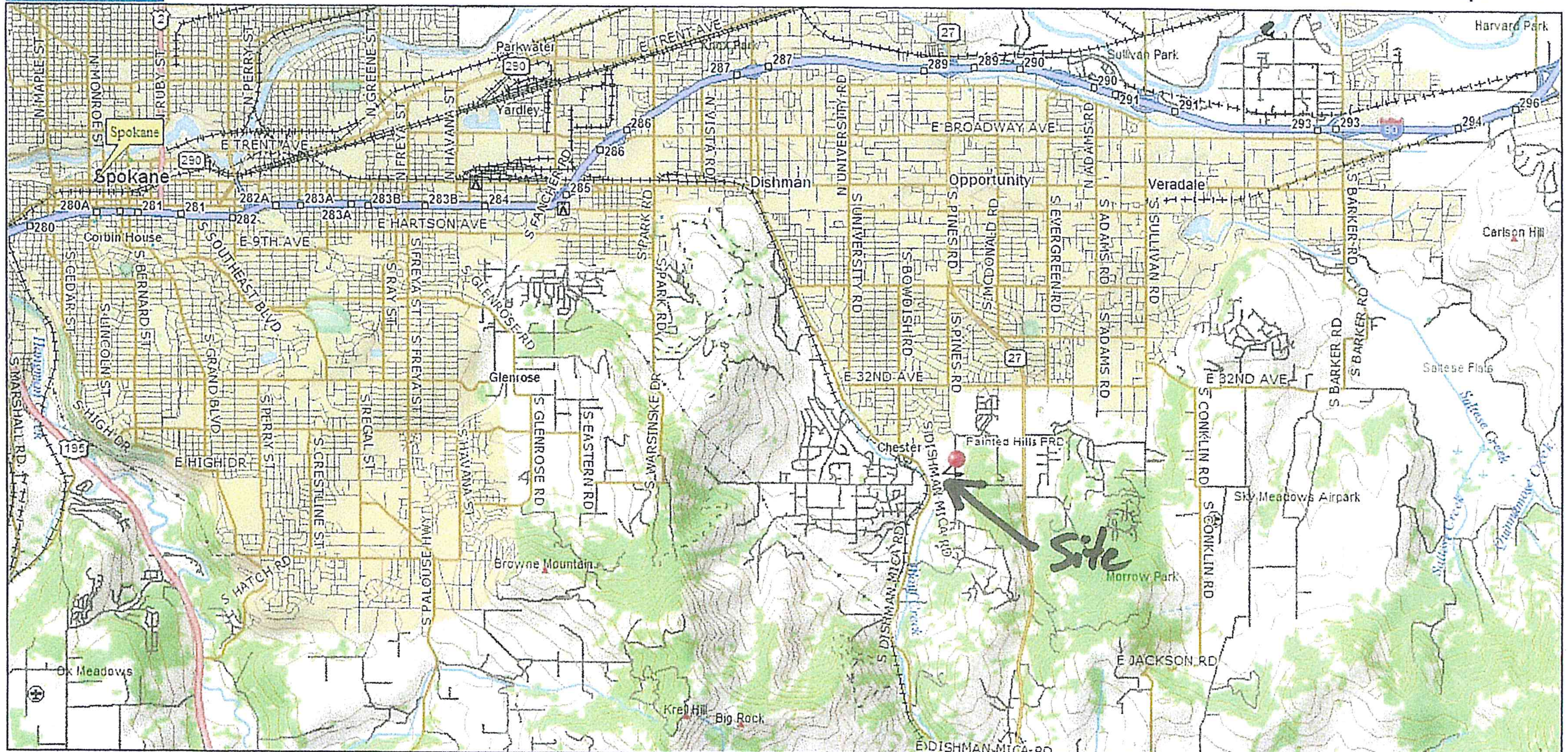


Figure 1: Site Location

DeLorme

Topo USA® 8



Data use subject to license.

TN
MN (14.7°E)

0 1 2 3 mi
0 1 2 3 4 km
Data Zoom 11-0

Figure 2

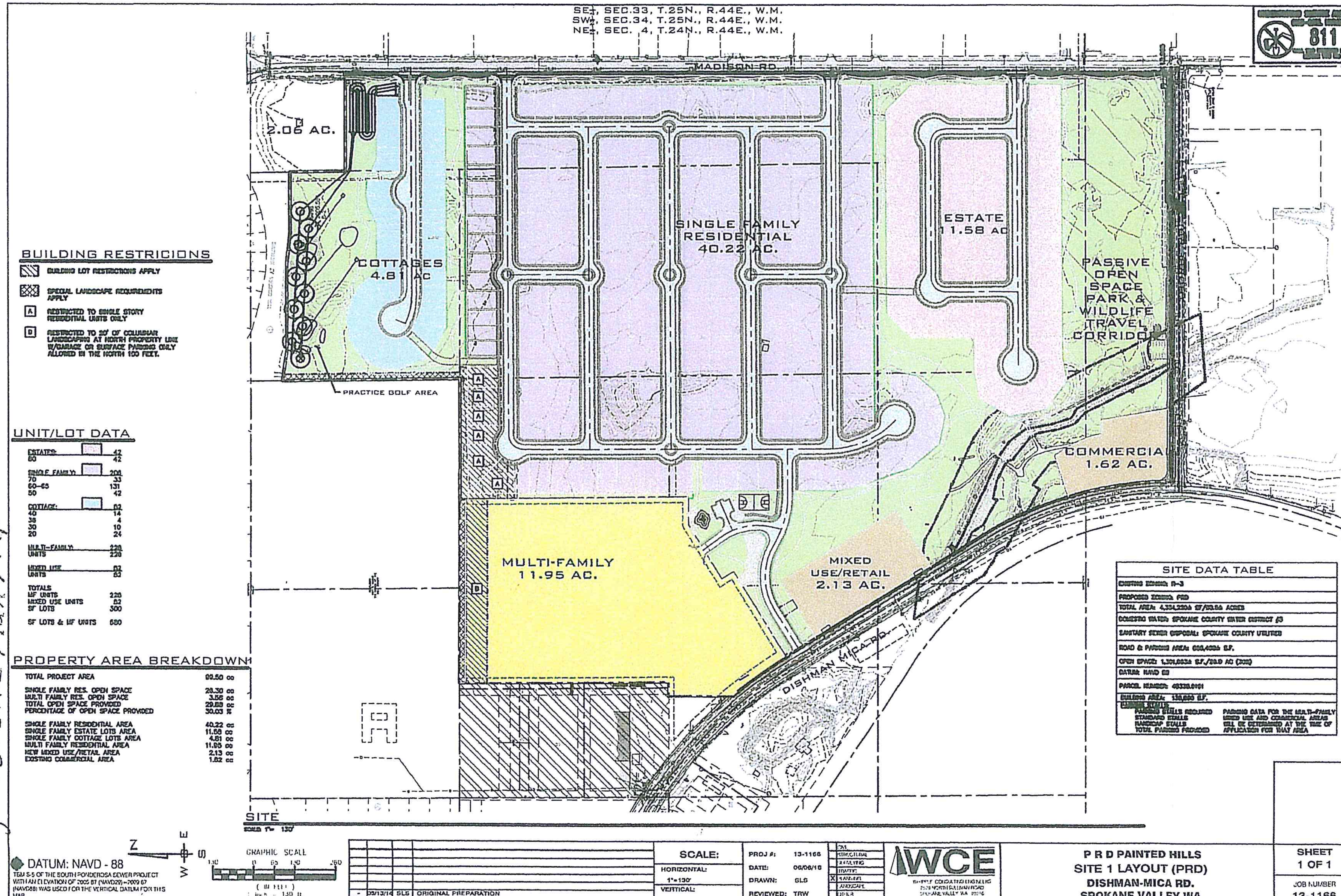


Figure 3: Site Plan Map

The Project Area does not meet any of the Department of Natural Resources (DNR) criteria for High Quality Terrestrial Habitat. Washington Department of Fish and Wildlife (WDF&W) maps (Appendix 2: Critical Areas Maps) indicate the subject property falls within an Elk polygon (WDF&W Priority Habitat). An 8+ acre wildlife travel corridor is proposed along the entire south end of the project and the corridor will be enhanced with vegetative plantings to accommodate animals traveling through the area.

Chester Creek and its associated 100-foot buffer bisects the SW corner of the property. Buffer Width Averaging is proposed to compensate for the encroachment of two lots and foot paths in the riparian buffer. The impact mitigation also includes riparian buffer enhancement. The existing buffer is almost totally devoid of woody vegetation because it was previously a driving range and/or maintained golf course fairway. An evaluation of streams and wetlands is included in this report.

2.0: Methods of Investigation

The north parcel of the Project Area is located in Sec. 33, T25N, R44E and the south parcel is located in Sec. 4, T24N, R44E of Spokane County, WA (Figures 1-3). Biology Soil & Water, Inc. (BSW) investigated the property on March 1 and 29, and April 19, 2015 for wetlands, riparian habitat, and species protected under the Federal, State, and local regulations. The undersigned is familiar with the soils, vegetation, and hydrologic characteristics of this property from previous investigations of adjacent properties in the immediate vicinity and throughout the drainage basin.

3.0: Description of the Action and Project Areas

Spokane is located in a valley at the westmost extent of the Rocky Mountains. From the north side of the Spokane River valley, the Selkirk Mountains extend north into Canada. On the south side of the Spokane River valley, a forested finger of the Bitterroot Mountains extends east from Lake Coeur d'Alene to Dishman Hills. The subject property is located in the Chester Creek valley with forested foothills on the east and west sides of the valley. The Painted Hills PRD is surrounded primarily by residential development with varying degrees of housing density, a few small undeveloped tracts of agricultural land in the Chester Creek valley, and forested land with varying densities of residential development (Figure 4).

3.1: Description of the Action Area

For purposes of describing habitat in the surrounding area, the Action Area is defined as a half mile radius of the project area. Habitat types in the Action Area would be described as a mosaic of urban developed, fragments of conifer forest, and small tract agriculture. From the north property line, dense residential development extends north into the City. A church and residential development border the painted Hills PRD at the NW corner. Horizon Middle School is located NE of the site. From the east property line (S. Madison Rd) hay fields and pasture extend 250-500 feet toward the toe of the surrounding forested slopes. Sparse residential extends east up the forested hillsides. Commercial and single family residential development extends south from Thorpe Road except for the Chester Creek drainage and associated flood plain that is mainly forested and small tract agriculture. Undeveloped forested hillsides extend about 1200 feet east to the densely developed Ponderosa neighborhood. A mixture of commercial and residential land uses extend NW along Dishman-Mica Road.

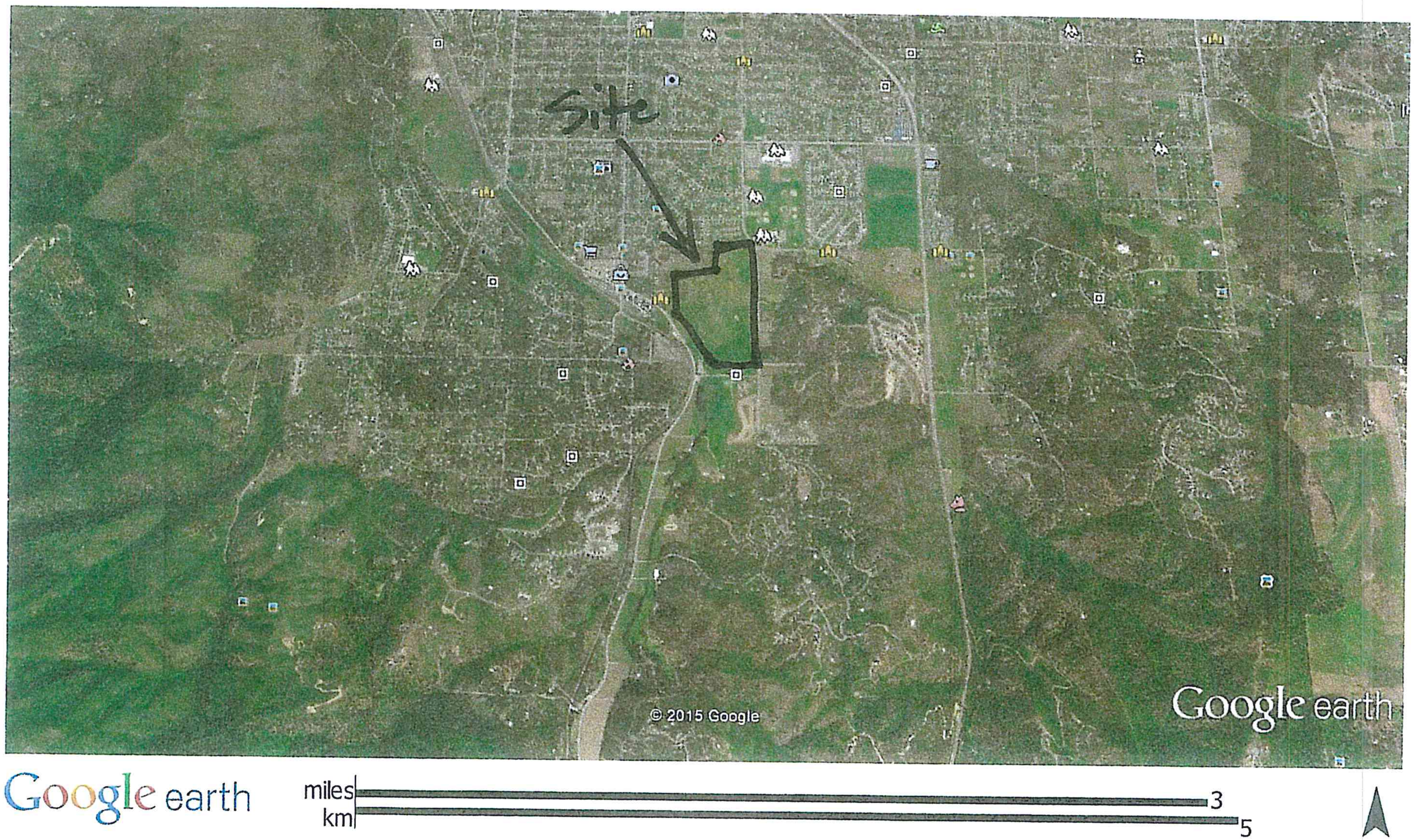


Figure 4

Land uses in the Action Area are a mosaic of dense residential development on former agricultural land, remaining undeveloped small tracts of agricultural land, and forested land with varying densities of residential development. Large mammals that are willing to cross highways and residential developments interspersed with open farm land will find connectivity to a few hundred acres of wooded and sparsely populated foothills extending south and west from the Painted Hills PRD site to Dishman Hills.

3.2: Description of the Project Area

The 93+ acre Painted Hills PRD property was formerly a golf course. Black Realty Inc. bought the property in a trustees auction in the fall of 2013 after the owners filed for bankruptcy in 2012. Except for cart paths, sand traps, and man-made water hazards, the entire property was planted in non-native turf grasses with sparse conifer and deciduous trees lining some of the fairways. The turf grass was maintained by treatment with herbicides and regular mowing of the greens, fairways and rough. These practices virtually eliminated the native herbaceous plant community.

Honey willows were planted inside the OHWM of Chester Creek whose channel was historically dredged and maintained for flood control. The banks of the channel are covered with Reed canarygrass. Outside the OHWM of the stream channel where the vegetation was not mowed or maintained, the vegetative community is dominated with Canarygrass. Teasel, tansy, thistle, wormwood, and lettuce are also well represented.

4.0: Project Risk Assessment and Impacts

Listed threatened and endangered species identified by jurisdictions for potential occurrence in Spokane County include the Yellow-billed Cuckoo (*Coccyzus americanus*), Canada Lynx (*Lynx canadensis*), Bull trout (Salvelinus confluentus), Water howellia (*Howellia aquatilis*) and Spalding's silene (*Silene spaldingii*). A BSW field investigation determined that the project would have NO EFFECT on any of the above listed species.

4.1: Yellow-billed Cuckoo (*Coccyzus americanus*), Federal Status: Threatened

The yellow-billed cuckoo was formerly a very rare summer visitor to western Washington, especially in the Puget Sound area (Roberson 1980). Jewitt et al. (1953) described the former breeding range in Washington as ranging north to Bellingham, east to Ellensburg, south to Vancouver, and west to Grays Harbor. There are only two published records of yellow-billed cuckoo in eastern Washington. Yellowbilled cuckoos were detected on July 21, 1956, 20 miles north of Grand Coulee Dam in Okanogan County (Weber and Larrison 1977) and in June 1978 at George, Grant County (Roberson 1980).

The March and April investigations occurred before the Yellow-billed cuckoo would have migrated into the Spokane County area if it seasonally utilized the area for breeding or nesting. The investigation for the Yellow-billed cuckoo focused on specific habitat requirements of that species. Cuckoos prefer to nest in areas with at least 10 hectares (ha) (25 acres) of contiguous (riparian) woodland (Laymon 1998). The typical patch size is 20 ha (50 acres) or greater, and the likelihood of occupancy increases dramatically with increasing patch size, but they have been found breeding in patch sizes as small as 4 ha (10 acres) along the Colorado River in southern California (Johnson, Matthew J., 2007). Yellow-billed cuckoo's nest in undisturbed stands of cottonwood/willow galleries greater than 10 acres in total area and greater than 100 meters wide along waterways.

The project area does not contain, and is not in close proximity to, adequate habitat patches for that species. The largest habitat patch consisting of species utilized by the yellow-billed cuckoo is less than one tenth of the minimum patch size utilized by this reclusive species. The yellow-billed cuckoo is known not to utilize any habitat with characteristics of those found along Chester Creek adjacent to this project. This project will not impact yellow-billed cuckoo populations or habitat components. There is no suitable habitat for the yellow billed cuckoo in the vicinity of this project.

4.2: Bull Trout (*Salvelinus confluentus*) Threatened

The U.S. Fish and Wildlife Service (USF&WS) lists the Columbia River population of bull trout as threatened. Small pockets of bull trout are present in isolated habitat fragments in the main stem and tributaries of the Columbia River. One isolated fragment of the Columbia River segment includes Coeur d'Alene Lake, its tributaries in the drainage basin, and the Spokane River. Bull trout populations have been identified in Coeur d'Alene Lake and three tributaries in its sub-basin, but no bull trout populations are known to occur presently, or have been noted historically, in the Spokane River downstream from the Post Falls Hydroelectric Dam (PBTTAT, 1998).

The Post Falls dam stops the migration of fish out of the Coeur d'Alene basin downstream into the Spokane River. Waterfalls and dams prevents the upstream and downstream migration of bull trout into the segment of the Spokane River and its tributaries in the vicinity of the project area. No dam on the Spokane River has a fish passage facility and all dams create fish barriers for upstream and downstream migration. EPA fact sheets for 1999 NPDES permits for wastewater treatment plants discharging to the Spokane River state that bull trout cannot get past the Post Falls Dam (EPA 2008). There is no known population of bull trout in the Spokane River downstream of the Post Falls dam (FERC 2006). The USFWS does not include the Spokane River and its tributaries located downstream from the Post Falls dam in bull trout recovery planning efforts (Federal Register / Vol. 75, No. 200 / Monday, October 18, 2010). The project will have No Effect on Bull Trout.

Bull Trout Critical Habitat

Activities that may adversely modify critical habitat include those that alter the primary constituent elements to an extent that the value of critical habitat for both the survival and recovery of the bull trout is appreciably reduced. The proposed project will not destroy or adversely modify critical habitat by altering primary constituent elements. The value of critical habitat for both the survival and recovery of the bull trout will not be reduced as a result of this project. The project will not alter the minimum flow or natural flow regime of the subject stream, alter any segment of the stream, riparian vegetation, or any chemical parameters so as to reduce water quality, alter channel morphology or create instream barriers to bull trout movement. No decrease in water quantity will occur because of the project. **The project will cause no significant and detrimental alterations to water quality and will have NO EFFECT on proposed Bull Trout Critical Habitat.**

4.3: Spalding's catchfly (*Silene spaldingii*), Federal Status: Threatened

The range of Spalding's silene (*Silene spaldingii*) includes eastern Washington, northeast Oregon, Idaho, and western Montana. Spalding's silene occurs primarily in open grasslands with minor shrub and/or (occasionally) scattered conifer components. Spalding's silene is found most commonly in Idaho fescue/snowberry associations at elevations of 1900-3050 feet. These sites are typically dominated by Idaho fescue and have sparse cover of snowberry where the total vegetative cover is greater than 100%. Some of these sites occur in a mosaic of grassland and ponderosa pine forest. Spalding's silene populations have been found on all aspects, although there seems to be a preference for slopes that face north. On drier sites, the species can be found on the bluebunch wheatgrass/Idaho fescue association.

Spalding's silene can occupy habitats that vary from sagebrush plains to mountain ridges. Spalding's silene generally occurs in native grasslands that are in reasonably good ecological condition, although populations have persisted in areas that have had moderate grazing pressure. Populations tend to be quite small and are currently quite fragmented, raising questions about their long-term viability. Fire may have historically played a role in maintaining habitat particularly in sites that are interspersed with ponderosa pine forest. Much of the historically suitable habitat has been lost through conversion or degradation.

The timing of the site investigation did not coincide with the flowering of listed plant species. The project biologist is a qualified botanist and wetland professional that routinely completes site investigations during all seasons when snow does not cover vegetation. Site investigations often occur when salient plant flowering parts are senescent or may not be sufficiently preserved to allow taxonomic identification beyond genus to the species level. Twenty years of experience in plant identification during all life history and seasonal growth habits has equipped the project biologist to conduct accurate plant identifications and wetland investigations in accordance with best available science and consistent with the accepted professional practices for the conditions at the time the work was performed.

Individual plants exhibit essential identification characteristics unique to their genera, but display sufficient variation so it is possible to categorize and differentiate each species within a genus using taxonomic keys. During plant senescence, individual characteristics often become blurred making it difficult or impossible for a botanist to differentiate among species within the genus. The sepals of the genus *Silene* form a bulbous calyx that is easily recognized and sufficient to identify the plant to genus. The Threatened species *Silene spaldingii* overlaps in range and is somewhat similar in appearance with some other species in the genus.

The field biologist is familiar with the species and has observed it at other locations. During the field investigation, the *Silene* genus was not identified in the Action or Project Areas. Previous years of cultivation, followed by the planting of turf grasses, years of mowing, and herbicide applications is sufficient grounds for discounting effects on Spalding's silene when considered alone. No populations of Spalding's silene were identified in the Project Area during the field investigation. **The project will have NO EFFECT on Spalding's Silene and will not result in the destruction or adverse modification of potential, designated or proposed Spalding's silene Critical Habitat.**

4.4: Water howellia (Howellia aquatilis)

Howellia is found in seasonal wetlands, ponds and lakes because its seeds do not germinate under water. Since seeds germinate in the fall and over-winter as seedlings Howellia requires a dry autumn followed by a wet spring in order to establish for the year. In addition to seasonally fluctuating ponds, Howellia requires fertile, highly organic soils, which are generally maintained by deciduous trees surrounding the ponds. Research indicates that Howellia does not form a persistent seed bank, making this annual especially dependent on year to year reproductive success in order to persist.

No Howellia was observed in the Project Area. Howellia is found in seasonal wetlands, ponds and lakes. No Howellia habitat occurs in the Project Area. **The project will have NO EFFECT on the Howellia aquatilis species and will not result in the destruction or adverse modification of potential, designated or proposed Howellia Critical Habitat.**

4.5: Canada lynx (Lynx canadensis) Federal Status: Threatened

Lynx prefer dense coniferous forest with sapling/pole thickets, rock outcrops, and wetlands at elevations of around 4000' to 4500'. The elevation of the Action Area is around 2010-2015 feet. Denning usually occurs in mature old growth stands with lots of deadfall. These forested stands do not occur in the Action Area. Lynx prefer snowshoe hare habitat, as they are dependent on snowshoe hare as a staple food item. Snowshoe hare prefers dense lodgepole stands that do not occur in the Project or Action Areas. BSW did not find any evidence of Canada lynx in the low elevations associated with the Project Area. **The project will have NO EFFECT on the Canada lynx or Canada lynx habitat.**

4.6: Species of Concern

The site was also investigated for the presence of species from the Species of Concern list for Spokane County published by the U.S. Fish and Wildlife Service. Most of these species are also included in the WDF&W list of priority species that was adopted by the City of Spokane Valley. Each species is listed below, followed by an evaluation of available habitat, observed habitat utilization, and potential project effects.

Bald eagle *(Haliaeetus leucocephalus)*

The Bald eagle is listed as a State Sensitive species. Eagles do not nest near the Project Area. Human activity associated with major roads and urban development are limiting factors for Bald eagles in the Action Area. At any location in Spokane County road kill can provide food for transient opportunist eagles. However, Bald eagles do not routinely forage in the Action Area and no nest sites were observed by BSW within one-half mile of the Project Area. BSW concludes that noise and human activity during construction will not impact eagle nesting as no nests were identified in the Action Area. Perching and foraging opportunities occur on the stream bank and eagles could utilize the stream corridor. **The project will have NO EFFECT on the Bald eagle.**

Western Burrowing Owl *(Athene cunicularia)* No historical observation in the vicinity. No individuals, nests, or sign observed during the site survey. **No Effect from project.**

California floater *(Anodonta californiensis)* freshwater mussel. **No Effect from project.**

Ferruginous hawk *(Buteo regalis)* nests on rocky ledge or high ground vantage on prairie. **No Effect from project.**

Giant Columbia spire snail *(Fluminicola columbiana)* cold, unpolluted, medium to large streams. **No Effect from project.**

Loggerhead shrike *(Lanius ludovicianus)* A robin sized gray, black, and white bird of open areas. Community types not dominated by shrubs, such as grasslands and riparian areas, are not used. Loggerhead Shrikes prefer nesting in big sagebrush and antelope bitterbrush, and avoid spiny hopsage, rabbitbrush, and green rabbitbrush (*Chrysothamnus viscidiflorus*). Nest shrubs are taller, closer to an edge, and contain denser cover and fewer main stems than unoccupied shrubs. Roost shrubs are large, dense live shrubs, whereas tall, dead shrubs that provide good visibility are used for perching. **No Effect from project.**

Longeared myotis ***(Myotis evotis)*** Roosts are sometimes found in crevices in small basalt rock formations. Compared to random plots, roosts are in more open, rocky habitats, closer to edge of forest stands, and relatively distant from sources of permanent water. Often roost in Ponderosa pine trees >30 cm in diameter and >12 m high. Less use of grasslands and closed pine than expected. **No significant effect if present in vicinity.**
Northern goshawk ***(Accipiter gentilis)*** goshawks select relatively closed-canopy coniffSerous/boreal forest habitat for nesting - **No significant effect.**
Olivesided flycatcher ***(Contopus cooperi)*** found in boreal and western coniferous forests - **No Effect**
Pallid Townsend's bigeared bat (Corynorhinus townsendii pallescens) Eastside mixed conifer forest, shrub-steppe, and riparian-wetlands. In Washington, old buildings, silos, concrete bunkers, barns, caves, and mines are common roost structures. **No effect on roosting or hibernicula**
Peregrine falcon (Falco peregrinus) Two subspecies of peregrine falcons (Falco peregrinus) occur in Washington state at present, (F. p. pealei and F. p. anatum). Peale's peregrine falcon is a coastal subspecies so our concern in Spokane County is with F. p. anatum (Continental peregrine falcon). DDT exposure totally eliminated this subspecies from former breeding sites in eastern Washington. Following a ban on the use of DDT, captive-reared young birds have been released at several sites in Spokane County in an attempt to augment natural reintroductions by wild birds. There is no potential for degradation or loss of critical habitat for peregrine falcons in the project area. Peregrine falcons nest on cliffs or even man-made structures such as buildings or bridges that do not occur in the project area so no action is required to protect nest sites from human disturbance. The primary method used to reintroduce falcons to the wild is called "hacking". WDF&W does not currently use any hack sites in the vicinity. **No significant effect**
Redband trout (Oncorhynchus mykiss) No Effect from project.
Sagebrush lizard ***(Sceloporus graciosus)*** **No Effect from project.**
Westslope cutthroat trout ***(Oncorhynchus clarki lewisi)*** **No Effect from project.**
Palouse goldenweed ***(Haplopappus liatriformis)*** palouse, not in our area **No Effect**

4.7: WDF&W Priority Species Deer, Elk, and Gray Wolf

Impacts to the WDF&W Priority Species White-tailed deer and Elk will be minimized by protecting a travel corridor through the site. The subject property is not mapped as White-tailed deer priority habitat. Wooded lands to the east and south are mapped as priority white-tailed deer habitat. However, deer utilize the site as they do all undeveloped parcels in the area. The site falls within the northern extent of the mapped Elk Habitat polygon in the Spokane Valley. The site does not provide cover or refugia required by elk and is not elk habitat, but Elk moving through the general area between Mica Peak and Dishman Hills could potentially cross the subject property on east/west treks. The developer will protect and enhance an east/west 8+ acre deer and elk travel corridor across the property. Woody vegetative plantings prescribed for the corridor will provide some habitat value and protective cover where none currently exists. Deer will continue to use the area set aside as a travel corridor.

The site is also mapped as Gray wolf habitat. It is possible that wolves could travel through the area in search of prey. There are deer and abundant small (domesticated) mammals available in this residential area so their presence would not be well received in the surrounding neighborhoods. Wolves could also utilize the 8+ acre travel corridor for safe east/west passage through the property.

4.8: Wetlands

Wetland Inventory Maps of the site show two wetlands on the property (Appendix 2). Both of the wetlands are shown to occur on the west side of Chester Creek. BSW investigated the mapped wetlands on March 1, 2015 and in each mapped wetland, dug a test hole on top of the creek bank in close proximity to the Chester Creek OHWM. On March 1, neither of the test holes had saturated soils in the top 16 inches of the soil profile. In Test Hole #1 the water table was at 21 inches and saturation occurred at 16 inches. In Test Hole 2, there was no saturation in the top 24 inches of the soil profile. The test holes were inspected again on March 29th and the water level in test holes was lower than on March 1st. This result was expected due to the landscape position of the mapped wetlands. The year to date precipitation for Spokane was hovering slightly above normal for the year to slightly below normal for the year to date so wetland hydrology should have been present in what was a normal year at the time of the investigation if the subject areas were wetlands. The argument that Spokane was below normal for the hydrologic year is not valid for this drainage basin because it has a low elevation and runoff comes earlier in the year than many other drainages as will be explained in detail below.

The wetland hydrologic criteria was not met in either test hole at the start of the growing season when the water table should have been at its annual high. Stream high water conditions consistent with a high water table does not typically occur during the growing season on Chester Creek. Seasonal high water occurs in the winter during rain on snow and frozen ground conditions. During the growing season, wetland conditions do not occur outside of the stream OHWM where the National Wetland Inventory Map indicates the wetlands occur. David Moore, DOE, investigated the site on June 8, 2016 and concurred with that finding.

4.8.1: Chester Creek Flood Frequency

A hydrologic and hydraulic analysis for Chester Creek was completed by Michael Baker Jr., Inc. and approved by Spokane County in a letter to the Federal Emergency Management Agency dated August 6, 1990. There are no long-term gage records for Chester Creek. The limited gage measurements on Chester Creek were collected near the Dishman-Mica Road crossing of Chester Creek from December 1994 through March 1995 and November 1995 through February 1996 when no flood events occurred. In February 2006, the hydraulic analysis for Chester Creek was revised by West Consultants, Inc. under a FEMA contract. The analysis established flood magnitude-frequency estimates for the watercourse. A steady flow model has been developed for Chester Creek.

The reports conclude that spring floods in the upper Spokane River basin are due to snowmelt runoff from high elevation watersheds. Such floods are of less significance on Chester Creek because the lower elevation of the watershed limits the size of the snowpack so spring runoff occurs about a month earlier and at more gradual rates than on the Spokane River. Nearly all maximum annual flood peaks on Chester Creek occur during the winter. Warm winds and rain can melt the snow rapidly. The May 1948 flood on Hangman Creek was a non-typical flood caused by a heavy snowpack, a late, cold spring, and heavy rains during the critical snow melting period. All other maximum annual flood peaks on Hangman Creek occurred during the winter. When winter rain causes snowmelt on frozen soil conditions, short-duration, intense runoff generates a flood peak during winter storms. During the more extreme events, Chester Creek runs over its banks filling depressions in the flood zone.

The duration of flooding is generally between 100 hours and 1000 hours, or between four days and forty days with smaller events occurring with greater frequency than large events.

Hydric soils form under saturated soil conditions. Wetlands have to exhibit saturated soils during the growing season, but those conditions seldom occur outside of the stream channel on Chester Creek because flooding usually happens in the winter. Floods are typically of a small magnitude so when over bank flow fills depressions outside of the channel, the water has usually infiltrated before the growing season begins. The subject areas may have been exposed to more frequent flooding in the past, but good planning and flood control measures designed to minimize flooding have moderated those historical flood events to some degree. Chester Creek does not follow the same hydrograph as snowmelt dominated systems.

4.8.2: Flood Protection Measures

Channel geometry for Chester Creek were developed from surveys conducted in March 2003. Overbank geometry were developed from topography developed by TerraPoint (2003). Flood plain boundaries for Chester Creek and Unnamed Tributary to Chester Creek were delineated using 2 foot contour interval maps developed by TerraPoint from LiDAR data.

Previously, a watershed plan for Chester Creek was designed with management recommendations for drainage, flooding, water quality, and riparian habitat. As a result, flood control improvements have been implemented along Chester Creek. The improvement area began at the Painted Hills Golf Course. In 1998, a project to install new culverts and extensive dredging of the channel between Thorpe Road and Schaffer Road was implemented. Two large volume borrow pits were constructed downstream. Each pit was designed for the retention and infiltration of Chester Creek floodwaters up to a 25 year event. One borrow pit was constructed just north of E. 40th Avenue and the other just south of 28th Avenue.

The Chester Creek channel has been historically maintained as has been reported in the literature and supported by direct evidence of spoil piles on the channel banks. Dredging makes the channel deeper and the dredging spoil piles make the channel banks higher. As a result of channel dredging, the surrounding areas are dewatered faster and the water table falls a corresponding distance deeper below the soil surface. Soils in the areas mapped as wetland exhibit some relic hydric characteristics from infrequent historical flooding, but with the exception of rare flood events, the water table is too far below the soil surface at the start of the growing season to meet the wetland hydrologic criteria.

The two mapped wetlands do not meet the hydrologic criteria so they are not wetlands. They are low lying areas adjacent to Chester Creek that have been historically flooded, but flooding is far too infrequent for the subject areas to meet the wetland hydrologic criteria. Even if they were wetlands, they are on the opposite side of the creek from where development is proposed so the riparian buffer would be more restrictive and extend further east into the development than a wetland buffer.

The undersigned filled out the current Wetland Rating Form and determined that if the mapped wetlands were actually wetlands, they would be Category 2 with a total point score of 19 points. The City Code assigns buffer widths based on points scored on the previous rating form. Using the previous rating form, the wetland scores 18 points for habitat functions so the buffer width would be 100 feet. The 100-foot buffer applied from the "(non)wetlands" located on the west side of the creek would only extend about 70 feet east of the creek so the 100-foot riparian buffer would be more restrictive to development and extend further east, even if wetlands did occur on the site as mapped. There are no wetlands on the subject property.

Additional flood control measures are being incorporated into the project design (see the Painted Hills Flood Control Plan). In the original version of this report, shallow ponds and subsurface gravel galleries were proposed at the south end of the property in the proposed wildlife travel corridor. The stormwater plan was subsequently revised to eliminate the ponds and gravel galleries. A three foot box will be installed in the Right of Way to prevent back up on the Haase property south of Thorpe. On the north side of Thorpe, water will proceed east in a concrete channel to Madison Road where it will be piped north to an infiltration field at the north end of the development. This plan revision will eliminate potential wetland impacts on the south side of Thorpe.

Other flood control measures will be required by FEMA as part of the levee certification process. To my knowledge, the channel was last dredged and maintained in 1998. Since that time honey willows planted in the Chester Creek channel have grown quite large. Roots of the honey willow compromise the integrity of the levee and their removal is required by FEMA as part of the levee certification process. Those riparian zone impacts cannot be mitigated in the stream channel or on the stream banks so the mitigation (replacement plantings) will occur in the riparian buffer and in the wildlife travel corridor. Replacement plantings of trees and shrubs will be installed as detailed later in this report.

4.9: Riparian Areas

The DNR Water Type Map (Figure 5) defines Chester Creek as a Type F Water. Chapter 21.40 of the City of Spokane Valley Municipal Code, titled Critical Areas, bases stream buffer widths on the DNR Riparian Management Zones. Chester Creek is greater than 15 feet in width (bankfull) so the appropriate buffer width can be found in Table 21.40-10 of the City Code. The DNR guidance states that in Eastern Washington, if there is no site index information, as in this case, assume Site Class III unless site specific information indicates otherwise. The table indicates that a Type F Natural Water not classified as a Shoreline of the State, having a Site Class 3 designation, has a total buffer width of 100 feet. BSW delineated the Chester Creek OHWM in the field on March 31, 2015. The OHWM flags were surveyed and plotted on the site plan map along with the 100-foot riparian buffer by Whipple Consulting Engineers.

The DNR Water Type Map also identified a Type F Water located about one mile east of the subject property. The map showed the stream crossing SR27 and running NW across a cultivated field before disappearing. There is no stream in that location so a Water Type Modification Form was submitted to Spokane County. The form was circulated to all appropriate agencies, the Water Type change was approved, and that stream segment was removed from the map. However, the FEMA map shows potential flood waters traveling toward the proposed development from that general direction. So additional work is being required by FEMA to raise the levee of an unregulated, man-made ditch located on adjacent property to the north. Several years ago, the ditch was proposed, approved, and created to convey stormwater to a borrow pit. After the levee improvements now required by FEMA, floodwater will have the same fate as stormwater and be conveyed into the borrow pit where it will infiltrate and have no impact on the proposed development. No impacts are proposed to regulated waters by this FEMA requirement so no mitigation is required.

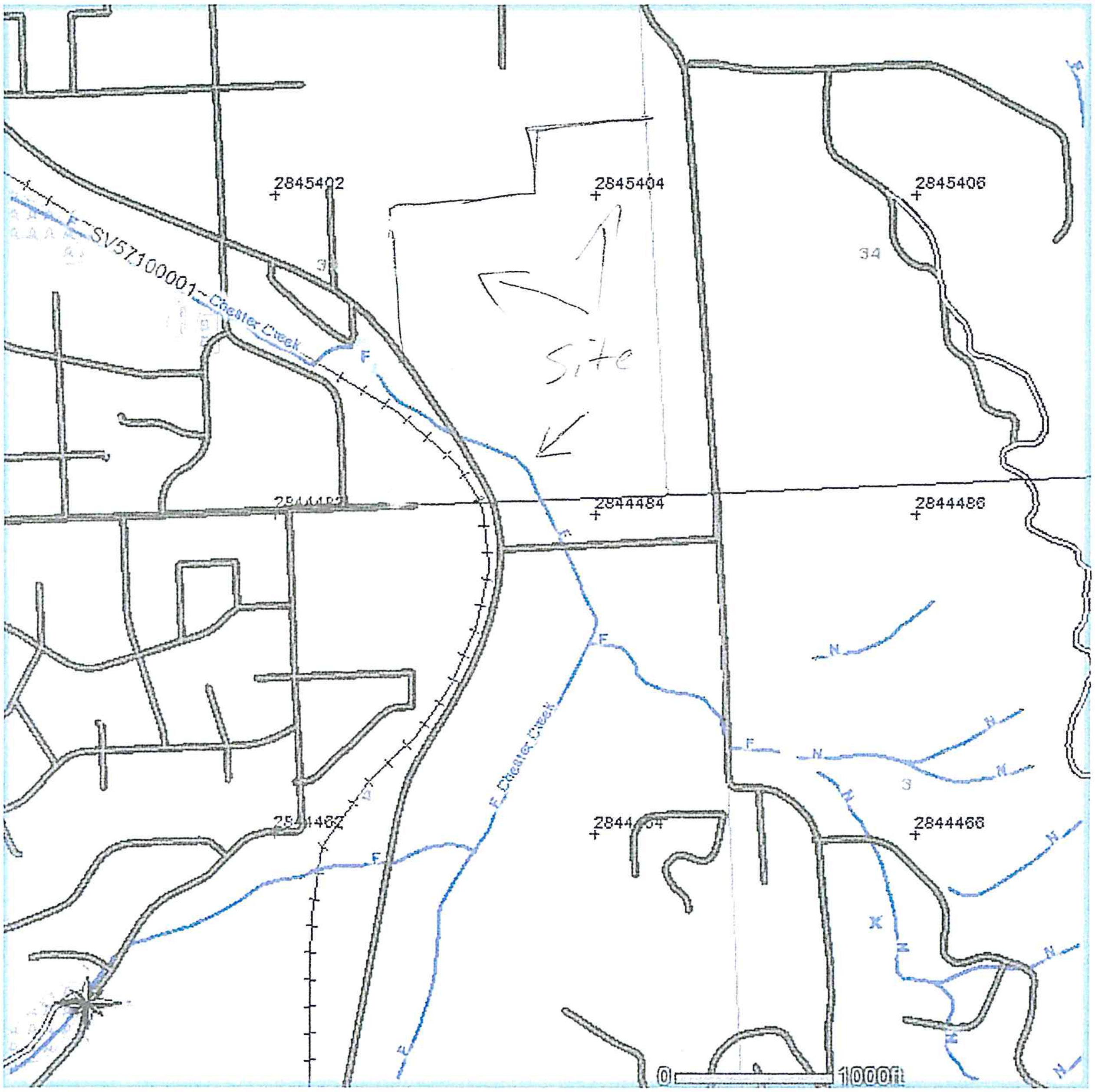
5.0: Riparian Buffer Impacts, Buffer Averaging, and Impact Mitigation

Chester Creek and its associated 100-foot buffer bisects the SW corner of the property. Buffer Width Averaging and buffer enhancement are proposed as mitigation for proposed riparian buffer impacts. The existing buffer is almost totally devoid of woody vegetation because the site was previously utilized and maintained as a golf course and driving range.

Figure 5: **FOREST PRACTICE WATER TYPE MAP**

TOWNSHIP 0 NORTH HALF undefined, RANGE 0 (W.M.) HALF undefined, SECTION 0

Application #:____________________________



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Buffer impacts are proposed in six areas (Figure 6) with a total buffer impact of 23,877 sq. ft. (0.55 acres). The impacts will be mitigated in several ways. Buffer Averaging will be employed to insure no net loss of buffer occurs. The existing buffer will be enhanced by the planting of tree and shrub patches. The buffer replacement area will be enhanced by the planting of tree and shrub patches. The proposed 8+ acre wildlife habitat/travel corridor will be enhanced by the planting of tree and shrub patches.

5.1: Buffer Impacts from Two Homes

Part of the buffer impact (8725.60 ft2) results from two lots located in close proximity to the southmost bridge across Chester Creek. The subject area experienced the highest intensity human activity on the property during the years of golf course operation. Foot and golf cart traffic from the club house was directed by cart paths over two bridges to the fairways, driving range, and practice areas across the creek where the buffer impact from two lots is proposed. The only remaining woody vegetation is located inside the Chester Creek channel where honey willows were planted in the channel thirty years ago. FEMA requires all woody vegetation and roots to be removed within 15 feet of the levee so no woody vegetation will remain in the subject area. The removal of woody vegetation and continued use of the two bridges and trails crossing the stream and buffer has the effect of funneling, controlling, and limiting human access to this narrow corridor or choke point.

The existing bridges will be utilized and the cart paths will be extended east to connect the housing development on the east side of the creek to the bar and restaurant located in the former golf course clubhouse on the west side of the creek. This part of the riparian buffer will continue to experience high intensity human activity. This part of the buffer historically experienced the highest degree of degradation and will continue to experience the greatest intensity of human activity. The proposed impacts occur in an existing disturbed area that will benefit the least from protection, while the mitigation is proposed where it will have the greatest benefit for wildlife.

The Critical Areas Ordinance states that buffer areas may be modified by the director if "the riparian area contains variations in sensitivity due to existing physical characteristics which justify the averaging." The variation in habitat physical characteristics and sensitivity in the riparian buffer are a result historical land uses and variation in the intensity of human activity. The area around the two bridges will benefit least from protection or habitat enhancement due to historical and continued high intensity human activity in this existing disturbed footprint.

Some vegetative plantings will be installed between the proposed buffer encroachment and the creek, but there will be little wildlife activity in this area. Woody vegetation plantings will function mainly as human esthetic improvements but will have some benefit for birds. The vast majority of the vegetative plantings prescribed as mitigation for the buffer reduction will be installed in patches throughout the rest of the buffer where there will be little human activity and the vegetative enhancements will provide greater function for wildlife habitat. In the proposed buffer replacement area there is currently little woody vegetation so native trees and shrubs will be planted densely to improve habitat quality. Habitat enhancement will also occur in the designated wildlife travel corridor and where wildlife will benefit the most from the enhancement.

Variations in sensitivity are created by the existing physical characteristics (bridges and trails), historical land uses (vegetation removal and intense human activity), and the continued concentration of human activity on trails and bridges through that narrow corridor across the stream and buffer on both sides. That corridor has the least habitat function because it has the least wildlife activity. The proposed buffer impact will occur in the least sensitive area from the perspective of wildlife presence, use, and function. Buffer enhancement will occur where there is the least human activity and the greatest benefit for wildlife from the perspective of wildlife presence, use, and function. The total area contained within the buffer after averaging is greater than that contained within the standard buffer prior to averaging.

5.2: Buffer Impacts from the Trails and Road Improvement

Three separate buffer impacts will occur from trails. Two of the impacts will result when the existing trails are extended from the bridges into the development and connected to a proposed trail in the 8+ acre wildlife travel corridor. A third impact will occur when an existing parking lot at the south end of the property is connected to the trail system. The three buffer impacts result in an additional 4356.09 sq. ft. of riparian buffer impact. The buffer impact areas will be replaced in the remediation area shown in Figure 6. The required improvement of Thorpe Road will result in an additional 2,752 sq. ft. of buffer impact. Those impacts are listed under the heading of Right-of-Way impacts on Figure 6. The total riparian buffer impact area of 23876.38 sq. ft. will be replaced with 24,136.34 sq. ft. of new buffer. The proposed 8+ acre Wildlife Travel Corridor is basically an extension of the buffer replacement area and will also be enhanced with vegetative plantings (Figure 7).

5.3: Mitigation of Willow Removal from the Chester Creek Levee

As previously stated in Section 4.8.2 of this report (titled Flood Protection Measures) the creek banks in the project area are defined as a levee and are subject to a certification process. The channel may not have been dredged or maintained since 1998. Since that time, willows have grown taller in the Chester Creek channel. Willow roots compromise the integrity of the levee and their removal is required by FEMA as part of the levee certification process.

The impacts associated with willow removal will be temporary. The equipment will operate when the channel is dry so water quality impacts are not an issue. Best Management Practices and spill control protocols will be strictly adhered to and peripheral impacts will be held to a minimum. The channel may be dry, but the equipment operators must respect the sensitivity of the area, install construction fences to identify minimized work areas, and take all prudent measures to minimize impact in the buffer. All temporary impact areas will be restored at the earliest possible moment to prevent soil erosion. The replacement woody vegetation plantings cannot be placed in the stream channel or within 15 feet of the levee so the replacement planting will occur in the riparian buffer and wildlife travel corridor as detailed later in this report.

5.4: Temporary Buffer Impact Mitigation

Since the original HMP was submitted in 2015, it was determined that the height of the levee must be increased in two places. The purpose of raising the levee is to provide an additional one foot of freeboard at existing crossings. Starting at, and extending 100 feet north from Thorpe Road, the levee height will be raised one foot on the east side of the creek. The levee will also be raised one foot in height on the east side of the creek between and around the two foot bridges. This work will be completed in strict accordance with the Best Management Practices and comply with FEMA specifications. All areas with exposed soils on the new levee and peripheral disturbed soils will be planted with a native seed mix as specified by FEMA to prevent erosion and facilitate future levee inspection.

5.5: Buffer Impacts in the Two Commercial Triangles

One small area of buffer impact could occur where Chester Creek exits the property and flows under Dishman-Mica Road (Figures 6 & 7). The riparian buffer extends slightly into an 1134.16 sq. ft. triangle of a commercially zoned lot. The triangle may never be impacted, but if the adjacent commercial area is developed, the adjacent land use will effectively destroy the buffer function. BSW is identifying that as an impact and relocating the small triangle of buffer to the proposed buffer averaging replacement and enhancement area that will provide greater benefit than leaving it in place in its current condition along the road where it has no habitat value.

The same is true for a commercially zoned 5921.97 sq. ft. triangle of buffer located east of the restaurant parking lot (west side of the creek). An existing building in that general area may be torn down so the existing parking lot could be expanded at some future date. The subject triangle was historically mowed adjacent to the parking lot and provided no habitat function. The vegetative community is dominated by canarygrass with lettuce, tansy, knapweed, and wormwood also represented. The commercially zoned triangle may never be impacted, but if the adjacent area is developed, that land use will effectively destroy the buffer function. BSW is identifying it as an impact and relocating the buffer to the proposed buffer replacement and enhancement area that would provide greater benefit than leaving it in its current condition where it has no habitat value. The area between the potential future impact and the stream will be enhanced as part of the mitigation plan. The buffer will be smaller in that area, but the resulting mitigation and vegetative enhancement will represent an improvement over the existing condition and justifies moving it instead of leaving it at the present location.

5.6: Mitigation Area Summary

The proposed buffer mitigation provides very generous compensation for the proposed impacts. Buffer impacts are proposed in six areas with a total buffer impact of 23,877 sq. ft. (0.55 acres). The impacts will be mitigated in several ways. Buffer Averaging will be employed to insure no net loss of buffer occurs. The 23,877 sq. ft. impact area will be replaced with a 24,137 sq. ft. area that is contiguous with the existing riparian buffer. The area of proposed buffer reduction will be enhanced by the planting of tree and shrub patches. The remaining riparian buffer will also be enhanced by planting patches of native woody vegetation on both sides of the stream. The buffer replacement area will be enhanced by planting native tree and shrub patches. The buffer replacement area will be contiguous with the 8+ acre Wildlife Travel Corridor where additional tree and shrub plantings are proposed to mitigate the approximate 200 lineal feet of temporary impacts to the levee. All proposed temporary impact areas will also be restored with native vegetation as prescribed by FEMA (COE guidelines).

The proposed vegetative enhancement of the remaining buffer areas, replacement buffer areas, and wildlife travel corridor provides generous mitigation to offset the impacts. The proposed vegetative enhancement represents a significant improvement compared to the existing condition and historical land uses of the last several decades, so buffer averaging results in the necessary biological, chemical, and physical support necessary to protect fish and wildlife.

Monitoring of the vegetative plantings will continue for 5 years or until the City of Spokane Valley is satisfied that the conditions of the mitigation plan have been met. Reinforcement plantings and weed control will be prescribed by the project biologist as determined by annual site monitoring.

The minimum container size shall be one half gallon. Vegetation shall be planted at the landscapers discretion according to conditions on the ground and the location of existing vegetation. Plantings shall be interspersed around existing vegetation, and where possible, in patches of 15-25 plants of mixed size and species as indicated in the plan.

5.7: Noxious weed control

The dominant invasive species that were identified on the site include tumble mustard and knapweed. These species are known for their ability to propagate and spread rapidly with catastrophic impacts on native species. As required by Washington State Noxious Weed Control law, RCW 17.10, and the Spokane County Noxious Weed Board, invasive species will be managed through control measures that do not adversely impact native vegetation. Funds will be allocated for noxious weed monitoring and herbicide control as part of the proposed mitigation for this project. Black Realty shall contract their preferred weed control specialist to monitor the site and provide weed control in the enhancement area at the appropriate intervals throughout the growing season to prevent seed set.

5.8: Revegetation with Woody Plants

In addition to noxious weed control, mitigation for buffer impacts will include the planting of native trees and shrubs. The buffer will be re-vegetated with native plants including species from the tree, shrub, and grass vegetative strata. The replication of natural spatial relationships, structural complexity, vertical stratification, and microhabitat diversity will be stressed in the planting design to achieve a mosaic of open areas and dense tree/shrub clusters. Vegetation will not be planted in a uniform manner. Shrubs will be planted in grouped patches and interspersed with other shrub species and height classes. Patch size will be variable with curving edges. The incorporation of these elements will increase landscape diversity and promote habitat elements that are often scarce or absent at sites that have been disturbed. Native species and endemic plant materials will be selected for site revegetation to help maintain ecotypes that are adapted to local climatic and soil conditions and preserve local genotypes.

5.9: Objectives for the Restored Riparian Buffer

Restoration will be achieved by planting native trees, shrubs and grasses primarily to provide food and cover for wildlife. The Vegetation Plan will incorporate as many design features as possible for each function in order to increase the value for that function.

Objective a: Re-establish species diversity and structural diversity in the buffer by replanting native tree and shrub species from each vegetative class.

Objective b: Re-establish vegetative species and structural diversity to re-establish bird and mammal habitat values in the enhanced buffer areas.

Objective c: Re-establish vegetative density in the riparian buffer area.

5.10 Planting Strategy

Woody plant materials will be installed at the industry standard density of 360 stems per acre. The buffer replacement area is 0.55 acres X 360 stems/acre = about 200 containers. The Buffer Replacement Area shall have 200 containers planted within that polygon. An additional 200 containers will be distributed throughout the east and west sides of the creek in the existing buffer and buffer reduction areas (Zone 1 and Zone 2, Figure 8). An additional 400 containers shall be planted in patches of 20 containers throughout the designated wildlife travel corridor. The replication of structural complexity, vertical stratification, and microhabitat diversity will be emphasized in the planting design. Shrubs will be planted in the buffer with the goal of providing wildlife habitat and enhancing the functions and values of the buffer. The vegetation will be planted in patches, have curving edges, and will not be planted in a uniform manner.

5.11: Rationale

Structural complexity refers to the arrangement and degree of interspersion of plant community types throughout the system. Complex structural patterns (such as variable patch size, curving edges, and high degree of interspersion between species) increase the value of a system for wildlife. Good wildlife habitat consists of open areas interspersed with clusters of vegetation, several horizontal layers, and a variable structural pattern. **Vertical stratification** describes a community with good structural diversity and several horizontal layers (logs, woody debris, forbs, shrubs, and trees). Woody debris provides travel routes, perch sites, cover, and thermal refuge for a variety of small mammals and ground nesting birds. **Microhabitat diversity** refers to variety in microhabitat types. Examples of microhabitat types include herbaceous cover and shrubs that provide food, habitat, and substrate for a variety of animals.

6.0: Mitigation Planting Plan

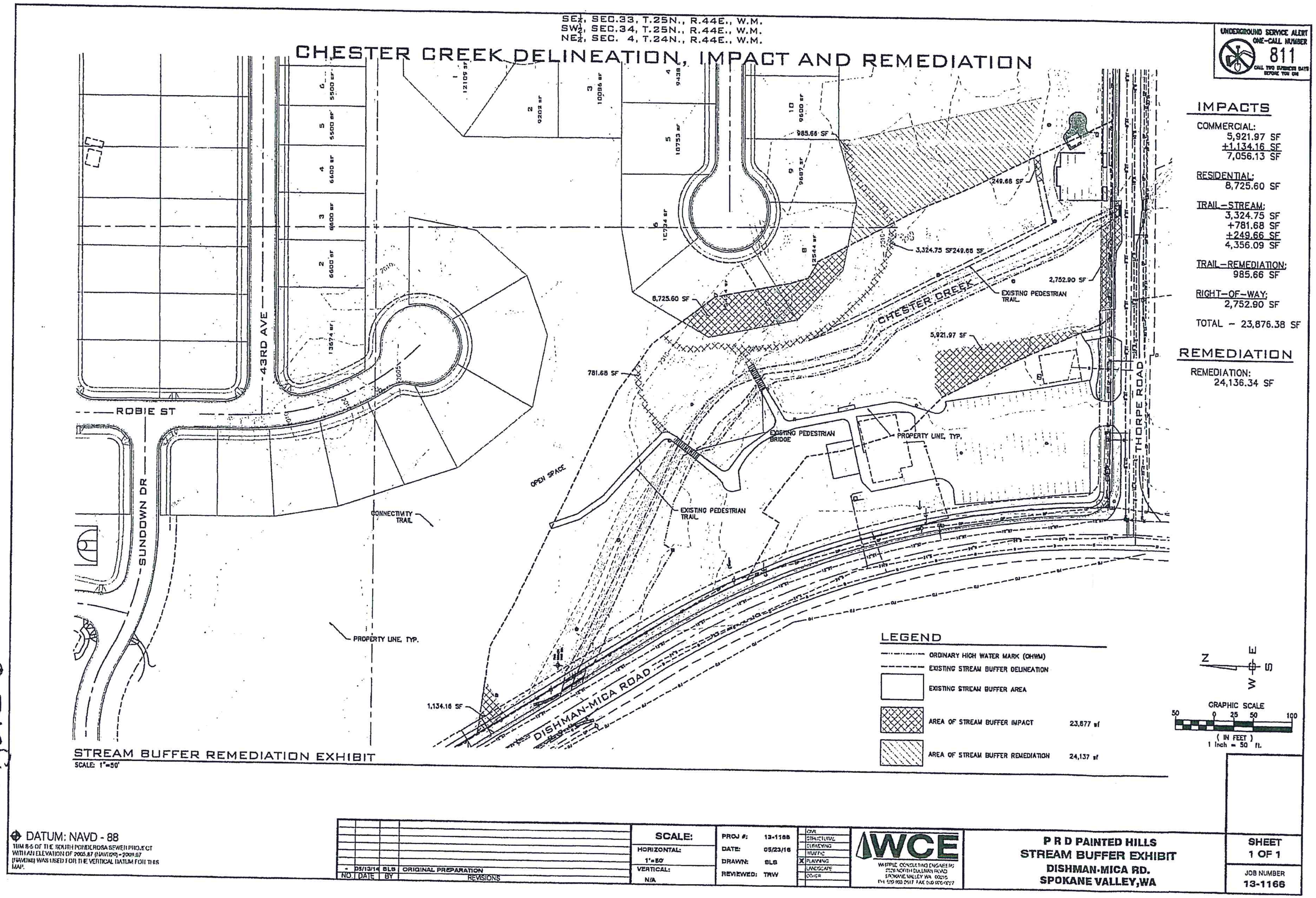
6.1: Materials Specification

Clusters of vegetation will be planted according to the guidelines prescribed above. The specified number of containers will be planted within each zone as shown in Figure 8.

Zones 1 and 2: Riparian Buffer on East and West Sides of Chester Creek

A total of 200 containers planted in existing buffer areas

	Common Name	Scientific Name	# Planted
Trees	Ponderosa pine	*Pinus ponderosa*	20
Large shrubs	serviceberry	*Amelanchier alnifoloia*	40
	mock orange	*Philadelphus lewisii*	40
Small shrubs	Wood's rose	*Rosa woodsii*	30
	common snowberry	*Symphoricarpos albus*	50
	Phlox sp.	*Phlox speciosa or longifolia*	20
Total			200



SE¼, SEC.33, T.25N., R.44E., W.M.
SW¼, SEC.34, T.25N., R.44E., W.M.
NE¼, SEC. 4, T.24N., R.44E., W.M.
CHESTER CREEK DELINEATION, IMPACT AND REMEDIATION
UNDERGROUND SERVICE ALERT ONE-CALL NUMBER 811
IMPACTS
COMMERCIAL:
5,921.97 SF
+1,134.16 SF
7,056.13 SF
RESIDENTIAL:
8,725.60 SF
TRAIL–STREAM:
3,324.75 SF
+781.68 SF
+249.66 SF
4,356.09 SF
TRAIL–REMEDIATION:
985.66 SF
RIGHT-OF-WAY:
2,752.90 SF
TOTAL – 23,876.38 SF
REMEDIATION
REMEDIATION:
24,136.34 SF
43RD AVE
ROBIE ST
SUNDOWN DR
THORPE ROAD
DISHMAN-MICA ROAD
CHESTER CREEK
OPEN SPACE
CONNECTIVITY TRAIL
PROPERTY LINE, TYP.
EXISTING PEDESTRIAN TRAIL
EXISTING PEDESTRIAN BRIDGE
985.66 SF
249.66 SF
3,324.75 SF
2,752.90 SF
8,725.60 SF
5,921.97 SF
781.68 SF
1,134.16 SF
LEGEND
ORDINARY HIGH WATER MARK (OHWM)
EXISTING STREAM BUFFER DELINEATION
EXISTING STREAM BUFFER AREA
AREA OF STREAM BUFFER IMPACT 23,877 sf
AREA OF STREAM BUFFER REMEDIATION 24,137 sf
GRAPHIC SCALE
(IN FEET)
1 inch = 50 ft.
STREAM BUFFER REMEDIATION EXHIBIT
SCALE: 1"=50'
DATUM: NAVD - 88
SCALE:
HORIZONTAL: 1"=50'
VERTICAL: N/A
PROJ #: 13-1166
DATE: 05/23/16
DRAWN: BLB
REVIEWED: TRW
- 05/13/14 BLB ORIGINAL PREPARATION
NO. DATE BY REVISIONS
WCE
P R D PAINTED HILLS
STREAM BUFFER EXHIBIT
DISHMAN-MICA RD.
SPOKANE VALLEY,WA
SHEET 1 OF 1
JOB NUMBER 13-1166

Figure 6

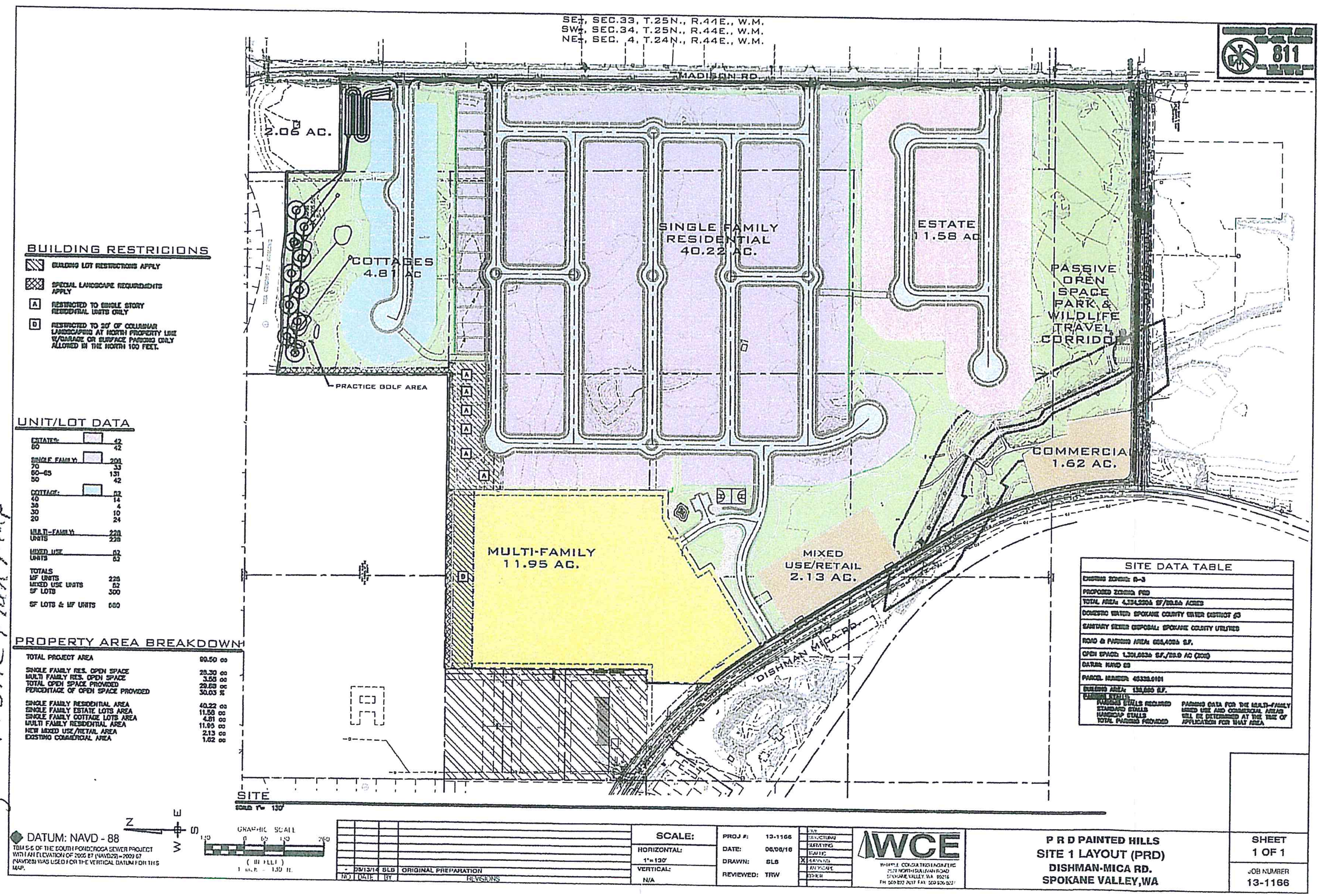


Figure 7: Site Plan Map

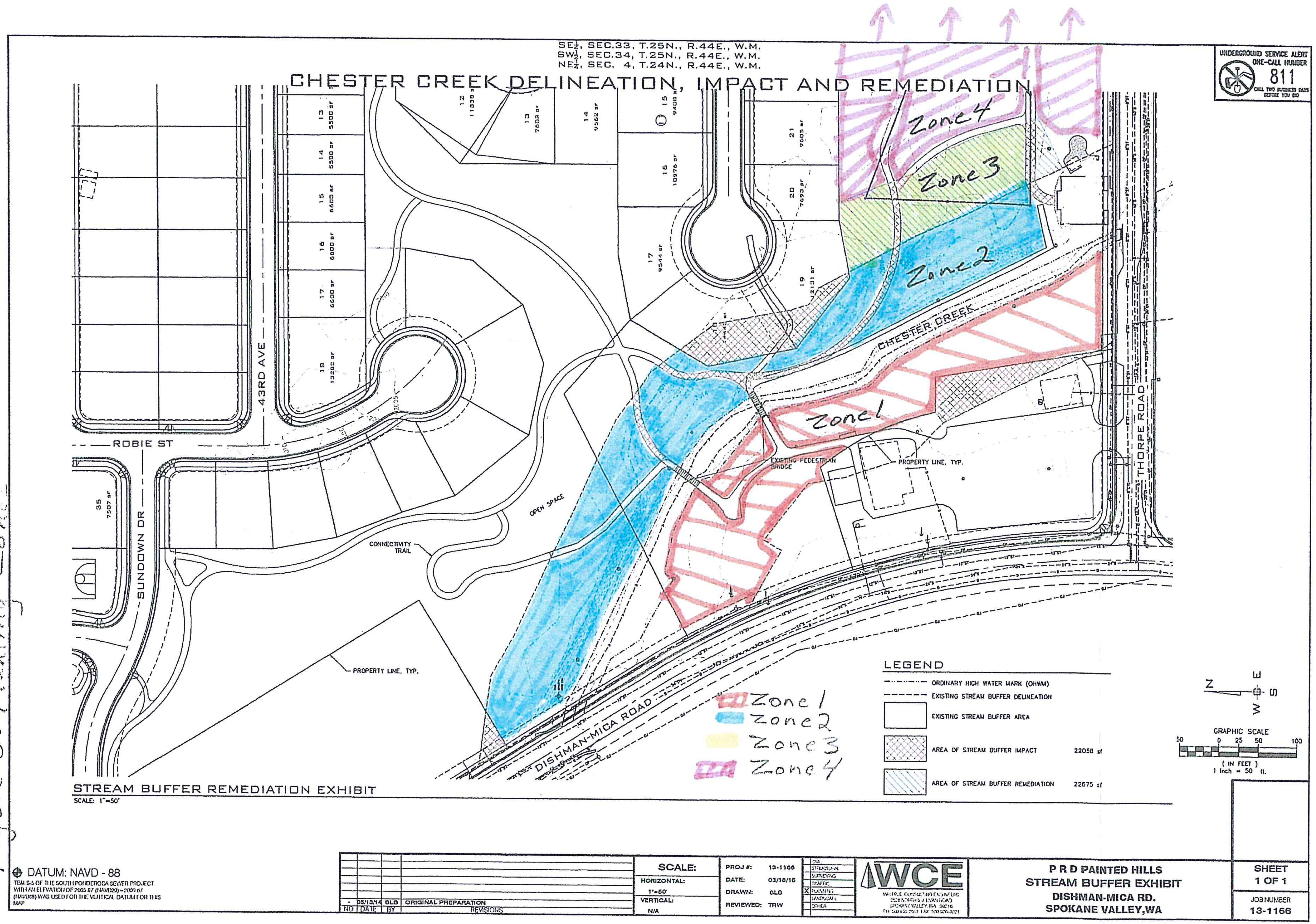


Figure 8: Planting Zones

Zone 3 - Buffer Replacement Area on East Side of Chester Creek

200 plants in patches

	Common Name	Scientific Name	# Planted
Trees	Ponderosa pine	*Pinus ponderosa*	22
Large shrubs	serviceberry	*Amelanchier alnifoloia*	33
	Rocky mountain juniper	*Juniperous scopulorum*	30
	chokecherry	*Prunus virginiana*	20
	mock orange	*Philadelphus lewisii*	30
Small shrubs	Wood's rose	*Rosa woodsii*	20
	common snowberry	*Symphoricarpos albus*	25
	Phlox sp.	*Phlox speciosa or longifolia*	20
Total			200

Zone 4 - Wildlife Travel Corridor on East Side of Chester Creek

400 plants in patches

	Common Name	Scientific Name	# Planted
Trees	Ponderosa pine	*Pinus ponderosa*	50
Large shrubs	serviceberry	*Amelanchier alnifoloia*	60
	Rocky mountain juniper	*Juniperous scopulorum*	30
	chokecherry	*Prunus virginiana*	50
	mock orange	*Philadelphus lewisii*	60
Small shrubs	Wood's rose	*Rosa woodsii*	70
	common snowberry	*Symphoricarpos albus*	80
Total			400

Shrubs shall be planted in the approximate prescribed quantities depending on plant availability. Large shrubs should be planted in clusters on 10-foot centers. Small upland shrubs should be clustered on 3-6 foot centers around large shrubs.

Depending on availability, the mixture of grass species listed below should be drill seeded or hydroseeded at a density of 22 pounds PLS per acre in all disturbed areas. Grasses should be planted during the growing season when precipitation and temperature levels will insure germination and survival. Grasses should be planted early in the fall so that the crop is well established by October 15. If germination, growth, and root development are substantial before the end of the growing season, some degree of erosion control will be provided during the winter and spring months that follow. **It may be necessary to irrigate the soil surface to keep it in a moist condition for the first two weeks after seeding. Irrigation should supplement rainfall as required to achieve a total from combined sources of 2 inches per week and no more than 0.25 inches per hour.** Seed can also be installed to lie dormant over the winter and germinate in the spring.

Grasses

Common Name	Scientific Name	Bunch or Sod	PLS (lb/acre)
bluebunch wheatgrass	*Agropyron spicatum*	B	8.0
Idaho fescue	*Festuca idahoensis*	B	6.0
prairie junegrass	*Koeleria cristata*	B	8.0
Total			22.0

6.2: FEMA Mitigation Requirements

All work on the levee and embankment shall be completed in strict compliance with FEMA requirements using the US Army Corps of Engineers manual titled Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures (ETL 1110-2-583 dated 30 April 2014). The manual states that all vegetation not in compliance with the ETL shall be removed. The removal of noncompliant vegetation includes trunk, stump, root ball, and roots greater than 1/2 inch diameter in the levee, or within 15 feet of the flood damage reduction structure. The following paragraphs have been inserted from COE manuals for reference. The conditions listed below shall be strictly adhered to, but project construction shall not be limited to the conditions listed below, but must be in compliance with all conditions in the referenced COE manual.

"The only acceptable ground cover in the COE mandated vegetation free zone is perennial grasses to prevent erosion. Noxious weeds are not tolerable. The grass species must not grow to exceed 12 inches in height and be tolerant of mowing to a height of 3 inches to allow levee inspection at least once per year. It will be necessary to mow, burn, or graze to inspect for and control pests, weeds, and burrowing animals, repair damage to the embankment, and maintain the grass cover crop. Woody vegetative plantings prescribed for mitigation in this report shall not be placed in the levee, or within 15 feet of the flood damage reduction structure.

The native grass species selected for the project shall be appropriate to the local climate, conditions, and surrounding or adjacent land uses. BSW recommends a sod type species, not a bunch grass type, should be selected or prescribed by COE, will tolerate mowing to heights as low as 3 inches as follows: "at least once each year for inspection, and in anticipation of flood conditions and associated monitoring and flood-fighting activities. b. If the local climate, hydraulic and hydrologic environment, soils, or other conditions will not support such grass species, then non-vegetative means of erosion control shall be employed, e.g., riprap, pavement, articulating concrete mats, or other engineered surface. c. A maximum grass height is specified for embankment dams and their appurtenant structures (see Paragraph 3-4c, "Vegetation-Free Zones")." "Paragraph 3-4c. Vegetation-Free Zones. Vegetation-free zones shall, when dry, be mowed to a height of 3–6 in. at any time the grass reaches a height of 12 in.. Mowing shall be triggered by grass heights of less than 12 in. if important to the health maintenance of the particular grass species. The maximum height of grasses shall be 12 in."

"5-2. Operations and Maintenance Manual. For each project, it is important that the O&M manual include an annual maintenance program to control animal burrows and vegetative growth. It is also important that vegetation be managed in such a manner as to avoid the need for mechanized removal and associated embankment repair, and avoid any incidental growth and subsequent presence of endangered species that might prohibit access and activities necessary for O&M. 5-3. Removal of Non-Compliant Vegetation. a. All vegetation not in compliance with this ETL shall be removed. A detailed removal plan shall be submitted to the local USACE District Levee Safety Officer for review and comment before removal of vegetation. The removal plan shall expand on the following basic requirements. (1) By excavation, remove the trunk (or stem), stump, rootball, and all roots with diameters greater than ½ in. All such roots in, or within 15 ft of, the flood damage reduction structure shall be completely removed. (2) Assure that the resulting void is free of organic debris. (3) Fill and compact the void according to the original soil and compaction specifications: or, if no specifications exist, match adjacent soil and compaction. b. Removal of non-compliant vegetation can create significant issues for the owner/operator, as maintenance may require environmental permits. The local sponsor must coordinate with the Corps and other appropriate agencies and obtain all the required environmental permits (including Corps of Engineers 404 permits) before conducting work within the levees. Mechanized land clearing below the plane of the "Ordinary High Water Mark" will normally require Clean Water Act permits before work can commence. (Note that "Ordinary High Water Mark" is defined in 33 CFR Part 328.3(e)."

A grass seed mixture recommended or approved by FEMA and/or COE must be applied on the approximate 200 lineal feet of levee that will be raised by one foot and all peripheral embankment areas where the vegetation is temporarily disturbed by equipment. The agencies should prescribe one grass seed mixture for the Riparian Area (wetland species) and one for the adjacent upland.

A list of suppliers who will prepare the prescribed grass seed mixtures and supply nursery stock specified in the vegetation plan follows.

Grass seed: Grassland West 1-800-582-2070
PO Box 489
908 Port Drive
Clarkston, WA 99403

Trees, & Shrubs:

Plants of the Wild
PO Box 866
Tekoa, WA 99033
509-284-2848

Wildlife Habitat Institute
1025 East Hatter Creek Road
Princeton, ID 83857
208-875-8704

6.3: Ponderosa Pine Planting

ALWAYS plant after December 15 and before March 31. Plant ONLY conservation grade seedlings 20-24 feet from fast growing deciduous trees. Plant seedlings **on 30 foot centers** with no shrubs inter-planted close to the trees to prevent shading and competition that greatly reduces survival. A mulch of Ponderosa pine needles applied in a 3-6 foot radius around the tree trunk at planting will greatly reduce competition and increase tree survival.

Ponderosa pine out-planting survival following *Rhizopogon rubescens* inoculation is 2-3 times higher compared to non-inoculated. Numerous studies have shown that ectomycorrhizal fungi can profoundly affect conifer performance by facilitating nutrient and water uptake, maintaining soil structure, and protecting roots from pathogens and environmental extremes. A specific ectomycorrhizal fungus, *Rhizopogon rubescens*, inoculated onto the root systems of Ponderosa pine seedlings greatly increase survival. Irrigation options are being explored at this mitigation site, but the landscaper should buy plants that have been inoculated or dust the planting holes with this fungi if it is available.

6.4: Additional Planting Guidelines

Depending on availability, the mixture of grass species listed above should be seeded at a density of 25 pounds PLS per acre. Grasses should be planted during the growing season when precipitation and temperature levels will insure germination and survival. Grasses should be planted in early April so that the crop is well established before dry weather, in the fall so that the crop is well established before October 15, or dormant seeded late in the fall so the seed will not germinate until spring. Site preparation and planting should occur in the fall and winter.

Seeding rates of live, germinable seed or Live Pure Seed (LPS) are a product of seed lot purity and germination percentage. LPS calculations are based on the number of seeds per pound and the number of seeds per square foot at one pound per acre. A nursery will prepare a custom seed mix with the prescribed LPS for each species.

Trees and shrubs should be planted after the end of the growing season when the plants are dormant. The best time to plant is late winter when sub-zero temperatures are over but plants are still dormant. Plants may be planted any time during the growing season when the daytime high temperatures are 70F or cooler if irrigation is available from the time of planting through the rest of the growing season. Each tree or shrub planted should be clearly identified with an easy to identify tag that identifies the species. Without such identification it is impossible for the monitoring biologist to tell which plants are enhancement plantings and which are native to the site.

6.5: Additional Site Protection Measures

Many people drive, park and passively enjoy recreation in the area so the enhancement areas must be protected from human traffic after planting. Signs should be posted every 100 feet to explain the sensitivity of the newly planted areas and discourage foot traffic in newly seeded areas. Permanent signs with Riparian Buffer Area, Natural Area Do Not Disturb, or similar language should be posted around the areas protected as riparian buffer.

6.6: Timeline for Construction

Due to the appeals process, it is very difficult to predict when construction will be permitted. It is very unlikely that construction will begin in 2016, more likely that construction will begin in 2017. Regardless of which year construction begins, it is known that the first construction phase will include the stormwater plan and the levee work. When that work is completed, disturbed areas will be reclaimed and planted in accordance with the terms of this mitigation plan. BSW will monitor site impacts and mitigation work to insure the work is completed as specified in this plan. The five year monitoring requirement for each phase will be implemented as described below.

6.7: ESA and FEMA Compliance

The purpose of this report is to confirm that the project is in compliance with Sections 9 and 10 of the Endangered Species Act. The proposed flood control and floodplain changes will have no effect on any listed species. For the Chester Creek Main Channel (golf course overflow reach) most of the 1% annual-chance floodplain within the project site is effectively being intercepted and directed to the infiltration facilities located on the north end of the project area, rather than entering the existing golf course and infiltrating. For the Chester Creek Unnamed Tributary, the floodway and 1% annual chance floodplain are being intercepted by the gravel pit infiltration facility just north of 40th, and are being removed from the FEMA mapping. These actions are simply enhancement of the existing facility and the proposed changes will have no effect on any listed habitat or species.

7.0 THE MONITORING PLAN

All monitoring plans require that a mitigation site be monitored annually to determine whether the goals and performance standards have been met. Monitoring typically lasts for 5 years or until the City of Spokane Valley is satisfied that the conditions of the mitigation plan have been met. The site should be monitored in the spring to evaluate the success of weed control from the previous year and prescribe weed control for the current year. The monitoring will also evaluate plant survival to insure that performance standards for percent ground cover of native vegetation are met. Planting of the original grass seed mixture will be repeated to fill in problem areas if they occur.

The City of Spokane Valley will be notified immediately after diagnosis of failing functions, hydrologic systems, or biological vitality and integrity of the plantings as determined through annual monitoring. The vegetation will be managed to insure 80% areal cover with native grasses after five years (year 1=20%, year 2-30%, year 3=50%, year 4=70%, year 5=80%). Tree and shrub stock will be monitored to insure 80% survival after 5 years. Reinforcement plantings will be performed annually as necessary to insure performance standards are met at the end of five years.

This above Monitoring Plan refers only to mitigation plantings prescribed by BSW and does not apply to levee monitoring and maintenance that will be continued indefinitely and is outside of the professional capabilities of the undersigned.

8.0 LIMITATIONS

Within the limitations of scope, schedule, and budget, BSW services have been executed in accordance with best available science and generally accepted professional practices for the conditions at the time the work was performed. This report is not intended to represent a legal opinion. Specifically, there is no positive or negative recommendation towards the purchase, sale, lease, or construction on the subject property. No warrant, expressed or implied, is made.

Larry Dawes 8/30/2016

Larry Dawes Date
Principal Biologist
Biology Soil & Water, Inc.
3102 N. Girard Road
Spokane Valley, WA 99212-1529
Phone 509-327-2684
Email: bswinc@icehouse.net

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Appendix 1
U.S. Fish & Wildlife Service
SPOKANE COUNTY
Updated 8/29/2015

LISTED

Threatened
Salvelinus confluentus) (Bull trout) – Columbia River distinct population segment
Howellia aquatilis (Water howellia), plant
Silene spaldingii (Spalding's silene), plant
Spiranthes diluvialis (Ute ladies'-tresses), plant
Lynx canadensis (Canada lynx)
Coccyzus americanus (Yellow-billed cuckoo)

SPECIES OF CONCERN
Bald eagle *(Haliaeetus leucocephalus)* (delisted, monitor status)
Burrowing owl *(Athene cunicularia)*
California floater *(Anodonta californiensis)*, mussel
Ferruginous hawk *(Buteo regalis)*
Giant Columbia spire snail *(Fluminicola columbiana)*
Loggerhead shrike *(Lanius ludovicianus)*
Long-eared myotis (*Myotis evotis*)
Northern goshawk *(Accipiter gentilis)*
Olive-sided flycatcher *(Contopus cooperi)*
Pallid Townsend's big-eared bat *(Corynorhinus townsendii pallescens)*
Peregrine falcon (*Falco peregrinus*) (Delisted, monitor status)
Redband trout *(Oncorhynchus mykiss)*
Sagebrush lizard *(Sceloporus graciosus)*
Westslope cutthroat trout *(Oncorhynchus clarki lewisi)*

Vascular Plants
Haplopappus liatriformis (Palouse goldenweed)

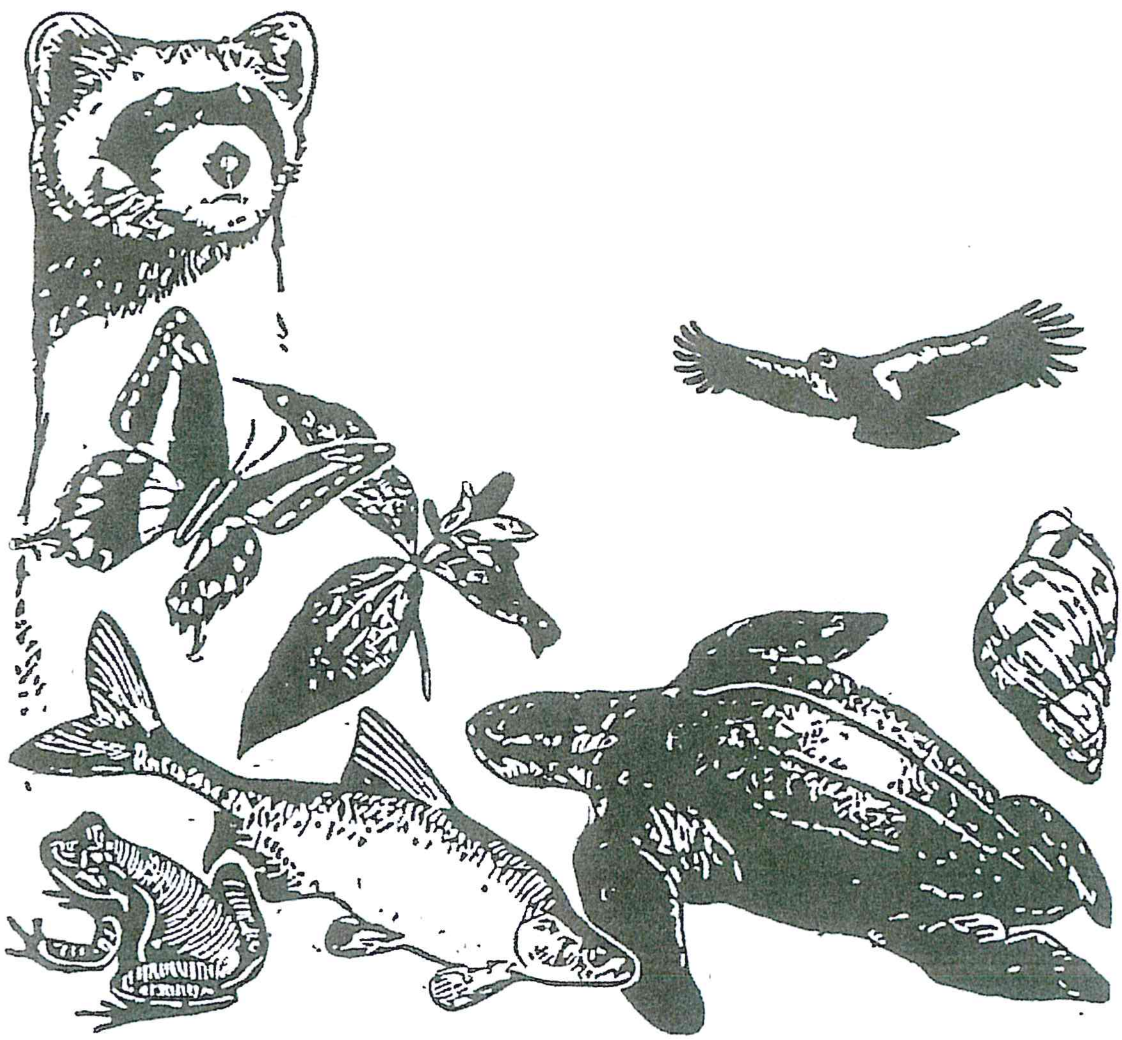
Appendix 2
Critical Areas Maps

U.S. Fish & Wildlife Service

IPaC Trust Resources Report

Generated August 29, 2016 07:52 PM MDT, IPaC v3.0.8

This report is for informational purposes only and should not be used for planning or analyzing project level impacts. For project reviews that require U.S. Fish & Wildlife Service review or concurrence, please return to the IPaC website and request an official species list from the Regulatory Documents page.



IPaC - Information for Planning and Conservation (https://ecos.fws.gov/ipac/): A project planning tool to help streamline the U.S. Fish & Wildlife Service environmental review process.

U.S. Fish and Wildlife Service

Trust Resources List

Endangered Species Act Species List (*USFWS Endangered Species Program*).

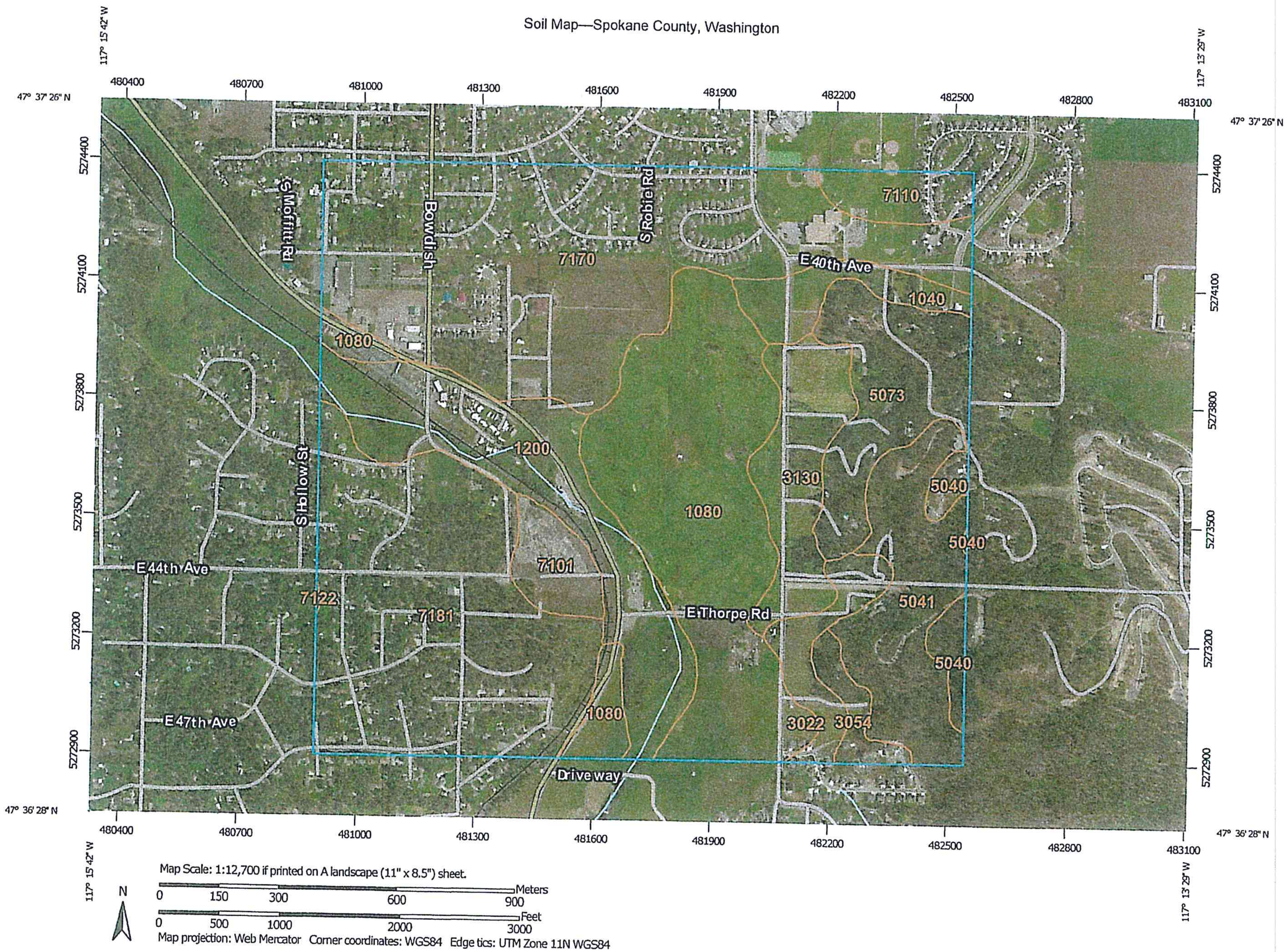
There are a total of 5 threatened or endangered species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fishes may appear on the species list because a project could cause downstream effects on the species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section below for critical habitat that lies within your project area. Please contact the designated FWS office if you have questions.

Species that should be considered in an effects analysis for your project:

Birds	Status		Has Critical Habitat	Contact
Yellow-Billed Cuckoo (*Coccyzus americanus*) Population: Western U.S. DPS	Threatened	species info	Proposed critical habitat	Washington Fish And Wildlife Office
Fishes				
Bull Trout (*Salvelinus confluentus*) Population: U.S.A., conterminous, lower 48 states	Threatened	species info	Final designated critical habitat	Washington Fish And Wildlife Office
Flowering Plants				
Spalding's Catchfly (*Silene spaldingii*)	Threatened	species info		Washington Fish And Wildlife Office
Water howellia (*Howellia aquatilis*)	Threatened	species info		Washington Fish And Wildlife Office
Mammals				
Canada Lynx (*Lynx canadensis*) Population: (Contiguous U.S. DPS)	Threatened	species info	Final designated critical habitat	Washington Fish And Wildlife Office

Critical habitats within your project area:

There are no critical habitats within your project area.


117° 15' 42" W
117° 13' 29" W
47° 37' 26" N
47° 36' 28" N
480400
480700
481000
481300
481600
481900
482200
482500
482800
483100
5274400
5274100
5273800
5273500
5273200
5272900
S Moffitt Rd
Bowdish
S Robie Rd
E 40th Ave
S Hollow St
E 44th Ave
E Thorpe Rd
E 47th Ave
Driveway
7110
7170
1040
1080
5073
1200
3130
5040
7101
7122
7181
5041
3022
3054
Map Scale: 1:12,700 if printed on A landscape (11" x 8.5") sheet.
N
0
150
300
600
900
Meters
0
500
1000
2000
3000
Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Spokane County, Washington
Survey Area Data: Version 5, Sep 4, 2014

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

Date(s) aerial images were photographed: Jun 4, 2011—Jul 5, 2011

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

Map Unit Legend

Spokane County, Washington (WA063)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1040	Hardesty ashy silt loam, 0 to 3 percent slopes	14.4	2.3%
1080	Narcisse silt loam, 0 to 3 percent slopes	108.4	17.7%
1200	Endoaquolls and Fluvaquents, 0 to 3 percent slopes	61.9	10.1%
3022	Bong ashy sandy loam, moist, 0 to 8 percent slopes	14.3	2.3%
3054	Clayton ashy fine sandy loam, 0 to 8 percent slopes	7.2	1.2%
3130	Phoebe ashy sandy loam, 0 to 3 percent slopes	29.2	4.8%
5040	Spokane-Swakane complex, 3 to 15 percent slopes	7.9	1.3%
5041	Spokane-Swakane complex, 15 to 30 percent slopes	43.1	7.0%
5073	Lenz-Rock outcrop complex, 15 to 30 percent slopes	37.6	6.1%
7101	Pits-Dumps complex	12.0	2.0%
7110	Urban land-Opportunity, disturbed complex, 0 to 3 percent slopes	11.4	1.9%
7122	Urban land-Marble, disturbed complex, 8 to 15 percent slopes	0.1	0.0%
7170	Urban land-Springdale, disturbed complex, 0 to 3 percent slopes	153.0	24.9%
7181	Urban land-Phoebe, disturbed complex, 3 to 8 percent slopes	112.9	18.4%
Totals for Area of Interest		613.5	100.0%

U.S. Fish and Wildlife Service

National Wetlands Inventory

May 14, 2015

Wetlands

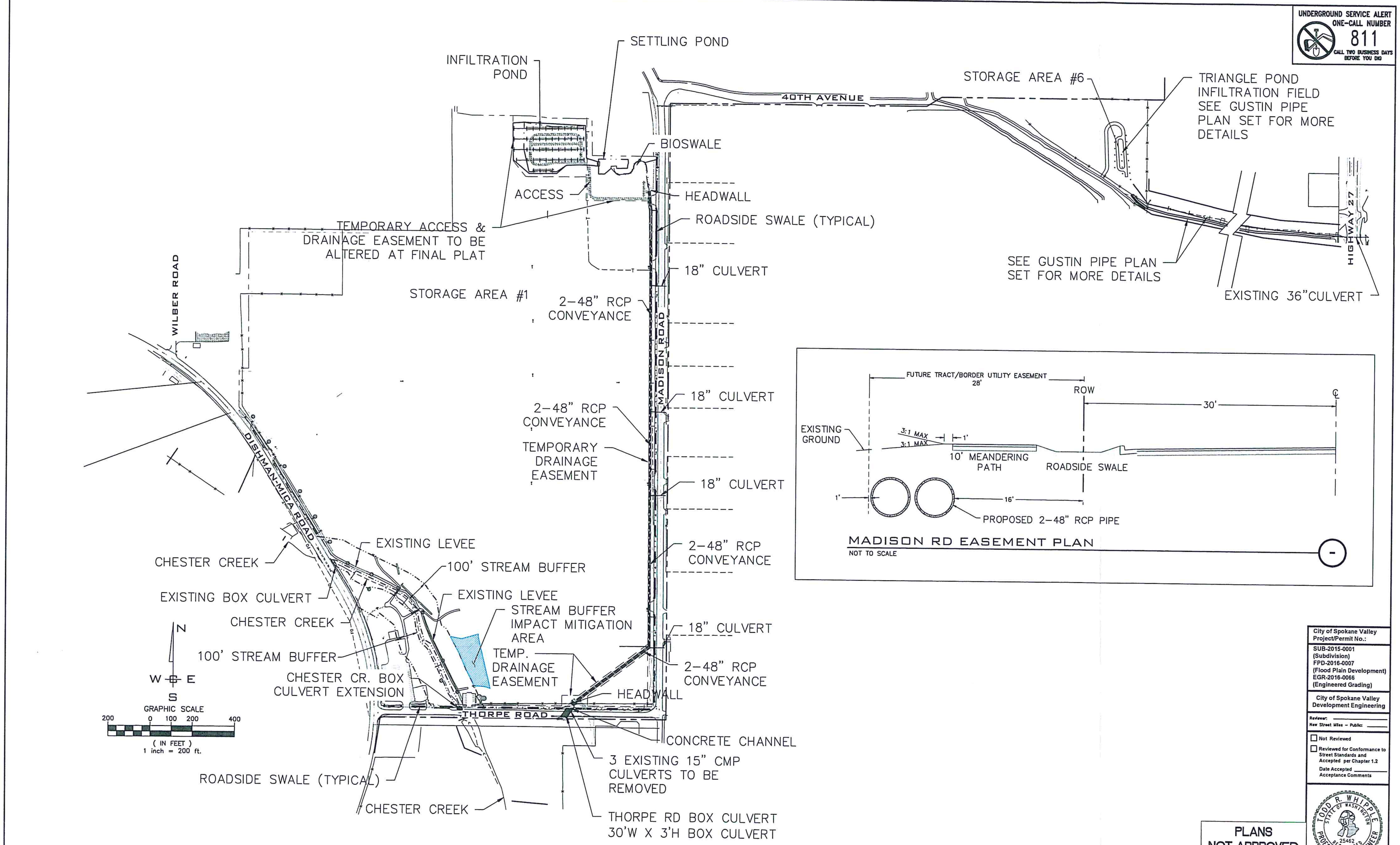
- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

User Remarks:

No wetland hydrology at either location. NOT a wetland.

SITE ELEMENT PLAN



City of Spokane Valley Project/Permit No.:
SUB-2015-0001 (Subdivision)
FPD-2016-0007 (Flood Plain Development)
EGR-2016-0066 (Engineered Grading)

City of Spokane Valley Development Engineering

Reviewer: ______
New Street Miles – Public: ______

☐ Not Reviewed
☐ Reviewed for Conformance to Street Standards and Accepted per Chapter 1.2
Date Accepted ______
Acceptance Comments

TODD R. WHIPPLE — STATE OF WASHINGTON — 25462 REGISTERED PROFESSIONAL ENGINEER

PLANS NOT APPROVED BY AGENCY

DATUM: NAVD - 88

TBM S-5 OF THE SOUTH PONDEROSA SEWER PROJECT WITH AN ELEVATION OF 2005.87 (NAVD29)=2009.67 (NAVD88) WAS USED FOR THE VERTICAL DATUM FOR THIS MAP.

NO.	DATE	BY	REVISIONS
2	08-14-18	JPP	REVISED PLANS
1	08-12-16	JPP	ORIGINAL PREPARATION

SCALE:	
HORIZONTAL:	1" = 200'
VERTICAL:	N/A
PROJ #:	13-1166
DATE:	08/14/18
DRAWN:	JPP
REVIEWED:	TRW

X CIVIL
STRUCTURAL
SURVEYING
TRAFFIC
PLANNING
LANDSCAPE
OTHER

WCE
WHIPPLE CONSULTING ENGINEERS
2528 NORTH SULLIVAN ROAD
SPOKANE VALLEY, WA 99216
PH: 509-893-2617 FAX: 509-926-0227

SPOKANE VALLEY PAINTED HILLS PRD
SITE ELEMENT PLAN
DISHMAN-MICA RD.
SPOKANE VALLEY,WA

SHEET C1.3

JOB NUMBER 13-1166

100 Year Flood Event

Thorpe Road Crossing
- 64 cfs with Channel South of Thorpe
- 91 cfs without Channel South of Thorpe

Madison Hills Flow to Culverts
- 15 cfs through 4 - 18" Culverts

Gustin Pipe Flow to Triangle Pond
- 16 cfs through 36" Culvert under Highway 27

Ben Goodmansen

From: Ken Puhn <kpuhn@westconsultants.com>
Sent: Monday, July 16, 2018 8:37 AM
To: Ben Goodmansen
Subject: requested info for Painted Hills

Ben,

Per our conversation you had requested confirmation of water surface elevations in the vicinity of the Madison culverts and also the flood discharges entering your facilities. The 100-year water surface elevations calculated by our XPSWMM model within the Madison pipes are shown in the table below. The 100-yr discharges are shown in the 2nd table below. Note that the levee breach discharge came down slightly once I had the final design in the model.

Let me know if you need anything else.

Ken

Node	Max 100-yr WSE
Pipe_Inlet	2009.49
SDMH 1B	2008.30
SDMH 1A	2008.12
SDMH 2A	2007.61
SDMH 2B	2007.86
SDMH 3B	2006.51
SDMH 3A	2006.14
SDMH 4B	2005.64
SDMH 5B	2004.63
SDMH 4A	2004.11
SDMH 6B	2003.99
SDMH 5A	2003.81
Pipe_Outlet	2003.71
US of Spreader	2003.72

Location	100-yr (cfs)	100-yr levee breach (cfs)
Gustin Ditch Downstream of Hwy 27	16	n/a
Golf Course Overflow @ Thorpe	64	91
Golf Course Overflow plus Madison hills inflows	79	106

System Capacity

Box Culvert Capacity
216.4 cfs @ 2 ft of depth, 1 ft of Freeboard

Madison Mainline Pipe Capacity
154.32 cfs & 3.8 ft of depth

Bio Filtration Channel
269.86 cfs @ 6 ft of depth

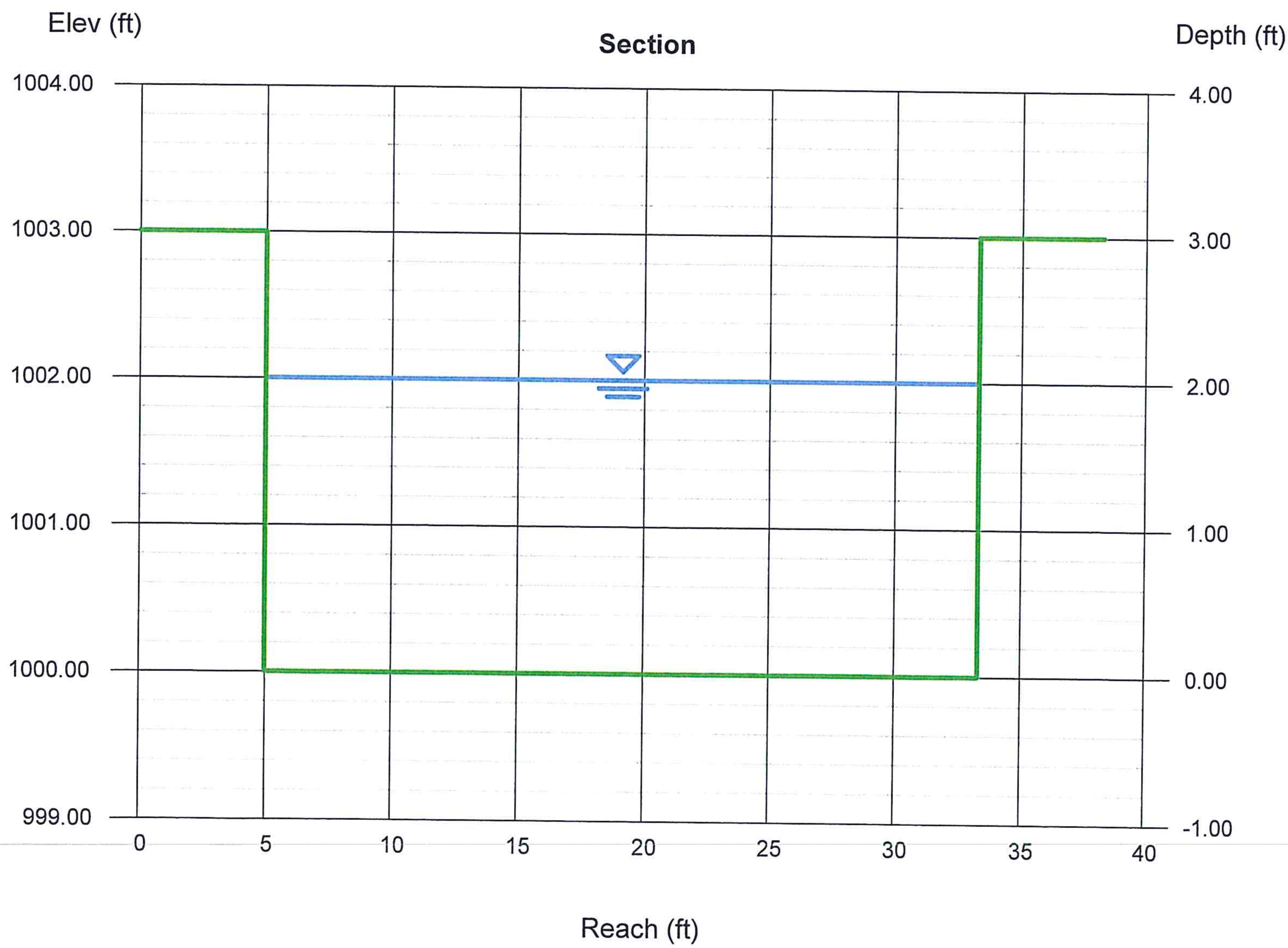
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 7 2018

Box Culvert Capacity

Rectangular		**Highlighted**	
Bottom Width (ft)	= 28.33	Depth (ft)	= 2.00
Total Depth (ft)	= 3.00	Q (cfs)	= 216.40
		Area (sqft)	= 56.66
Invert Elev (ft)	= 1000.00	Velocity (ft/s)	= 3.82
Slope (%)	= 0.50	Wetted Perim (ft)	= 32.33
N-Value	= 0.040	Crit Depth, Yc (ft)	= 1.22
		Top Width (ft)	= 28.33
Calculations		EGL (ft)	= 2.23
Compute by:	Q vs Depth		
No. Increments	= 30		

N-value come from SRSM page 5-11 table 5-4
Rock lined - Jagged & Irregular



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Tuesday, Jun 19 2018

Madison Pipe (1- 48 in Pipe)

Circular

Diameter (ft)	= 4.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 0.25
N-Value	= 0.013

Per Table 8-4 SRSM

Calculations

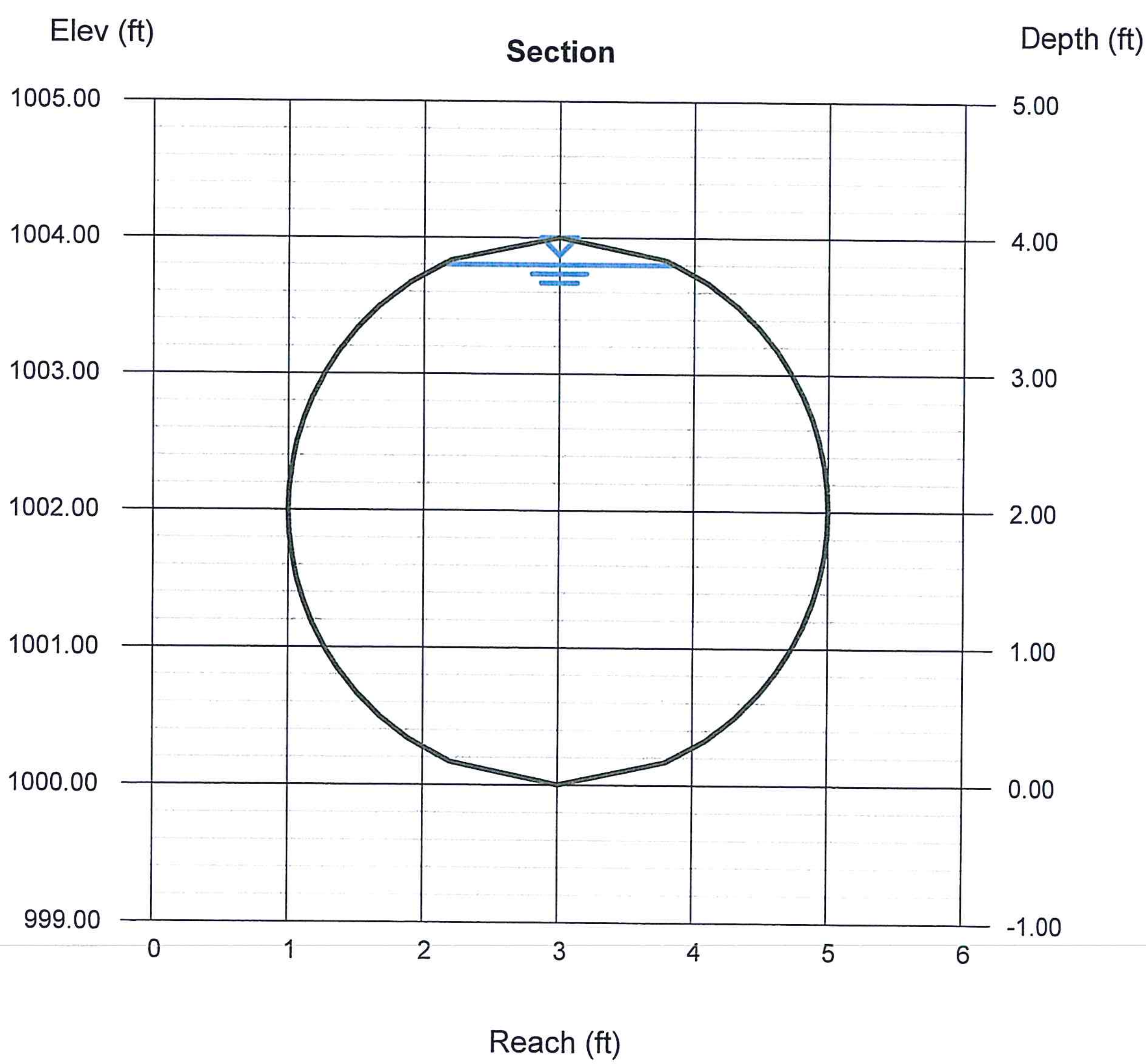
Compute by:	Q vs Depth
No. Increments	= 20

Highlighted

Depth (ft)	= 3.80
Q (cfs)	= 77.16
Area (sqft)	= 12.34
Velocity (ft/s)	= 6.25
Wetted Perim (ft)	= 10.78
Crit Depth, Yc (ft)	= 2.66
Top Width (ft)	= 1.73
EGL (ft)	= 4.41

1 PIPE MAX FLOW (= 77.16)

2 PIPE MAX FLOW = 154.32 cfs



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Jun 7 2018

Bioswale Capacity

Trapezoidal

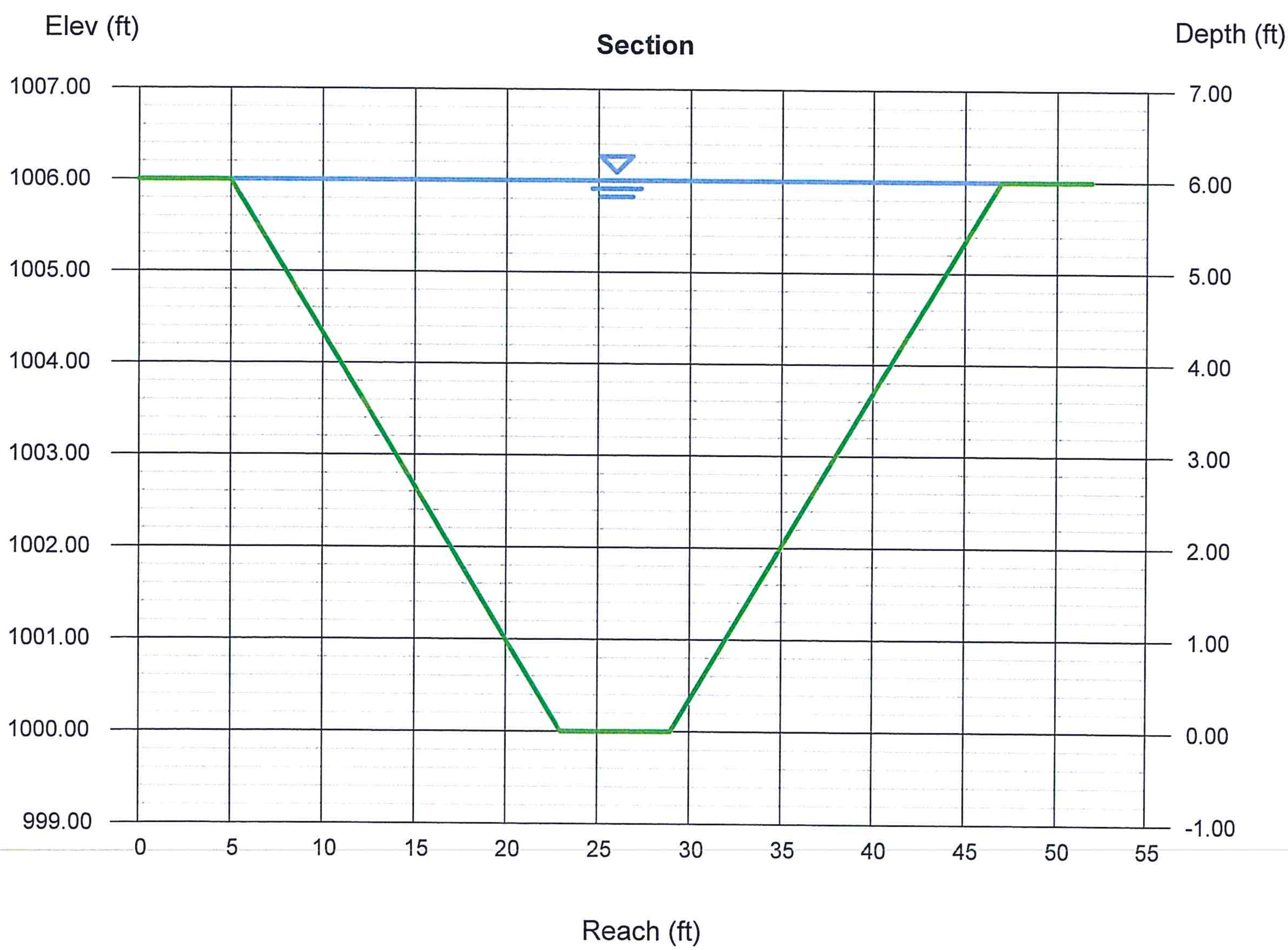
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.00
N-Value	= 0.175

Calculations

Compute by:	Q vs Depth
No. Increments	= 20

Highlighted

Depth (ft)	= 6.00
Q (cfs)	= 269.86
Area (sqft)	= 144.00
Velocity (ft/s)	= 1.87
Wetted Perim (ft)	= 43.95
Crit Depth, Yc (ft)	= 2.64
Top Width (ft)	= 42.00
EGL (ft)	= 6.05



BOX CULVERT/CONCRETE CHANNEL CALCULATIONS

PIPE SYSTEM CALCULATIONS

MADISON ROAD CULVERT FLOW CALCULATIONS

Storage and Discharge

Pond Summary Worksheet

- Settling Pond
- Infiltration Pond
- Emergency Park Storage

GRAVEL GALLERY WORKSHEET - NORTH

- Outflow 162.64 cfs – Storage Volume 109,805 cf

WHIPPLE CONSULTING ENGINEERS
POND VOLUME CALC SHEET

Date: 6/19/2018

Project: 13-1166 FLOOD PONDS
Designer: JPP

Volume to Bioswale Outlet

	Ponds	Bottom Area sf	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Inlet Elevation (avg)	Conic Volume to Rim cf	Side Slope Volume cf	*Treatment* Total Volume to Rim cf	Conic Volume to Inlet cf	Side Slope Volume cf	*Storage* Total Volume to Inlet cf
	STORAGE	61,004	247	1995.80	1996.80	1997.80	61,004	1,482	62,486	122,008	5,928	127,936
	***SETTLING**	7,172	85	1996.80	1996.80	1997.80	0	0	0	7,172	508	7,680
Total		**68,176**							**62,486**			**135,616**

*Assumes portion of Bioswale to reach a depth of 1' but does not include additional volume

Volume to Pipe Inlet

	Ponds	Bottom Area sf	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Inlet Elevation (avg)	Conic Volume to Rim cf	Side Slope Volume cf	Total Volume to Rim cf	Conic Volume to Inlet cf	Side Slope Volume cf	*Total Volume to Inlet cf
	STORAGE	61,004	247	1995.80	1996.80	2000.24	61,004	1,482	62,486	270,858	29,214	300,072
	SETTLING	7,172	85	1996.80	1996.80	2000.24	0	0	0	24,672	6,013	30,685
Total		**68,176**							**62,486**			**330,757**

*Does not include additional storage provided by Bioswale

Emergency Park Storage

	Ponds	Bottom Area sf	Squared Side lf	Pond Bottom Elevation at Drywell	Pond Drywell Elevation	Pond Inlet Elevation (avg)	Conic Volume to Rim cf	Side Slope Volume cf	Total Volume to Rim cf	Conic Volume to Inlet cf	Side Slope Volume cf	*Total Volume to Inlet cf
	Rim	176,181	420	2006.00	2007.00	2011.00	176,181	2,518	**178,699**	880,905	62,961	**943,866**

ac-ft = 4.10 21.67

WHIPPLE CONSULTING ENGINEERS

GRAVEL GALLERY CALC SHEET

5/15/2018

13-1166 Painted Hills PRD
ENGINEER JPP

Note: infiltration rates per IPEC Geotechnical Report Dated December 31, 2013

Gallery Depth (Min)	Porosity of Gravel (Typ)			Infiltration Rate
ft	cf/cf			cfs/sf
10	0.3			1.80E-03
4	0.3			1.80E-03

Gallery		Number of Galleries	Length	Width	Ground Water EL.	Gravel Gallery Bott. EL	Volume	Storage Volume	Perimeter	Sidewall Area	Bottom Area	Outflow
			ft	ft	ft	ft	cf	cf	ft	sf	sf	cfs
CONTACT AREA		1	246.99	246.99	-	-	244016	73205	988	3,952	61,004	**116.92**
A		1	280.00	10.00	-	-	28,000	**8,400**	580	5,800	0	**10.44**
B		1	280.00	10.00	-	-	28,000	**8,400**	580	5,800	0	**10.44**
C		1	280.00	10.00	-	-	28,000	**8,400**	580	5,800	0	**10.44**
D		1	280.00	10.00	-	-	28,000	**8,400**	580	5,800	0	**10.44**
E		1	100.00	10.00	-	-	10,000	**3,000**	220	2,200	0	**3.96**
Totals								**109,805**				**162.64**

*Note: Btm Area = Gallery Area - Contact Area

Storage Volume = Volume* Porosity
Sidewall Area= Perimeter*Depth
OutFlow = Sidewall Area+ Bottom Area * Infiltration Rate

Note: Outflow Assumes a Full Gallery

BIO-FILTRATION CHANNEL WORKSHEET

79 cfs With Channel South of Thorpe
83% of treatment achieved

106 cfs Without Channel South of Thorpe
69% of treatment achieved

Open- Channel Hydraulics, Chow (reference)

Bio-filtration Swale Design

Based on King County 2005 Surface Water Design Manual (Section 6.2 and 6.3)

Modified to model flow of flood water utilizing reference Open Channel Hydraulics, CHOW

Design Flow:

Q_{wq} = 79.00 **cfs** With channel south of Thorpe

Calculation of swale depth

$Q = 1.49\ A\ R^{0.67} S^{0.5}\ n^{-1}$ Manning's equation

OR

$b = Q_{wq}\ n_{wq}\ (1.49 * y^{1.67} S^{0.5})^{-1}$

OR

$y = [Q_{wq}\ n_{wq}\ (1.49 * b * S^{0.5})^{-1}]^{0.6}$

where

b = bottom width of swale (ft)…minimum 2 ft width required, maximum 10 ft

Q_{wq} = water quality design flow (cfs)

n_{wq} = Manning's roughness coefficient for vegetal retardance conditions (CHOW)

y = design flow depth

S = longitudinal slope (along direction of flow) (ft/ft), slope shall be between 1%-6%. If less than 1.5%, underdrains must be provided. Slope less than 1% is considered a "wet biofiltration swale" and must be designed under those guidelines. Slope greater than 6% requires check dams with vertical drops of 12-inches

width known:

b = 6.00 ft

S = 0.010 ft/ft

n_{wq} = 0.175

y = 5.17 ft

Determining design flow velocity:

$V_{wq} = Q_{wq} / A_{wq}$, max 1.0 fps

$A_{wq} = b*y + Z*y^2$

where

V_{wq} = design flow velocity (fps)

A_{wq} = cross-sectional area of flow at design depth (sf)

Z = side slope length per unit height (e.g. for 3:1, Z = 3)

Z = 2

A_{wq} = 111.10 sf

V_{wq} = 0.71 fps

Calculate swale length to achieve a minimum hydraulic residence time of 9 minutes (540 seconds):

$L = 540 * V_{wq}$, minimum swale length is 100 ft

L = 383.98 ft

Calculation to verify n - value

Per Table on page 182 of Open-Channel Hydraulics

Area	Wp	Rh	V
111.10	38.68	2.87	0.71

VRh =VR	n - plot
2.04	0.175

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Jun 19 2018

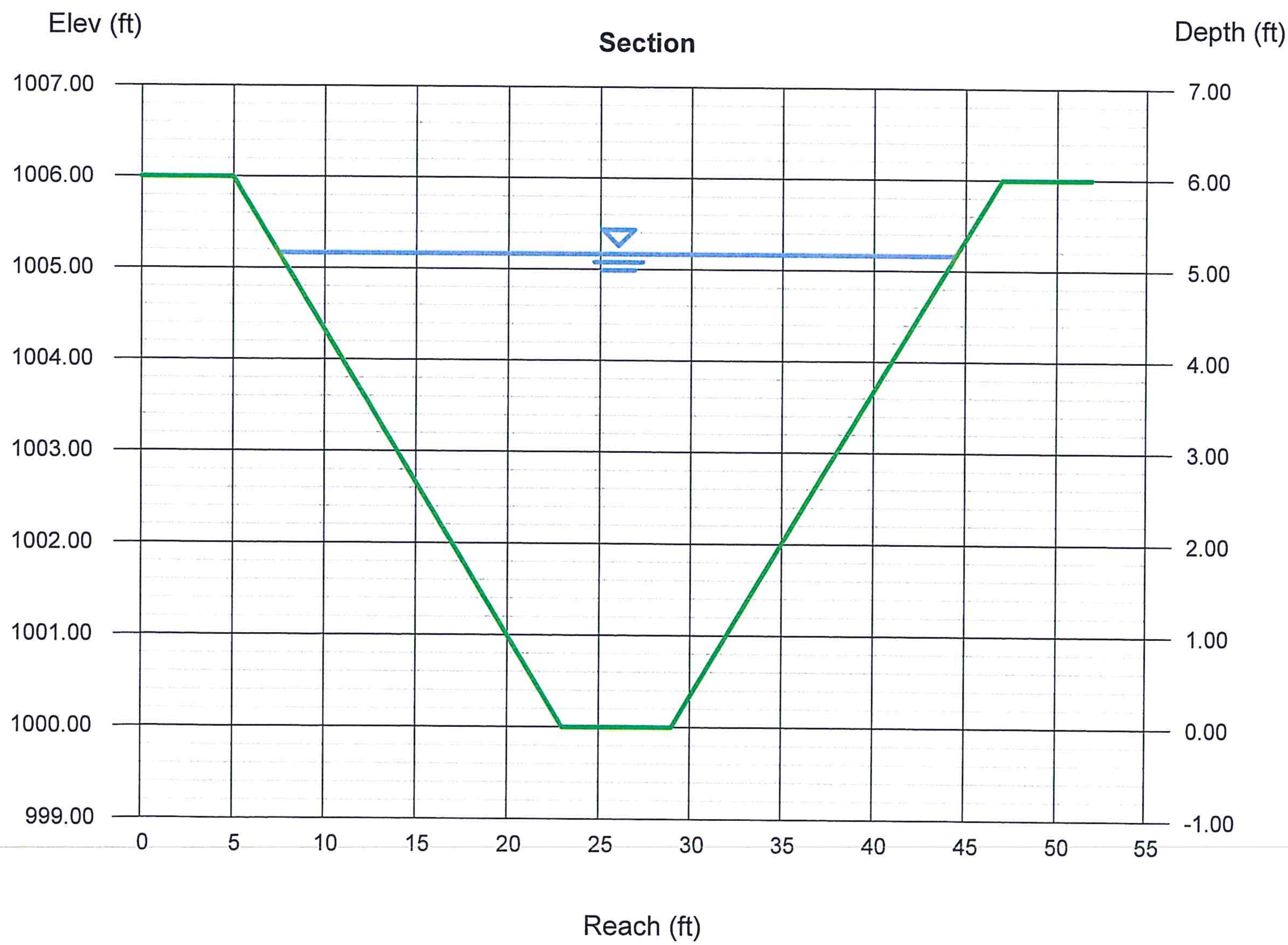
Bioswale @79 cfs

Trapezoidal	
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.00
N-Value	= 0.175
Calculations	
Compute by:	Q vs Depth
No. Increments	= 36

Highlighted	
Depth (ft)	= 5.17
Q (cfs)	= 190.65
Area (sqft)	= 111.08
Velocity (ft/s)	= 1.72
Wetted Perim (ft)	= 38.68
Crit Depth, Yc (ft)	= 2.22
Top Width (ft)	= 37.00
EGL (ft)	= 5.21

Depth from Biofiltration sheet

WP on Biofiltration sheet



Bio-filtration Swale Design

Based on King County 2005 Surface Water Design Manual (Section 6.2 and 6.3)

Modified to model flow of flood water utilizing reference Open Channel Hydraulics, CHOW

Design Flow:

Q_{wq} = **106.00 cfs** Without channel south of Thorpe

Calculation of swale depth

$Q = 1.49\ A\ R^{0.67} S^{0.5}\ n^{-1}$ Manning's equation

OR

$b = Q_{wq}\ n_{wq}\ (1.49 * y^{1.67} S^{0.5})^{-1}$

OR

$y = [Q_{wq}\ n_{wq}\ (1.49 * b * S^{0.5})^{-1}]^{0.6}$

where

- b = bottom width of swale (ft)…minimum 2 ft width required, maximum 10 ft
- Q_{wq} = water quality design flow (cfs)
- n_{wq} = Manning's roughness coefficient for vegetal retardance conditions (CHOW)
- y = design flow depth
- S = longitudinal slope (along direction of flow) (ft/ft), slope shall be between 1%-6%. If less than 1.5%, underdrains must be provided. Slope less than 1% is considered a "wet biofiltration swale" and must be designed under those guidelines. Slope greater than 6% requires check dams with vertical drops of 12-inches

width known:

b = 6.00 ft

S = 0.010 ft/ft

n_{wq} = 0.130

y = 5.16 ft

Determining design flow velocity:

$V_{wq} = Q_{wq} / A_{wq}$, max 1.0 fps

$A_{wq} = b*y + Z*y^2$

where

- V_{wq} = design flow velocity (fps)
- A_{wq} = cross-sectional area of flow at design depth (sf)
- Z = side slope length per unit height (e.g. for 3:1, Z = 3)

Z = 3

A_{wq} = 123.80 sf

V_{wq} = 0.86 fps

Calculate swale length to achieve a minimum hydraulic residence time of 9 minutes (540 seconds):

$L = 540 * V_{wq}$, minimum swale length is 100 ft

L = 462.36 ft

Calculation to verify n - value

Per Table on page 182 of Open-Channel Hydraulics

Area	Wp	Rh	V
123.80	38.63	3.20	0.86

VRh =VR	n - plot
2.74	0.175

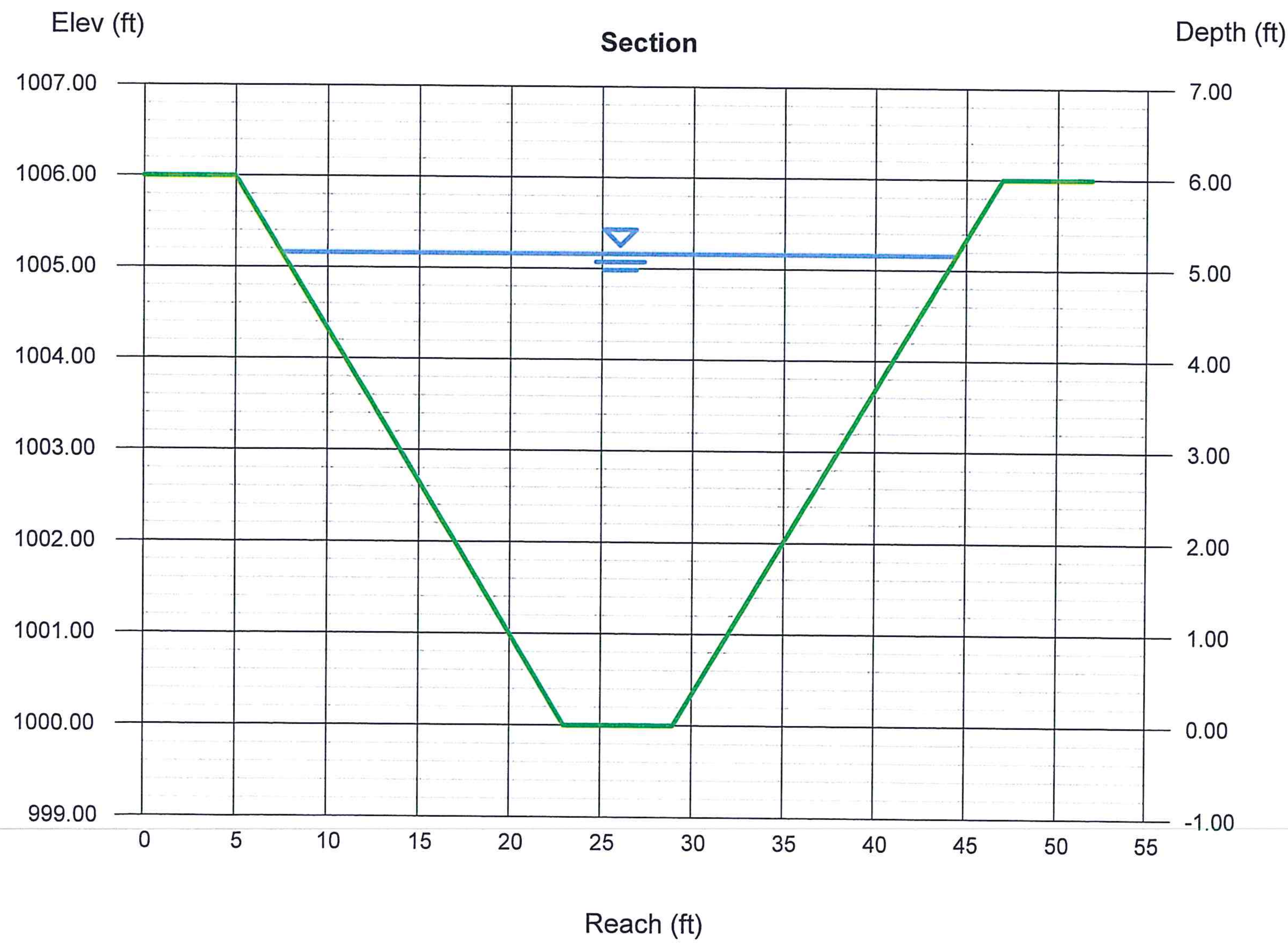
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Jul 17 2018

Bioswale @ 106 cfs

Trapezoidal	
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 6.00
Invert Elev (ft)	= 1000.00
Slope (%)	= 1.00
N-Value	= 0.130
Calculations	
Compute by:	Q vs Depth
No. Increments	= 50

Highlighted	
Depth (ft)	= 5.16
Q (cfs)	= 255.89
Area (sqft)	= 110.84
Velocity (ft/s)	= 2.31
Wetted Perim (ft)	= 38.63
Crit Depth, Yc (ft)	= 2.57
Top Width (ft)	= 36.96
EGL (ft)	= 5.24



OPEN-CHANNEL HYDRAULICS

VEN TE CHOW, Ph.D.

Professor of Hydraulic Engineering
University of Illinois

McGRAW-HILL BOOK COMPANY

New York Toronto London

1959

TABLE 7-5. GUIDE IN SELECTION OF VEGETAL RETARDANCE*

Stand	Average length of grass, in.	Degree of retardance
Good	>30	A Very high
	11–24	B High
	6–10	C Moderate
	2–6	D Low
	<2	E Very low
Fair	>30	B High
	11–24	C Moderate
	6–10	D Low
	2–6	D Low
	<2	E Very low

* U.S. Soil Conservation Service [41].

7-18. The Permissible Velocity. The permissible velocity of flow in a grassed channel is the velocity that will prevent severe erosion in the channel for a reasonable length of time. Permissible velocities for different vegetal covers, channel slopes, and soil conditions, recommended on the basis of investigation by the Soil Conservation Service, are shown in Table 7-6.

7-19. Selection of Grass. The selection of grass for the channel lining depends mainly on the climate and soil in which the plant will grow and survive under the given conditions. From the hydraulic viewpoint, stability and other factors should also be considered. In general, a higher discharge requires a stronger or better lining. On steep slopes, bunch grasses, such as alfalfa, lespedeza, and kudzu, will develop channeling of the flow and, hence, are unsatisfactory for lining. For slopes greater than 5%, only fine and uniformly distributed sod-forming grasses, such as Bermuda grass, Kentucky bluegrass, and smooth brome, are recommended for lining where the main flow occurs. Because of the objectionable spreading nature of sod-forming grasses, the top portion of the sides and the berm may be planted with grasses that do not spread easily, such as weeping love grass. For fast establishment of the lining, Bermuda grass and weeping love grass are recommended. Sometimes annuals are used as temporary protection until permanent covers by native grasses are established. Silt deposition in channels may be controlled by lining with bunch grasses, which will develop channeled flow, increase velocity, and thus reduce silting.

7-20. Procedure of Design. After the kind of grass for channel lining is selected, the degree of retardance can be determined from the condition of the stem length and the density of growth. During the period of establishment, the grass will grow and the channel will be stabilized under a condition of low degree of retardance. The channel will not reach its maximum capacity until the grass cover is fully developed and well established. Therefore, it is suggested that the hydraulic design of a grassed channel consist of two stages. The first stage (*A*) is to design the channel for stability, that is, to determine the channel dimensions under the condition of a *lower* degree of retardance. The second stage

TABLE 7-6. PERMISSIBLE VELOCITIES FOR CHANNELS LINED WITH GRASS*

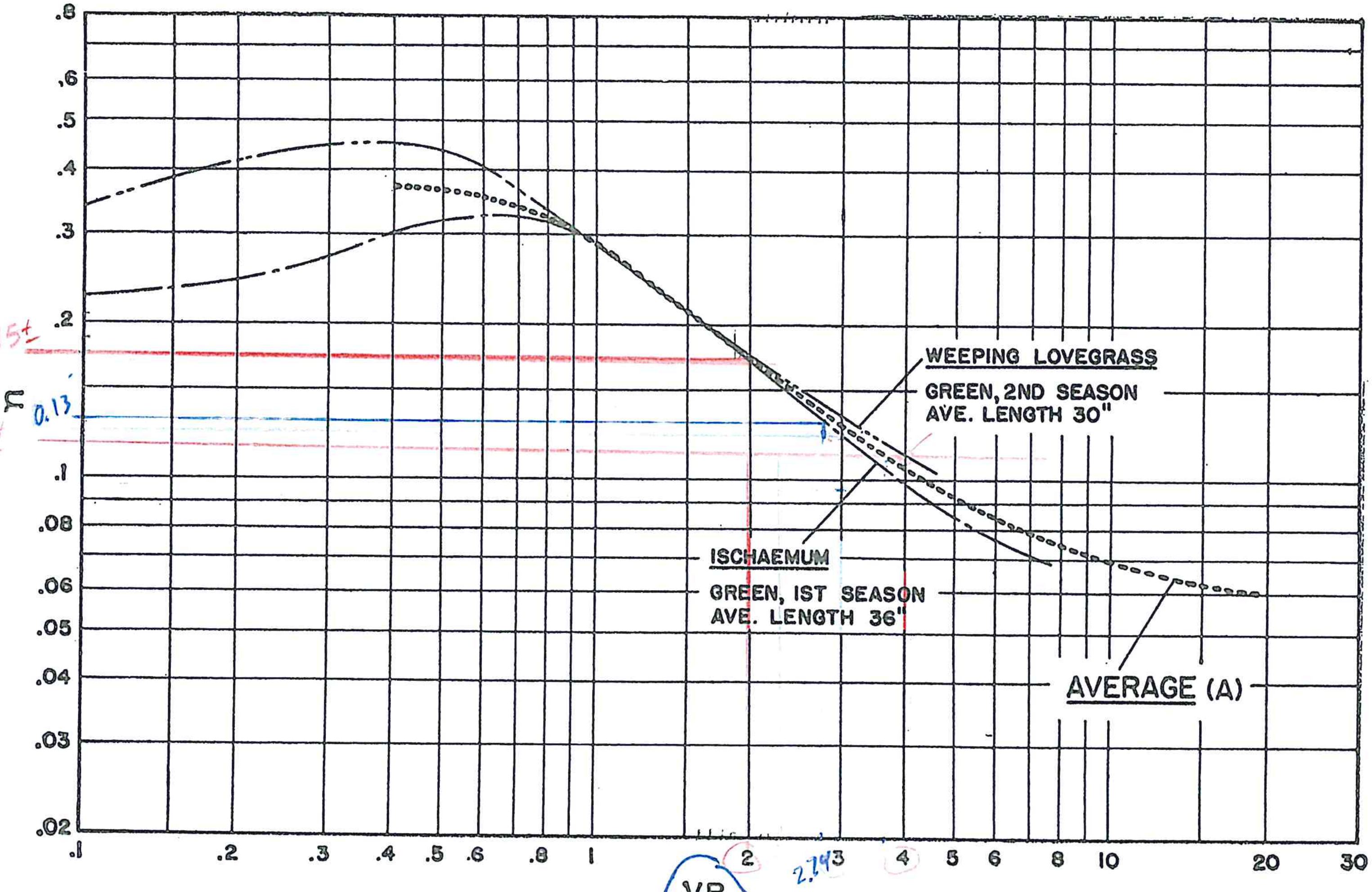
Cover	Slope range, %	Permissible velocity, fps	
		Erosion-resistant soils	Easily eroded soils
Bermuda grass	0–5 5–10 >10	8 7 6	6 5 4
Buffalo grass, Kentucky bluegrass, smooth brome, blue grama	0–5 5–10 >10	7 6 5	5 4 3
Grass mixture	0–5 5–10	5 4	4 3
	Do not use on slopes steeper than 10%		
Lespedeza sericea, weeping love grass, ischaemum (yellow bluestem), kudzu, alfalfa, crabgrass	0–5	3.5	2.5
	Do not use on slopes steeper than 5%, except for side slopes in a combination channel		
Annuals—used on mild slopes or as temporary protection until permanent covers are established, common lespedeza, Sudan grass	0–5	3.5	2.5
	Use on slopes steeper than 5% is not recommended		

REMARKS. The values apply to average, uniform stands of each type of cover. Use velocities exceeding 5 fps only where good covers and proper maintenance can be obtained.

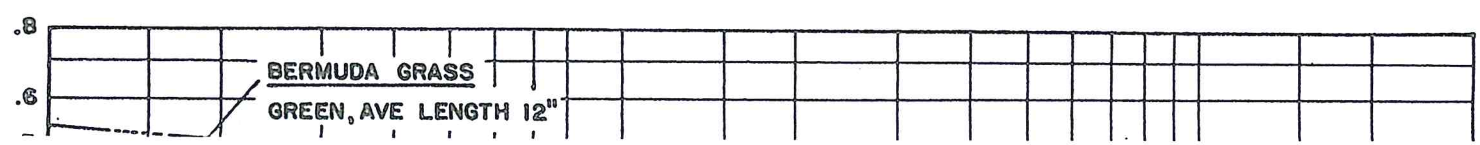
* U.S. Soil Conservation Service [41].

(*B*) is to review the design for maximum capacity, that is, to determine the increase in depth of flow necessary to maintain a maximum capacity under the condition of a *higher* degree of retardance. For instance, if common lespedeza is selected as the grass for lining, the common lespedeza of low vegetal retardance (green, average length 4.5 in.) is used for the first stage in design. Then, in the second stage, the common lespedeza of moderate vegetal retardance (green, uncut, average length 11 in.) should be used. Finally, a proper freeboard is added to the computed

OPEN CHANNEL HYDRAULICS, CHOW



(*a*) Curves for A or very high vegetal retardance.



Geotechnical Reports

Triangle Pond Infiltration (Storage Area 6)
IPEC Proposed Stormwater Pond dated October 14, 2014

North Pond Location Boring
IPEC Supplemental Geotechnical Evaluation dated April 19, 2016

Pavement Design (Public Roads)
IPEC Geotechnical Evaluation – Proposed Street Improvements dated June 26, 2017

Full-Scale Drywell Testing
IPEC Full-Scale Drywell Testing dated August 21, 2017
IPEC Addendum to Full-Scale Drywell Testing dated August 22, 2017

Mounding Analysis
IPEC Mounding Analysis dated August 22, 2017

IPEC

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

October 14, 2014
Project No. 14-086

NAI Black
c/o Mr. Bryan Walker
107 South Howard
Suite 500
Spokane, WA 99201

Re: **Geotechnical Evaluation**
Proposed Stormwater Pond
Parcel No. 45343.9052
Spokane Valley, WA

Dear Mr. Walker:

As you authorized, we have completed a geotechnical evaluation for geotechnical evaluation at the above-referenced site in Spokane Valley, Washington. The purpose of our services is to evaluate the subsurface soil and groundwater conditions relative to use as a stormwater management facility as part of the Painted Hills golf course property stormwater management system. This report summarizes the results of our site investigation, engineering analyses and recommendations.

PROJECT DESCRIPTION

We understand that the proposed project may consist of a residential development. The site consists of 91 acres currently developed as a golf course. Stormwater runoff will be treated using drywells and/or gravel galleries for subsurface infiltration. These type of facilities will also be used to manage potential floodwaters, if needed. To account for stormwater runoff volumes from the unnamed tributary along State Highway 27, you propose to use this parcel as a stormwater pond with drywells for subsurface infiltration.

AVAILABLE INFORMATION

We were provided a conceptual site plan for the project by Whipple Consulting Engineers, Inc. (WCE). This plan showed the proposed pond limits, proposed and existing ground surface elevation contours, and property lines. This plan was prepared by WCE and was not dated.

FIELD EVALUATION

Procedures

A geotechnical engineer from Inland Pacific Engineering Company (IPEC) observed the excavation of four test pits at the site. The test pits were excavated on October 1, 2014 using a rubber-tired backhoe operated by an independent firm working under subcontract to IPEC. The geotechnical engineer from IPEC observed the test pit excavations and logged the surface and subsurface conditions. Ground surface elevations at the test pits were interpolated from the contours shown on the site plan.

The soils encountered in the test pits were visually and manually classified in the field by our field personnel in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)". The samples were returned to our facility for review of the classification by a geotechnical engineer and laboratory testing.

Soils Encountered

The test pist encountered glacially deposited silty sand at the surface overlying poorly graded sands to the termination depths of the test pits.

Groundwater was not encountered in the test pits during or after excavation. Well log data in the vicinity of the site indicate that groundwater levels range from approximately 90 to 100 feet.

Geologic maps indicate the soils in this area consist primarily of glacially deposited sands and gravels. According to the Soil Survey of Spokane County, the site soils are classified as Urban land-Springdale, disturbed complex. These soils are described as somewhat excessively drained soils that formed in sandy and gravelly glaciofluvial deposits with minor amounts of volcanic ash and loess in the upper part. The native soils exposed in the test pits were consistent with the NRCS data.

Laboratory Testing

We performed grain size analysis tests on samples obtained from the test pits. The tests were performed in accordance with ASTM Method of Test D 6913. The results of the tests performed are attached to this report.

ANALYSIS AND RECOMMENDATIONS

Stormwater Recommendations
Based on the data obtained from the test pits, field permeability test, and laboratory tests performed, it is our opinion that swales and drywells would be suitable for infiltration of stormwater.

We estimated a design outflow rate for drywells using the results of the laboratory tests and the procedures described in the SRSM manual, Appendix 4A (Spokane 200 Method). The following table summarizes the results of the analysis.

Test Pit	Depth (feet)	USCS Classification	Percent Fines	Normalized Outflow Rate (cfs/ft)	Recommended Design Drywell Outflow Rate (cfs)	
					Type A	Type B
TP-1	10 – 12	SP	1.0	0.5	0.3	1.0
TP-2	10 – 12	SP	1.5	0.5	0.3	1.0
TP-3	10 – 12	SP	1.4	0.5	0.3	1.0
TP-4	10 – 12	SP	1.6	0.5	0.3	1.0

These recommended design outflow rates include a safety factor of 1.3 as required by the SRSM.

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

Sincerely,
Inland Pacific Engineering Company

Paul T. Nelson, P.E.
Principal Engineer

PAUL T NELSON
STATE OF WASHINGTON
37228
REGISTERED
PROFESSIONAL ENGINEER
10-14-14

Attachments: Figure 1, Site Location Map
Figure 2, NRCS Map
Figure 3, Test Pit Location Map
Logs of Test Pits TP-1 through TP-4
Descriptive Terminology
Laboratory Test Results

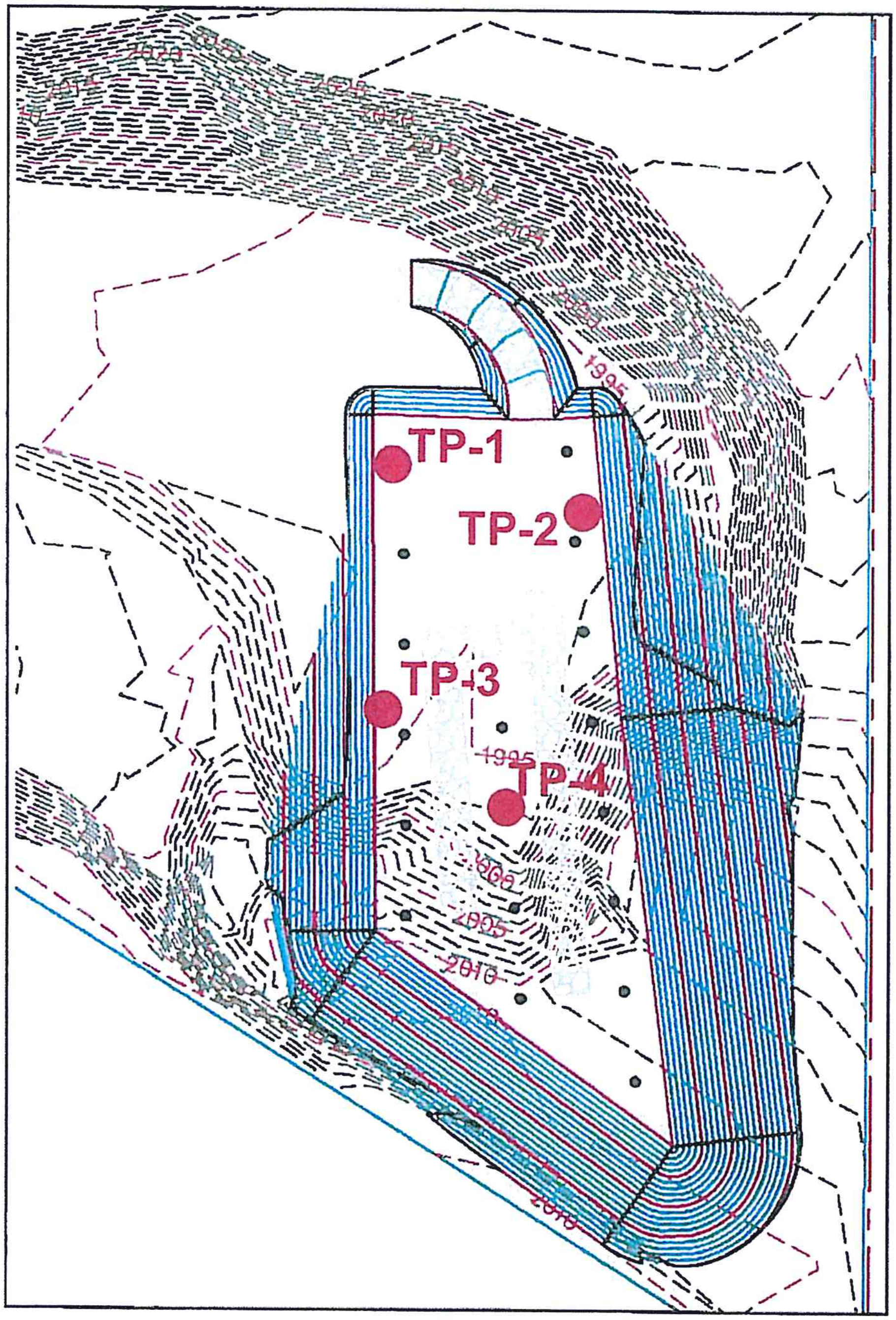
FIGURE 1

Site Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 14-086 Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	October 9, 2014

FIGURE 2

NRCS Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 14-086	October 9, 2014
	Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	

FIGURE 3



Test Pit Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 14-086	October 9, 2014
	Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	

LOG OF TEST PIT

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

PROJECT:	14-086 Geotechnical Evaluation Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	TEST PIT:	TP-1
		LOCATION:	See Test Pit Location Map
		DATE: 10/1/14	SCALE: 1"=2'

ELEV. 1994.5	DEPTH 0.0	ASTM D2487 Symbol	DESCRIPTION OF MATERIALS	WL	TESTS OR NOTES
1993.5	1.0	SM	SILTY SAND WITH GRAVEL, fine to coarse grained, brown, moist. (Glacial Outwash)		
1979.5	15.0	SP	POORLY GRADED SAND WITH GRAVEL, medium to coarse grained, with Cobbles, brown, moist. (Glacial Outwash)		
			End of test pit. Groundwater not encountered. Test pit immediately backfilled.		

LOG OF TEST PIT

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

PROJECT:	14-086 Geotechnical Evaluation Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	TEST PIT:	TP-2
		LOCATION:	See Test Pit Location Map
		DATE: 10/1/14	SCALE: 1"=2'

ELEV. 1994.5	DEPTH 0.0	ASTM D2487 Symbol	DESCRIPTION OF MATERIALS	WL	TESTS OR NOTES
1993.0	1.5	SM	SILTY SAND WITH GRAVEL, fine to coarse grained, brown, moist. (Glacial Outwash)		
1979.5	15.0	SP	POORLY GRADED SAND WITH GRAVEL, medium to coarse grained, with Cobbles, brown, moist. (Glacial Outwash)		
			End of test pit. Groundwater not encountered. Test pit immediately backfilled.		

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

PROJECT: 14-086 Geotechnical Evaluation Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	TEST PIT: **TP-3** LOCATION: See Test Pit Location Map DATE: 10/1/14 SCALE: 1"=2'

ELEV. 1995	DEPTH 0.0	ASTM D2487 Symbol	DESCRIPTION OF MATERIALS	WL	TESTS OR NOTES
1994	1.0	SM	SILTY SAND WITH GRAVEL, fine to coarse grained, brown, moist. (Glacial Outwash)		
1980	15.0	SP	POORLY GRADED SAND WITH GRAVEL, medium to coarse grained, with Cobbles, brown, moist. (Glacial Outwash)		
			End of test pit. Groundwater not encountered. Test pit immediately backfilled.		

LOG OF TEST PIT

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

PROJECT: 14-086 Geotechnical Evaluation Proposed Stormwater Pond Parcel No. 45343.9052 Spokane County, WA	TEST PIT: **TP-4** LOCATION: See Test Pit Location Map DATE: 10/1/14 SCALE: 1"=2'

ELEV. 1996	DEPTH 0.0	ASTM D2487 Symbol	DESCRIPTION OF MATERIALS	WL	TESTS OR NOTES
1995	1.0	SM	SILTY SAND WITH GRAVEL, fine to coarse grained, brown, moist. (Glacial Outwash)		
1981	15.0	SP	POORLY GRADED SAND WITH GRAVEL,medium to coarse grained, with Cobbles, brown, moist. (Glacial Outwash)		
			End of test pit. Groundwater not encountered. Test pit immediately backfilled.		

IPEC

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

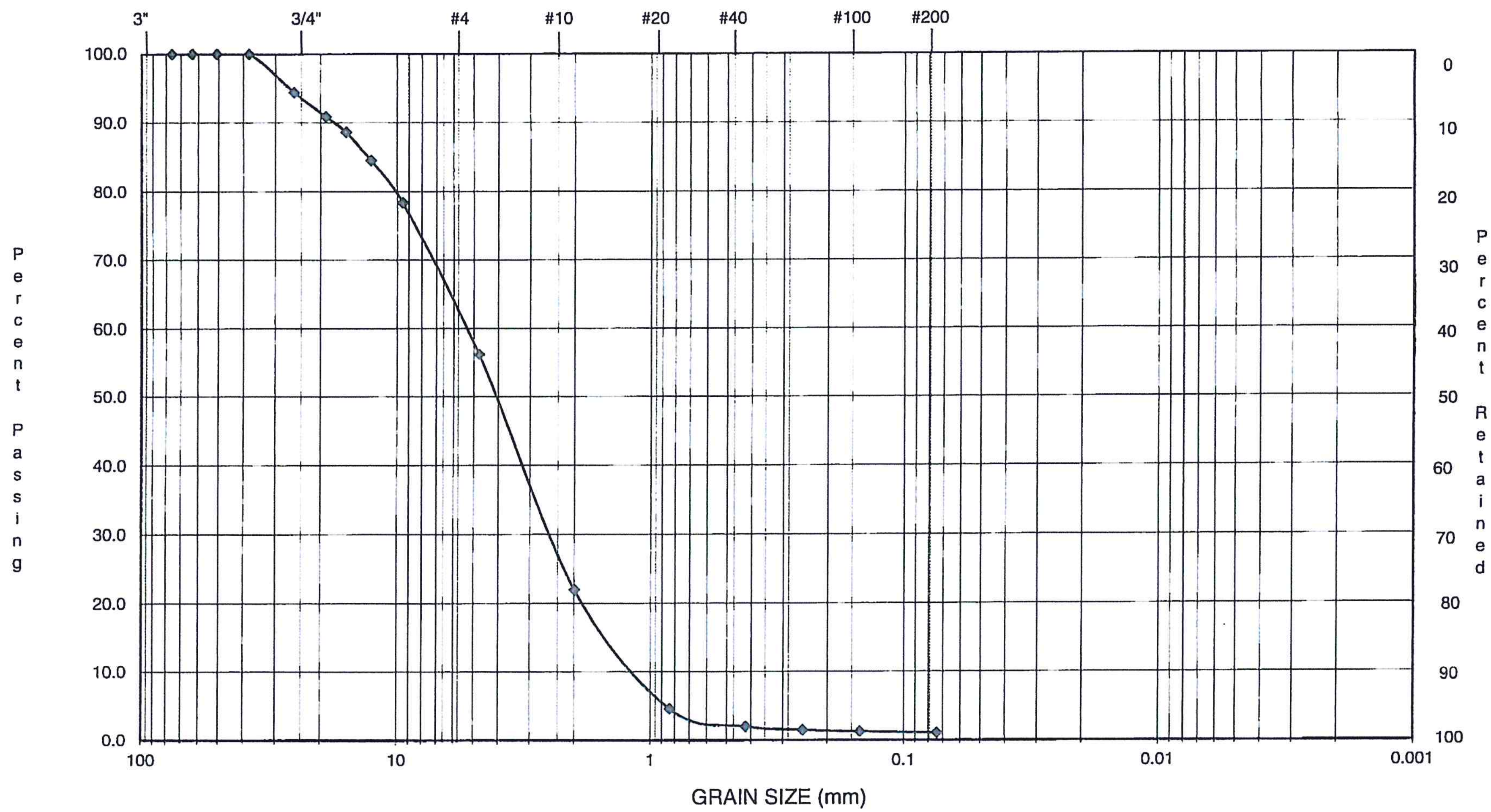
RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALVE			
COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
DENSITY	N(BLOWS/FT)	CONSISTENCY	N(BLOWS/FT)
Very Loose	0 - 4	Very Soft	0 - 1
Loose	4 - 10	Soft	2 - 3
Medium-Dense	11 - 30	Rather Soft	4 - 5
		Medium	6 - 8
Dense	31 - 50	Rather Stiff	9 - 12
		Stiff	13 - 16
Very Dense	> 50	Very Stiff	17 - 30
		Hard	> 30

USCS SOIL CLASSIFICATION				
MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse-Grained Soils <50% passes #200 sieve	Gravel and Gravelly Soils <50% coarse fraction passes #4 sieve	Gravel (with little or no fines)	GW	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravel (with >12% fines)	GM	Silty Gravel
			GC	Clayey Gravel
	Sandy and Sandy Soils >50% coarse fraction passes #4 sieve	Sand (with little or no fines)	SW	Well Graded Sand
			SP	Poorly Graded Sand
		Sand (with >12% fines)	SM	Silty Sand
			SC	Clayey Sand
Fine-Grained Soils >50% passes #200 sieve	Silt and Clay Liquid Limit < 50		ML	Silt
			CL	Lean Clay
			OL	Organic Silt and Clay (low plasticity)
	Salt and Clay Liquid Limit > 50		MH	Inorganic Silt
			CH	Fat Clay
			OH	Organic Clay and Silt (med to high plasticity)
Highly Organic Soils			PT	Peat / Muck

MODIFIERS	
DESCRIPTION	RANGE
Occasional	<5%
Trace	5% - 12%
With	>12%

MOISTURE CONTENT	
DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Dry of optimum moisture content
Wet	Wet of optimum moisture content

MAJOR DIVISIONS WITH GRAIN SIZE								
SIEVE SIZE	12"	3"	3/4"	4	10	40	200	
GRAIN SIZE (INCHES)	12	3	0.75	0.19	0.079	0.0171	0.0029	
Boulders	Cobbles	Gravel		Sand			Silt and Clay	
		Coarse	Fine	Coarse	Medium	Fine		



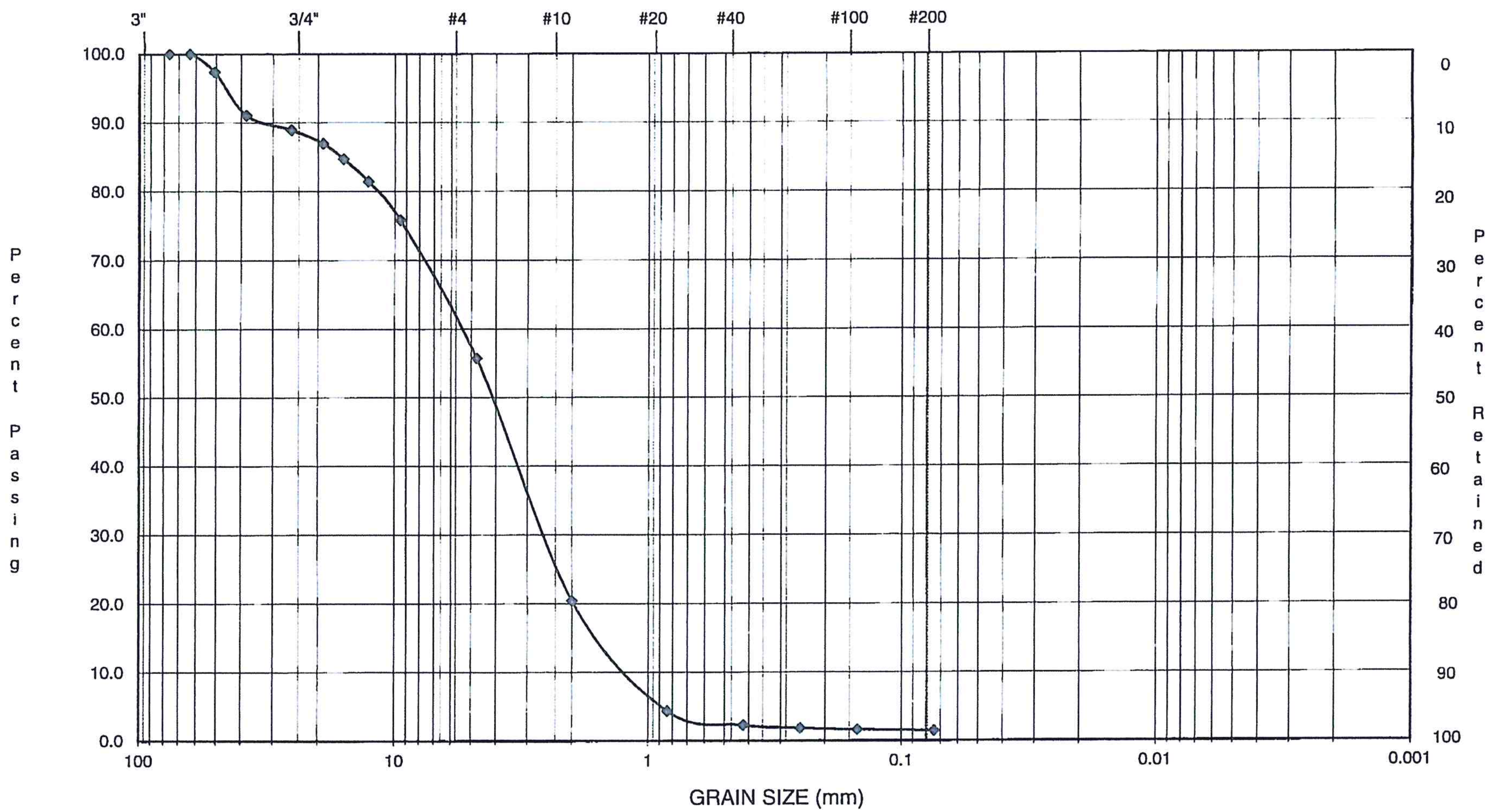
UNIFIED SOIL CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: L14-039	Sample Description: SP Poorly Graded Sand with Gravel	Lab No. L14-039

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting
P.O Box 1566, Veradale, WA 99037 (509) 209-6262

GRAIN SIZE REPORT

Project:	40th Avenue Stormwater
Location:	TP-1 @ 10-12'
Job No.:	14-086
Date:	10/1/2014



UNIFIED SOIL CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: L14-040

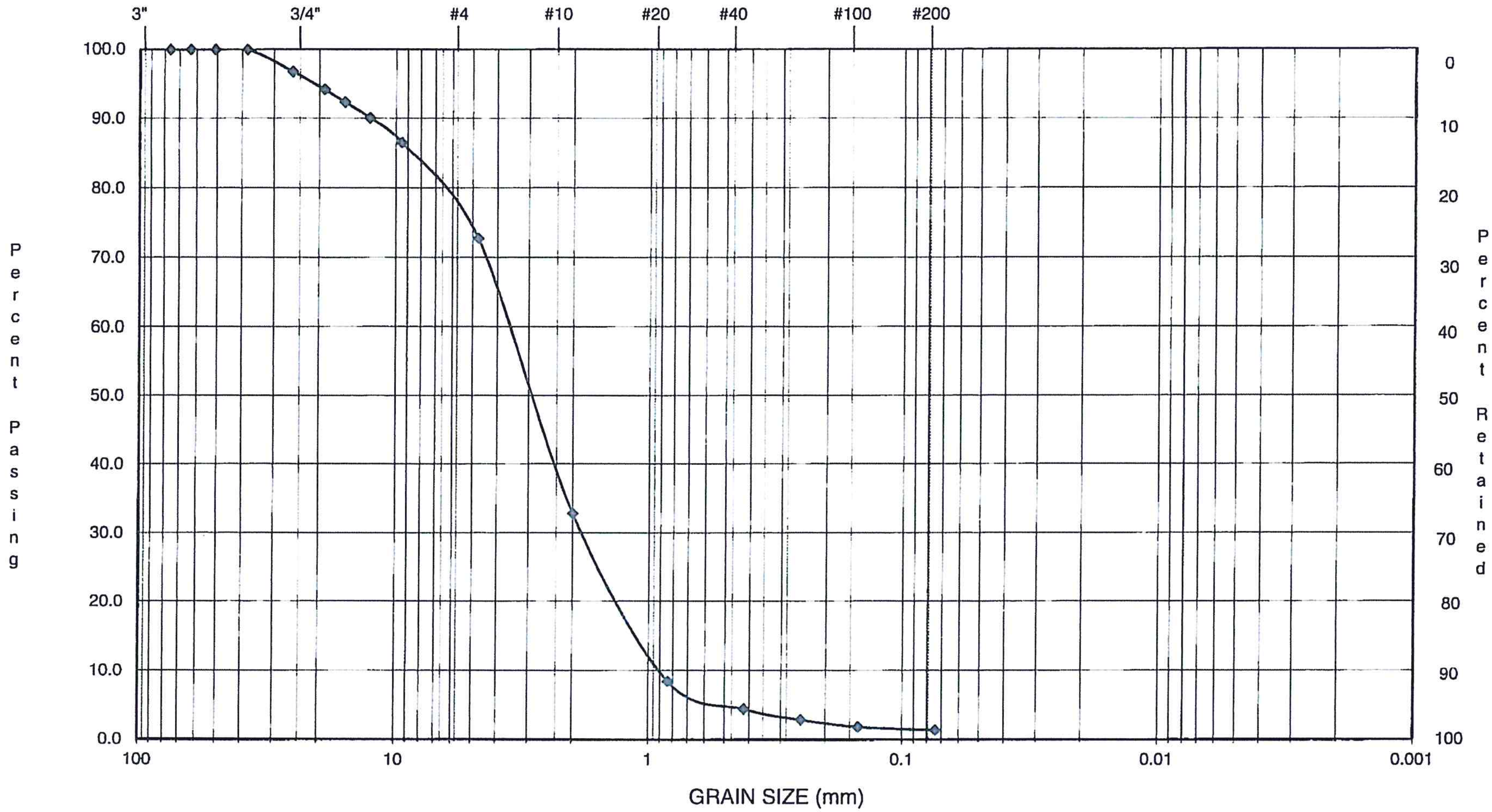
Sample Description: SP Poorly Graded Sand with Gravel

Lab No. L14-040

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting
P.O Box 1566, Veradale, WA 99037 (509) 209-6262

GRAIN SIZE REPORT

Project: 40th Avenue Stormwater
Location: TP-2 @ 10-12'
Job No.: 14-086
Date: 10/1/2014



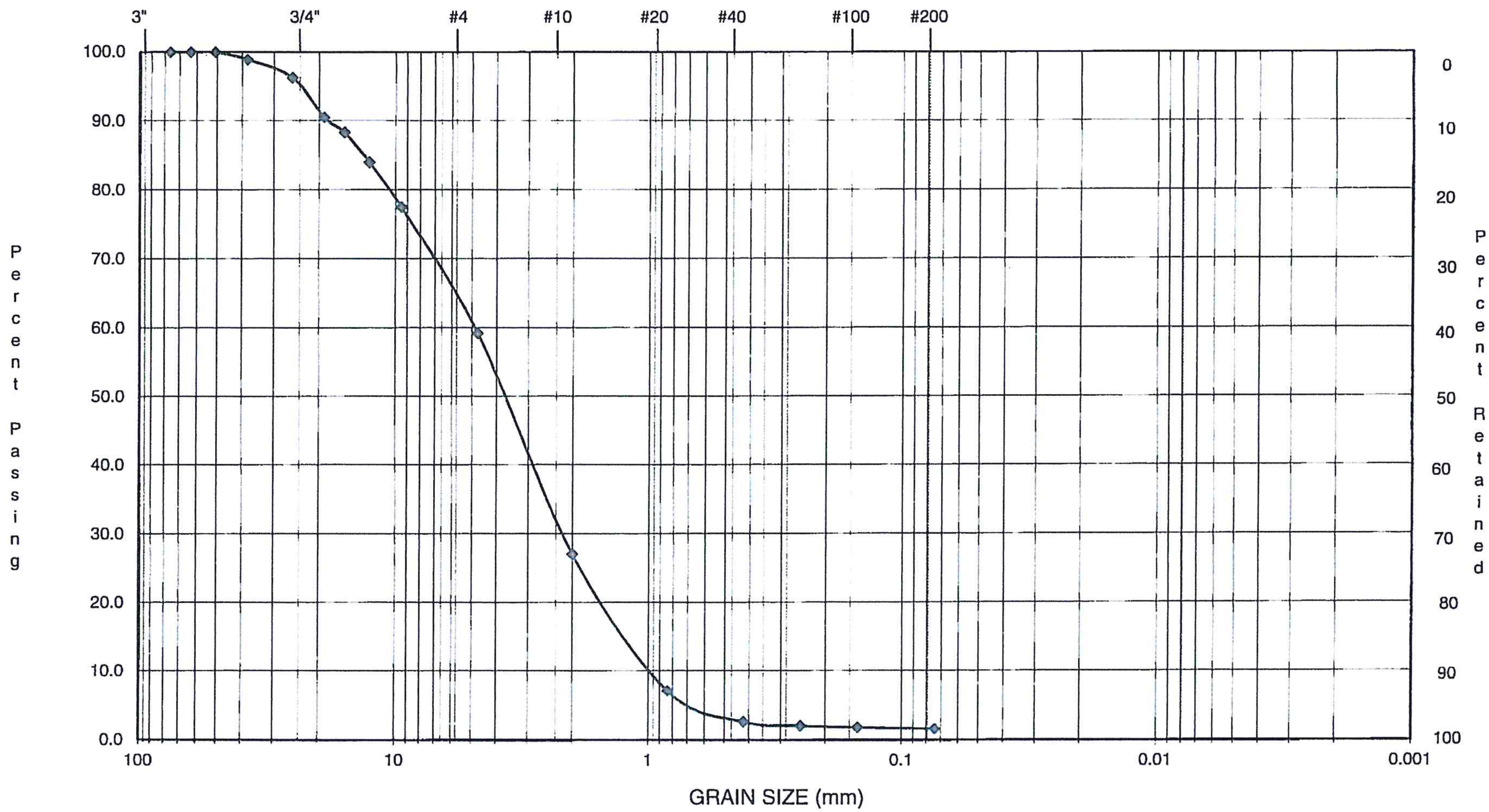
UNIFIED SOIL CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification:	Sample Description:	Lab No.
L14-041	SP Poorly Graded Sand with Gravel	L14-041

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting
P.O Box 1566, Veradale, WA 99037 (509) 209-6262

GRAIN SIZE REPORT

Project:	40th Avenue Stormwater
Location:	TP-3 @ 10-12'
Job No.:	14-086
Date:	10/1/2014



UNIFIED SOIL CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: L14-042

Sample Description: SP Poorly Graded Sand with Gravel

Lab No. L14-042

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting
P.O Box 1566, Veradale, WA 99037 (509) 209-6262

GRAIN SIZE REPORT

Project: 40th Avenue Stormwater

Location: TP-4 @ 10-12'

Job No.: 14-086

Date: 10/1/2014

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

April 19, 2016
Project No. 16-249

NAI Black
c/o Mr. Bryan Walker
107 South Howard
Suite 500
Spokane, WA 99201

Re: **Supplemental Geotechnical Evaluation**
Painted Hills Golf Course Property
4403 South Dishman-Mica Road
Spokane Valley, WA

Dear Mr. Walker:

As you authorized, we have completed the supplemental geotechnical evaluation for the Painted Hills Golf Course property at the above-referenced site in Spokane Valley, Washington. The purpose of the supplemental evaluation is to provide additional soil and groundwater data to address concerns of the City of Spokane Valley. This report summarizes the results of our field investigation, laboratory testing, engineering analyses, and our opinions and recommendations for stormwater management.

PROJECT DESCRIPTION

We understand that the proposed project may consist of a residential development. The site consists of 91 acres currently developed as a golf course. Stormwater runoff will be treated using drywells and/or gravel galleries for subsurface infiltration. These type of facilities will also be used to manage potential floodwaters, if needed. This supplemental evaluation is intended to provide additional subsurface data at the north end of the site to assist in identifying areas where subsurface infiltration of stormwater may be feasible due to the presence of suitable soils at depth.

AVAILABLE INFORMATION

We were provided a topographic survey for the project site by Whipple Consulting Engineers, Inc. (WCE). This topographic survey showed the existing roadways, existing structures, property lines, and existing ground surface elevation contours. This plan was prepared by WCE and was dated November 7, 2013. The site was used as a golf course prior to our evaluation. The site is relatively level with some elevated golf greens and excavated areas for water hazards. The site is primarily grass-covered with scattered trees along the fairways and pine trees in the undeveloped area to the northwest. The clubhouse building is present at the southwest corner.

In addition, we performed a preliminary geotechnical evaluation for the property in December 2013. The results of that evaluation, along with our opinions and recommendations, are summarized in our Preliminary Geotechnical Evaluation dated December 31, 2013.

We also performed a geotechnical evaluation for certification of the existing levee along Chester Creek in April 2014. The results of that evaluation are summarized in our Geotechnical Evaluation report dated February 12, 2015.

Lastly, we performed a geotechnical evaluation in July 2015 consisting of ten 50-foot borings in the south half of the property. The results of that evaluation are summarized in our Geotechnical Evaluation Phase 2 report dated July 23, 2015.

FIELD EVALUATION

Procedures

A geotechnical engineer from Inland Pacific Engineering Company (IPEC) observed the drilling of three penetration test borings at the site. The borings were drilled between March 17 and 19, 2016 using a truck-mounted drill operated by an independent firm working under subcontract to IPEC. A geotechnical engineer or engineering assistant from IPEC observed the borings and logged the surface and subsurface conditions. After we logged the borings, they were abandoned in accordance with state requirements. Ground surface elevations at the borings were provided by WCE.

The soils encountered in the borings were visually and manually classified in the field by our field personnel in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)". The samples were returned to our facility for review of the classification by a geotechnical engineer and laboratory testing.

Soils Encountered
In general, the borings encountered 2 feet of topsoil at the surface. Below the topsoil, the borings generally encountered glacially-deposited silty to clayey sands and/or gravels overlying poorly graded sands to termination depths of the borings. The clayey sands and gravels were generally encountered in the upper 12 to 18 feet.

Penetration resistances in the sands and gravels ranged from 15 to 90 blows per foot (BPF) and averaged 37 BPF, indicating that these soils were medium dense to very dense, but were typically dense.

Geologic maps indicate the soils in this area consist primarily of alluvial and/or glacially deposited silts, clays, sands, and gravels. According to the Soil Survey of Spokane County, the site soils are classified by the Natural Resource Conservation Service (NRCS) as Hardesty ashy silt loam, Narcisse silt loam, Endoaquolls and Fluvaquents, Phoebe ashy sandy loam, and Urban land-Springdale disturbed complex. The native soils encountered in the borings were consistent with the NRCS data.

Groundwater was encountered in Boring B-2 at a depth of 71 feet. This depth corresponds to an elevation of 1934.6. Groundwater was not encountered in the remaining borings. The observed water levels further indicates that groundwater levels drop generally from south to north with higher levels near Chester Creek. Fluctuations in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw and other seasonal and annual factors not evident at the time the observations were made.

ANALYSIS, OPINIONS, AND RECOMMENDATIONS

Based on the data obtained from the recent and previous borings, previous test pits, field permeability tests, and laboratory tests performed, it is our opinion that subsurface infiltration of stormwater is feasible. The most promising layers are the glacial sands and gravels. These soils would be suitable for infiltration using standard drywells.

We will perform a mounding analysis for the drywells after the proposed full-scale drywell test is completed to assess down-gradient impacts

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

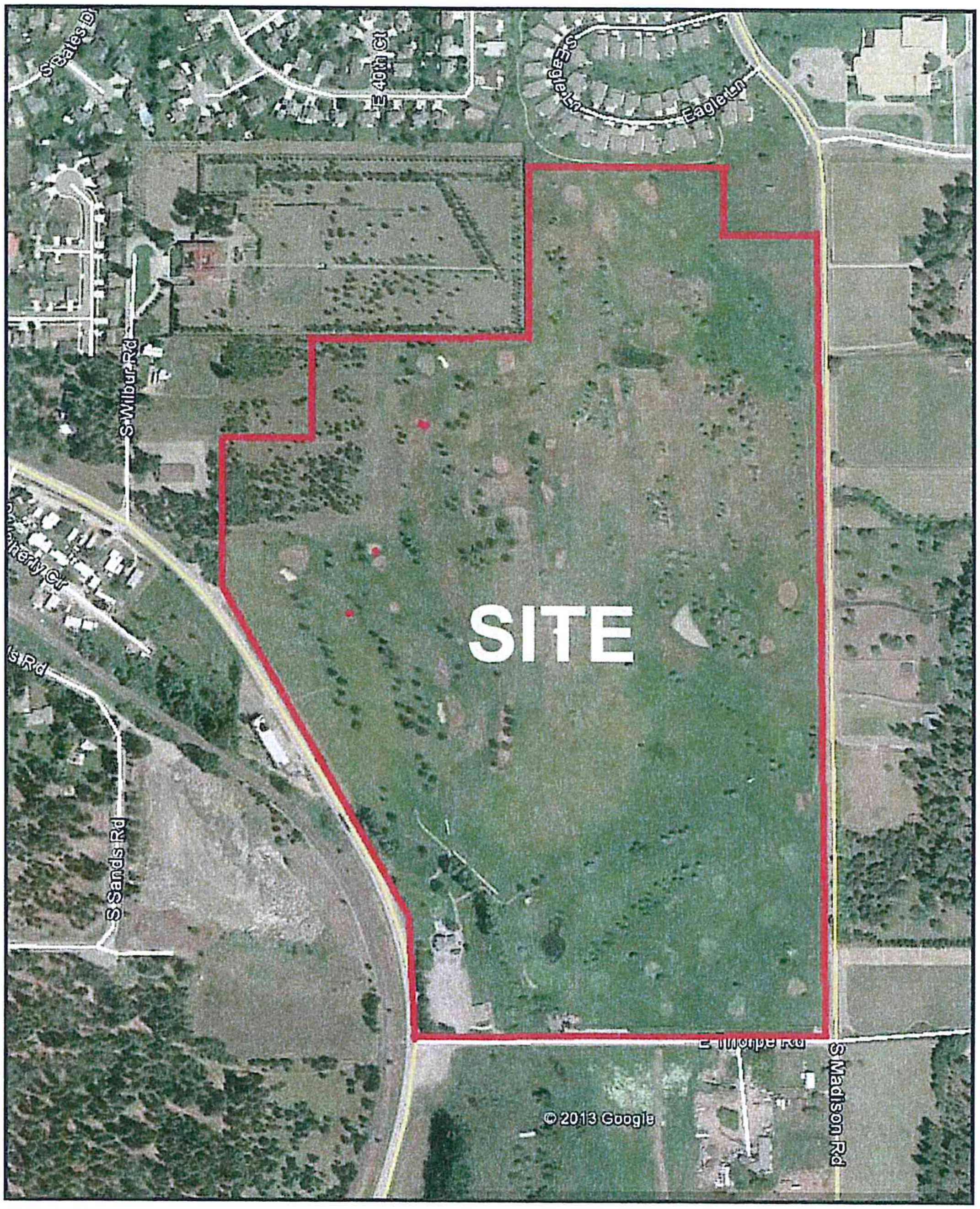
Sincerely,

Paul T. Nelson, P.E.
Principal Engineer

PAUL T NELSON
STATE OF WASHINGTON
37228
REGISTERED
PROFESSIONAL ENGINEER
4-19-16

Attachments: Figure 1, Site Location Map
Figure 2, NRCS Map
Figure 3, Boring Location Map
Logs of Borings B-1 through B-3
Descriptive Terminology
Laboratory Test Results

FIGURE 1

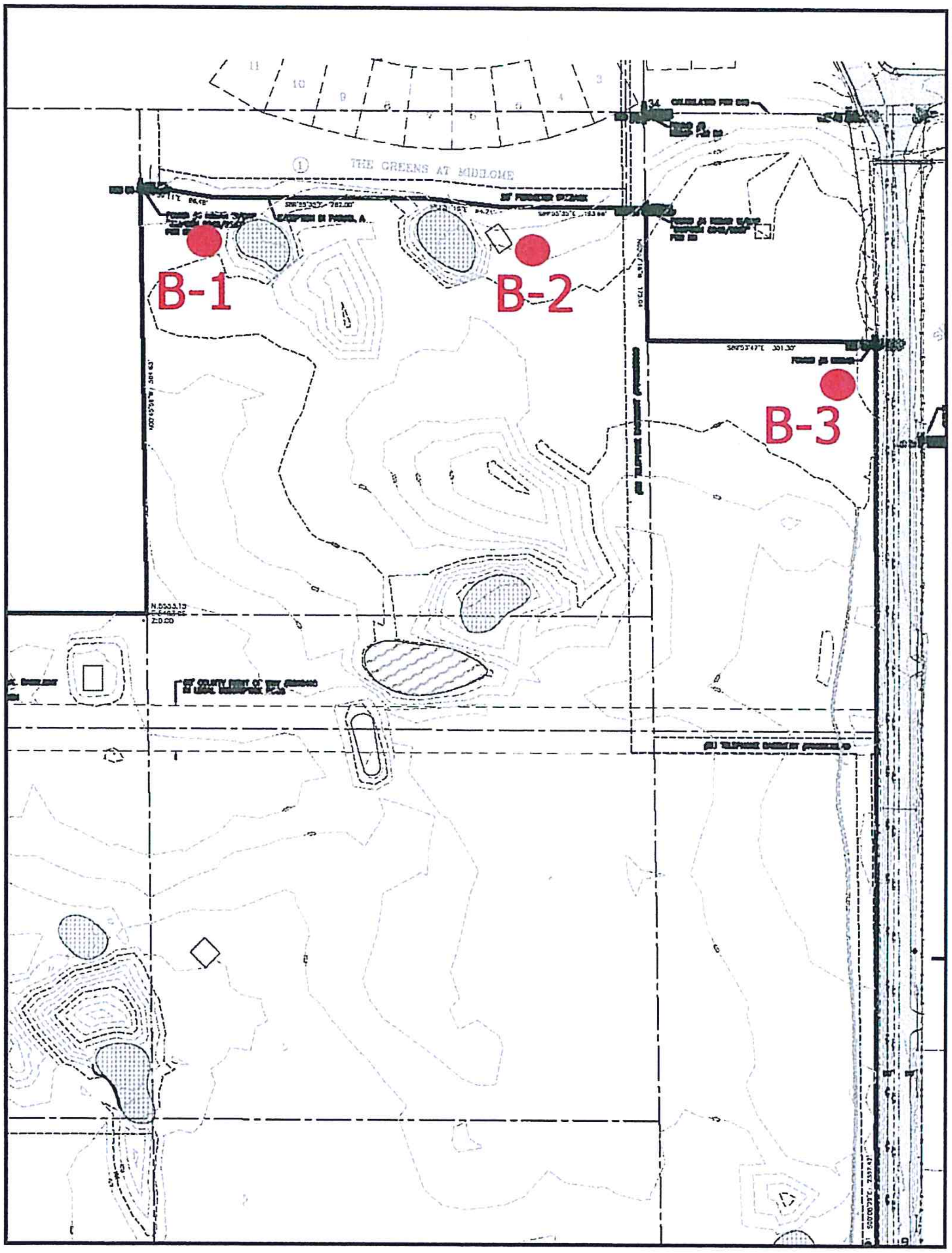


Site Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249	April 19, 2016
	Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	

FIGURE 2

NRCS Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249 Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	April 19, 2016

FIGURE 3



Boring Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249 Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	April 19, 2016

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

BORING NUMBER B-1

CLIENT	NAI Black	**PROJECT NAME**	Painted Hills Supplemental
PROJECT NUMBER	16-249	**PROJECT LOCATION**	4403 South Dishman-Mica Road
DATE STARTED	3/17/16 **COMPLETED** 3/17/16	**GROUND ELEVATION**	2005.9 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR	Johnson Exploration Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	Hollow Stem Auger	**AT TIME OF DRILLING**	--- Not encountered
LOGGED BY	PRF **CHECKED BY** PTN	**AT END OF DRILLING**	--- Not encountered
NOTES		**AFTER DRILLING**	--- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM	2.0	(SM) SILTY SAND, fine to medium grained, with roots, dark brown, moist. (Topsoil) — 2003.9
5	SS		SP-SM		(SP-SM) POORLY GRADED SAND with SILT, medium to coarse grained, a trace of Gravel, brown, moist, medium dense. (Glacial Outwash)
10	SS				
15	SS			17.0	1988.9
20	SS		SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, brown, moist, very dense to medium dense. (Glacial Outwash)
25	SS				
30	SS	Fines = 7%			

GENERAL BH / TP / WELL - GINT STD US LAB.GDT - 4/5/16 11:26 - J:_IPEC PROJECTS_2016 PROJECTS\16-249 PAINTED HILLS SUPPLEMENTAL\GINT\16-249 PAINTED HILLS SUPPLEMENTAL.GPJ

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3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

BORING NUMBER B-1

CLIENT NAI Black

PROJECT NAME Painted Hills Supplemental

PROJECT NUMBER 16-249

PROJECT LOCATION 4403 South Dishman-Mica Road

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
			SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, brown, moist, very dense to medium dense. (Glacial Outwash) *(continued)*
35	SS				
40	SS				
45	SS				
50	SS				
50.5					1955.4

End of boring.

Groundwater not encountered with 49' of hollow-stem auger in the ground.

Groundwater not encountered immediately after withdrawal of the auger.

Bore hole then abandoned.

BORING NUMBER B-2

CLIENT NAI Black
PROJECT NAME Painted Hills Supplemental
PROJECT NUMBER 16-249
PROJECT LOCATION 4403 South Dishman-Mica Road
DATE STARTED 3/17/16 **COMPLETED** 3/18/16
GROUND ELEVATION 2005.6 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Johnson Exploration Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Not encontered
LOGGED BY PRF **CHECKED BY** PTN
AT END OF DRILLING 71.00 ft / Elev 1934.60 ft
NOTES
AFTER DRILLING 73.50 ft / Elev 1932.10 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				SM	2.0	(SM) SILTY SAND, fine to medium grained, with roots, dark brown, moist. (Topsoil) 2003.6
				SC	6.5	(SC) CLAYEY SAND with GRAVEL, medium to coarse grained, brown, moist to wet, dense. (Glacial Outwash) 1999.1
5	SS	12-33 (45)				
				GC	12.0	(GC) CLAYEY GRAVEL with SAND, fine to coarse grained, brown, moist, dense. (Glacial Outwash) 1993.6
10	SS	24-20 (44)				
				SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, a trace of Cobbles, brown, moist, very dense to medium dense. (Glacial Outwash)
15	SS	24-29 (53)				
20	SS	25-28 (53)				
25	SS	10-18 (28)	Fines = 8%			
30	SS	11-13 (24)				

(Continued Next Page)

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Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

BORING NUMBER B-2

CLIENT NAI Black
PROJECT NAME Painted Hills Supplemental
PROJECT NUMBER 16-249
PROJECT LOCATION 4403 South Dishman-Mica Road

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
				SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, a trace of Cobbles, brown, moist, very dense to medium dense. (Glacial Outwash) *(continued)*
35	SS	28-37 (65)				
40	SS	50/5"				
45	SS	50/5"				
50	SS	50/5"				
55						
60	SS	8-17 (25)				
65						

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DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
70	SS	21-11 (32)		SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, a trace of Cobbles, brown, moist, very dense to medium dense. (Glacial Outwash) *(continued)*
75						75.0 — 1930.6

End of boring.

Groundwater encountered at 71' with 75' of hollow-stem auger in the ground.

Goundwater encountered at 73.5' 10 minutes later.

Groundwater not encountered to cave-in depth of 15' immediately after withdrawal of the auger.

Bore hole then abandoned.

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Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

BORING NUMBER B-3

CLIENT NAI Black
PROJECT NAME Painted Hills Supplemental
PROJECT NUMBER 16-249
PROJECT LOCATION 4403 South Dishman-Mica Road
DATE STARTED 3/18/16 **COMPLETED** 3/19/16
GROUND ELEVATION 2004.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR Johnson Exploration Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING --- Not encountered
LOGGED BY PRF **CHECKED BY** PTN
AT END OF DRILLING --- Not encountered
NOTES
AFTER DRILLING --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			ML		(ML) SANDY SILT, with roots, dark brown, moist. (Topsoil)
2.0					2002.5
			GC		(GC) CLAYEY GRAVEL with SAND, fine to coarse grained, brown, moist, dense. (Glacial Outwash)
5	SS				
8.0					1996.5
			SC		(SC) CLAYEY SAND with GRAVEL, medium to coarse grained, brown, moist to wet, dense. (Glacial Outwash)
10	SS				
12.0					1992.5
			GC		(GC) SILTY CLAYEY GRAVEL with SAND, fine to coarse grained, brown, moist, medium dense. (Glacial Outwash)
15	SS				
18.0					1986.5
			SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, a trace of Cobbles, brown, moist, very dense to medium dense. (Glacial Outwash)
20	SS				
25	SS				
30	SS	Fines = 6%			

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Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

CLIENT NAI Black
PROJECT NAME Painted Hills Supplemental
PROJECT NUMBER 16-249
PROJECT LOCATION 4403 South Dishman-Mica Road

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
			SP		(SP) POORLY GRADED SAND with GRAVEL, medium to coarse grained, a trace of Cobbles, brown, moist, very dense to medium dense. (Glacial Outwash) *(continued)*
35	SS				
40	SS				
45	SS				
50	SS				50.5 ... 1954.0

End of boring.

Groundwater not encountered with 49' of hollow-stem auger in the ground.

Groundwater not encountered immediately after withdrawal of the auger.

Bore hole then abandoned.

IPEC

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALVE			
COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
DENSITY	N(BLOWS/FT)	CONSISTENCY	N(BLOWS/FT)
Very Loose	0 - 4	Very Soft	0 - 1
Loose	4 - 10	Soft	2 - 3
Medium-Dense	11 - 30	Rather Soft	4 - 5
		Medium	6 - 8
Dense	31 - 50	Rather Stiff	9 - 12
		Stiff	13 - 16
Very Dense	> 50	Very Stiff	17 - 30
		Hard	> 30

USCS SOIL CLASSIFICATION				
MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse-Grained Soils <50% passes #200 sieve	Gravel and Gravelly Soils <50% coarse fraction passes #4 sieve	Gravel (with little or no fines)	GW	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravel (with >12% fines)	GM	Silty Gravel
			GC	Clayey Gravel
	Sandy and Sandy Soils >50% coarse fraction passes #4 sieve	Sand (with little or no fines)	SW	Well Graded Sand
			SP	Poorly Graded Sand
		Sand (with >12% fines)	SM	Silty Sand
			SC	Clayey Sand
Fine-Grained Soils >50% passes #200 sieve	Silt and Clay Liquid Limit < 50		ML	Silt
			CL	Lean Clay
			OL	Organic Silt and Clay (low plasticity)
	Salt and Clay Liquid Limit > 50		MH	Inorganic Silt
			CH	Fat Clay
			OH	Organic Clay and Silt (med to high plasticity)
Highly Organic Soils			PT	Peat / Muck

MODIFIERS	
DESCRIPTION	RANGE
Occasional	<5%
Trace	5% - 12%
With	>12%

MOISTURE CONTENT	
DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Dry of optimum moisture content
Wet	Wet of optimum moisture content

MAJOR DIVISIONS WITH GRAIN SIZE

SIEVE SIZE						
12"	3"	3/4"	4	10	40	200
GRAIN SIZE (INCHES)						
12	3	0.75	0.19	0.079	0.0171	0.0029

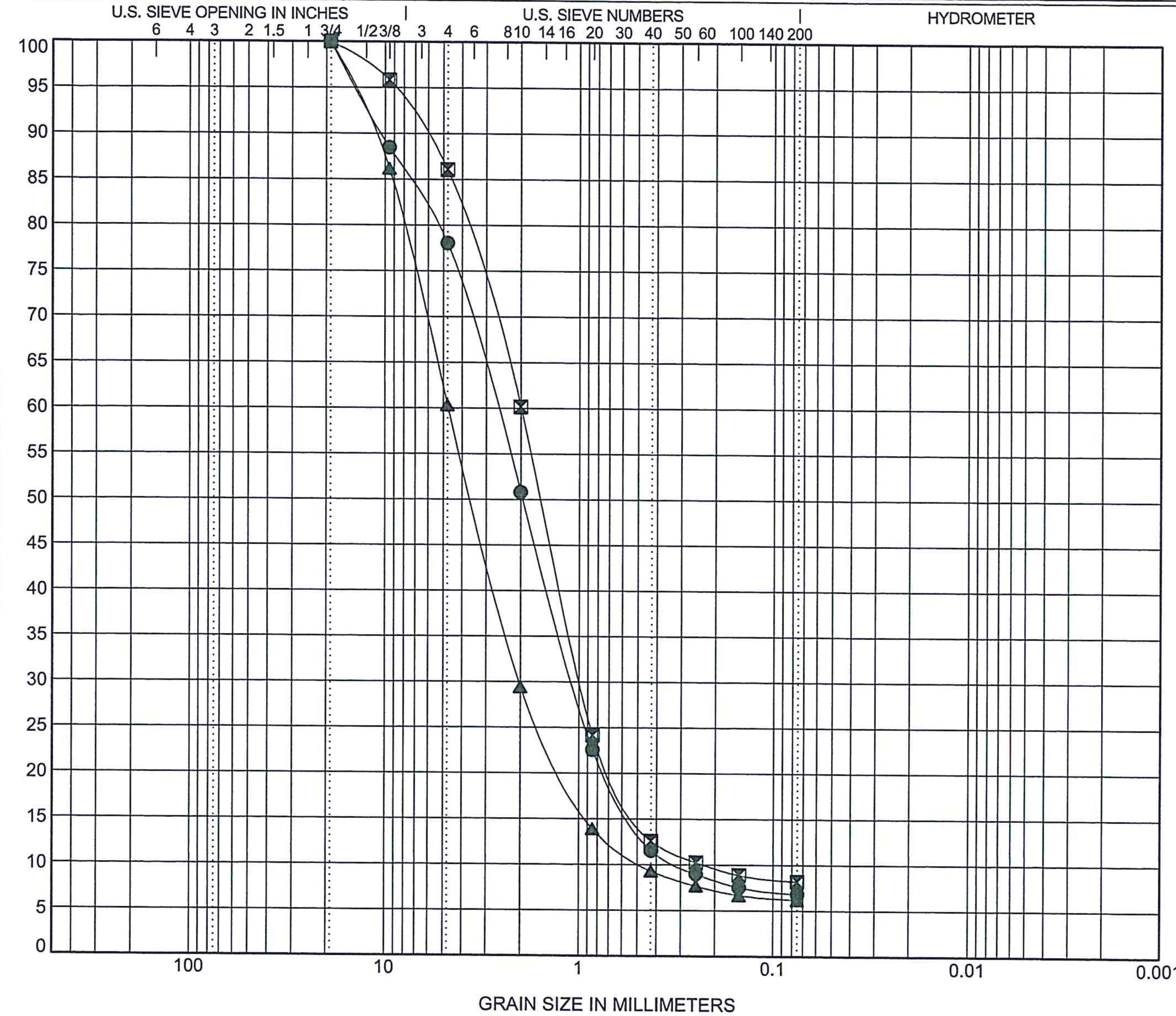
Boulders	Cobbles	Gravel		Sand			Silt and Clay
		Coarse	Fine	Coarse	Medium	Fine	

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

GRAIN SIZE DISTRIBUTION

CLIENT NAI Black **PROJECT NAME** Painted Hills Supplemental

PROJECT NUMBER 16-249 **PROJECT LOCATION** 4403 South Dishman-Mica Road



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● B-1	30.0	**SP-SM Poorly Graded Sand with Silt**				1.37	8.65
⊠ B-2	25.0	**SP-SM Poorly Graded Sand with Silt**				2.10	8.72
▲ B-3	30.0	**SP-SM Poorly Graded Sand with Silt**				1.85	9.95

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1	30.0	19	2.679	1.065	0.31	21.9	71.2	6.8	
⊠ B-2	25.0	19	1.992	0.977	0.228	13.9	77.9	8.2	
▲ B-3	30.0	19	4.708	2.032	0.473	39.7	54.1	6.2	

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

June 26, 2017
Project No. 16-249D

Mr. Bryan Walker
NAI Black
107 S Howard
Suite 500
Spokane, WA 99201

Re: **Geotechnical Evaluation**
Proposed Street Improvements
4403 South Dishman-Mica Road
Spokane Valley, WA

Dear Mr. Walker:

As you authorized, we have completed a geotechnical evaluation for the proposed street improvements to the roadways adjacent to the above referenced site in Spokane Valley, Washington. The purpose of the evaluation is to provide earthwork recommendations and pavement design for the proposed improvements. This report summarizes the results of our site observations, engineering analyses and recommendations.

PROJECT DESCRIPTION

The project consists of street improvements to the roadways adjacent to the proposed Painted Hills residential development located at the above referenced address. The improvements consist of about 6,000 feet of roadway on South Dishman Mica Road, East Thorpe Road, and South Madison Road.

P.O. Box 1566, Veradale, WA 99037
Phone 509-209-6262

AVAILABLE INFORMATION

We were provided a topographic survey for the project site by Whipple Consulting Engineers, Inc. (WCE). This topographic survey showed the existing roadways, existing structures, property lines, and existing ground surface elevation contours. This plan was prepared by WCE and was dated November 7, 2013. The site was used as a golf course prior to our evaluation. The site is relatively level with some elevated golf greens and excavated areas for water hazards. The site is primarily grass-covered with scattered trees along the fairways and pine trees in the undeveloped area to the northwest. The clubhouse building is present at the southwest corner.

We were also provided civil plans for the roadway improvements. The plans showed the layout and elevations of the proposed roadways and elevation contours. The plans were prepared by WCE and dated August 17, 2016.

In addition, we performed a preliminary geotechnical evaluation for the property in December 2013. The results of that evaluation, along with our opinions and recommendations, are summarized in our Preliminary Geotechnical Evaluation dated December 31, 2013.

We also performed a geotechnical evaluation for certification of the existing levee along Chester Creek in April 2014. The results of that evaluation are summarized in our Geotechnical Evaluation report dated February 12, 2015.

Furthermore, we performed a supplemental geotechnical evaluation in July 2015 consisting of ten, 50-foot borings in the south half of the property. The results of that evaluation are summarized in our Geotechnical Evaluation Phase 2 report dated July 23, 2015.

We also performed a second supplemental geotechnical evaluation at the north end of the property to evaluate soil conditions at depth and to better define the static groundwater elevation in this area. We then performed a full-scale drywell test on a drywell installed near Boring B-1 from our second supplemental geotechnical evaluation. The results of these evaluations are summarized in our Supplemental Geotechnical Evaluation dated April 19, 2016 and our Full-Scale Drywell Testing report dated June 28, 2016.

Lastly, we performed bore hole permeability testing at the north end of the property to evaluate infiltration rates at the depth of the drywell tested in our Full-Scale Drywell Testing report. We also tested infiltration rates at deeper depths. The results of that evaluation are summarized in our Bore Hole Permeability Testing report dated September 16, 2016.

FIELD EVALUATION

Procedures

A geotechnical engineer from Inland Pacific Engineering Company (IPEC) observed the excavation of twelve test pits at the site. The test pits were excavated on February 23, 2017 using a backhoe operated by an independent firm under subcontract to IPEC. A geotechnical engineer from IPEC observed the test pit excavations and logged the surface and subsurface conditions. After we logged each test pit, the test pit was immediately backfilled.

The soils encountered in the test pits were visually and manually classified in the field by our field personnel in accordance with ASTM D 2488, "Description and Identification of Soils (Visual-Manual Procedures)". The samples were returned to our facility for review of the classification by a geotechnical engineer and potential laboratory testing.

Soils Encountered

Geologic maps indicate the soils in this area consist primarily of alluvial and/or glacially deposited silts, clays, sands, and gravels. According to the Soil Survey of Spokane County, the site soils are classified by the Natural Resource Conservation Service (NRCS) as Narcisse silt loam (1080), Endoaquolls and Fluvaquents (1200), Hardesty ashy silt loam (1040), Phoebe ashy sandy loam (3130), Bong ashy loam, moist (3022), and Urban land-Springdale, disturbed complex (7170). The native soils encountered in the teste pits were consistent with the NRCS data.

At the surface, the test pits encountered topsoil ranging from about ½ to 2 feet. The topsoil consisted of clayey to silty sand, silty gravel, and lean clay.

Below the topsoil, the test pits along Dishman-Mica and Thorpe Road generally encountered alluvial soils to their termination depths. The alluvial soils consisted of lean clay and clayey to silty sand. Below the topsoil, the test pits along Madison Road generally encountered glacial outwash or alluvial soils to their termination depths. The glacial outwash consisted of clayey and silty to poorly graded sand with silt and silty gravel. The alluvial soils consisted of lean clay and clayey sand.

Groundwater was encountered in Test Pits TP-4 through TP-7 at depths ranging from 2 to 4 feet below existing grades at the time of our exploration. Seasonal and annual fluctuations of groundwater levels should be anticipated.

Laboratory Testing

We obtained samples of the subgrade soil from Test Pit TP-2, TP-4, and TP-7 during our site investigation. Grain size analyses and modified Proctor tests were performed by us on the samples obtained from TP-4 and TP-7 in accordance with ASTM D6913 and ASTM D1557, respectively. The results of the tests are attached.

In addition, resilient modulus (M_r) tests were performed on the samples obtained from TP-4 and TP-7 in accordance with AASHTO T307. The M_r tests were performed by Braun Intertec in Bloomington, Minnesota. Attached are data sheets summarizing the tests performed.

ANALYSIS AND RECOMMENDATIONS

Subgrade Preparation

After removing the asphalt from the existing roadways, we anticipate the subgrade will consist of existing roadway embankment fill. We have assumed that during the construction of the existing roadways, the fill was compacted in accordance with local jurisdiction standards. Where road widening is planned, we recommend removing any existing topsoil.

We recommend that the upper 8 inches of the resulting subgrade be scarified, moistened or dried to within 3 percent of optimum moisture, and compacted to a minimum of 95 percent of the modified Proctor maximum dry density determined in accordance with ASTM D 1557. Where fill is required, we recommend that it be similarly moisture conditioned and compacted. If there are areas that cannot be compacted, we recommend that the unstable soils be removed and replaced with soils similar to the surrounding subgrade soils.

We recommend that the subgrade surface be shaped to provide for positive drainage to minimize the potential for water to pond in the subgrade. Because the site soils are low to highly frost-susceptible, it will be important to avoid creating "bathtubs" in the subgrade where water can pond and freeze, which could heave the pavement.

If site grading and construction are anticipated during cold weather, recommend that good winter construction practices be observed. All snow and ice should be removed from excavated and fill areas prior to additional earthwork or construction. No fill or pavements should be placed on soil which have frozen or contain frozen material. Frozen soils should not be used as backfill or fill.

Test Rolling

Prior to placing the aggregate base, we recommend that all subgrade areas be proof-rolled with a loaded dump truck. This precautionary measure would assist in detecting any localized soft areas. Any soft areas discovered during the proof-rolling operation should be excavated and replaced with a suitable structural fill material. The structural fill should be similar to the existing subgrade soil type to provide a uniform subgrade. We recommend that the proof-rolling process be observed by an experienced geotechnical engineer to make the final evaluation of the subgrade.

Pavement Section Design

We performed a pavement section analysis in accordance with the "AASHTO Guide for Design of Pavement Structures, 1993" by the American Association of State Highway and Transportation Officials (AASHTO). For our analysis, we were provided an Average Daily Traffic (ADT) value of 5,300 for Dishman-Mica Road, 1,400 for Thorpe Road, and 1,700 for Madison Road. We were also provided percent trucks values of 2 percent for Thorpe and Madison Road, and 5 percent for Dishman-Mica Road. We were provided a percent growth value of 1.1 percent.
Based on these provided parameters, we calculated the following Equivalent Single Axle Loads (ESAL):

- Dishman-Mica Road: 2,617,545
- Thorpe Road: 330,000
- Madison Road: 389,954

We used resilient modulus values from the laboratory test results of (M_r) of 5,821 pounds per square inch (psi) for Thorpe Road and an M_r of 11,985 psi for Dishman-Mica and Madison Road. We also used the following parameters in our analysis provided in Chapter 8 of the City of Spokane Valley Street Standards, dated December of 2009:

- Reliability: 90 percent
- Standard Deviation: 0.45
- Initial Serviceability Index: 4.2
- Terminal Serviceability Index:
  - Dishman-Mica Road: 2.50
  - Thorpe Road: 2.25
  - Madison Road: 2.25
- Structural Layer Coefficients:
    - Asphalt: 0.42
    - Aggregate Base: 0.14
- Drainage Layer Coefficient:
  - Dishman-Mica Road: 1.05
  - Thorpe Road: 0.85
  - Madison Road: 0.95

Based on this data, we calculated the following design structural numbers:

- Dishman-Mica Road: 3.4
- Thorpe Road: 3.1
- Madison Road: 2.5

Based on our analysis, we recommend the following pavement sections:

- Dishman-Mica Road:
  - 4 inches of asphalt overlying 12 inches of crushed aggregate base
- Thorpe Road:
  - 4 inches of asphalt overlying 12 inches of crushed aggregate base
- Madison Road:
  - 4 inches of asphalt overlying 6 inches of crushed aggregate base

We recommend specifying crushed aggregate base meeting the requirements of the Washington Department of Transportation (WSDOT) Standard Specification 9-03.9(3) for crushed gravel surfacing (base course and/or top course). We recommend that the asphalt concrete pavement meet the requirements of WSDOT Standard Specification for Class ½ inch HMA asphalt concrete pavements. We recommend that the crushed gravel surfacing be compacted to a minimum of 95 percent of the modified Proctor maximum dry density. We recommend that the asphaltic concrete surface be compacted to minimum of 92 percent of the Rice density.

GENERAL RECOMMENDATIONS

The analyses and recommendations submitted in this report are based on the data obtained from the test pits excavated at the locations indicated on the Test Pit Location Map on Figure 3. It should be recognized that the explorations performed for this evaluation reveal subsurface conditions only at discreet locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

We made water level observations in the test pits at the times and conditions stated on the test pit logs. These data were interpreted in the text of this report. The period of observation was relatively short and fluctuation in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications and construction planning should recognize the possibility of fluctuations.

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

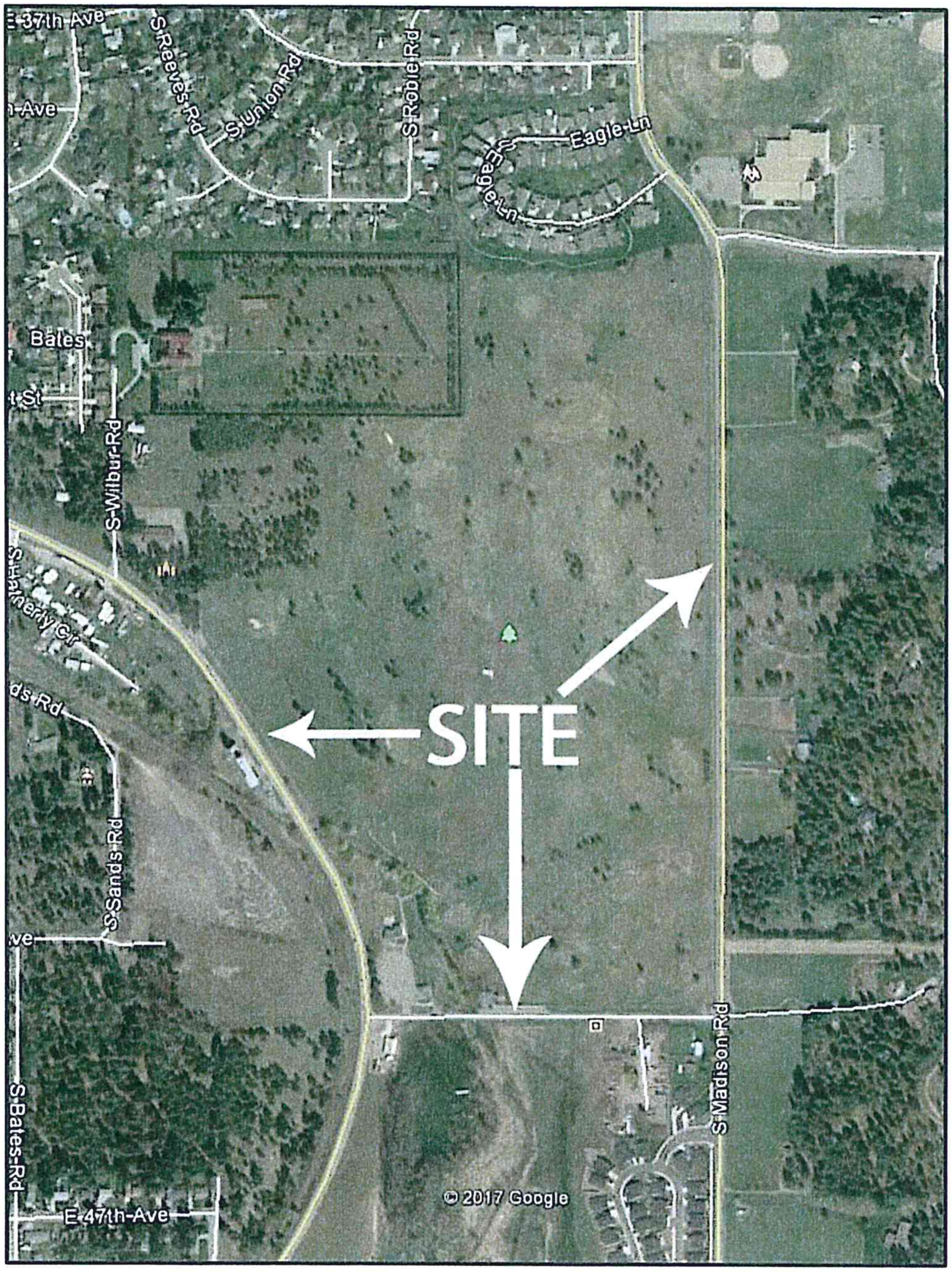
Sincerely,
Inland Pacific Engineering Company

Gregory J. Voigt, P.E.
Project Engineer

Paul T. Nelson, P.E.
Principal Engineer

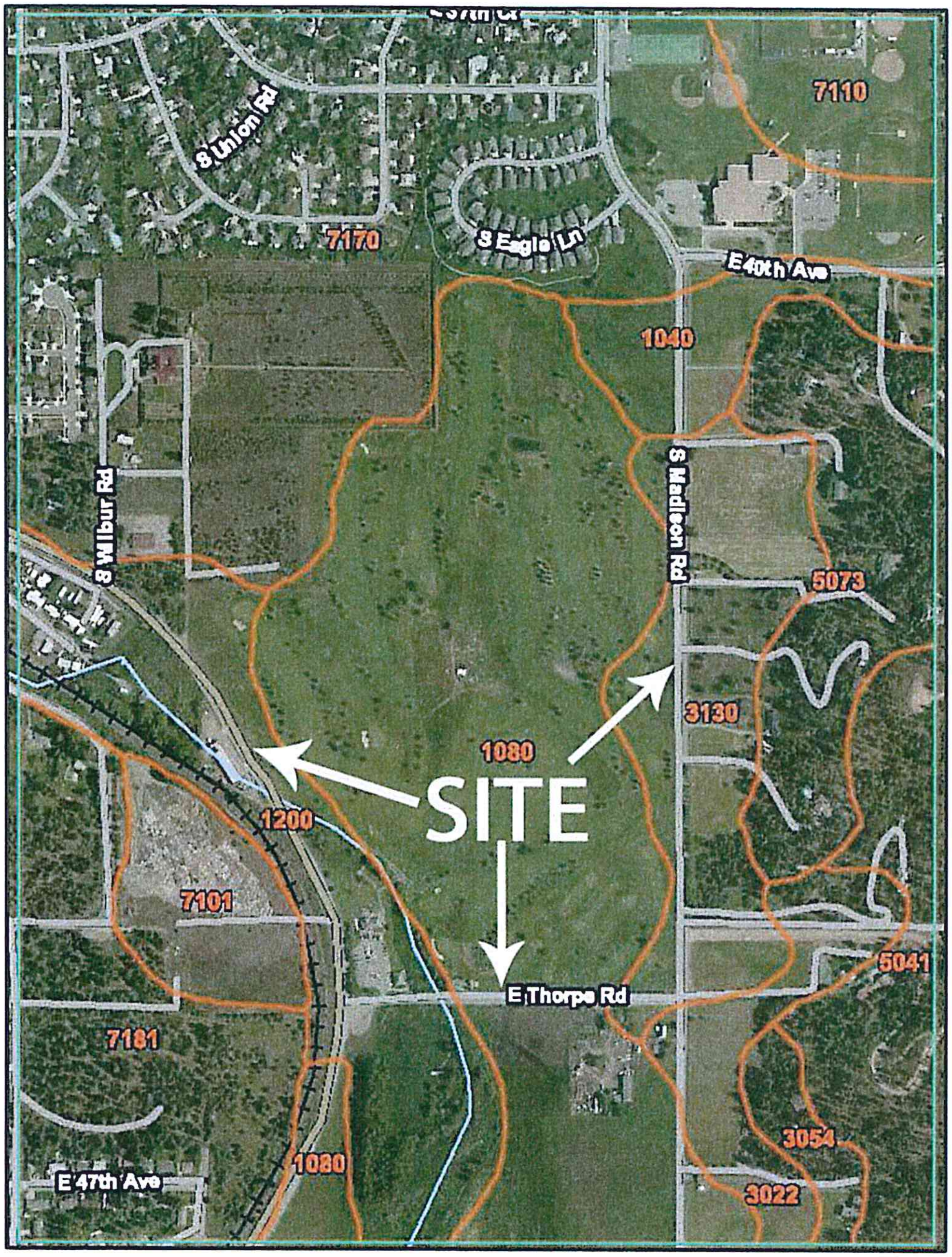
Attachments: Figure 1, Site Location Map
Figure 2, NRCS Map
Figure 3, Test Pit Location Maps
Logs of Test Pits
Descriptive Terminology
Laboratory Test Results

FIGURE 1



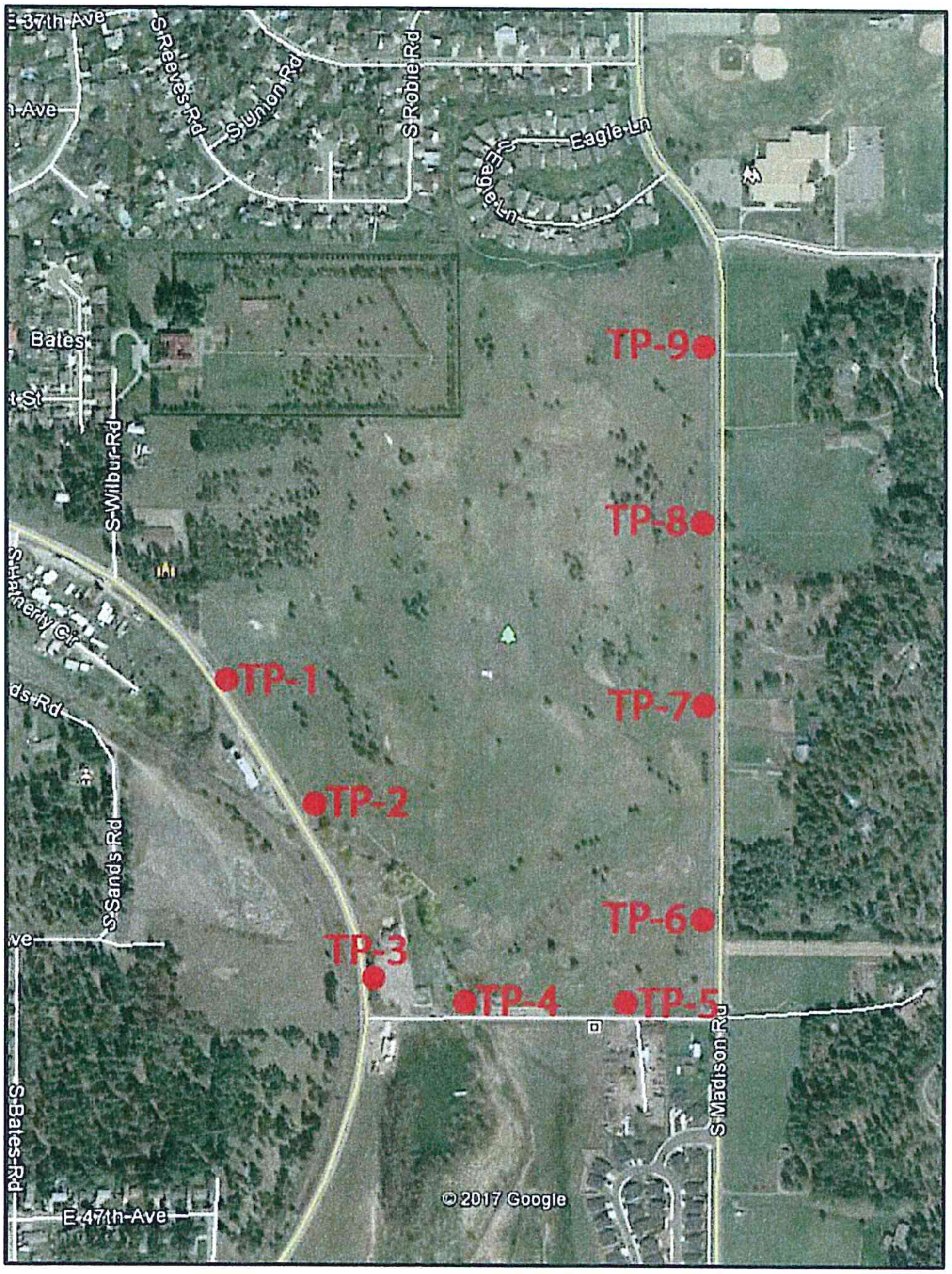
Site Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249D	June 26, 2017
	Proposed Street Improvements 4403 S Dishman-Mica Rd Spokane Valley, WA	

FIGURE 2



NRCS Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249D	June 26, 2017
	Proposed Street Improvements 4403 S Dishman-Mica Rd Spokane Valley, WA	

FIGURE 3



Test Pit Location Map 1		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249D Proposed Street Improvements 4403 S Dishman-Mica Rd Spokane Valley, WA	June 26, 2017

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-1

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION --- Not encountered
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION --- Not encountered
NOTES
AFTER EXCAVATION --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SC	0.5	(SC) CLAYEY SAND, fine-grained, trace roots, dark brown, moist. (Topsoil)
2.5		CL	3.0	(CL) LEAN CLAY with SAND, brown, moist. (Alluvium)
5.0		SC	5.0	(SC) CLAYEY SAND, fine-grained, brown, moist. (Alluvium)

End of test pit.

Groundwater not encountered.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-2

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION --- Not encountered
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION --- Not encountered
NOTES
AFTER EXCAVATION --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		GM	0.5	(GM) SILTY GRAVEL, fine to coarse-grained, trace roots, dark brown, moist. (Topsoil)
2.5		CL	3.0	(CL) LEAN CLAY with SAND, brown, moist. (Alluvium)
5.0		SC	5.0	(SC) CLAYEY SAND, fine-grained, brown, moist. (Alluvium)

End of test pit.

Groundwater not encountered.

Test pit immediately backfilled.

IPEC

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3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-3

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION --- Not encountered
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION --- Not encountered
NOTES
AFTER EXCAVATION --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SM	0.5	(SM) SILTY SAND, fine-grained, dark brown, moist. (Topsoil)
2.5		SM	5.0	(SM) SILTY SAND, fine-grained, brown, moist. (Alluvium)
5.0				

End of test pit.

Groundwater not encountered.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-4

CLIENT NAI Black

PROJECT NAME Proposed Street Improvements

PROJECT NUMBER 16-249D

PROJECT LOCATION Spokane Valley, WA

DATE STARTED 2/23/17 COMPLETED 2/23/17

GROUND ELEVATION ______ TEST PIT SIZE 30 inches

EXCAVATION CONTRACTOR Alpine Excavating

GROUND WATER LEVELS:

EXCAVATION METHOD Backhoe

AT TIME OF EXCAVATION 2.00 ft

LOGGED BY GV CHECKED BY PTN

AT END OF EXCAVATION 2.00 ft

NOTES

AFTER EXCAVATION 2.00 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			CL		(CL) LEAN CLAY with SAND, dark brown, moist. (Topsoil)
2.5		Fines = 38%	SM	2.0	(SM) SILTY SAND, fine-grained, with seams of Silt, brown, water-bearing. (Alluvium)
5.0				5.0	

End of test pit.

Groundwater encountered at 2 feet.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-5

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
∇ **AT TIME OF EXCAVATION** 2.00 ft
LOGGED BY GV **CHECKED BY** PTN
▼ **AT END OF EXCAVATION** 2.00 ft
NOTES
▼ **AFTER EXCAVATION** 2.00 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		CL		(CL) LEAN CLAY with SAND, trace roots, dark brown, moist. (Topsoil)
2.5		CL	2.0 ▼	(CL) LEAN CLAY with SAND, brown, wet. (Alluvium)
5.0			5.0	

End of test pit.

Groundwater encountered at 2 feet.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-6

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION 3.50 ft
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION 3.50 ft
NOTES
AFTER EXCAVATION 3.50 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SC	0.5	(SC) CLAYEY SAND, fine-grained, dark brown, moist. (Topsoil)
		SC	1.5	(SC) CLAYEY SAND, fine-grained, brown, moist. (Alluvium)
2.5 5.0		SP-SM	5.0	(SP-SM) POORLY GRADED SAND with SILT, fine to coarse-grained, brown, moist to water-bearing. (Glacial Outwash)

End of test pit.

Groundwater encountered at 3 1/2 feet.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-7

CLIENT	NAI Black	**PROJECT NAME**	Proposed Street Improvements
PROJECT NUMBER	16-249D	**PROJECT LOCATION**	Spokane Valley, WA
DATE STARTED	2/23/17 **COMPLETED** 2/23/17	**GROUND ELEVATION**	**TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR	Alpine Excavating	**GROUND WATER LEVELS:**	
EXCAVATION METHOD	Backhoe	AT TIME OF EXCAVATION	4.00 ft
LOGGED BY	GV **CHECKED BY** PTN	AT END OF EXCAVATION	4.00 ft
NOTES		AFTER EXCAVATION	4.00 ft

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0 – 2.0			CL		(CL) LEAN CLAY with SAND, trace roots, dark brown, moist. (Topsoil)
2.0 – 5.0		Fines = 50%	CL		(CL) SANDY LEAN CLAY, brown, moist to wet. (Alluvium) ▼ (4.0)

End of test pit.

Groundwater encountered at 4 feet.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-8

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION
TEST PIT SIZE 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION --- Not encountered
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION --- Not encountered
NOTES
AFTER EXCAVATION --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SC	1.0	(SC) CLAYEY SAND with GRAVEL, fine to medium-grained, dark brown, moist. (Topsoil)
2.5		SC	5.0	(SC) CLAYEY SAND with GRAVEL, fine to medium-grained, brown, moist. (Glacial Outwash)
5.0				

End of test pit.

Groundwater not encountered.

Test pit immediately backfilled.

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

TEST PIT NUMBER TP-9

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA
DATE STARTED 2/23/17 **COMPLETED** 2/23/17
GROUND ELEVATION **TEST PIT SIZE** 30 inches
EXCAVATION CONTRACTOR Alpine Excavating
GROUND WATER LEVELS:
EXCAVATION METHOD Backhoe
AT TIME OF EXCAVATION --- Not encountered
LOGGED BY GV **CHECKED BY** PTN
AT END OF EXCAVATION --- Not encountered
NOTES
AFTER EXCAVATION --- Not encountered

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0		SC	1.0	(SC) CLAYEY SAND, fine-grained, dark brown, moist. (Topsoil)
		SM	2.0	(SM) SILTY SAND with GRAVEL, fine to medium-grained, brown, moist. (Glacial Outwash)
2.5		GM	5.0	(GM) SILTY GRAVEL, fine to coarse-grained, brown, moist. (Glacial Outwash)
5.0				

End of test pit.

Groundwater not encountered.

Test pit immediately backfilled.

IPEC

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALVE			
COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
DENSITY	N(BLOWS/FT)	CONSISTENCY	N(BLOWS/FT)
Very Loose	0 - 4	Very Soft	0 - 1
Loose	5 - 10	Soft	2 - 3
Medium-Dense	11 - 30	Rather Soft	4 - 5
		Medium	6 - 8
Dense	31 - 50	Rather Stiff	9 - 12
		Stiff	13 - 16
Very Dense	> 50	Very Stiff	17 - 30
		Hard	> 30

USCS SOIL CLASSIFICATION				
MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse-Grained Soils <50% passes #200 sieve	Gravel and Gravelly Soils <50% coarse fraction passes #4 sieve	Gravel (with little or no fines)	GW	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravel (with >12% fines)	GM	Silty Gravel
			GC	Clayey Gravel
	Sandy and Sandy Soils >50% coarse fraction passes #4 sieve	Sand (with little or no fines)	SW	Well Graded Sand
			SP	Poorly Graded Sand
		Sand (with >12% fines)	SM	Silty Sand
			SC	Clayey Sand
Fine-Grained Soils >50% passes #200 sieve	Silt and Clay Liquid Limit < 50		ML	Silt
			CL	Lean Clay
			OL	Organic Silt and Clay (low plasticity)
	Salt and Clay Liquid Limit > 50		MH	Inorganic Silt
			CH	Fat Clay
			OH	Organic Clay and Silt (med to high plasticity)
Highly Organic Soils			PT	Peat / Muck

MODIFIERS	
DESCRIPTION	RANGE
Occasional	<5%
Trace	5% - 12%
With	>12%

MOISTURE CONTENT	
DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Dry of optimum moisture content
Wet	Wet of optimum moisture content

MAJOR DIVISIONS WITH GRAIN SIZE							
SIEVE SIZE							
	12"	3"	3/4"	4	10	40	200
GRAIN SIZE (INCHES)							
	12	3	0.75	0.19	0.079	0.0171	0.0029
Boulders	Cobbles	Gravel		Sand			Silt and Clay
		Coarse	Fine	Coarse	Medium	Fine	

IPEC
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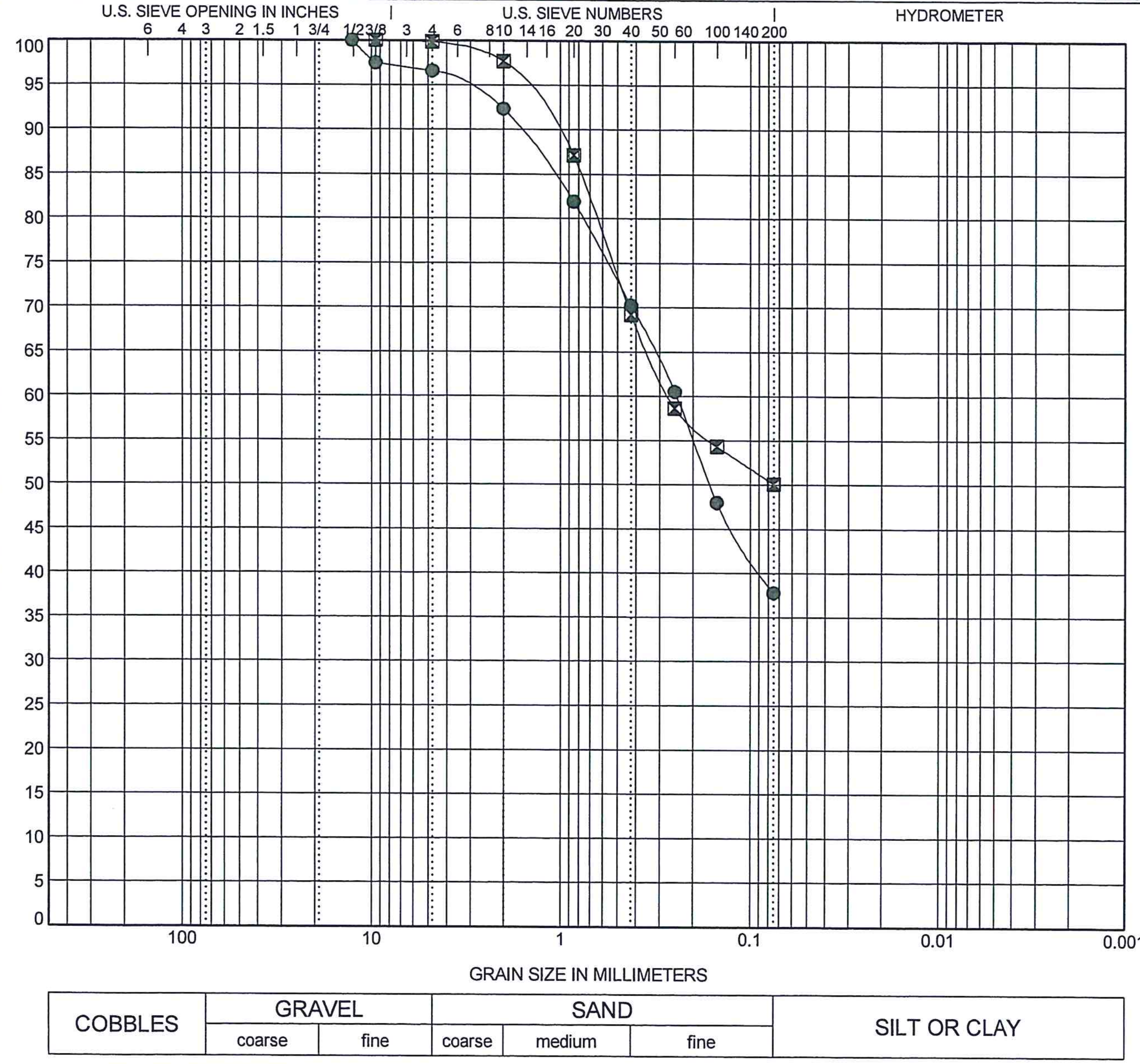
Telephone: 509-209-6262
Fax: 509-290-5734

GRAIN SIZE DISTRIBUTION

CLIENT NAI Black **PROJECT NAME** Proposed Street Improvements

PROJECT NUMBER 16-249D **PROJECT LOCATION** Spokane Valley, WA



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● TP-4	3.0	**SILTY SAND(SM)**					
⊠ TP-7	3.0	**SANDY LEAN CLAY(CL)**					

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● TP-4	3.0	12.7	0.245			3.4	58.8	37.8	
⊠ TP-7	3.0	9.5	0.268			0.2	49.7	50.1	

Resilient Modulus Testing - AASHTO T307 US Customary Units

Date: April 10, 2017

Project: B1702069

Client:
Inland Pacific Engineering Company
Paul Nelson
P.O. Box 1566
Veradale, WA 99037

Project Description:
Resilient Modulus Test
AASHTO T307
Client ID: Proposed Street Improvements
Station: TP-4

Sample Information

Braun Sample ID./ File Name:	1	Sample Diameter, in.:	2.82	Sample M.C., % before, after:	13.9, 13.6
Sample Type:	Type 2	Sample Height, in.:	5.58	Sample Dry Den., pcf:	97.8
Test Date:	06-Apr-2017	Desired M.C., %:	13.5	Failed in Shear?:	YES
Comments:	Spokane Valley, WA	Desired Dry Density., pcf:	98.8	Triaxial Shear Strength, psi:	44.2

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Maximum Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Maximum Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov Def. LVDT 1 Reading	Recov Def. LVDT 2 Reading	Average Recov Def. LVDT 1 and LVDT 2	Resilient Strain	Resilient Modulus
DESIGNATION	S3	Scyclic	c1	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	H average		Mr
UNIT	psi	psi	---	lbs.	lbs.	lbs.	psi	psi	psi	inches	inches	inches	in/in	psi
PRECISION	- - -.-	- - -.-	-	- - - -.-	- - - -.-	- - -.-	- - -.-	- - -.-	- - -.-	-.- - - - -	-.- - - - -	-.- - - - -	-.- - - - -	- - -
SEQUENCE 1	6.0	2.1	1	13.4	11.0	2.4	2.2	1.8	0.4	0.00074	0.00063	0.00069	0.00012	14,342
			2	13.4	11.0	2.4	2.1	1.8	0.4	0.00071	0.00060	0.00066	0.00012	15,062
			3	13.2	10.7	2.5	2.1	1.7	0.4	0.00078	0.00067	0.00072	0.00013	13,377
			4	13.3	10.9	2.4	2.1	1.8	0.4	0.00085	0.00074	0.00079	0.00014	12,325
			5	13.5	11.1	2.5	2.2	1.8	0.4	0.00082	0.00071	0.00077	0.00014	12,968
	COLUMN AVERAGE			13.4	10.9	2.4	2.1	1.8	0.4	0.00078	0.00067	0.00073	0.00013	13,615
	STANDARD DEV.			0.12	0.12	0.03	0.02	0.02	0.00	0.00006	0.00005	0.00006	0.00001	1,091

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 2	6.0	4.0	1	25.2	21.3	3.9	4.1	3.4	0.6	0.00168	0.00149	0.00159	0.00028	12,106
			2	25.2	21.3	3.9	4.0	3.4	0.6	0.00175	0.00156	0.00165	0.00030	11,586
			3	25.2	21.4	3.8	4.0	3.4	0.6	0.00154	0.00136	0.00145	0.00026	13,326
			4	25.2	21.6	3.6	4.1	3.5	0.6	0.00168	0.00149	0.00158	0.00028	12,307
			5	25.1	21.2	3.8	4.0	3.4	0.6	0.00168	0.00149	0.00159	0.00028	12,060
	COLUMN AVERAGE			25.2	21.4	3.8	4.0	3.4	0.6	0.00167	0.00148	0.00157	0.00028	12,277
	STANDARD DEV.			0.07	0.14	0.12	0.01	0.02	0.02	0.00008	0.00007	0.00008	0.00001	643
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 3	6.0	5.7	1	35.7	31.0	4.7	5.7	5.0	0.8	0.00257	0.00230	0.00244	0.00044	11,443
			2	35.4	30.4	5.1	5.7	4.9	0.8	0.00267	0.00239	0.00253	0.00045	10,797
			3	35.7	31.0	4.8	5.7	5.0	0.8	0.00257	0.00230	0.00243	0.00043	11,461
			4	35.6	30.7	4.9	5.7	4.9	0.8	0.00267	0.00239	0.00253	0.00045	10,906
			5	35.5	30.7	4.8	5.7	4.9	0.8	0.00278	0.00249	0.00264	0.00047	10,474
	COLUMN AVERAGE			35.6	30.8	4.8	5.7	4.9	0.8	0.00260	0.00233	0.00246	0.00044	11,016
	STANDARD DEV.			0.12	0.25	0.14	0.02	0.04	0.02	0.00006	0.00005	0.00006	0.00001	429
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 4	6.0	8.1	1	50.7	44.2	6.5	8.1	7.1	1.0	0.00385	0.00414	0.00400	0.00071	9,961
			2	50.6	43.8	6.8	8.1	7.0	1.1	0.00383	0.00412	0.00397	0.00071	9,914
			3	50.6	43.9	6.7	8.1	7.1	1.1	0.00384	0.00413	0.00398	0.00071	9,925
			4	50.5	43.8	6.7	8.1	7.0	1.1	0.00365	0.00393	0.00379	0.00068	10,400
			5	50.6	44.9	5.8	8.1	7.2	0.9	0.00384	0.00414	0.00399	0.00071	10,110
	COLUMN AVERAGE			50.6	44.1	6.5	8.1	7.1	1.0	0.00380	0.00409	0.00395	0.00070	10,062
	STANDARD DEV.			0.07	0.44	0.41	0.01	0.07	0.07	0.00008	0.00009	0.00009	0.00002	204

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 5	6.0	10.1	1	62.9	56.3	6.6	10.1	9.0	1.1	0.00483	0.00524	0.00503	0.00090	10,059
			2	62.8	56.0	6.8	10.1	9.0	1.1	0.00481	0.00521	0.00501	0.00089	10,073
			3	62.9	54.9	8.0	10.1	8.8	1.3	0.00482	0.00523	0.00502	0.00090	9,840
			4	62.9	55.0	7.9	10.1	8.8	1.3	0.00462	0.00500	0.00481	0.00086	10,292
			5	63.0	54.9	8.1	10.1	8.8	1.3	0.00481	0.00521	0.00501	0.00090	9,855
	COLUMN AVERAGE			62.9	55.4	7.5	10.1	8.9	1.2	0.00478	0.00518	0.00498	0.00089	10,024
	STANDARD DEV.			0.05	0.68	0.71	0.01	0.11	0.11	0.00009	0.00010	0.00010	0.00002	186
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 6	4.0	2.1	1	13.0	11.0	2.0	2.1	1.8	0.3	0.00057	0.00085	0.00071	0.00013	13,985
			2	13.0	11.0	2.0	2.1	1.8	0.3	0.00059	0.00088	0.00073	0.00013	13,512
			3	13.0	10.9	2.1	2.1	1.8	0.3	0.00062	0.00092	0.00077	0.00014	12,725
			4	13.0	11.0	2.0	2.1	1.8	0.3	0.00063	0.00093	0.00078	0.00014	12,771
			5	13.0	11.0	2.0	2.1	1.8	0.3	0.00058	0.00087	0.00073	0.00013	13,602
	COLUMN AVERAGE			13.0	11.0	2.0	2.1	1.8	0.3	0.00060	0.00089	0.00074	0.00013	13,319
	STANDARD DEV.			0.04	0.05	0.04	0.01	0.01	0.01	0.00003	0.00004	0.00003	0.00001	551
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 7	4.0	4.0	1	24.8	21.3	3.5	4.0	3.4	0.6	0.00194	0.00206	0.00200	0.00036	9,597
			2	24.8	21.7	3.1	4.0	3.5	0.5	0.00203	0.00215	0.00209	0.00037	9,312
			3	24.7	21.4	3.3	4.0	3.4	0.5	0.00193	0.00205	0.00199	0.00036	9,649
			4	25.0	21.7	3.3	4.0	3.5	0.5	0.00208	0.00220	0.00214	0.00038	9,128
			5	24.8	21.4	3.4	4.0	3.4	0.6	0.00195	0.00207	0.00201	0.00036	9,541
	COLUMN AVERAGE			24.8	21.5	3.3	4.0	3.5	0.5	0.00199	0.00211	0.00205	0.00037	9,445
	STANDARD DEV.			0.09	0.18	0.14	0.02	0.03	0.02	0.00006	0.00007	0.00007	0.00001	219

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 8	4.0	5.9	1	36.6	32.1	4.5	5.9	5.2	0.7	0.00319	0.00338	0.00328	0.00059	8,804
			2	36.6	32.2	4.4	5.9	5.2	0.7	0.00333	0.00353	0.00343	0.00061	8,450
			3	36.6	32.0	4.6	5.9	5.1	0.7	0.00318	0.00337	0.00328	0.00059	8,788
			4	36.7	32.1	4.6	5.9	5.2	0.7	0.00317	0.00336	0.00327	0.00058	8,845
			5	36.6	32.0	4.6	5.9	5.1	0.7	0.00346	0.00367	0.00356	0.00064	8,085
	COLUMN AVERAGE			36.6	32.1	4.5	5.9	5.2	0.7	0.00327	0.00346	0.00336	0.00060	8,595
	STANDARD DEV.			0.03	0.08	0.09	0.00	0.01	0.01	0.00012	0.00013	0.00013	0.00002	326

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 9	4.0	7.8	1	48.8	43.2	5.5	7.8	6.9	0.9	0.00444	0.00469	0.00457	0.00082	8,523
			2	48.6	42.9	5.7	7.8	6.9	0.9	0.00462	0.00488	0.00475	0.00085	8,120
			3	48.6	42.1	6.5	7.8	6.8	1.1	0.00463	0.00489	0.00476	0.00085	7,969
			4	48.7	43.8	4.9	7.8	7.0	0.8	0.00462	0.00489	0.00475	0.00085	8,295
			5	48.8	42.8	5.9	7.8	6.9	1.0	0.00463	0.00489	0.00476	0.00085	8,095
	COLUMN AVERAGE			48.7	43.0	5.7	7.8	6.9	0.9	0.00459	0.00485	0.00472	0.00084	8,200
	STANDARD DEV.			0.09	0.63	0.59	0.01	0.10	0.10	0.00008	0.00009	0.00008	0.00002	214

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 10	4.0	9.8	1	61.2	54.6	6.6	9.8	8.8	1.1	0.00562	0.00594	0.00578	0.00103	8,496
			2	61.3	54.0	7.2	9.8	8.7	1.2	0.00566	0.00598	0.00582	0.00104	8,358
			3	61.2	53.2	8.0	9.8	8.6	1.3	0.00565	0.00596	0.00580	0.00104	8,256
			4	61.2	54.4	6.8	9.8	8.7	1.1	0.00561	0.00591	0.00576	0.00103	8,497
			5	61.2	53.8	7.4	9.8	8.6	1.2	0.00539	0.00568	0.00554	0.00099	8,735
	COLUMN AVERAGE			61.2	54.0	7.2	9.8	8.7	1.2	0.00558	0.00589	0.00574	0.00103	8,468
	STANDARD DEV.			0.04	0.53	0.53	0.01	0.09	0.09	0.00011	0.00012	0.00012	0.00002	180

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 11	2.0	1.8	1	11.1	9.5	1.6	1.8	1.5	0.3	0.00041	0.00083	0.00062	0.00011	13,686
			2	11.1	9.5	1.6	1.8	1.5	0.3	0.00051	0.00095	0.00073	0.00013	11,774
			3	11.1	9.4	1.7	1.8	1.5	0.3	0.00045	0.00089	0.00067	0.00012	12,675
			4	11.1	9.5	1.6	1.8	1.5	0.3	0.00040	0.00083	0.00062	0.00011	13,915
			5	11.0	9.4	1.7	1.8	1.5	0.3	0.00049	0.00095	0.00072	0.00013	11,666
	COLUMN AVERAGE			11.1	9.5	1.6	1.8	1.5	0.3	0.00045	0.00089	0.00067	0.00012	12,743
	STANDARD DEV.			0.03	0.08	0.05	0.01	0.01	0.01	0.00005	0.00006	0.00005	0.00001	1,045
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 12	2.0	3.7	1	23.1	20.2	2.9	3.7	3.2	0.5	0.00234	0.00258	0.00246	0.00044	7,387
			2	23.0	20.2	2.8	3.7	3.2	0.5	0.00245	0.00268	0.00257	0.00046	7,088
			3	23.0	20.2	2.8	3.7	3.3	0.4	0.00244	0.00268	0.00256	0.00046	7,118
			4	23.0	20.2	2.9	3.7	3.2	0.5	0.00233	0.00256	0.00245	0.00044	7,413
			5	23.1	20.3	2.8	3.7	3.3	0.5	0.00234	0.00258	0.00246	0.00044	7,423
	COLUMN AVERAGE			23.0	20.2	2.8	3.7	3.2	0.5	0.00238	0.00262	0.00250	0.00045	7,286
	STANDARD DEV.			0.04	0.05	0.04	0.01	0.01	0.01	0.00006	0.00006	0.00006	0.00001	168
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 13	2.0	5.3	1	33.2	29.2	4.0	5.3	4.7	0.7	0.00393	0.00411	0.00402	0.00072	6,526
			2	33.2	28.9	4.3	5.3	4.6	0.7	0.00410	0.00429	0.00419	0.00075	6,200
			3	33.2	29.3	3.9	5.3	4.7	0.6	0.00409	0.00428	0.00419	0.00075	6,308
			4	33.2	28.7	4.4	5.3	4.6	0.7	0.00392	0.00411	0.00402	0.00072	6,441
			5	33.2	29.1	4.1	5.3	4.7	0.7	0.00391	0.00410	0.00401	0.00072	6,538
	COLUMN AVERAGE			33.2	29.0	4.1	5.3	4.7	0.7	0.00399	0.00418	0.00408	0.00073	6,402
	STANDARD DEV.			0.04	0.23	0.23	0.01	0.04	0.04	0.00009	0.00010	0.00009	0.00002	146

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 14	2.0	7.2	1	44.7	36.2	8.5	7.2	5.8	1.4	0.00547	0.00573	0.00560	0.00100	5,821
			2	44.6	36.8	7.8	7.2	5.9	1.3	0.00549	0.00575	0.00562	0.00100	5,886
			3	44.6	36.5	8.1	7.2	5.9	1.3	0.00523	0.00548	0.00536	0.00096	6,134
			4	44.6	37.3	7.3	7.2	6.0	1.2	0.00549	0.00575	0.00562	0.00100	5,978
			5	44.7	36.3	8.4	7.2	5.8	1.3	0.00548	0.00573	0.00560	0.00100	5,830
	COLUMN AVERAGE			44.7	36.6	8.0	7.2	5.9	1.3	0.00543	0.00569	0.00556	0.00099	5,930
	STANDARD DEV.			0.04	0.44	0.46	0.01	0.07	0.07	0.00011	0.00012	0.00011	0.00002	130
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 15	2.0	9.1	1	56.7	47.0	9.6	9.1	7.6	1.5	0.00669	0.00695	0.00682	0.00122	6,202
			2	56.7	48.2	8.6	9.1	7.7	1.4	0.00704	0.00729	0.00716	0.00128	6,050
			3	56.7	48.0	8.7	9.1	7.7	1.4	0.00704	0.00729	0.00716	0.00128	6,024
			4	56.7	47.9	8.9	9.1	7.7	1.4	0.00672	0.00696	0.00684	0.00122	6,298
			5	56.7	46.8	9.9	9.1	7.5	1.6	0.00674	0.00698	0.00686	0.00123	6,136
	COLUMN AVERAGE			56.7	47.6	9.1	9.1	7.6	1.5	0.00685	0.00709	0.00697	0.00124	6,142
	STANDARD DEV.			0.03	0.60	0.59	0.01	0.10	0.10	0.00017	0.00018	0.00018	0.00003	112

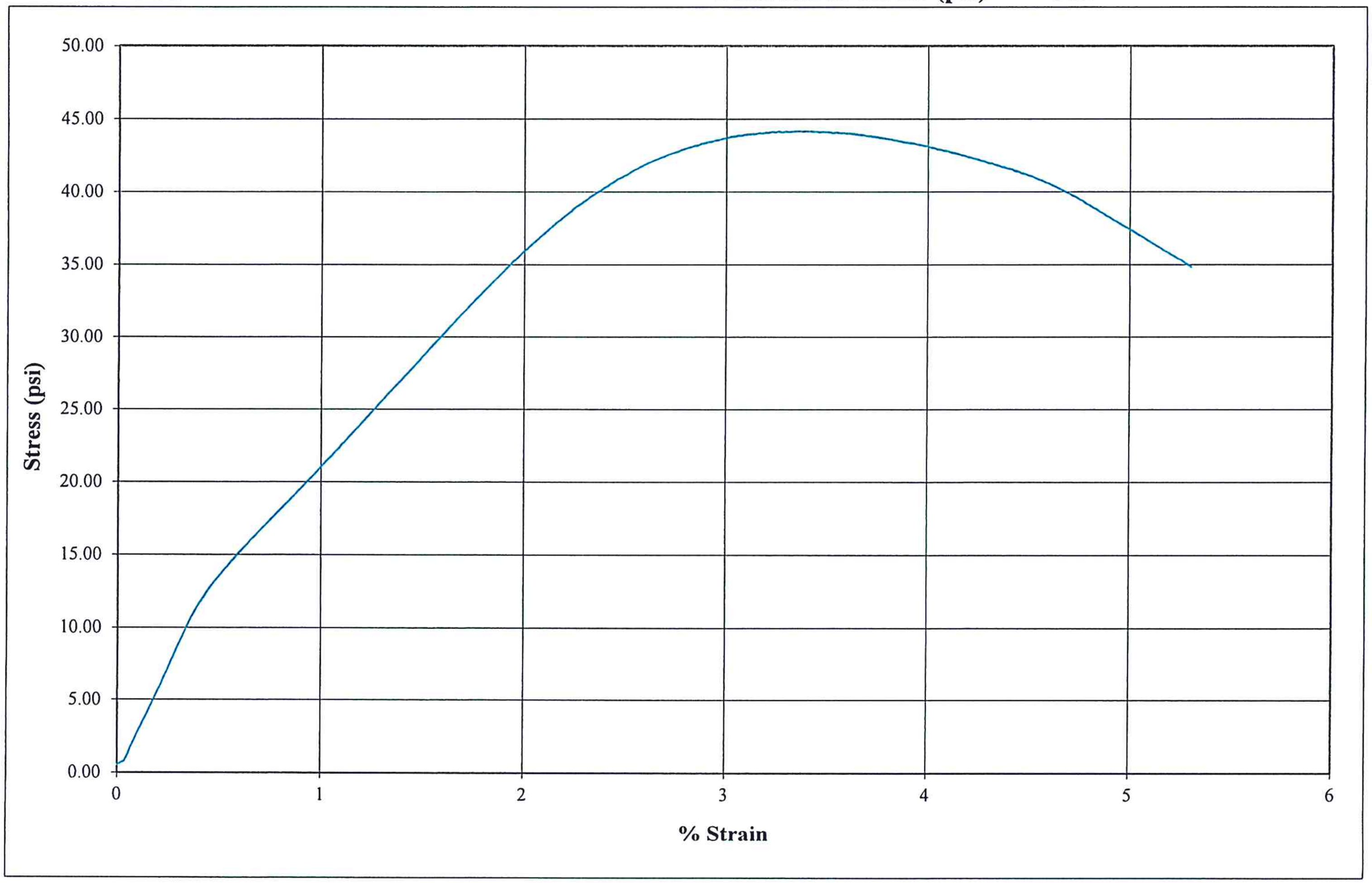
Sample ID: 1
Project: B1702069
Sheet No. 6 of 7

Erik J. Knudson
Laboratory Technician

Quick Shear

Confining Pressure 4 PSI

Peak Shear Stress (psi) = 44.2



Sample ID: 1

Project: B1702069

Sheet No. 7 of 7

Universal Model Calculations - US Customary Units

Braun Sample ID: 1

Station: TP-4

Project: B1702069

Seq.	Conf. psi	Axial Stress psi	Bulk psi	Deviator psi	M_r psi	Pred. Mr psi	Ln(Mr)	Ln(Bulk)	Ln(Dev)
1	6.0	2.1	20.1	1.8	13,615	16,232	9.519	3.003	0.563
2	6.0	4.0	22.0	3.4	12,277	12,263	9.415	3.093	1.233
3	6.0	5.7	23.7	4.9	11,016	10,688	9.307	3.166	1.598
4	6.0	8.1	26.1	7.1	10,062	9,465	9.217	3.263	1.959
5	6.0	10.1	28.1	8.9	10,024	8,828	9.213	3.336	2.187
6	4.0	2.1	14.1	1.8	13,319	13,025	9.497	2.645	0.569
7	4.0	4.0	16.0	3.5	9,445	10,061	9.153	2.772	1.239
8	4.0	5.9	17.9	5.2	8,595	8,818	9.059	2.884	1.640
9	4.0	7.8	19.8	6.9	8,200	8,112	9.012	2.987	1.932
10	4.0	9.8	21.8	8.7	8,468	7,672	9.044	3.084	2.161
11	2.0	1.8	7.8	1.5	12,743	9,796	9.453	2.052	0.418
12	2.0	3.7	9.7	3.2	7,286	7,662	8.894	2.272	1.178
13	2.0	5.3	11.3	4.7	6,402	7,026	8.764	2.428	1.540
14	2.0	7.2	13.2	5.9	5,930	6,853	8.688	2.578	1.773
15	2.0	9.1	15.1	7.6	6,142	6,534	8.723	2.714	2.034

Universal Model Calculations - US Customary Units

Braun Sample ID: 1

Station: TP-4

Project: B1702069

SUMMARY OUTPUT

ax5	k1	k2	k3
Value	3475.7918	0.606811974	-0.499551386
t-Stat	32.43723	5.954231958	-7.74275784

R-sqr Adj. 0.8169126

Std Err 0.1196666 or 12.71%

Regression Statistics	
Multiple R	0.918187299
R Square	0.843067917
Adjusted R Square	0.816912569
Standard Error	0.11966659
Observations	15

ANOVA

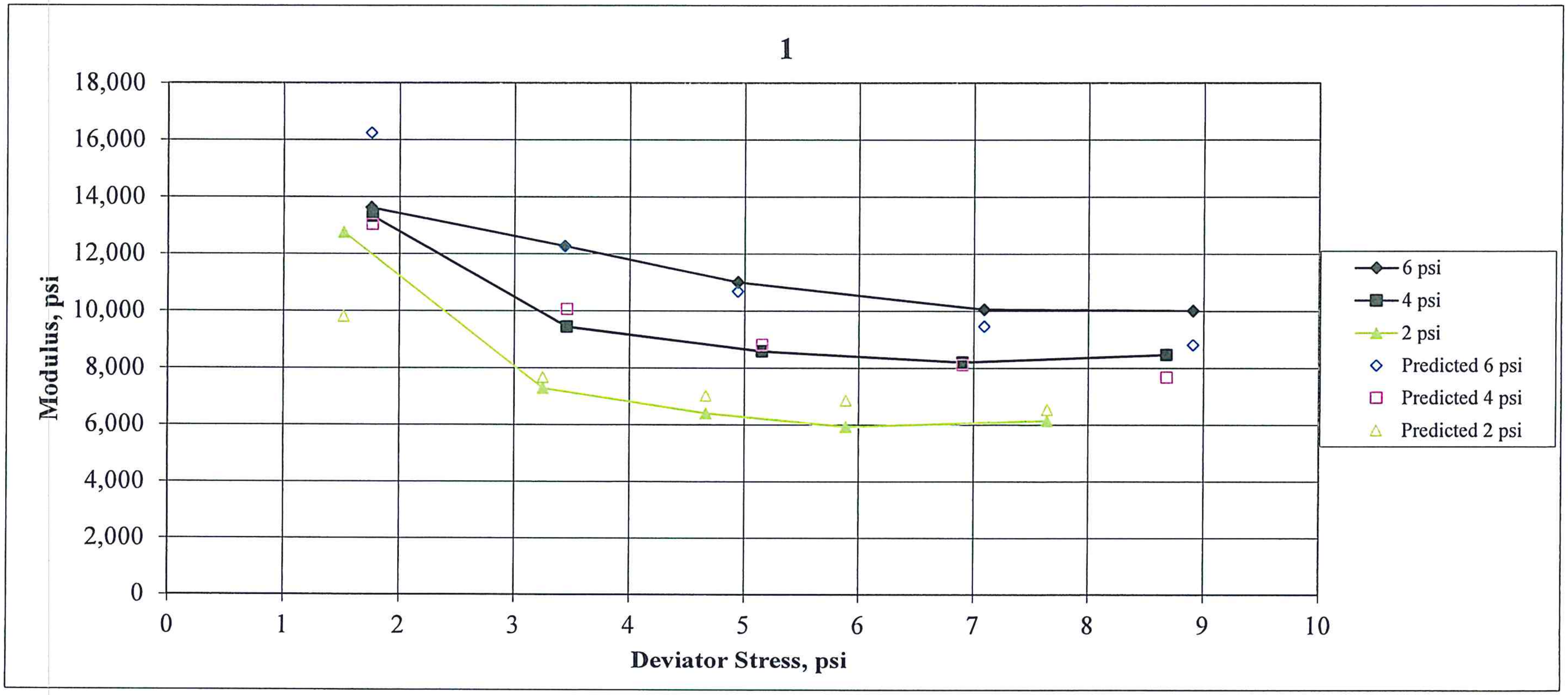
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.923161964	0.461581	32.2331	1.49372E-05
Residual	12	0.171841114	0.0143201		
Total	14	1.095003078			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	8.153577586	0.251364796	32.43723	4.661E-13	7.605900745	8.701254427	7.605900745	8.701254427
X Variable 1	0.606811974	0.10191272	5.954232	6.67E-05	0.384763232	0.828860715	0.384763232	0.828860715
X Variable 2	-0.49955139	0.064518534	-7.742758	5.246E-06	-0.640125196	-0.358977576	-0.640125196	-0.358977576

Universal Model Graph - US Customary Units

Braun Sample ID: 1
Station: TP-4

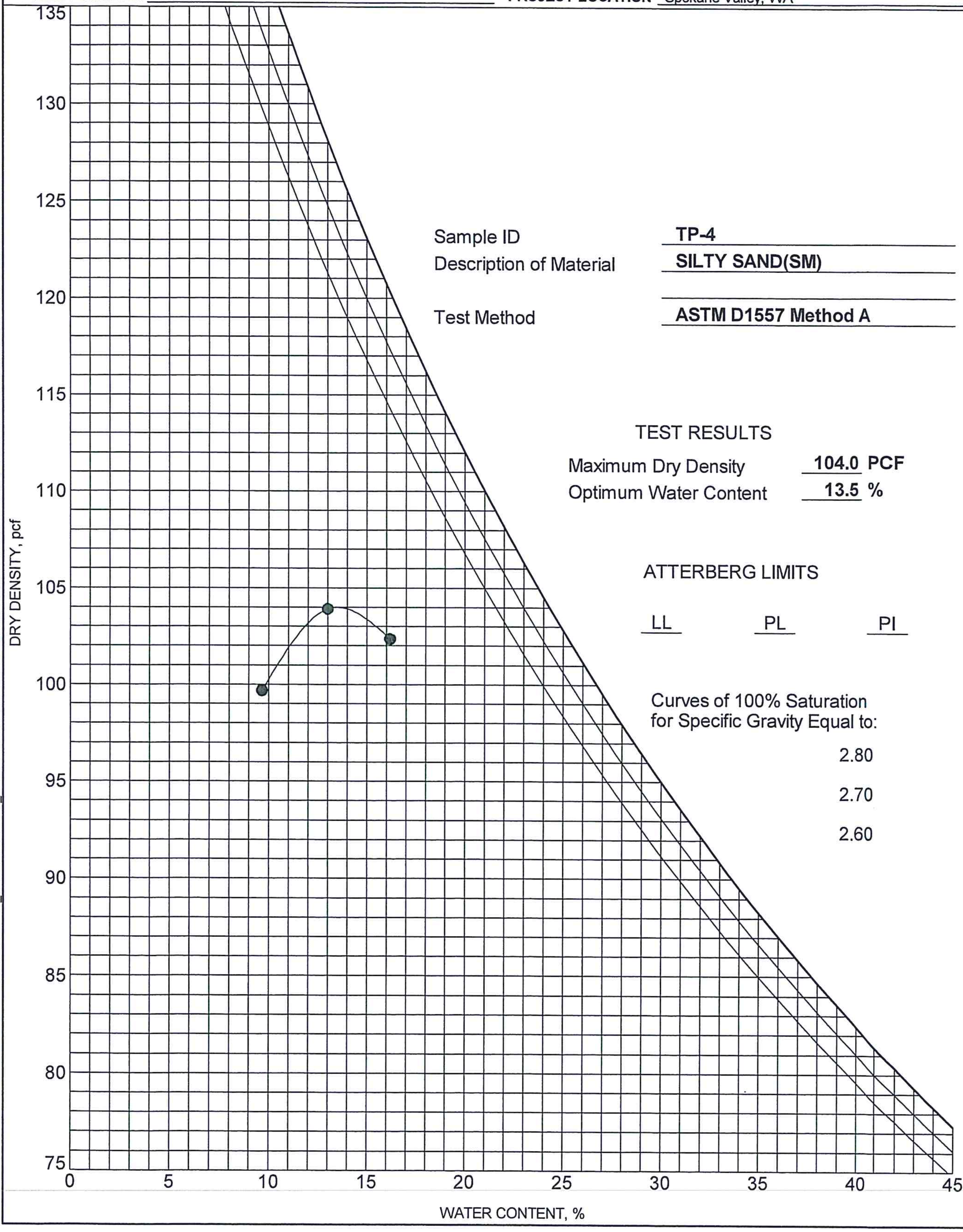
Project: B1702069



IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

MOISTURE-DENSITY RELATIONSHIP

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA



Sample ID **TP-4**
Description of Material **SILTY SAND(SM)**
Test Method **ASTM D1557 Method A**

TEST RESULTS

Maximum Dry Density **104.0 PCF**
Optimum Water Content **13.5 %**

ATTERBERG LIMITS

LL	PL	PI

Curves of 100% Saturation
for Specific Gravity Equal to:
2.80
2.70
2.60

Resilient Modulus Testing - AASHTO T307 US Customary Units

Date: April 10, 2017

Project: B1702069

Client:
Inland Pacific Engineering Company
Paul Nelson
P.O. Box 1566
Veradale, WA 99037

Project Description:
Resilient Modulus Test
AASHTO T307
Client ID: Proposed Street Improvements
Station: TP-7

Sample Information

Braun Sample ID./ File Name:	1	Sample Diameter, in.:	2.80	Sample M.C., % before, after:	14.7, 14.2
Sample Type:	Type 2	Sample Height, in.:	5.51	Sample Dry Den., pcf:	106.1
Test Date:	06-Apr-2017	Desired M.C., %:	14.3	Failed in Shear?:	YES
Comments:	Spokane Valley, WA	Desired Dry Density., pcf:	104.7	Triaxial Shear Strength, psi:	45.3

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PARAMETER	Chamber Confining Pressure	Nominal Maximum Axial Stress	Cycle No.	Actual Applied Maximum Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Maximum Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov Def. LVDT 1 Reading	Recov Def. LVDT 2 Reading	Average Recov Def. LVDT 1 and LVDT 2	Resilient Strain	Resilient Modulus
DESIGNATION	S3	Scyclic	c1	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	H average		Mr
UNIT	psi	psi	---	lbs.	lbs.	lbs.	psi	psi	psi	inches	inches	inches	in/in	psi
PRECISION	- - -.-	- - -.-	-	- - - -.-	- - - -.-	- - -.-	- - -.-	- - -.-	- - -.-	-.- - - - -	-.- - - - -	-.- - - - -	-.- - - - -	- - -
SEQUENCE 1	6.0	2.3	1	14.2	11.8	2.4	2.3	1.9	0.4	0.00049	0.00052	0.00051	0.00009	21,081
			2	14.3	11.9	2.3	2.3	1.9	0.4	0.00052	0.00057	0.00054	0.00010	19,724
			3	14.2	11.8	2.4	2.3	1.9	0.4	0.00051	0.00056	0.00053	0.00010	19,921
			4	14.2	11.8	2.4	2.3	1.9	0.4	0.00047	0.00051	0.00049	0.00009	21,508
			5	14.2	11.8	2.5	2.3	1.9	0.4	0.00050	0.00055	0.00053	0.00010	20,044
	COLUMN AVERAGE			14.2	11.8	2.4	2.3	1.9	0.4	0.00050	0.00054	0.00052	0.00009	20,456
	STANDARD DEV.			0.02	0.07	0.05	0.00	0.01	0.01	0.00002	0.00002	0.00002	0.00000	789

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 2	6.0	4.3	1	26.5	22.8	3.7	4.3	3.7	0.6	0.00104	0.00112	0.00108	0.00020	18,948
			2	26.5	22.9	3.6	4.3	3.7	0.6	0.00100	0.00107	0.00103	0.00019	19,938
			3	26.5	22.8	3.7	4.3	3.7	0.6	0.00099	0.00107	0.00103	0.00019	19,878
			4	26.4	22.8	3.6	4.3	3.7	0.6	0.00099	0.00107	0.00103	0.00019	19,906
			5	26.3	22.7	3.6	4.3	3.7	0.6	0.00095	0.00102	0.00099	0.00018	20,678
	COLUMN AVERAGE			26.4	22.8	3.6	4.3	3.7	0.6	0.00099	0.00107	0.00103	0.00019	19,870
	STANDARD DEV.			0.07	0.06	0.07	0.01	0.01	0.01	0.00003	0.00004	0.00003	0.00001	614
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 3	6.0	6.2	1	38.3	33.5	4.8	6.2	5.4	0.8	0.00165	0.00180	0.00173	0.00031	17,453
			2	38.3	33.4	4.9	6.2	5.4	0.8	0.00150	0.00164	0.00157	0.00028	19,131
			3	38.3	33.5	4.8	6.2	5.4	0.8	0.00157	0.00172	0.00164	0.00030	18,362
			4	38.4	33.6	4.8	6.2	5.4	0.8	0.00157	0.00172	0.00165	0.00030	18,344
			5	38.5	33.6	4.9	6.2	5.4	0.8	0.00156	0.00171	0.00164	0.00030	18,434
	COLUMN AVERAGE			38.4	33.5	4.8	6.2	5.4	0.8	0.00157	0.00172	0.00165	0.00030	18,345
	STANDARD DEV.			0.08	0.08	0.04	0.01	0.01	0.01	0.00007	0.00008	0.00008	0.00001	596
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 4	6.0	8.3	1	51.1	45.2	5.9	8.3	7.3	1.0	0.00218	0.00237	0.00227	0.00041	17,902
			2	51.2	45.2	6.0	8.3	7.3	1.0	0.00217	0.00237	0.00227	0.00041	17,907
			3	51.1	45.2	6.0	8.3	7.3	1.0	0.00227	0.00247	0.00237	0.00043	17,140
			4	51.2	45.3	5.8	8.3	7.3	0.9	0.00216	0.00235	0.00226	0.00041	18,047
			5	51.1	45.2	5.9	8.3	7.3	1.0	0.00226	0.00246	0.00236	0.00043	17,232
	COLUMN AVERAGE			51.2	45.2	5.9	8.3	7.3	1.0	0.00221	0.00240	0.00231	0.00042	17,645
	STANDARD DEV.			0.04	0.06	0.07	0.01	0.01	0.01	0.00005	0.00006	0.00005	0.00001	425

Sample ID: 1

Project: B1702069

Sheet No. 2 of 7

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 5	6.0	10.3	1	63.5	55.7	7.8	10.3	9.0	1.3	0.00279	0.00305	0.00292	0.00053	17,171
			2	63.5	56.3	7.2	10.3	9.1	1.2	0.00291	0.00319	0.00305	0.00055	16,615
			3	63.3	56.4	6.9	10.3	9.1	1.1	0.00278	0.00304	0.00291	0.00053	17,403
			4	63.6	56.5	7.1	10.3	9.1	1.2	0.00292	0.00319	0.00306	0.00055	16,605
			5	63.4	55.7	7.7	10.3	9.0	1.3	0.00295	0.00322	0.00308	0.00056	16,264
	COLUMN AVERAGE			63.5	56.1	7.3	10.3	9.1	1.2	0.00287	0.00314	0.00300	0.00054	16,812
	STANDARD DEV.			0.10	0.37	0.39	0.02	0.06	0.06	0.00008	0.00008	0.00008	0.00001	464
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 6	4.0	2.1	1	13.2	11.2	1.9	2.1	1.8	0.3	0.00046	0.00056	0.00051	0.00009	19,788
			2	13.2	11.2	2.0	2.1	1.8	0.3	0.00042	0.00052	0.00047	0.00009	21,408
			3	13.2	11.2	2.0	2.1	1.8	0.3	0.00040	0.00051	0.00046	0.00008	22,194
			4	13.2	11.3	1.9	2.1	1.8	0.3	0.00042	0.00052	0.00047	0.00009	21,464
			5	13.2	11.2	2.0	2.1	1.8	0.3	0.00046	0.00057	0.00051	0.00009	19,655
	COLUMN AVERAGE			13.2	11.2	2.0	2.1	1.8	0.3	0.00043	0.00054	0.00048	0.00009	20,902
	STANDARD DEV.			0.02	0.04	0.04	0.00	0.01	0.01	0.00002	0.00003	0.00003	0.00000	1,122
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 7	4.0	4.1	1	25.6	22.3	3.4	4.2	3.6	0.5	0.00109	0.00117	0.00113	0.00020	17,677
			2	25.6	22.2	3.4	4.1	3.6	0.6	0.00108	0.00116	0.00112	0.00020	17,900
			3	25.6	22.5	3.1	4.2	3.6	0.5	0.00108	0.00116	0.00112	0.00020	18,068
			4	25.5	22.2	3.3	4.1	3.6	0.5	0.00107	0.00115	0.00111	0.00020	18,003
			5	25.6	22.5	3.1	4.1	3.6	0.5	0.00113	0.00121	0.00117	0.00021	17,291
	COLUMN AVERAGE			25.6	22.3	3.3	4.1	3.6	0.5	0.00109	0.00117	0.00113	0.00020	17,788
	STANDARD DEV.			0.04	0.16	0.15	0.01	0.03	0.03	0.00002	0.00002	0.00002	0.00000	315

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 8	4.0	6.1	1	37.7	33.4	4.3	6.1	5.4	0.7	0.00184	0.00196	0.00190	0.00034	15,850
			2	37.8	33.5	4.3	6.1	5.4	0.7	0.00174	0.00186	0.00180	0.00033	16,722
			3	37.7	33.6	4.1	6.1	5.4	0.7	0.00184	0.00196	0.00190	0.00034	15,865
			4	37.8	33.2	4.6	6.1	5.4	0.7	0.00167	0.00178	0.00173	0.00031	17,283
			5	37.8	33.8	4.1	6.1	5.5	0.7	0.00168	0.00179	0.00174	0.00031	17,479
	COLUMN AVERAGE			37.8	33.5	4.3	6.1	5.4	0.7	0.00175	0.00187	0.00181	0.00033	16,640
	STANDARD DEV.			0.05	0.22	0.20	0.01	0.04	0.03	0.00008	0.00009	0.00008	0.00002	766
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 9	4.0	8.1	1	49.8	44.2	5.6	8.1	7.2	0.9	0.00247	0.00261	0.00254	0.00046	15,656
			2	49.9	44.3	5.6	8.1	7.2	0.9	0.00249	0.00263	0.00256	0.00046	15,588
			3	50.0	44.3	5.7	8.1	7.2	0.9	0.00247	0.00261	0.00254	0.00046	15,672
			4	49.9	43.9	6.0	8.1	7.1	1.0	0.00249	0.00263	0.00256	0.00046	15,404
			5	49.9	44.2	5.7	8.1	7.2	0.9	0.00248	0.00262	0.00255	0.00046	15,577
	COLUMN AVERAGE			49.9	44.2	5.7	8.1	7.2	0.9	0.00248	0.00262	0.00255	0.00046	15,579
	STANDARD DEV.			0.09	0.17	0.17	0.01	0.03	0.03	0.00001	0.00001	0.00001	0.00000	107
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 10	4.0	10.0	1	61.1	54.6	6.5	9.9	8.8	1.0	0.00320	0.00340	0.00330	0.00060	14,869
			2	60.6	53.2	7.4	9.8	8.6	1.2	0.00298	0.00317	0.00308	0.00055	15,573
			3	62.2	55.2	7.0	10.1	8.9	1.1	0.00317	0.00338	0.00328	0.00059	15,159
			4	62.0	54.7	7.3	10.0	8.9	1.2	0.00301	0.00321	0.00311	0.00056	15,843
			5	62.1	54.8	7.4	10.1	8.9	1.2	0.00331	0.00352	0.00342	0.00062	14,431
	COLUMN AVERAGE			61.6	54.5	7.1	10.0	8.8	1.1	0.00314	0.00334	0.00324	0.00058	15,175
	STANDARD DEV.			0.72	0.74	0.38	0.12	0.12	0.06	0.00014	0.00014	0.00014	0.00003	560

Sample ID: 1
Project: B1702069
Sheet No. 4 of 7

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 11	1.9	1.9	1	12.0	10.4	1.6	2.0	1.7	0.3	0.00028	0.00059	0.00043	0.00008	21,647
			2	12.0	10.4	1.6	1.9	1.7	0.3	0.00032	0.00063	0.00047	0.00009	19,828
			3	12.0	10.3	1.7	1.9	1.7	0.3	0.00028	0.00060	0.00044	0.00008	21,125
			4	12.0	10.3	1.7	1.9	1.7	0.3	0.00025	0.00055	0.00040	0.00007	23,217
			5	12.0	10.4	1.6	2.0	1.7	0.3	0.00028	0.00059	0.00044	0.00008	21,354
	COLUMN AVERAGE			12.0	10.4	1.7	1.9	1.7	0.3	0.00028	0.00059	0.00044	0.00008	21,434
	STANDARD DEV.			0.02	0.06	0.05	0.00	0.01	0.01	0.00002	0.00003	0.00002	0.00000	1,215
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 12	2.0	3.9	1	24.1	21.3	2.8	3.9	3.4	0.5	0.00130	0.00137	0.00134	0.00024	14,305
			2	24.0	21.3	2.7	3.9	3.5	0.4	0.00130	0.00137	0.00134	0.00024	14,336
			3	24.1	21.2	2.9	3.9	3.4	0.5	0.00131	0.00138	0.00134	0.00024	14,185
			4	24.1	21.2	2.9	3.9	3.4	0.5	0.00131	0.00138	0.00134	0.00024	14,196
			5	24.0	21.2	2.8	3.9	3.4	0.4	0.00119	0.00126	0.00123	0.00022	15,568
	COLUMN AVERAGE			24.1	21.2	2.8	3.9	3.4	0.5	0.00128	0.00135	0.00132	0.00024	14,518
	STANDARD DEV.			0.04	0.06	0.07	0.01	0.01	0.01	0.00005	0.00005	0.00005	0.00001	591
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 13	2.0	5.8	1	35.9	32.2	3.8	5.8	5.2	0.6	0.00212	0.00223	0.00217	0.00039	13,293
			2	35.9	31.9	4.0	5.8	5.2	0.7	0.00204	0.00214	0.00218	0.00038	13,745
			3	35.9	32.3	3.6	5.8	5.2	0.6	0.00213	0.00224	0.00218	0.00039	13,317
			4	36.0	32.3	3.7	5.8	5.2	0.6	0.00213	0.00224	0.00218	0.00039	13,323
			5	35.9	32.0	3.9	5.8	5.2	0.6	0.00203	0.00214	0.00209	0.00038	13,800
	COLUMN AVERAGE			35.9	32.1	3.8	5.8	5.2	0.6	0.00209	0.00220	0.00216	0.00039	13,496
	STANDARD DEV.			0.04	0.18	0.16	0.01	0.03	0.03	0.00005	0.00005	0.00004	0.00001	254

COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 14	2.0	7.8	1	48.1	40.2	7.8	7.8	6.5	1.3	0.00287	0.00301	0.00294	0.00053	12,301
			2	48.0	41.5	6.5	7.8	6.7	1.1	0.00287	0.00300	0.00293	0.00053	12,736
			3	48.1	41.4	6.7	7.8	6.7	1.1	0.00300	0.00314	0.00307	0.00055	12,131
			4	48.0	39.9	8.1	7.8	6.5	1.3	0.00286	0.00299	0.00293	0.00053	12,280
			5	48.1	41.3	6.8	7.8	6.7	1.1	0.00300	0.00314	0.00307	0.00055	12,089
	COLUMN AVERAGE			48.0	40.9	7.2	7.8	6.6	1.2	0.00292	0.00305	0.00299	0.00054	12,307
	STANDARD DEV.			0.03	0.72	0.72	0.01	0.12	0.12	0.00007	0.00008	0.00007	0.00001	257
COLUMN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEQUENCE 15	2.0	9.8	1	60.3	50.9	9.4	9.8	8.2	1.5	0.00352	0.00369	0.00361	0.00065	12,699
			2	60.2	51.1	9.2	9.8	8.3	1.5	0.00351	0.00367	0.00359	0.00065	12,792
			3	60.3	51.9	8.4	9.8	8.4	1.4	0.00352	0.00369	0.00361	0.00065	12,940
			4	60.2	52.4	7.8	9.8	8.5	1.3	0.00384	0.00402	0.00393	0.00071	11,985
			5	60.3	52.1	8.2	9.8	8.5	1.3	0.00369	0.00387	0.00378	0.00068	12,409
	COLUMN AVERAGE			60.2	51.7	8.6	9.8	8.4	1.4	0.00362	0.00379	0.00370	0.00067	12,565
	STANDARD DEV.			0.04	0.67	0.67	0.01	0.11	0.11	0.00014	0.00015	0.00015	0.00003	378

Sample ID: 1

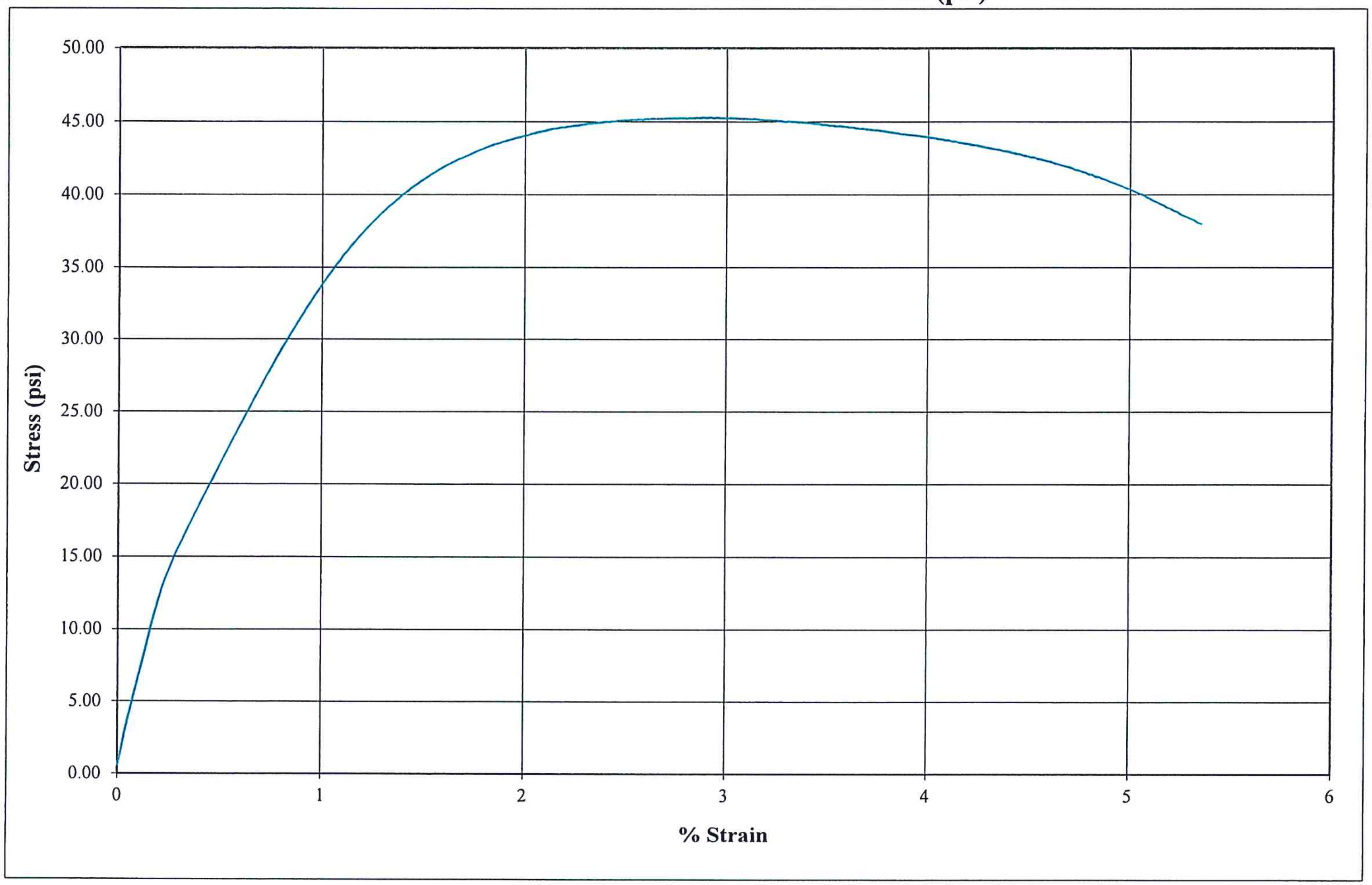
Project: B1702069

Sheet No. 6 of 7

Erik J. Knudson

Laboratory Technician

Quick Shear
Confining Pressure 4 PSI **Peak Shear Stress (psi) = 45.3**



Sample ID: 1
Project: B1702069
Sheet No. 7 of 7

Universal Model Calculations - US Customary Units

Braun Sample ID: 1

Station: TP-7

Project: B1702069

Seq.	Conf. psi	Axial Stress psi	Bulk psi	Deviator psi	M_r psi	Pred. Mr psi	Ln(Mr)	Ln(Bulk)	Ln(Dev)
1	6.0	2.3	20.3	1.9	20,456	23,592	9.926	3.011	0.650
2	6.0	4.3	22.3	3.7	19,870	19,613	9.897	3.104	1.307
3	6.0	6.2	24.2	5.4	18,345	17,768	9.817	3.187	1.692
4	6.0	8.3	26.3	7.3	17,645	16,552	9.778	3.269	1.992
5	6.0	10.3	28.3	9.1	16,812	15,799	9.730	3.342	2.208
6	4.0	2.1	14.1	1.8	20,902	21,278	9.948	2.649	0.598
7	4.0	4.1	16.1	3.6	17,788	17,740	9.786	2.782	1.287
8	4.0	6.1	18.1	5.4	16,640	16,138	9.720	2.897	1.692
9	4.0	8.1	20.1	7.2	15,579	15,250	9.654	3.000	1.969
10	4.0	10.0	22.0	8.8	15,175	14,667	9.627	3.090	2.178
11	1.9	1.9	7.7	1.7	21,434	17,875	9.973	2.047	0.519
12	2.0	3.9	9.9	3.4	14,518	15,326	9.583	2.293	1.236
13	2.0	5.8	11.8	5.2	13,496	14,194	9.510	2.470	1.650
14	2.0	7.8	13.8	6.6	12,307	13,802	9.418	2.623	1.890
15	2.0	9.8	15.8	8.4	12,565	13,363	9.439	2.758	2.125

Universal Model Calculations - US Customary Units

Braun Sample ID: 1 — Project: B1702069

Station: TP-7

SUMMARY OUTPUT

ax5	k1	k2	k3
Value	10724.224	0.332780325	-0.328339683
t-Stat	51.11372	4.526286657	-7.010227266

R-sqr Adj. 0.7739636

Std Err 0.0855097 or 8.93%

Regression Statistics	
Multiple R	0.897916763
R Square	0.806254513
Adjusted R Square	0.773963599
Standard Error	0.085509723
Observations	15

ANOVA

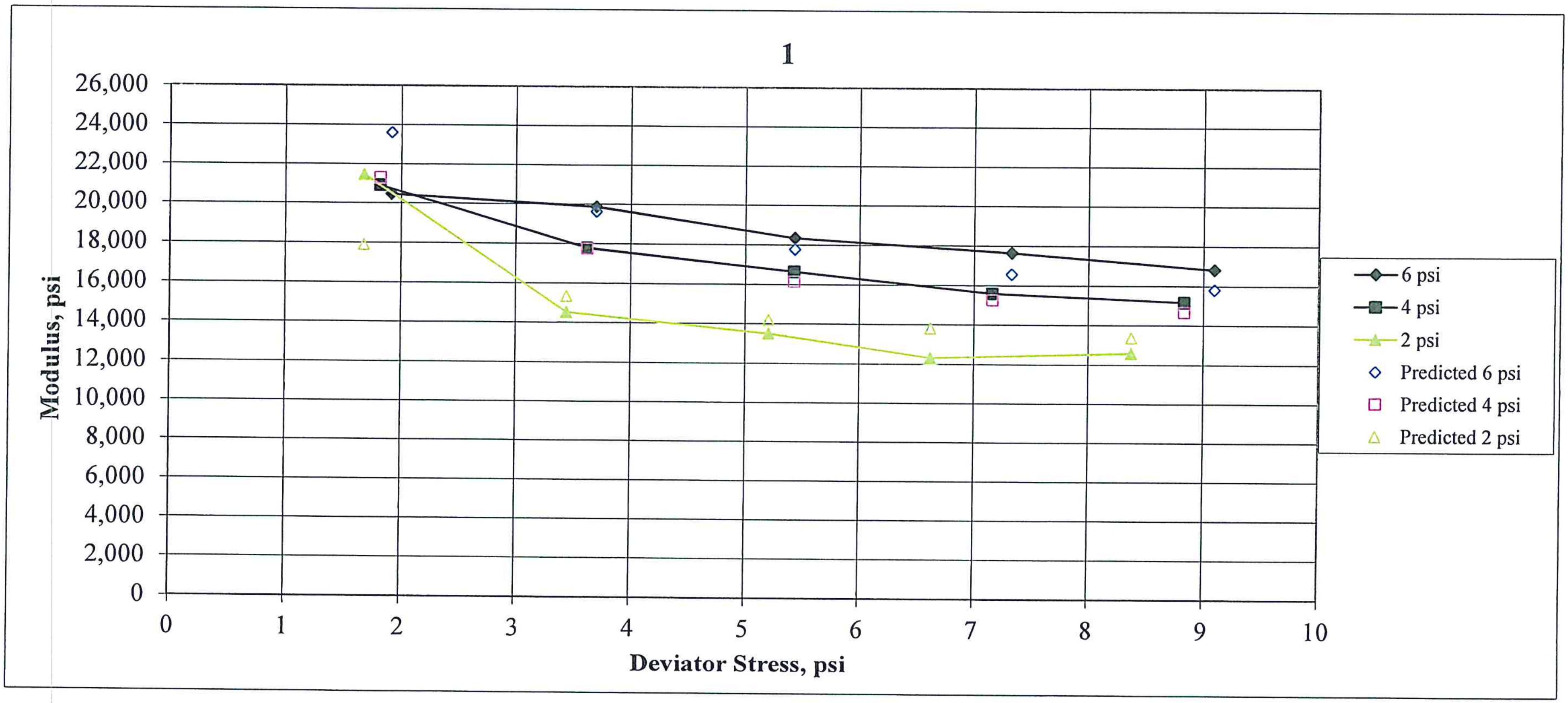
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0.365134451	0.1825672	24.968463	5.28919E-05
Residual	12	0.087742953	0.0073119		
Total	14	0.452877404			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	9.28026037	0.181561043	51.11372	2.065E-15	8.884672839	9.675847901	8.884672839	9.675847901
X Variable 1	0.332780325	0.073521708	4.5262867	0.0006942	0.172590285	0.492970365	0.172590285	0.492970365
X Variable 2	-0.32833968	0.046837238	-7.010227	1.414E-05	-0.430389258	-0.226290108	-0.430389258	-0.226290108

Universal Model Graph - US Customary Units

Braun Sample ID: 1
Station: TP-7

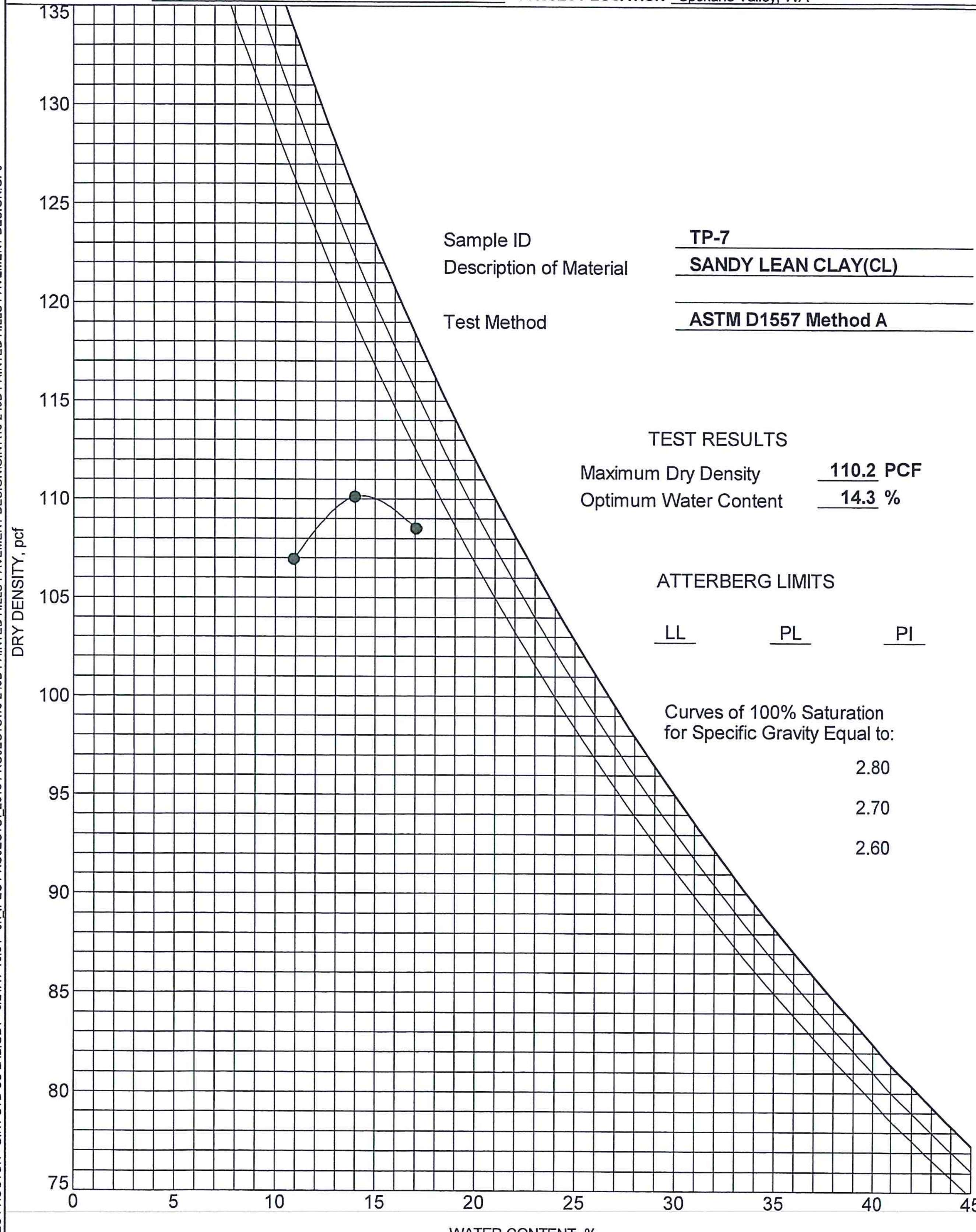
Project: B1702069



IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

MOISTURE-DENSITY RELATIONSHIP

CLIENT NAI Black
PROJECT NAME Proposed Street Improvements
PROJECT NUMBER 16-249D
PROJECT LOCATION Spokane Valley, WA



Sample ID **TP-7**
Description of Material **SANDY LEAN CLAY(CL)**
Test Method **ASTM D1557 Method A**

TEST RESULTS

Maximum Dry Density **110.2 PCF**
Optimum Water Content **14.3 %**

ATTERBERG LIMITS

LL	PL	PI

Curves of 100% Saturation
for Specific Gravity Equal to:
2.80
2.70
2.60

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

August 21, 2017
Project No. 16-249A

NAI Black
c/o Mr. Bryan Walker
107 South Howard
Suite 500
Spokane, WA 99201

Re: **Full-Scale Drywell Testing**
Proposed Stormwater Management Facility
4403 South Dishman-Mica Road
Spokane Valley, WA

Dear Mr. Walker:

As you authorized, we have completed a full-scale drywell test on the drywell installed at the above-referenced site in Spokane Valley, Washington. The purpose of the testing was to establish a design flow rate. This report summarizes the results of our site investigation, engineering analyses and recommendations.

AVAILABLE INFORMATION

We were provided a topographic survey for the project site by Whipple Consulting Engineers, Inc. (WCE). This topographic survey showed the existing roadways, existing structures, property lines, and existing ground surface elevation contours. This plan was prepared by WCE and was dated November 7, 2013. The site was used as a golf course prior to our evaluation. The site is relatively level with some elevated golf greens and excavated areas for water hazards. The site is primarily grass-covered with scattered trees along the fairways and pine trees in the undeveloped area to the northwest. The clubhouse building is present at the southwest corner.

In addition, we performed a preliminary geotechnical evaluation for the property in December 2013. The results of that evaluation, along with our opinions and recommendations, are summarized in our Preliminary Geotechnical Evaluation dated December 31, 2013.

We also performed a geotechnical evaluation for certification of the existing levee along Chester Creek in April 2014. The results of that evaluation are summarized in our Geotechnical Evaluation report dated February 12, 2015.

Lastly, we performed a geotechnical evaluation in July 2015 consisting of ten 50-foot borings in the south half of the property. The results of that evaluation are summarized in our Geotechnical Evaluation Phase 2 report dated July 23, 2015.

FIELD EVALUATION

A geotechnical engineer from Inland Pacific Engineering Company (IPEC) performed a full-scale drywell test on the Type 2 drywell (double depth) on May 6, 2016. The drywell test was performed in accordance with the Spokane Regional Stormwater Manual, Appendix 4B procedures. The drywell was installed at the location shown on Figure 3 (attached).

ANALYSIS AND RECOMMENDATIONS

We calculated a design outflow rate for the existing drywell using the results of the recent and previous laboratory tests and the procedures described in the SRSM manual, Appendix 4B (Full-Scale Drywell Test Method). Based on the test performed, we recommend using a design flow rate of 1.05 cfs for design. This recommended design outflow rate includes a safety factor of 1.1 as required by the SRSM. Attached are our calculations for the design outflow rate. If additional drywell barrels are added, the safety factor increases.

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

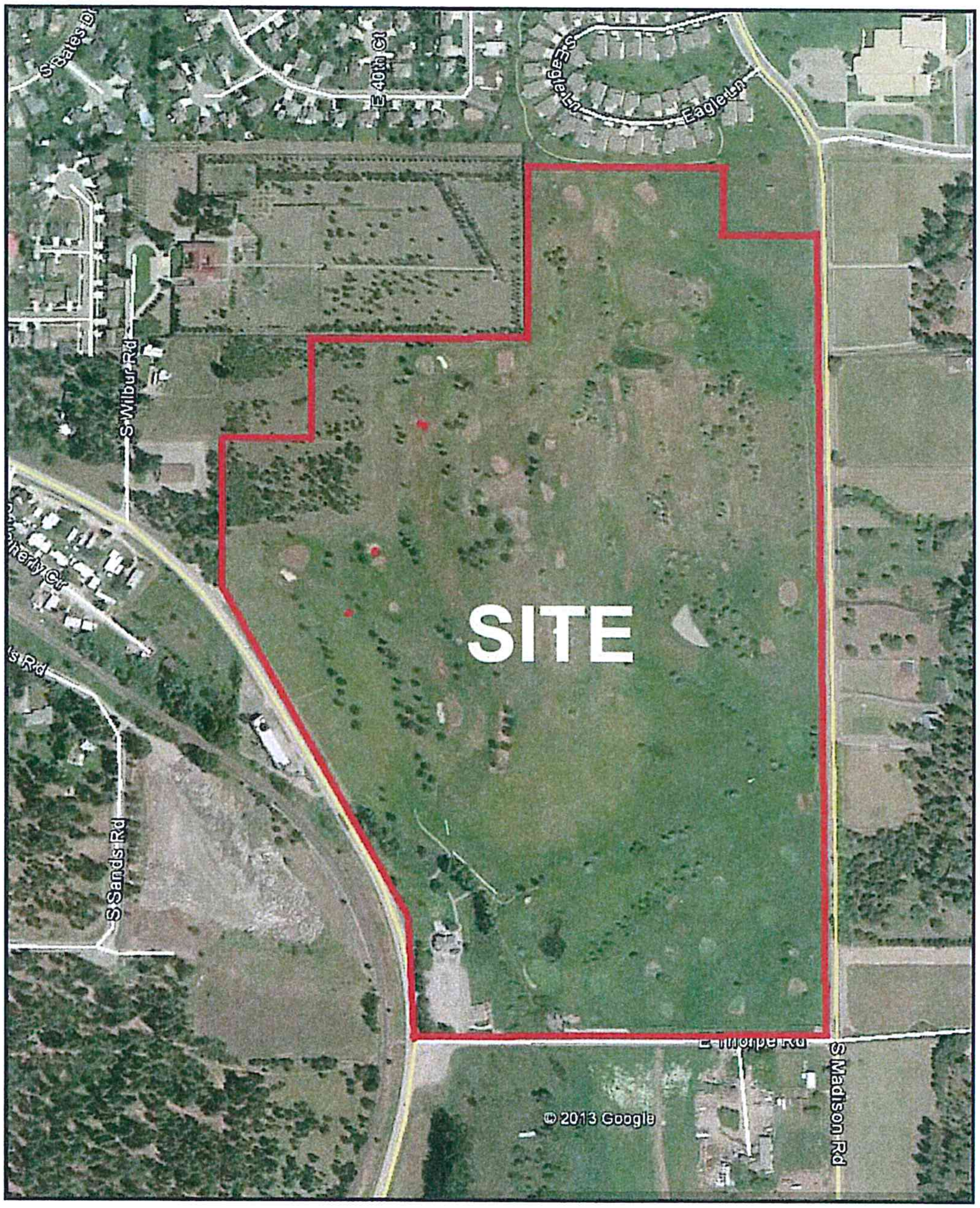
Sincerely,
Inland Pacific Engineering Company

Paul T. Nelson, P.E.
Principal Engineer

PAUL T NELSON
STATE OF WASHINGTON
37228
REGISTERED
PROFESSIONAL ENGINEER
8-21-17

Attachments:
- Figure 1, Site Location Map
- Figure 2, NRCS Map
- Figure 3, Drywell Location Map
- Laboratory Test Results
- Full-Scale Drywell Test Results
- Design Flow Rate Calculations

FIGURE 1

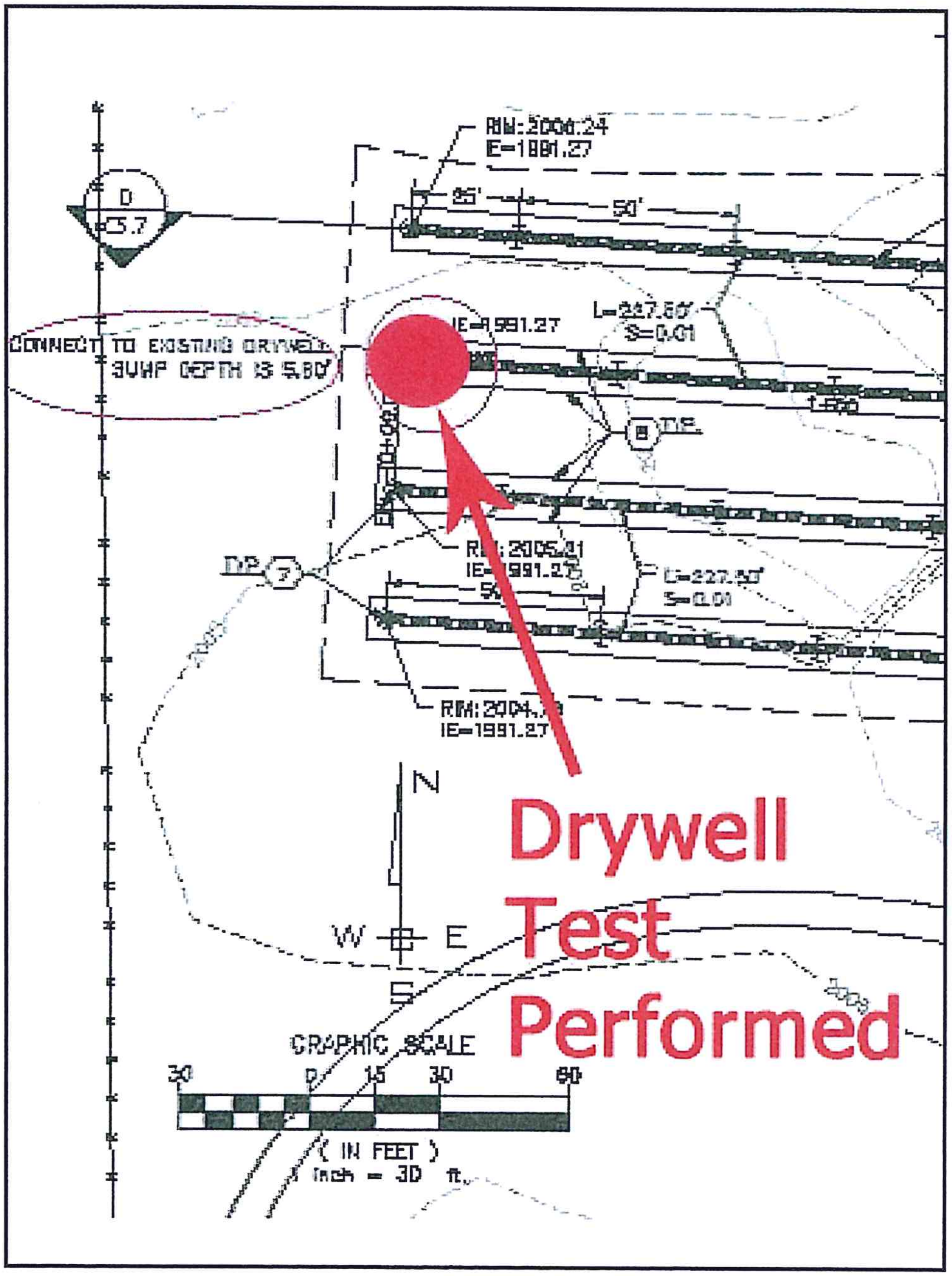


Site Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249A Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	June 28, 2016

FIGURE 2

NRCS Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249A	June 28, 2016
	Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	

FIGURE 3

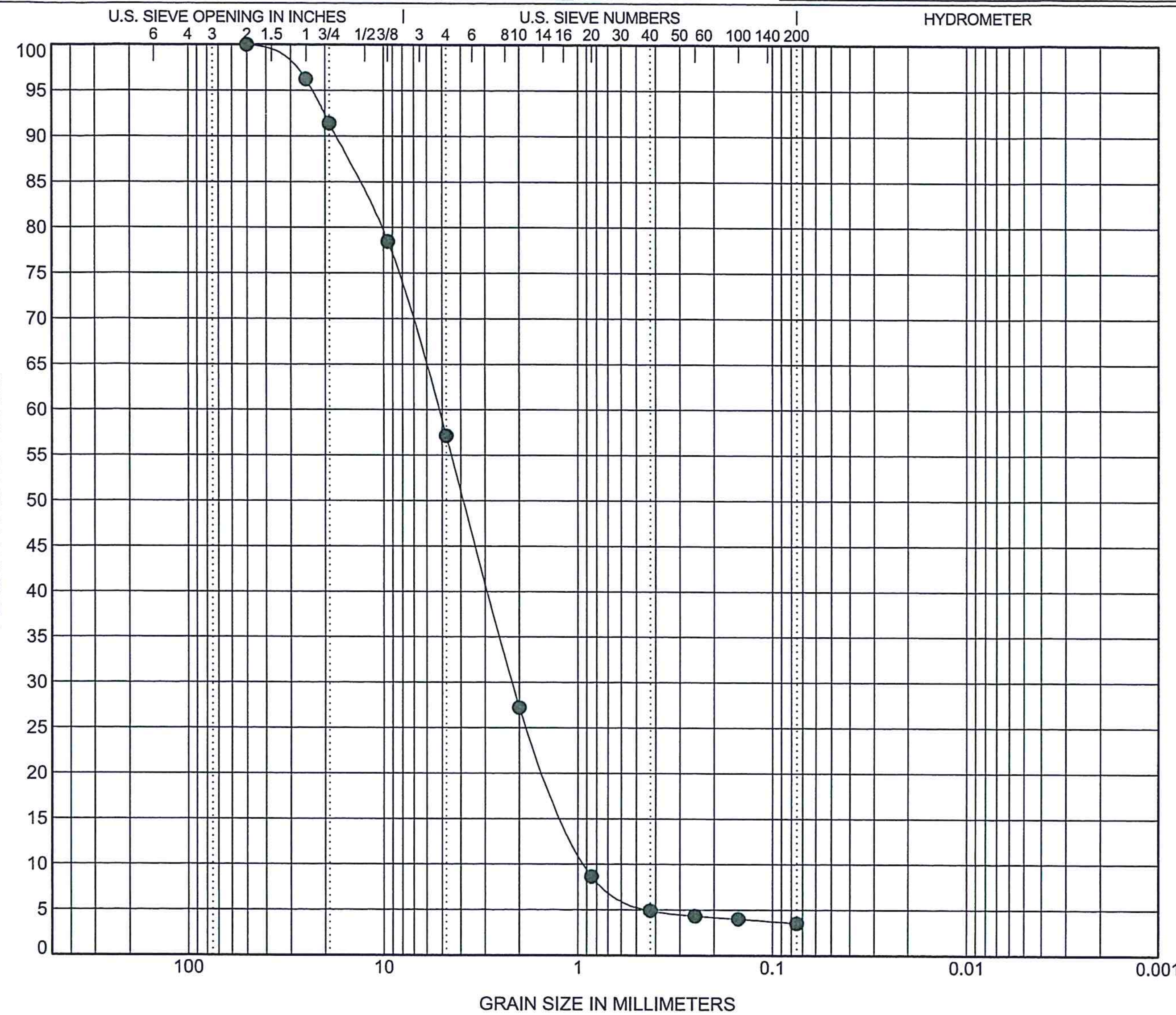


Boring Location Map		
IPEC Inland Pacific Engineering Company Geotechnical Engineering and Consulting	Project No. 16-249A Painted Hills Golf Course 4403 South Dishman-Mica Road Spokane County, WA	August 21, 2017

IPEC
Inland Pacific Engineering Company
3012 North Sullivan Road, Suite C
Spokane Valley, WA 99216
Telephone: 509-209-6262
Fax: 509-290-5734

GRAIN SIZE DISTRIBUTION

CLIENT NAI Black
PROJECT NAME Painted Hills Drywell Test
PROJECT NUMBER 16-249A
PROJECT LOCATION 4403 South Dishman-Mica Road



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**L16-057**	**20.0**	**SP Poorly Graded Sand with Gravel**				**1.00**	**5.76**

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**L16-057**	**20.0**	**50**	**5.212**	**2.167**	**0.904**	**42.9**	**53.6**	**3.5**	

IPEC

Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

Full-Scale Drywell Test Results

Project Name: Painted Hills Drywell Test

Test Date: 5/6/2016

Project Number: 16-249A

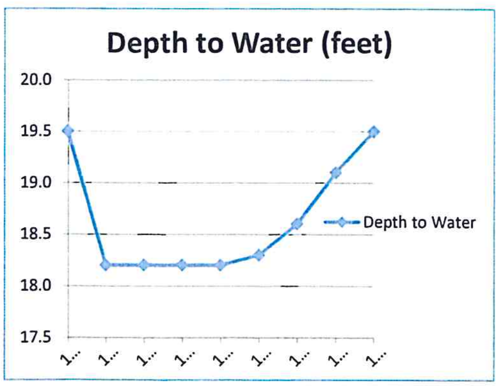
Test Location: Existing Drywell

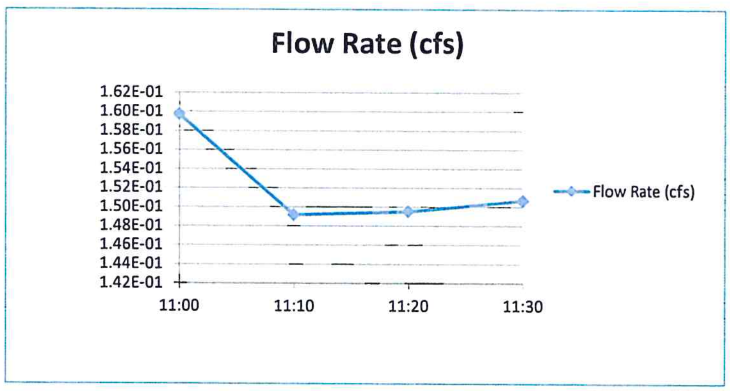
Client: NAI Black

Depth: 20'

Time	Elapsed Time (seconds)	Depth to Water (feet)	Flow Meter Reading (ft^3)	Volume of Water (ft^3)	Flow Rate (cfs)
10:00	0	19.5	596.6		
11:00	3600	18.2	1171.5	574.90	1.60E-01
11:10	600	18.2	1261.0	89.50	1.49E-01
11:20	600	18.2	1350.7	89.70	1.50E-01
11:30	600	18.2	1441.1	90.40	1.51E-01
11:35		18.3			
11:40		18.6			
11:45		19.1			
11:50		19.5			

Average Flow Rate: 1.50E-01





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Phone 509-209-6262

From SRSM Appendix 4B:

1.) Calculate normalized outflow rate (q_A)

$$q_A = \left(\frac{Q}{H}\right) H_D$$

Q = stabilized flow rate from test
H = level of water in the drywell
H_D = maximum head in drywell (10 feet for double depth)

Q = 0.150 cfs
H = 1.3 ft
H_D = 10

$$q_A = \left(\frac{0.150}{1.3}\right)(10) = \underline{1.15 \text{ cfs}}$$

2.) Determine Design Outflow rate (q_D) from Table 4B-1 and 3.5% passing 200 sieve
FS = 1.1

$$q_D = \frac{q_A}{F.S.} = \frac{1.15}{1.1} = \underline{1.05 \text{ cfs}}$$

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P.O. Box 1566, Veradale, WA 99037
Phone 509-209-6262

NAME OF PROJECT			SHEET NUMBER
Painted Hills Drywell Test			1 OF 1
COMPUTED BY	CHECKED BY	JOB NUMBER	DATE
ATN	PTA	16-249A	6-28-16

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

August 22, 2017
Project No. 16-249A

NAI Black
c/o Mr. Bryan Walker
107 South Howard
Suite 500
Spokane, WA 99201

Re: **Addendum to Full-Scale Drywell Testing**
Proposed Stormwater Management Facility
4403 South Dishman-Mica Road
Spokane Valley, WA

Dear Mr. Walker:

As you authorized, we have completed a full-scale drywell test on the drywell installed at the above-referenced site in Spokane Valley, Washington. The purpose of the testing was to establish a design flow rate. This addendum provides our recommendations for a design infiltration rate for proposed gravel galleries between the drywells.

AVAILABLE INFORMATION

We were provided a topographic survey for the project site by Whipple Consulting Engineers, Inc. (WCE). This topographic survey showed the existing roadways, existing structures, property lines, and existing ground surface elevation contours. This plan was prepared by WCE and was dated November 7, 2013. The site was used as a golf course prior to our evaluation. The site is relatively level with some elevated golf greens and excavated areas for water hazards. The site is primarily grass-covered with scattered trees along the fairways and pine trees in the undeveloped area to the northwest. The clubhouse building is present at the southwest corner.

In addition, we performed a preliminary geotechnical evaluation for the property in December 2013. The results of that evaluation, along with our opinions and recommendations, are summarized in our Preliminary Geotechnical Evaluation dated December 31, 2013.

P.O. Box 1566, Veradale, WA 99037
Phone 509-209-6262

We also performed a geotechnical evaluation for certification of the existing levee along Chester Creek in April 2014. The results of that evaluation are summarized in our Geotechnical Evaluation report dated February 12, 2015.

Lastly, we performed a geotechnical evaluation in July 2015 consisting of ten 50-foot borings in the south half of the property. The results of that evaluation are summarized in our Geotechnical Evaluation Phase 2 report dated July 23, 2015.

FIELD EVALUATION

A geotechnical engineer from Inland Pacific Engineering Company (IPEC) performed a full-scale drywell test on the Type 2 drywell (double depth) on May 6, 2016. The drywell test was performed in accordance with the Spokane Regional Stormwater Manual, Appendix 4B procedures. The drywell was installed at the location shown on Figure 3 (attached).

ANALYSIS AND RECOMMENDATIONS

We calculated a design outflow rate for the existing drywell to be 1.05 cfs for design. This recommended design outflow rate included a safety factor of 1.1 as required by the SRSM. Using this design outflow rate and assuming a typical infiltration area of 600 square feet for a Type 2 drywell, we recommend using a design infiltration rate of 1.8×10^{-3} cubic feet per second per square foot (cfs/ft^2). This recommended infiltration rate also includes a safety factor of 1.1.

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

Sincerely,
Inland Pacific Engineering Company

Paul T. Nelson, P.E.
Principal Engineer

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

August 22, 2017
Project No. 16-249

NAI Black
c/o Mr. Bryan Walker
107 South Howard
Suite 500
Spokane, WA 99201

Re: **Mounding Analysis**
Painted Hills Golf Course Property
4403 South Dishman-Mica Road
Spokane Valley, WA

Dear Mr. Walker:

As requested by Mr. Todd Whipple of Whipple Consulting Engineers, Inc. (WCE), we have prepared this report for the above-referenced site in Spokane Valley, Washington. The purpose of our services was to perform a mounding analysis for the proposed infiltration galleries at the north side of the site. This report summarizes the results of our additional engineering analyses and opinions.

AVAILABLE INFORMATION

We were provided a topographic survey for the project site by Whipple Consulting Engineers, Inc. (WCE). This topographic survey showed the existing roadways, existing structures, property lines, and existing ground surface elevation contours. This plan was prepared by WCE and was dated November 7, 2013. The site was used as a golf course prior to our evaluation. The site is relatively level with some elevated golf greens and excavated areas for water hazards. The site is primarily grass-covered with scattered trees along the fairways and pine trees in the undeveloped area to the northwest. The clubhouse building is present at the southwest corner.

We were also provided civil plans for the roadway improvements. The plans showed the layout and elevations of the proposed roadways and elevation contours. The plans were prepared by WCE and dated August 17, 2016.

P.O. Box 1566, Veradale, WA 99037
Phone 509-209-6262

In addition, we performed a preliminary geotechnical evaluation for the property in December 2013. The results of that evaluation, along with our opinions and recommendations, are summarized in our Preliminary Geotechnical Evaluation dated December 31, 2013.

We also performed a geotechnical evaluation for certification of the existing levee along Chester Creek in April 2014. The results of that evaluation are summarized in our Geotechnical Evaluation report dated February 12, 2015.

Furthermore, we performed a supplemental geotechnical evaluation in July 2015 consisting of ten, 50-foot borings in the south half of the property. The results of that evaluation are summarized in our Geotechnical Evaluation Phase 2 report dated July 23, 2015.

We also performed a second supplemental geotechnical evaluation at the north end of the property to evaluate soil conditions at depth and to better define the static groundwater elevation in this area. We then performed a full-scale drywell test on a drywell installed near Boring B-1 from our second supplemental geotechnical evaluation. The results of these evaluations are summarized in our Supplemental Geotechnical Evaluation dated April 19, 2016 and our Full-Scale Drywell Testing report dated June 28, 2016.

ANALYSIS AND OPINIONS

We performed a mounding analysis for the proposed infiltration galleries to assess potential down-gradient impacts due to infiltration of the 100-year flood event. We performed the analyses based on work by Bianchi and Muckel (1970) and using methods developed by Todd (1080). Using these methods, we estimated the geometry of groundwater mounding by using the hydraulic conductivity (permeability) calculated based on our full-scale drywell test using the United States Bureau of Reclamation USBR 7300-89 procedure and transmissivity of the soils to estimate the mounding as a function of distance from the center of an equivalent square pond basin.

We used a specific yield of 0.27 for the soils and an unsaturated aquifer thickness of 70 feet based on our previous borings. The annual stormwater volume and pond area were provided by WCE. The following table summarizes the input values.

Location	Water Volume (ft^3)	Total Gallery Area (ft^2)	Hydraulic Conductivity (cm/s)
Infiltration Gallery	72,384	33,928	7.1×10^{-3}

For the flood event stormwater volume, we calculated a groundwater mound height ranging from 9.01 feet at the pond center dissipating to less than 6 inches approximately 275 feet from the center of the pond. Based on the results of the mounding analysis and the depth to groundwater, it is our opinion that infiltration of stormwater in the proposed pond will not have significant down-gradient adverse impacts and will likely migrate north towards the Spokane River. Results of our mounding analysis are attached.

REMARKS

This report is for the exclusive use of the addressee and the copied parties to use in design of the proposed project and to prepare construction documents. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

Services performed by the geotechnical engineers for this project have been conducted in a manner consistent with that level of care ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is intended or made.

GENERAL REMARKS

It has been a pleasure being of service to you for this project. If you have any questions or need additional information, please do not hesitate to call me at (509) 209-6262 at your convenience.

Sincerely,
Inland Pacific Engineering Company

Paul T. Nelson, P.E.
Principal Engineer

PAUL T NELSON
STATE OF WASHINGTON
37228
REGISTERED
PROFESSIONAL ENGINEER
8-22-17

Attachments: 100-Year Flood Groundwater Mounding Analysis Results

IPEC
Inland Pacific Engineering Company
Geotechnical Engineering and Consulting

Project Number: 16-249

Client: NAI Black

Test Location: Infiltration Gallery

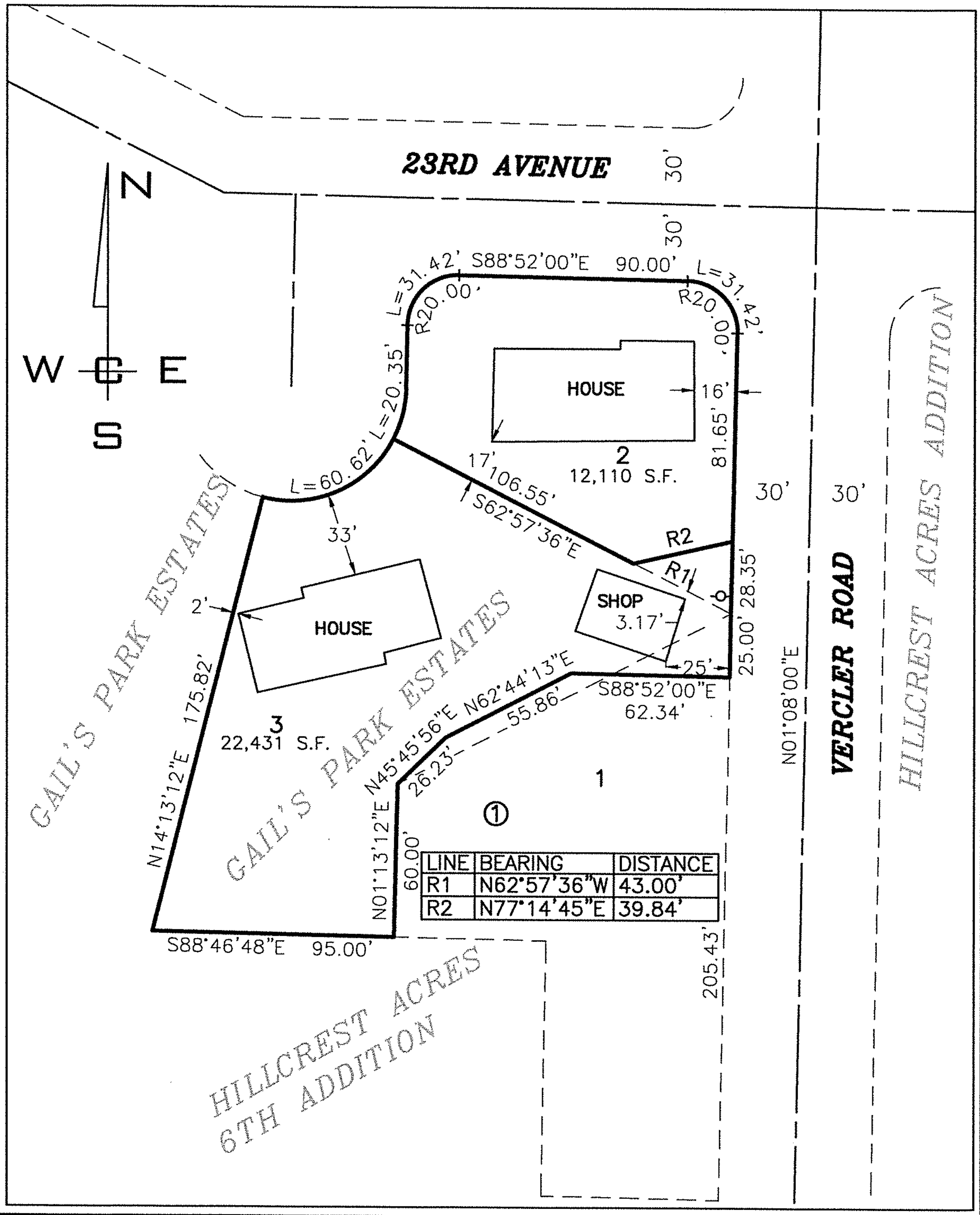
100-YEAR FLOOD GROUNDWATER MOUND HEIGHT CALCULATIONS - INFILTRATION GALLERY

Project: Painted Hills

k = 0.0071 cm/s

Parameter	Symbol	Units	Distance										
Area of Infiltration	A_i	ft^2	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04	3.4E+04
Length of Equivalent Square for Basin	L	ft	184	184	184	184	184	184	184	184	184	184	184
Inflow Rate (total)	W_t	ft^3/day	72384	72384	72384	72384	72384	72384	72384	72384	72384	72384	72384
Inflow Rate (per unit surface area)	W	ft/day	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Time Since Start of Inflow	t	days	3	3	3	3	3	3	3	3	3	3	3
Distance From Center of Recharge	x	ft	0	92	184	276							
Hydraulic Conductivity	k	cm/s	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03	7.1E-03
Aquifer Thickness	b	ft	70	70	70	70	70	70	70	70	70	70	70
Transmissivity	T	ft^2/day	1409	1409	1409	1409	1409	1409	1409	1409	1409	1409	1409
Specific Yield	S_y	dimensionless	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Distance Ratio	x/L	dimensionless	0.00	0.50	1.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$L/(4Tt/S)^{0.5}$	ω	dimensionless	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74
hS/Wt	ψ	dimensionless	0.38	0.25	0.14	0.02	0.00						
Mound Height	**H**	**ft**	**9.01**	**5.93**	**3.32**	**0.47**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Inland Pacific Engineering Company
P.O Box 1566
Veradale, WA 99037



LINE	BEARING	DISTANCE
R1	N62°57'36"W	43.00'
R2	N77°14'45"E	39.84'

PROJ #: 18-2117
DATE: 08/09/18
DRAWN: JAG
APPROVED: JAG
SCALE: 1"=100'

PROPOSED CONDITIONS VERCLER RD. & 23RD AVE.

SPO-VAL, WASHINGTON

WCE
WHIPPLE CONSULTING ENGINEERS
CIVIL AND TRANSPORTATION ENGINEERING
21 SOUTH PINES ROAD
SPOKANE VALLEY, WASHINGTON 99206
PH: 509-893-2617 FAX: 509-926-0227